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PLASTICS AND ITS EFFECTS ON ENVIRONMENT

1. Introduction:

Plastic is a toxic material that is severely affecting marine creatures and the marine ecosystems and ultimately humans. We only see the stuff that floats. But it can sink and or float depending on the environmental conditions of the ocean. Because the specific gravity of much of it is roughly that of the ocean water, it can rise in rough seas and sink during the calms. Sunlight, which has very limited penetration in the water, breaks it down into continuously smaller particles until it reaches molecular size. Some of the plastic debris has taken a fifty-year voyage in violent seas since it was first produced. And it doesn't appear to be breaking down into something that is even close to the natural materials of the earth they once came from. There are estimates of how long this will take, but it clearly takes more than fifty years. According to a study published in 1992 by the US Environmental Protection Agency (EPA), plastic pellets were one of the most abundant types of debris found in US harbors of the Atlantic, Pacific, and Gulf of Mexico. These hurdles are the feed stock of the plastics industry and come in a variety of shapes — spherical, ovoid, and cylindrical — with sizes ranging from one to five millimeters diameter. In 1992, nearly sixty billion pounds of these plastic pellets were made annually in the United States and are shipped via train, truck, and ship. The most commonly produced resins include polyethylene, polypropylene, and polystyrene. Considering the magnitude of the problem, the most logical sources would be somewhere along the supply chain of the plastics industry.

The disposable plastic bottle symbolizes waste and litter around the world. But it is not just plastic bottles and careless littering that threaten to turn the oceans from life sustaining to life threatening. Bottles and straws bags, discarded toys, product packaging and cheap holiday decorations. Household and industrial waste of a thousand kinds. Littered, dropped, and dumped. Used despite safer alternatives, carelessly disposed, improperly managed. Not reduced, not reused and not recycled. Plastic in the oceans is entirely caused by human action and human inaction. It has as much potential to do harm as the worst climate change scenario and is having greater immediate effects.

There are a number of ways that marine science, waste management, recycling and materials experts, biochemists and medical professionals might be brought together to work on the interrelated problems from a number of critical angles. But currently, there are no major collaborative efforts among these disciplines. If plastic in the ocean can be safely collected, existing and new technologies can be used to reprocess and reuse it. Research can determine the requirements, risks and potential for commercially viable operations that could turn this environmental disaster into an economic opportunity for the right companies. Less than 20 percent of leakage originates from ocean-based sources like fisheries and fishing vessels. This means over 80 percent of ocean plastic comes from land-based sources; once plastic is discarded, it is not well managed, and thus leaks into the ocean. Over half of land-based plastic-waste leakage originates in just five countries: China, Indonesia, the Philippines, Thailand, and Vietnam. These countries have all succeeded at achieving significant growth in recent years, and they are at a stage of economic growth in which consumer demand for safe and disposable products is growing much more rapidly than local waste-management infrastructure. This creates a dual problem: the scale of collection and the retention of waste within the system itself. Our field research and interviews with public officials have also shown that these countries acknowledge the problem and are actively looking for collaborative solutions. Of the leakage that comes from land-based sources, we found that 75 percent comes from uncollected waste, while the remaining 25 percent leaks from within the waste-management system itself. Post collection leakage can be caused by improper dumping, as well as formal and informal dump sites that are poorly located or lack proper controls.

Mega- and macro-plastics have accumulated in the highest densities in the Northern Hemisphere, adjacent to urban centre's, in enclosed seas and at water convergences (fronts). Report reveals that, lower densities on remote island shores, on the continental shelf seabed and the lowest densities (but still a documented presence) in the deep sea and Southern Ocean. The longevity of plastic is estimated to be hundreds to thousands of years, but is likely to be far longer in deep sea and non-surface polar environments. Plastic debris poses considerable threat by choking and starving wildlife, distributing non-native and potentially harmful organisms, absorbing toxic chemicals and degrading to micro-plastics that may subsequently be ingested. Well-established annual surveys on coasts and at sea have shown that trends in mega- and macro-plastic accumulation rates are no longer uniformly increasing: rather stable, increasing and decreasing trends have all been reported. The average size of plastic particles in the environment seems to be decreasing, and the abundance and global distribution of micro-plastic fragments have increased over the last few decades. However, the environmental consequences of such microscopic debris are still poorly understood.

2. What are Plastics?

Plastics are derived from materials found in nature, such as natural gas, oil, coal, minerals and plants. The very first plastics were made by nature, rubber from a rubber tree is actually a plastic. Interest in making plastics arose in the 1800s to replace scarce materials such as ivory and tortoise shell. The first synthetic plastics were derived from cellulose, a substance found in plants and trees. Cellulose was heated with chemicals and resulted in a new material that was extremely durable. The raw materials for today's plastics come from many places (some even use salt!), but most plastics can be made from the hydrocarbons that are readily available in natural gas, oil and coal.

3. Types of Plastics

There are two types of plastics: thermoplastics and thermosetti ng polymers. Thermoplastics are the plastics that do not undergo chemical change in their composition when heated and can be molded again and again. Examples include polyethylene, polypropylene, po lystyrene and polyvinyl chloride. Common thermoplastics range from 20,000 to 500,000 amount, while thermosets are assumed to have infinite molecular weight. These chains are made up of many repeating molecular units, known as repeat units, derived from monomerseach polymer chain will have several thousand repeating units. Thermosets can melt and take shape once; after they have solidified, they stay solid. In the thermosetting process, a chemical reaction occurs that is irreversible. The vulcanization of rubber is a thermosetting process. Before heating with sulfur, the polyisoprene is a tacky, slightly runny material, but after vulcanization the product is rigid and non-tacky.

4. Chemistry of Plastics

The chemistry of plastics can be complex, but the basics are straightforward. Think back to your high school science lessons about atoms and molecules (groups of atoms). Plastics are simply chains of like molecules linked together. These chains are called polymers. This is why many plastics begin with "poly," such as polyethylene, polystyrene, and polypropylene. Polymers often are made of carbon and hydrogen and sometimes oxygen, nitrogen, sulfur, chlorine, fluorine, phosphorous, or silicon.

The term "plastics" encompasses all these various polymers. Although there are many polymers, plastics in general are lightweight with significant degrees of strength. Plastics can be molded, extruded, cast and blown into seemingly limitless shapes and films or foams or even drawn into fibers for textiles. Many types of coatings, sealants and glues are actually plastics, too.

4.1 Classification of Plastics based on Chemistry

Plastics are usually classified by their chemical structure of the polymer's backbone and side chains. Some important groups in these classifications are the acrylics, polyesters, silicones, polyur ethanes, and halogenated plastics. Plastics can also be classified by the chemical process used in their synthesis, such as condensation, polyaddition, and cross-linking.

