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Evolution of Marine Mammals

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Department of Oceanography and Coastal area studies, School of Marine Sciences, Alagappa University, Thondi-623409, Tamilnadu, India.Abstract :

The fossil record demonstrates that mammals re-entered the marine realm on at least seven separate occasions. Five of these clades are still extant, whereas two are extinct. This review presents a brief introduction to the phylogeny of each group of marine mammals, based on the latest studies using both morphological and molecular data. Evolutionary highlights are presented, focusing on changes affecting the sensory systems, locomotion, breathing, feeding, and reproduction in Cetacea, Sirenia, Desmostylia, and Pinnipedia. Aquatic adaptations are specifically cited, supported by data from morphological and geochemical studies

Introduction :

Living groups of marine mammals vary greatly in their diversity. Species level identification of most fossils is problematic, so most studies of diversity of extinct organisms are done at the genus level. Including both fossil and recent cetaceans, there are around 245 genera described thus far, with around 32 genera of sirenians and around 62 genera of pinnipeds. At particular times in the past, (e.g., the middle Miocene) generic diversity of cetaceans was approximately double what it is today Description and behaviour:

Marine mammals evolved from their land dwelling ancestors over time by developing adaptations to life in the water. To aid swimming, the body has become streamlined and the number of body projections has been reduced. The ears have shrunk to small holes in size and shape. Mammary glands and sex organs are not part of the external physiology, and posterior (hind) limbs are no longer present.

Marine Mammals

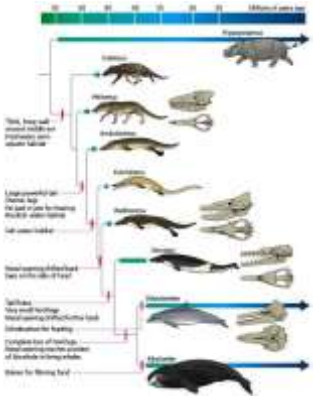
2,400 years ago, Aristotle, a Greek scientist and philosopher, recognized that whales are mammals, not fish, because they nurse their young and breathe air like other mammals.

There are numerous myths and legends surrounding marine mammals. The Greeks believed that killing a dolphin was as bad as murdering a human. An Amazon legend said that river dolphins came to shore dressed as men to woo pretty girls during fiestas. During the Middle Ages, there were numerous legends surrounding the

narwhals' amazing tusk, which was thought to have come from the unicorn.

Marine mammals evolved from their land dwelling ancestors over time by developing adaptations to life in the water. To aid swimming, the body has become streamlined and the number of body projections has been reduced. The ears have shrunk to small holes in size and shape. Mammary glands and sex organs are not part of the external physiology, and posterior (hind) limbs are no longer present.

Mechanisms to prevent heat loss have also been developed. The cylindrical body shape with small appendages reduces the surface area to volume ratio of the body, which reduces heat loss. Marine mammals also have a counter current heat exchange mechanism created by convergent evolution where the heat from the arteries is transferred to the veins as they pass each other before getting to extremities, thus reducing heat loss. Some marine mammals also have a thick layer of fur with a water repellent undercoat and/or a thick layer of blubber that can't be compressed. The blubber provides insulation, a food reserve, and aids with buoyancy. These heat loss adaptations can also lead to overheating for animals that spend time out of the water. To prevent overheating, seals or sea lions will swim close to the surface with their front flippers waving in the air. They also flick sand onto themselves to keep the sun from directly hitting their skin. Blood vessels can also be expanded to act as a sort of radiator. One of the major behavioral adaptations of marine mammals is their ability to swim and dive. Pinnipeds swim by paddling their flippers while sirenians and cetaceans move their tails or flukes up and down Some marine mammals can swim at relatively high speeds. Sea lions swim up to 35 kph and orcas can reach 50 kph. The fastest marine mammal, however, is the common dolphin, which reaches speeds up to 64 kph. While swimming, these animals take very quick breaths. For example, fin whales can empty and refill their huge lungs in less than 2 seconds. During dives marine mammals' larynx and esophagus close automatically when they open their mouths to catch prey. Oxygen is stored in hemoglobin in the blood and in myoglobin in the muscles. The lungs are also collapsible so that air is pushed into the windpipe preventing excess nitrogen from being absorbed into the tissues.