4.2 Classifications based on Physical property

Other classifications are based on qualities that are relevant for manufacturing or product design. Examples of such classes are the thermoplastic and thermoset, elastomer, structural, biodeg radable, and electrically conductive. Plastics can also be classified by various physical properties, such as density, tensile strength, glass transition temperature, and resistance to various chemical products.

4.2.1 Biodegradable plastic

Biodegradable plastics break down (degrade) upon exposure to sunlight (e.g., ultra-violet radiation), water or dampness, bacteria, enzymes, wind abrasion, and in some instances, rodent, pest, or insect attack are also included as forms of biodegradation or environmental degradation. Some modes of degradation require that the plastic be exposed at the surface, whereas other modes will only be effective if certain conditions exist in landfill or composting systems. Starch powder has been mixed with plastic as a filler to allow it to degrade more easily, but it still does not lead to complete breakdown of the plastic. Some researchers have actually genetically engineered bacteria that synthesize a completely biodegradable plastic, but this material, such as Biopol, is expensive at present.[21] Companies have made biodegradable additives to enhance the biodegradation of plastics.

4.2.2. Natural vs synthetic

Most plastics are produced from petrochemicals. Motivated by the finiteness of petrochemical reserves and threat of global warming, bioplastics are being developed. Bioplastics are made substantially from renewable plant materials such as cellulose and starch. In comparison to the global consumption of all flexible packaging, estimated at 12.3 million tonnes/year, estimates put global production capacity at 327,000 tonnes/year for related bio-derived materials.

4.2.3. Crystalline vs amorphous

Some plastics are partially crystalline and partially amorphous in molecular struct ure, giving them both a melting point (the temperature at which the attractive intermolecular forces are overcome) and one or more glass transitions (temperatures above which the extent of localized molecular flexibility is substantially increased). The so-called semi-crystalline plastics include polyethylene, polypropylene, poly (vinyl chloride), polyamides (nylons), polyesters and some polyurethanes. Many plastics are completely amorphous, such as polystyrene and its copolymers, poly (methyl methacrylate), and all thermosets. Thermoplastics which are softened by heat and can be moulded. (Injection moulded, blow moulded or vacuum formed). Good examples are acrylic, polypropylene, polystyrene, polythene and PVC.

Thermosets which are formed by ha heat process but are then set (like concrete) and cannot change shape by reheating. Good examples are melamine (kitchen worktops), Bakelite (black saucepan handles), polyester and epoxy resins. Composites are made by mixing materials together to get enhanced properties. Polyester resin is mixed with glass fibre to make GRP used for boatbuilding and fishing rods. Epoxy resin plus carbon fibre is stronger than steel but lighter. Plastic is defined as any synthetic or semi-synthetic organic material that can be shaped or molded into any form. Chemical composition of plastics includes chains of carbon, oxygen, sulfur or nitrogen.

4.3 Uses of plastic

4.3.1. Enhancement of the quality of life:

Internet, electronic devices and even surgical instruments play a very important role in making life easier for the people. They use plastic as the medium to make the product durable and light weight. Continuous innovation has led to the refinement of products made from plastic to ensure sustainable development.

4.3.2. Preservation of precious resources:

Pipelines are being constructed with the help of the plastic material to ensure that flow of water to different parts of the world. Moreover, they are also used in the construction of houses for plumbing. Unlike iron, plastic pipes don't rust when coming in contact with water; therefore they are used in multiple application right from residences to industries. Usage of plastic is instrumental in reducing the problem of deforestation because in past woods were cut for usage in daily life however their usage has become limited over a period of time.

4.3.3 Efficient use of resources:

According to experts, Plastic usage has gone on a long way in reduce the dependence on oil. Plasticrecycling has become a thriving industry in modern times with the waste being directed to the landfill. Plastic is also used to capture the solar energy in order to generate electricity and save on the energy bills. Majority of people are suffering from the rise in the price of fossil fuels, hence optimizing their usage will help to reduce the manufacturing cost and inflation.

4.4. Effects of plastics in the Environment

Although there are little to no empirical data on the quantity of anthropogenic debris (hereafter debris) entering the marine environment, estimates place it at approximately 6.4 million tons annually (UNEP 2005), such as the 2011 Japanese tsunami which created an estimated 1.5 million tons of floating debris (NOAA 2012). Because there is presently no way to map the movement of debris in real time, best estimates of where debris accumulates come from oceanographic models. predicts that floating debris accumulates in 5 main oceanic gyres and occurs predominantly in subtropical regions. Debris gathers in drift lines and convergence zones, which are also important feeding areas for many oceanic species, including sea birds, pelagic fish, and sea turtles.

Plastic is the primary type of debris found in marine and coastal environments and plastics are the most common form of debris ingested by wildlife With the exponential increase in global plastic production over the past 60 years it is likely that effects on marine wildlife from ingestion of plastic have also increased. Ingestion of marine debris affects over 170 species. Debris ingestion can result in death by perforation or impaction of the gastrointestinal system and toxic compounds in plastics may have sublethal effects on development and population dynamics. The role plastic products play in the daily lives of people all over the world is interminable. We could throw statistics at you all day long (e.g. Upwards of 300 million tons of plastic are consumed each year), but the impact of these numbers border on inconceivable.

For those living on the coasts, a mere walk on the beach can give anyone insight into how staggering our addiction to plastic has become as bottles, cans, bags, lids and straws (just to name a few) are ever-present. In other areas that insight is more poignant as the remains of animal carcasses can frequently be observed; the plastic debris that many of them ingested or became entangled in still visible long after their death. Sadly, an overwhelming amount of plastic pollution isn't even visible to the human eye, with much of the pollution occurring out at sea or on a microscopic level. The short-lived use of millions of tons of plastic is, quite simply, unsustainable and dangerous. We have only begun to see the far-reaching consequences of plastic pollution and how it affects all living things. According to a study from Plymouth University, plastic pollution affects at least 700 marine species, while some estimates suggest that at least 100 million marine mammals are killed each year from plastic pollution.

4.5. Effects of Plastic Pollution

It seems rather obvious that this amount of a material that isn't meant to break down can wreak havoc on natural environments, leading to long-term issues for plants, animals, and people. Some of the major long-term effects of plastic pollution are:

4.5.1. It Upsets the Food Chain

Because it comes in sizes large and small, polluting plastics even affect the world's tiniest organisms such as plankton. When these organisms become poisoned due to plastic ingestion, this causes problems for the larger animals that depend on them for food. This can cause a whole slew of problems, each step further along the food chain. Plus, it means that plastic are present in the fish that many people eat every day.

4.5.2. Groundwater Pollution

Water conservation is already a concern in places ranging from California to parts of India, but the world's water is in great danger because of leaking plastics and waste. If you've ever seen a garbage dump, imagine what happens every time it rains – then imagine that being in your drinking water. Groundwater and reservoirs are susceptible to leaking environmental toxins. Most of the litter and pollution affecting the world's oceans also derives from plastics. This has had terrible consequences on many marine species, which can lead to consequences for those that eat fish and marine life for nutrients – including people.

4.5.3. Land Pollution

When plastic is dumped in landfills, it interacts with water and form hazardous chemicals. When these chemicals seep underground, they degrade the water quality. Wind carries and deposits plastic from one place to another, increasing the land litter. It can also get stuck on poles, traffic lights, trees, fences, tower etc. and animals that may come in the vicinity and might suffocate them to death.

4.5.4. Air Pollution

Burning of plastic in the open air, leads to environmental pollution due to the release of poisonous chemicals. The polluted air when inhaled by humans and animals affect their health and can cause respiratory problems. Some of the marine species most deeply impacted by plastic pollution in Ocean.

4.5.5. Marine Pollution

Picture showing the plastic straw blocked the nose of the sea turtles when removing it by vertenarians the turtle died (Picture courtesy: S.A. Williamson)

Like many other marine animals, **sea turtles** mistake plastic waste for a viable food source, sometimes causing blockages in their digestive system. Though the declining sea turtle populations in the oceans are due to a variety of factors (most all of which involve human exploitation), plastic pollution plays a significant role. Separate studies from 2013 suggest as many as 50 percent of sea turtles are ingesting plastic at an unprecedented rate, and dying because of it. Another study of the Loggerhead species found that 15 percent of young turtles examined had ingested such enormous quantities of plastic that their digestive system was obstructed.

Marine life can become entangled in a variety of ocean debris including fishing nets, lines, and lures. Still, there are a number of **seals and sea lions** that become entangled in plastic bags or plastic packing bands leading to injury and death. In fact, plastic packing bands and rubber bands continue to deeply impact the Steller Sea Lion population. An eight-year study in Southeast Alaska and British Columbia documented 388 sea lions entangled in plastic debris. These plastic packing bands and rubber bands can become so embedded in the animal that it can lead to severe infection and death.

Plastic pollution leads to the deaths of millions of **marine bird** species each year. Arguably more so than other birds, the Laysan albatross has been deeply impacted by plastic debris through their hunting techniques. When the albatross dives into the ocean to catch fish, squid or other food they use their beak to skim the surface, picking up plastic along the way. Shockingly, an estimated 98 percent of albatross studied are found having ingested some kind of plastic debris.

Once the plastic has been ingested, it causes an obstruction in the digestive tract and can puncture internal organs.

Fish, along with pretty much any marine mammal that brings in water through its gills, are increasingly at risk to microscopic plastic debris. A study performed at the University of Exeter UK suggested that microscopic marine debris could take up to six times as long for the animal to rid themselves of in comparison to ingesting the debris orally. Of course plastic pollution deeply impacts species of fish, but unlike other animals on our list, this is the one animal that's also commonly eaten by humans. A number of studies suggest that the fish humans continue to consume have at one time or another ingested plastic microfibers, including brown trout, cisco, and perch.

Like other marine mammals, **whales** often mistakes marine debris for a potential food source. In some species, similar to that of the albatross, the whales' mouth is so large it unknowingly picks up plastic debris (a technique observed in baleen whales). Necropsies performed after numerous whale strandings saw an increase in the amount of plastic debris found.

A study also found that hundreds of species of **cetaceans** have been negatively impacted by plastic pollution in the past two decades. The obstructions often puncturing and tearing the stomach lining, leading to starvation and death.According to Marine Pollution Bulletin, cetaceans are ingesting plastic debris at a rate as high as 31 percent, and in turn, 22 percent of those cetaceans were at an increased risk of death. It's clear that plastic pollution impacts virtually every living organism in, or thriving off of, the oceans of our world. This is simply not acceptable. The balance of our ecosystem is essential to our quality of life and will ultimately depend on when the world decides to stop turning a blind eye to the issue and make the necessary lifestyle changes. We all must remain diligent as we work to minimize our own individual consumption of plastic products. So, whether you're just beginning the journey to minimizing plastic in your life or not, there are a few key steps that never hurt to repeat.

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Use of Sea Surface Temperature for Cyclone Intensity Prediction Needs a Relook

If a cyclone's track and intensity can be predicted precisely, the losses due to cyclones can be minimized. While efforts are under way to improve the understanding of the physics of the problem of track and intensity prediction, it is worthwhile to look again at the efficiency of the input parameters presently used in models and to look for new approaches.

Sea surface temperature (**SST**) is one such parameter that needs to be reconsidered for cyclone studies. SST is the only oceanographic input used in most of the statistical and dynamical prediction models, though it is well known that cyclones interact with the upper layers of the ocean, not just with the surface. Although the upper ocean drives SST depending on mixed layer depth and upper ocean salinity, in many cases SST does not represent the upper ocean heat content (UOHC) or the energy available to the cyclones. Recently, Ali et al. [2013] studied the statistical relationship between **Cyclone Intensity** (**CI**) and SST in the tropical Indian Ocean (TIO; 30°S–30°N, 30°E–120°E) and concluded that satellite derived SST (a skin temperature) is not a good indicator of CI. They suggested a more accurate parameterization of SST throughout the lifetime of a cyclone, for example, a parameter that also depends on**Upper Oceanic Heat Content**(**UOHC**).

Thus, the use of satellite derived SST alone as a measure of CI needs to be reconsidered in the north Indian Ocean, as these two fields are often negatively correlated. Because the ocean affects the cyclones through SST, a more accurate parameterization of SST throughout the lifetime of a cyclone is suggested. Replacing SST with **Ocean Mean Temperature** (OMT), representing the heat energy available for cyclones in the upper layers, is one such option. This parameter can be computed from OHC or TCHP, which in turn can be computed from satellite derived SSHA. Because OMT has the same units as SST, it can be easily assimilated into models and thus could be a good way to help improve cyclone intensity predictions.

Keywords: Cyclone Intensity (CI), Sea Surface Temperature (SST)

Reference:Ali, M. M., D. Swain, T. Kashyap, J. P. McCreary, and P. V. Nagamani (2013), Relationship between cyclone intensities and sea surface temperature in the tropical Indian Ocean, IEEE Geosci. Remote Sens.