Decreasing pressure can cause excess nitrogen to expand in the tissues as animals ascend to shallower depths, which can lead to decompression sickness aka “the bends.” Bradycardia, the reduction of heartrate by 10 to 20%, also takes place to aid with slowing respiration during dives and the blood flow to non-essential body parts. These adaptations allow sea otters to stay submerged for 4 to 5 minutes and dive to depths up to 55 m. Pinnipeds can often stay down for 30 minutes and reach average depths of 150-250 m. One marine mammal with exceptional diving skills is the Weddell seal, which can stay submerged for at least 73 minutes at a time at depths up to 600 m. The length and depth of whale dives depends on the species. Baleen whales feed on plankton near the surface of the water and have no need to dive deeply so they are rarely seen diving deeper than 100 m. Toothed whales seek larger prey at deeper depths and some can stay down for hours at depths of up to 2,250 m.

Marine mammals are often very social animals. Dolphins travel in pods (schools) and catch rides on the bow waves of boats. Marine mammals are also known to help each other when one member of the group is injured. There have been accounts of members of a pod refusing to leave the wounded or dying, a trait often exploited by whalers. Cetaceans (whales and dolphins) often hunt together, often with one

leading the pod to act as a scout when entering unfamiliar territory. This close knit socialization is thought to be a factor in some whale strandings when a pod follows one or more members of the group that have become disoriented due to storm, illness, or injury.

Many marine mammals also participate in yearly migrations, either in groups or individually. Toothed whales are an exception and only move about in search of food, but some baleen whales (such as gray whales) embark on extremely long migrations, moving from tropical breeding grounds in winter to feeding areas in colder waters during the summer.

Results :

Cetacean Evolutionary the limbs and vertebral column show very little change in morphology, but they do have some histological changes that indicate they walked around in shallow water (Madar, 1998). The skull and dentition do, however, show changes indicating

activity in the water. The anterior end of the rostrum is elongate, which arranges the incisors in a line with the cheek teeth, rather than in an arc across the front of the snout as in most mammals. This arrangement also has the effect of placing the external nares posterior to the tip of the rostrum, because the premaxilla is elongated anterior to the external nares.

Discussion :

Before comparing the evolutionary histories of each of the clades of marine mammals, it is worth emphasizing that the evolutionary histories outlined here are only the most basic and superficial sketches of the morphological changes that these groups have undergone.REFERENCE :

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BIOFUEL FROMMARINE ALGAE

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Any material that may be used for work or to react with other substances to release energy as thermal energy is considered a fuel. Although the idea was first limited to materials that could release chemical energy, it has subsequently been extended to include various heat-producing sources, including nuclear energy.The definition of a fuel is something that provides us with energy. Fuel is any molecule formed during carbon fixation that can give energy in a mechanical situation. Fossil fuel is currently the main source of energy on which humans rely. Unfortunately, the stocks of oil and other fuels are running out very quickly. Furthermore, using fossil fuels raises the possibility of adverse environmental consequences such as rising sea levels, changing climate, loss of biodiversity, and the release of hazardous gasses. The modern world's rapid motorization and industrialization is the primary cause of the rising demand for fossil fuels. Consequently, this impacts worldwide economic operations and raises the price of crude oil. Thus a biofuel technology been discovered.Biofuel is regarded as the purest and most readily available fuel on Earth. Biofuels are produced by directly burning dry matter, such as wood and straw, to liberate biomass, which then transforms into a liquid and gaseous fuel. Sludge, sewage, and vegetable oil matter are examples of organic matter that can also be used as a source of biofuels through wet processes like fermentation and digestion.Biofuel is generally available in all regions of the world, which mainly include fuels like, Biodiesel, Bioethanol etc. The two most common types of biofuels in use today are bioethanol and biodiesel. Both of which represent the first generation of biofuel technology. Brazil is the largest producer of bioethanol, while the EU is the largest producer of biodiesel.