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Mapping of shoreline changes in-between Devipattinam and Kilakkarai, Tamilnadu, Southeast Coast of India.

1. Introduction

Shoreline is the boundary between land and sea which is dynamic in nature. Beaches/ sea shores are ephemeral environment between land and sea with unique and fragile ecosystems which change position continuously due to dynamic conditions. Shoreline change may occur due to both natural and the man-made processes. While the effects of waves, currents, tides and winds are primary natural factors that influence the coast, the other aspects eroding the coastline include the sand sources and sinks, changes in relative sea level, geomorphological characteristics of the shore etc. Anthropogenic effects that trigger beach erosion are construction of artificial structures, mining of beach sand, offshore dredging or building of dams or rivers. Shoreline changes occur over a wide range of time scales from geological to short lived extreme events (Addo 2008). Shoreline assessment is a major concern in environmental monitoring and integrated coastal zone management (ICZM). Shoreline changes draw more attention since they are most important environmental indicators that directly affect the economic development and land management. In developing countries, coastal erosion is a major crisis and it potentially impacts the coastal population and natural environment. The landward displacement of the shoreline caused by the forces of waves and currents is termed as coastal erosion. It is the loss of sub aerial landmass into the sea due to natural processes such as waves, winds and tides, or even due to human interference. Monitoring changes in littoral profiles to develop signatures of erosion is one approach used to quantify coastal erosion (Kana 2003). Numerous researchers viz., Selvavinayagam (2008); Chand and Acharya (2010); Kumaravel et al. (2013); Usha and Subramaniam (1994); Usha et al. (2013); Anitha and Usha (2014a,b) have monitored the shoreline changes along Tamil Nadu coast based on remote sensing and geospatial techniques. The main objective of this paper is to assess the long term shoreline changes along Tamilnadu coast, in a view to identify and quantify the erosion and accretion areas. Remote sensing and GIS can be used as an effective tool to identify the areas that are vulnerable to coastal erosion along the coast.

2. Shoreline Changes

Geocoded IRS LISS II data of 1995, IRS LISS III 1979, LANDSAT ETM 2006 and SOI topographic sheets of 1969 were used to prepare shoreline maps on 1:50,000 scale. Multi-date shoreline maps of 1969 and1979 1995, and 2006 were digitized and projected using polygonal using ARC- GIS and were overlaid using tic coordinates of the study area. Overlaid maps were edited and labelled. Finally a temporal shoreline change map was generated using intercept option of ARC-VIEW and identified erosion and accretion areas along the coasts of island and offshore islands in Gulf of Mannar with sufficient ground truth verification. The changes were estimated for a period of 27 years between 1979 and 2006.

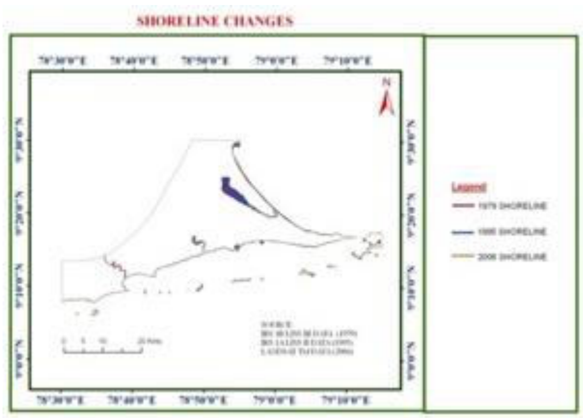

Fig.1 Shoreline Changes

3. Bathymetry Mapping

Any changes in sea floor may be the result of sea-level variation or to a change in the elevation of land surface. Changes in absolute water-surface levels are worldwide due to the interconnectivity of the oceans and are termed eustatic changes. Changes in the absolute level of the land are localized. They may be due to tectonic adjustments or due to adjustments caused by their distribution of weight on the land surface. As and when sedimentation or ice build-up occurs, such changes are known as isostatic. A rise in the sea level or down warping of land would involve the opposite movements of sea and land. Synonymous with positive and negative changes are the forms of sea-level transgression and regression, although in many cases these terms also refer to the horizontal movement of the shoreline associated with vertical changes of sea level. Recent depth contour map of 1999 has been compared with bathymetry map of 1975 (Figure 8a&b); it reflects that the seafloor level decreased along the coastal and around the islands in the study area. It may be due to emerging of land or lowering of sea level (due to tectonism) and sediment deposit. In very few places particularly at river mouths and in island areas, the sea floor level has increased, which may be due to erosion caused by anthropogenic activities.

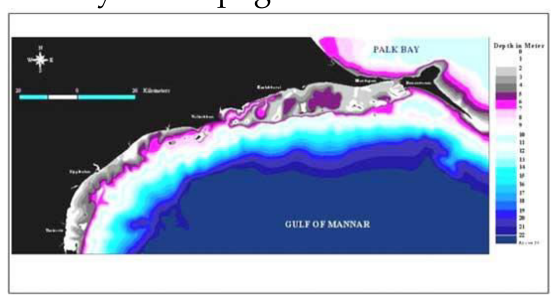

Fig.2 Bathymetry maps of Gulf of Mannar (1975) Thanikachalam et.al. (2002)

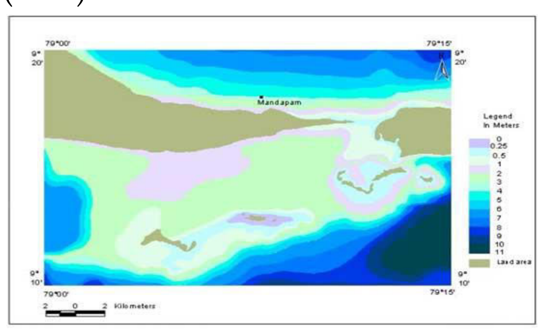

Fig.3 Bathymetry map of Mandapam coastal region (1999) Thanikachalam et.al. (2002)

The average depth reduction of seafloor along the coast of the study area has been estimated as 0.51m over a period of 24 years. The average decrease and increase of depth around the islands in the study area have been calculated as 0.56m and 0.38m respectively. Assuming that the rate of change of depth of sea floor is uniform over a year, the rate of decrease of depth is estimated as 0.021m/year along the coast and 0.023 m/year around the island, and also the rate of increase of depth as 0.015 m/year around the island. The annual sediment deposit on Gulf of Mannar sea floor is 0.001m/year (Basanta Kumar Jena 1997), so it will become 0.024m for a period of 24 years. As found from the present study, the decrease of depth for the period of 24 years (1975 to 1999) is 0.51m. Out of this 0.51 m of decrease of depth, sedimentation will account for about 0.024m. The remaining 0.486 m reduction in depth may be due to emerging of land or lowering of sea level (by tectonic activities). From this, the rate of emerging of land or lowering of sea level can be estimated as 0.02m/year.

4. Continental shelf morphology

In Gulf of Mannar, the slope and width of the continental shelf is approximately the same as the average for the eastern coast of India (Ahmad 1972). The total width of the shelf is around 30 km having a slope of about 21′. The slope near the shore is about 4′. Shelf morphology (Figure 2 and 3) of the study area has been described in detail by dividing the study area into four segments viz (1) Tuticorin to Vaippar River, (2) Vaippar River to Gundar River, (3) Gundar River to Palar River and (4) Palar River to Dhanushkodi shelf regions.

Figure.4 Three dimensional model for Gulf of Mannar sea floor.Thanikachalam et.al.(2002)

In the shore between Tuticorin to Vaippar River, the sea floor is sloping gently down to 5m depth while in Sippikkulam coast where the sea floor is very steep down to 2m depth and it extending up to 0.129 km from the coast. In between 4 and 5m depths, some elevated rises and islands are noticed. At a distance of 4.30 km (78° 12'16"E-8 49'N) from Tuticorin coast, a 3.9 m elevated rise was observed. Just northeast of this riise a 6m elevated island (78° 12'28" E-8 49'35"N) called Van Island, which is situated 5 km away from Tuticorin coast. Around this island the sea floor is sloping very gently down to 2m depth in southeast, east, northeast and north directions. Whereas west, southwest, and north-western parts of the island, the sea floor slope is very steep. On the north-eastern, eastern and southern sides of the island, the sea floor is covered by fringing coral reef, extending down to 2 m depth with an average distance of 1.50 km from the coast of the island. Between the depths of 3m and 4m, there is another island called Koswari Island, which is located at 78°13'22" E-8°52'2" N, with a distance of 6.09 km from Taruvaikkulam coast. In between 5 and 10m depths, the sea floor slopes moderately. From the depth of 10m to 20 m, the sea floor slopes gently, having a distance of 16.65km between them. At a depth of 20m, the seafloor falls suddenly with a very steep slope (continental slope) extending till 30m depth. The width of this slope has been calculated as 7.27 km. The total width of continental shelf in Tuticorin region has been calculated as 26.75 km. In the coast from Veppaloadi to Sippikkulam, between 4m and 6m depths, elevated islands namely KariyaShuli and VilanguShuli Islands are situated at a distance of 4.77 km and 6.56 km from Sippikulam coast respectively. The sea floor is found to be sloping gently towards north, east and south from the shore of VilanguShuli Island, whereas west of the the sea floor tends to slope very steeply. An extensive well-developed fringing reef has been identified around VilanguShuli and KariaShuli Islands extending to 3 meters depth.

In the shore between Vaippar and Muttiapuram, the sea floor is at a depth of 3 m., which extends to an average distance of 3.51 km from the shore. In the area near the mouth of Vembar the sea floor topography is plain with a depth of 2 m. Between 2 m and 20 m the sea floor slopes very gently and extends to a distance of 19.75 km. A sudden steep slope is encountered at 20m depth, this area is the starting point of the continental slope and it extends to the depth of 30m. The width of the slope has been calculated as 5.45 km and the width of the continental shelf has been calculated as 19.75 km. In the area from TerkkuNarippeyur to Gundar River, the shelf is found at a depth of 3m, extending to 0.36 km south and southeast of Narippeyur coast and 0.88 km south of Gundar River mouth. Between the depths of 7 and 8 km, the sea floor is very broad and the slope is very gentle. An elevated island is found exposed above sea level viz., UppuTanni Island situated at 6.72 km from Gundar River mouth. The sea floor is plain up to 1m depth in all directions around the island except in the north and northeastern directions where the slope is very steep. The shore between Gundar and Palar River, the sea floor is found at a depth of 3m, and this deep extends to 1.19 km from the coast. At the south of Mel Mendal coast the sea floor slopes very steeply to 7 m depth and extends to 1.44 km from the coast. Between the depths of 10 and 20 m the sea floor slopes moderately with a width of 7.52 km. At an average depth of 20 to 30 m, there is a continental slope with 16.56km width. In between 7 and 8 m depths, the sea floor is broad and has a very gentle slope. In this region particularly at latitude of 9°6'5"N and longitude of 78°32'10"E, an island, namely Shalli Island, having 9 m elevation from sea floor is encountered. On the northern and southern sides of this island, the sea floor slopes very steep, while on the eastern and western sides, the slope is gentle. Towards east from Shalli Island another island namely NallaTanni Island is encountered (78°34'29"E - 9°6'11"N). Around this island the sea floor slopes very gently, particularly in the northeast, east and south-eastern sides of the island, which extends to a depth of 4 m from the shore of the island. Whereas northern and southwestern sides of this island, the seafloor have a very steep slope, extending to a depth of 4 m at a distance of 0.36 m from the coast of the island. The region between Palar River mouth and Dhanushkodi shelf, the topography has some irregularities. In the area opposite to Palar River mouth, there is a gentle depressed channel, having an approximate length of 4.41 km towards south. The coast between Palar River mouth and Kalachimundal, the sea floor is found at a depth of 1 m and it extends to a distance of 0.28 km from the shore. Between these areas the sea floor gradient is very steep to a depth of 7m. The width of this area is 1.60 km. After reaching 7 m depth the sea floor rises upto 3 m depth, this depressed channel runs to a distance of 21.27 km towards northeast and south, and lies between 78°40'4'E-9°9'15"N and 78°47'37"E-9°13'8"N. The average width of this channel has been measured as 0.75 km. After reaching 3 m depth the sea floor has a sudden fall to 10 m depth. In between the two depressions, a flat-topped continental rise has been observed. The average width of the continental rise is 1.58 km and is located 5.7 km from the shore. On this rise, there are two elevated islands rising 4m from the sea floor and are located between 78°41'28"E-9°9'3"N and 78°43'32"E-9°9'4"N. These islands are called as Anaipar and Pilliyarmunai Islands. Around these islands the sea floor slopes very gently and extensively developed fringing corals are found within 2 m depth. Between 4 and 5m depth, at a lat-long of 78°45'8'E - 9°9'12"N, an island namely, Puvarasanpatti Island, having an elevation of 4.50 m from the sea floor is encountered. At a depth between 10 m and 20 the sea floor slopes gently. The width of this continental shelf is 18.17 m. In the area between Keelakkarai and Pudumadam, the seafloor is almost plain and has a depth of 3 to 4 m. This plain extends to a distance of 9.72 km from coast. In this plain some low elevated rise and Islands are observed. Located at a lat-long of 78°49'10"E-9°9'31"N an island namely Appa Island, having an elevation of 5 m from sea floor has been noticed. Around this island the sea floor slopes gently to 2 m depth. It extends to an average distance of 1.50 km. At 78°51'25"E - 9°14'2"N and 78°52'31"E - 9°14'32", two continental rise have been observed having an elevation of 1m from the sea floor. In between 4 and 5m depths, there are some low elevated islands (5.50 m from sea floor) namely Talairi, Valai and Muli Islands. They are located at an average distance of 8.45 km from Kaplar River mouth. In this region the sea floor gradient is very steep extending from 5 m depth to 10m depth and then it slopes gently upto 30 m depth. In the coast between Pudumadam and Thoniturai, the sea floor is almost plain having a depth of 2 to 3 m. This plain extends 6.95 km from the coast. Near SenniappaDargah and Thoniturai this plain is encountered at 2m depth and it extends to an average distance of 2.17 km from the coast of SenniappaDargah and 0.50 km from Thoniturai coast. Along this plain some low elevated continental rise (79°5'19"E - 9°12'14"N) and chain of islands have been observed. From SenniappaDargh to 6.65 km towards south, an island namely Musal Island having an elevation of 3.5m from sea floor is encountered. Around this island fringing corals have developed very extensively to a depth of 2 m, they extend 1.45 km towards north, 1.75 km towards northwest, 1.69 km towards west and 1.42 km towards south from the coast of the island. Around this island the sea floor slopes gently upto a depth of 2m. On the seaward side of this island, the sea floor slope is very steep to 10m depth and to an average distance of 2 m. About 6.18 km away from Marakkayarpattinam, there are two islands namely Manalli and Manalliputti Islands (79°7'26"E-9°12'23"N and 79°8'16"E - 9°12'23"N). Around these islands, the sea floor is encountered at 1m depth and the topography of the sea floor around this island has a moderate gradient. On the seaward side of this island, the sea floor slope is very steep, between 3 m and 6 m depths. The width of this slope is 0.73 km. At a depth of 6 to 7 m a plain having a width of 3.52 km is encountered. The sea floor slopes gently between 7 and 30 m depths. In the area between Thoniturai and Pamban canal, the sea floor is encountered at a depth of 1 m and extends to an average distance of 1.07 km from the coast of Thoniturai and Velupilliyarkovil. In this area the sea floor slopes very gently upto 2 m depth. In between 2 and 3 m depths, there is a vast plain sea floor extending 3.80 km from north to south and 23.3 km from east to west. Along this plain there are low elevated chain of islands (79°10'28"E - 9°14'28"N and 79°14'16"E - 9°13'28") namely Pumurichan, Kovi, Kursadi and Shingle islands. Around these islands the sea floor is encountered at a depth of 0.5m and extends to an average distance of 0.49 km towards north, 1 km towards south, 0.19 km towards east and 0.27 km towards west. In the north of these islands the sea floor slope is steep (till a depth of 1 m) whereas it is very gentle in the south (till a depth of 3 m). In between 3 m and 10 m the sea floor slope is steep having a width of 1.83 km. From 10 to 30 m the sea floor slopes moderately. In the area between Dhanuskodi and Kundugal the sea floor is at a depth of 6 m and slopes moderately up to 30 m depth. The width of the continental shelf in this area has been measured approximately as 26.25 km.

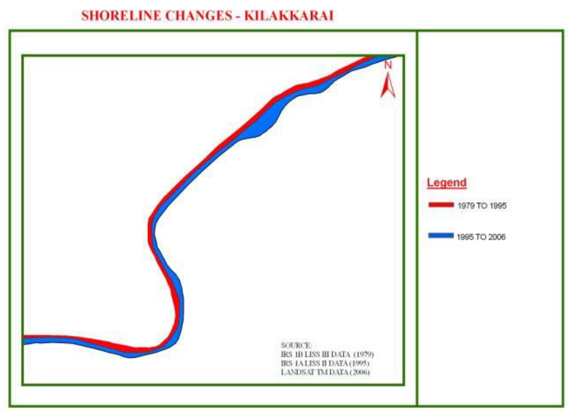

Figure.5 Shoreline changes-Kilakkarai

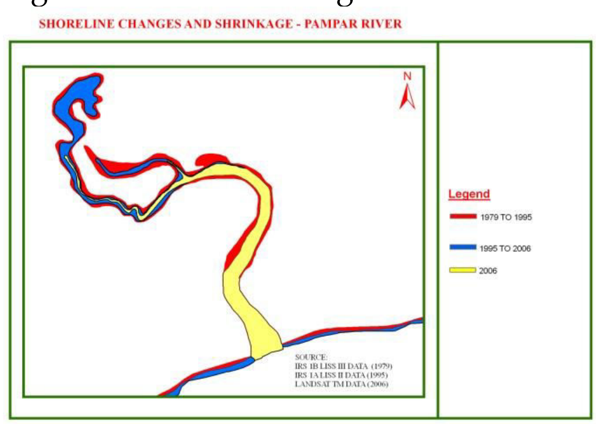

Figure.6 Shoreline changes and shrinkage-Pampar river

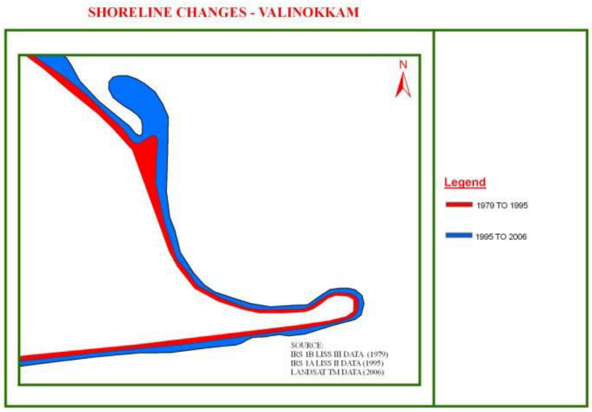

Figure.6 Shoreline changes-Valinokkam

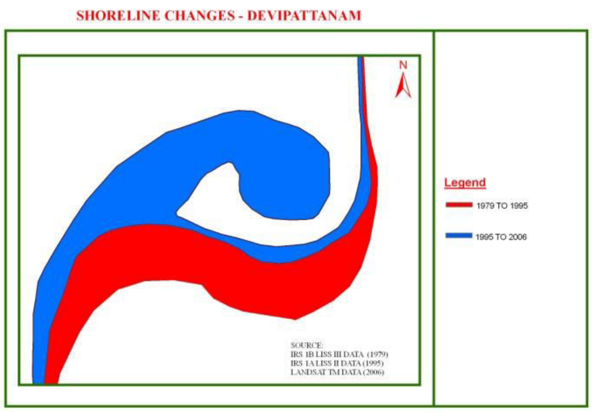

Figure.6 Shoreline changes-Devipattinam

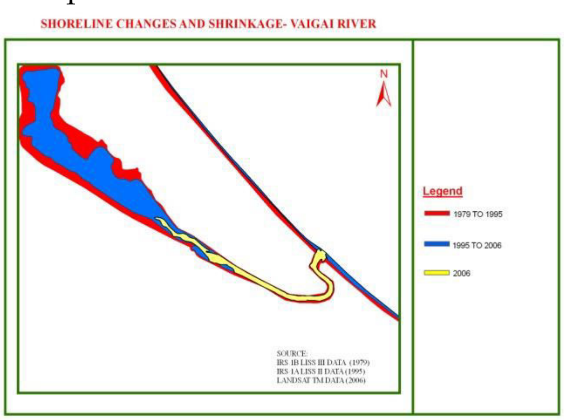

Figure.6 Shoreline changes and shrinkage-Vaikai river

5. Conclusion

Shoreline mapping, inventory and monitoring are very important information for characterization and management of coastal eco systems which is needs to be documented. In this paper we have analysed the shoreline changes rates using vector layer year wise different methods to provide consistent and reliable information in complex coastal ecosystems across different time scales. Shoreline changes along the Gulf of mannar coast over the last 27 years were studied. The high erosion was noticed on the Devipattinam region, whereas high accretion was notised along the Keelakkarai and Valinokkam. The shrinkage was noticed on the Vaikai and Pampar river mouth. Arc GIS and ENVI imagine software's are very much useful for bathymetry mapping. Various shelf morphological features like channels, continental raise and islands, and their slopes and extents are identified. The present study suggests that in the study area sea floor has been gradually rising due to tectonic upliftment.

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Earth Resources Satellites

There are three distinct groups of earth resources satellites. The first group of satellites record visible and near visible wavelengths. The five satellites of Landsat series which are the first generation earth resources satellites are a classic example of this group. The four IRS satellites and the more improved SPOT series of these satellites may be considered the second generation earth resources satellites of the same group. Group two satellites carry sensors that record thermal infrared wavelengths and include the Heat Capacity Mapping Mission satellites, namely, Explorer series. Group three satellites are eployed with sensors that record micro wavelengths. The seasat series and the ERS are examples of this group.

1. Landsat Satellite Programme

National Aeronautics and Space Administration (NASA) of USA with the cooperation of the U.S. Department of Interior planned the launching of a series of Earth Resources Technology Satellites (ERTS). ERTS-1 was launched by a Thor Delta rocket on July 23, 1972 and it operated until January 6,1978. It represented the first unmanned satellite designed to acquire data about the earth resources on a systematic, repetitive, medium resolution, multispectral basis. Subsequently, NASA renamed the ERTS programme as "Landsat" programme to distinguish it from the series of meteorological and oceanographic satellites that the USA launched later. ERTS-1 was retrospectively named Landsat-1. Five Landsat satellites have been launched so far and this experimental programme has evolved into an operational global resource monitoring programme. Three different types of sensors have been flown in various combinations on the five missions. These are Return Beam Vidicon (RBV) camera system, the Multispectral Scanner (MSS) system and the Thematic Mapper (TM). Table 4.1 summarizes the characteristics of Landsat-1, through 5, and the sensors used on these satellites and orbital characteristics. Landsat images have found a large number of applications, such as, agriculture, botany, cartography, civil engineering, environmental monitoring, forestry, geography, geology, land resources analysis, landuse planning, oceanography, and water quality analysis.

Satellite Capabilities :

Particulars	Landsat - 1 to 3	Landsat - 4 & 5
Altitude	919 Km	705 Km
Orbit	Near-Polar Sun-Synchronous	Near-Polar Sun-Synchronous
Inclination	99.09 Degree	98.2 Degrees
Period	103 minutes	99 minutes
Equatorial crossing time	0930 Hours	0945 Hours
Repeat Cycle	18 Days	16 Days
Swath Width	185 Km	185 Km
Data rate	15.06 Mbps	84.9 Mbps

Sensor Capabilities :

Sensor	Mission	Channel	Spectral Spatial Resolution (Microns)	Spatial Resolution	Radiometric Resolution
RBV	Landsat 1 to 3	1	0.475-0.575	80 m	6 bits (127 levels)
		2	0.580-0.680	80 m	
		3	0.690-0.830	80 m	
		4	0.505-0.750	80 m	
MSS	Landsat 1 to 5	1	0.5-0.6	79/82 m*	6 bits (127 levels)
		2	0.6-0.7	79/82 m*	
		3	0.7-0.8	79/82 m*	
		4	0.8-1.1	79/82 m*	
		5	10.4-12.6	240 m	
TM	Landsat 4 & 5	1	0.45-0.52	30 m	8 bits (255 levels)
		2	0.52-0.60	30 m	
		3	0.63-0.69	30 m	
		4	0.76-0.90	30 m	
		5	1.55-1.75	30 m	
		6	2.08-2.35	30 m	
		7	10.4-12.5	120 m	

2. SPOT Satellite Programme

France, Sweden and Belgium joined together and pooled up their resources to develop the System Pourl'

Observation dela Terre (SPOT), an earth observation satellite programme. The first satellite of the series, SPOT-1 was launched from Kourou Launch Range in French Guiana on February 21,1986 aboard an Ariance Launch vehicle (AIV). This is the first earth resource satellite system to include a linear array sensor employing the push broom scanning technique. This enables side-to-side oft-nadir viewing capabilities and affords a full scene stereoscopic imaging from two different viewing points of the same area. The high resolution data obtained from SPOT sensors, namely, Thematic Mapper (TM) and High Resolution Visible (HRV), have been extensively used for urban planning, urban growth assessment, transportation planning, besides the conventional applications related to natural resources.

SPOT Satellite	
Orbit :	Near-polar Sun-synchronous
Altitude :	832 km
Inclination :	98.7 Degrees
Equatorial Crossing Time :	10.30 Hours
Repeat Cycle	26 Days
HRV Sensor	
Channel	**Waveband (Microns) Multispectral**
1	0.50-0.59
2	0.61-0.68
3	0.79-0.89
Panchromatic	
1	0.51-0.73
Spatial resolution	20-m (Multispectral) (at nadir) 10 m (panchromatic)
Radiometric resolution :	8 bits (Multispectral) 6 bits (Panchromatic)
Swath Width :	117 Km (60 km per HRV, 3 Km overlap)
Angular field of view :	4.13 Degrees.
Off-nadir viewing :	$\pm 27^0$ in 45 steps of 0.6^0 (= $\pm$ Km from nadir)

3 Indian Remote Sensing Satellites (IRS)

The IRS mission envisages the planning and implementation of a satellite based remote sensing system for evaluating the natural resources. The principal components of the mission are: a three axis stabilised polar sunsynchronous satellite with multispectral sensors, a ground based data reception, recording and processing systems for the multispectral data, ground systems for the in-orbit satellite control including the tracking network with the associated supporting systems, and hardware and software elements for the generation of user oriented data products, data analysisand archival. The principal aim of the IRS mission is to use the satellite data in conjunction with supplementary/complementary information from other sources for survey and management of natural resources in important areas, such as, agriculture, geology and hydrology in association with the user agencies. IR$ series of satellites are IRS lA, IRS IB, IRS IC, IRS ID and IRS P4 apart from other satellites which were launched by the Government of India. The orbital and sensor characteristics of IRS IA and IB are the same and IRS IC and IRS ID have almost similar characteristics. IRS P4 is an oceanographic satellite, and this will be discussed in the next section. IRS has application potential in a wide range of disciplines such as management of agricultural resources, inventory of forest resources, geological mapping, estimation of water resources, study of coastal hydrodynamics, and water quality surveying. The sensor payload system consists of two push broom cameras (LiSS-II) of 36.25 m resolution and one camera .(LlSS-I) of

72.5 m resolution employing linear Charge Coupled Device (CCD) arrays as detectors. Each camera system images in four spectral bands in the visible and near IR region. The camera system consists of collecting optics, imaging detectors, inflight calibration equipment, and processing devices. The orbital characteristics of the IRS-1A, 1 B satellites and the sensor capabilities are given in Table 4.3. As IRS-1 D satellite is the latest satellite of the series and hence the system overview of IRS - 1 D is provided. The IRS-1 D is a three-axes body stabilized satellite, similar to IRS-1 C. Since IRS-1 C and 1 D are similar in orbital characteristics and sensor capabilities, the details of IRS-1 D are discussed as it is a very recent satellite. It will have an operational life of three years in a near polar sunsynchronous orbit at a mean altitude of 780 Km. The payload consists of three sensors, namely, Panchromatic camera (PAN), linear imaging and self-scanning sensor (LiSS-III) and wide Field sensor (WiFs). The satellite is equipped with an On-Board Tape Recorder (OBTR) capable of recording limited amount of specified sensor data. Operation of each of the sensors can be programmed. The payload operation sequence for the whole day can be loaded daily on to the on-board command memory when the satellite is within the visibility range. The ground segment consists of a Telemetry Tracking and Command (TTC) segment comprising a TTC network, and an Image segment comprising data acquisition, data processing and product generation system along with data dissemination centre. The over view of IRS-1 D mission is to provide optimum satellite operation and a mission control centre for mission management, spacecraft operations and scheduling. The three sensors on board IRS-1 D and IRS-1 C are described in the following paragraph. The panchromatic camera provides data with a spatial resolution of 5.2-5.8 m (at nadir) and a ground swath between 63 Km -70 Km (at nadir). It operates in the 0.50 - 0.75 microns spectral band. This camera can be steered upto ± 26 deg. storable upto ±398 Km across the track from nadir, which in turn increases the revisit capability to 3 days for most part of the cycle and 7 days in some extreme cases. The LlSS-1i1 sensor provides multispectral data collected in four bands of the visible, near infra-red (V,NIR) and short wave infra-red (SWIR) regions. While the spatial resolution and swath in the case of visible (two bands) and NIR (one band) regions are between 21.2 m to 23.5 m and 127 Km-141 Km.respectively, they are between 63.6 m to 70.5 m and 133 Km to 148 Km for the data collected in SWIR region. (Table 4.5). Plate 3 shows IRS-1D LlSS III FCC image (band 2, 3, 4) and corresponding black and white images of band 2, band 3, and band 4 of path 108, row 56 showing Culcutta and surrounding areas. The Wide Field Sensor (WiFS) sensor collects data in two spectral bands and has a ground swath between 728 Km to 812 Km with a spatial resolution of 169 m to 188 m.

Characteristics of Satellite		
Orbit	:	Near-polar, Sun-synchronous
Altitude	:	904 Km
Inclination	:	99.03 Degrees
Equatorial Crossing Time	:	10.00 Hours
Repeat Cycle	:	22 days
Eccentricity	:	0.002
Period	:	103 minutes

Sensor Capabilities

Linear Image Scanning System : LISS

No. of LISS Cameras	LRC (One)*	MRC (two)**
No. of Spectral Bands	4	4
IFOV (Microrad)	80	40
Geometric Resolution	72.5	36.25
Swath Width	148 Km	74 Km
Radiometric Resolution	7 bits	7 bits
Band-to-Band	0.5	0.5

* Low Resolution Camera
** Medium Resolution Camera

4. AEM Satellites

The (Heat capacity Mapping Mission) HCMM satellite is the first of a small and relatively inexpensive series of NASA's Applications Explorer Mission (AEM) satellites. Launched in April 1978, it lasted till September 1980. Table 4.7 summaries the details of AEM satellite and HCM sensor characteristics. The orbits of the satellite are arranged to ensure that images of each scene are obtained during the periods of maximum and minimum surface temperature for the determination of thermal inertia. The data from HCMM are intended primarily for conversion to thermal inertia maps for geological mapping. However, the images have found wider applications, such as, vegetation mapping, vegetation stress detection, microclimatology, soil moisture mapping, snowmelt prediction, and monitoring industrial thermal pollution.

Characteristics of Satellite		
Orbit	:	Near-polar Sun-synchronous
Altitude	:	620 Km
Inclination	:	97.6 Degrees
Equatorial CrossingTime	:	14.00 hrs (Ascending) 02.00 hrs (Decending)
Repeat Cycle	:	16 days

HCMM Sensor Capabilities

Channel	Waveband (Microns)
1	0.5-1 1
2	10.5-12.5
Spatial Resolution	500 m (channel -1) 600 m (channel-2)
Swath width	716 Km

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