Seaweed, or macroalgae, and some microalgae can be commercially produced in the ocean to produce coproducts like animal feed and biofuels. Both macro and microalgae can be used as feedstocks to produce liquid biofuels since they contain low amounts of lignin and high levels of structural polysaccharides.The majority of algae are single-celled plants that can grow in freshwater or marine. The majority of strains are photosynthetic and comprise the fastest growing plants on Earth. Similar to other plants, they emit copious amounts of oxygen into the atmosphere while converting light, water, CO_2, and other nutrients into biomass and energy. Through photosynthesis, a variety of algae strains and marine species obtain their energy from organic carbon instead of atmospheric carbon. Algae come in a

wide range of colors and shades, including red, green, brown, and blue-green with over 65,000 species currently recognized.The most often utilized procedures for biofuel production include pyrolysis, anaerobic digestion, fermentation, liquefaction, and transesterification. However, the hydrolysis processa rate-limiting phase that takes longermay be impacted by the intricate structure of the algal biomass. This affects the biofuel production; consequently it can be minimized by applying adequate pretreatment. Pretreatments increase solubilization by depolymerizing complicated structures and breaking molecular bonds . Using the dissolved samples in the conversion process is simple.

Some of the marine algae used for biodiesel includes *Caulerpataxifolia, Chaetomorphaantennina, Chaetomorphalinum, Ulvafasciata, Ulvaflexuosa*. Certain species of microalgae have the ability of producinghigh levels of carbohydrates instead of lipids as reserve polymers. These species are ideal candidates for the production of bioethanol as carbohydrates from microalgae can be extracted to produce fermentable sugars.It has been demonstrated that blue-green algae, such as *Spirogyra* species and *Chlorococum* sp., collect large amounts of polysaccharides in both their intricate cell walls as well as starch. The buildup of starch can be utilized to produce bioethanol.The results indicate that samples that are pre-extracted for lipids provide 60% higher ethanol concentrations from the blue-green algae *Chlorococum* sp. than those that are left as dried, complete cells. This suggests that the overall economic worth of microalgae can be increased by using them to produce ethanol and lipid-based biofuels from the same material. It's obvious that biofuel can act as a substitute for fossil fuel to cover all energy needs. Fuel and thought to be a greener approach for the transportation industry. India's coastal waters offer a variety of resources, and these marine resources can be effectively used to fulfill the country's future oil needs. In order to meet the economic energy needs of nations it is necessary to produce biofuels.

DEEP SEA SEDIMENTS

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Deep-sea sediments typically have sedimentation rates less than 30 $m/10^6$ years, and rates as low 0.1 $m/10^6$ years have been reported. The slow sedimentation rates and unusual sediment compositions reflect the low fluxes of aluminosilicates eroded from continent.Deep sea sediments are vast microbial habitats covering almost two thirds of the planet's surface and often with 100s of meters of accumulated sediment. Relative to near shore environments which are much more accessible, deep sea sediments have only been preliminarilycharacterized microbiologically andwith respect to their global biogeochemical importance. Recent culture-dependent approaches within the International Deep Ocean Drilling Program have isolated a number of potential diazotrophic bacteria, including organisms closely related to *Rhizobia* and *Vibrio diazotrophicus*. Diazotrophic bacteria have also been recently isolated from Mediterranean sapropels.

Deep sea sediments provide a way of looking back in time. Marine archives have been cored repeatedly by series of international ocean drilling collaborations. Although sample volumes are constrained by the diameter of the core and temporal resolution is limited by low sedimentation rates typical of many marine settings, marine cores are usually independently dated to the time of deposition. Creatures living near deep-sea hydrothermal vents are unlike any other form of life. They don't rely on the sun for their energy but on chemicals being pumped from below the Earth's crust. What happens on the deep-seabed affects the ocean surface levels. Deep-sea life supports a complex ocean food web and some twilight-zone inhabitants migrate to the surface to feed every night. Approximately 98% of ocean species live in, on, or just above the seafloor. Over half of all known coral species live in deep cold waters. Cold water corals can live for thousands of years and grow into beautiful structures that rise 35 meters high. Some deep-water fish species, such as the orange roughy, can live up to 150 years. Some coral species produce compounds used in antibiotics and painkillers. Compounds found in certain deep-sea sponges are potent immunosuppressive and anti-cancer agents.Seafans contain substances used to treat asthma and heart disease. The female Casper octopus, only discovered in 2016, wraps her body around her eggs on the deep seabed, often onto a manganese nodule a lump of rock containing some precious metals. The Casper octopus will protect her eggs until they hatch, and often starves to death in the

process. The recently discovered scaly-foot snail, which lives alongside deep-sea hydrothermal vents, is literally iron-platedthe only known creature that has iron sulphide in its skeleton and shell.

The Bleaching of Coral Reefs: A Bellwether of Climate Change

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Marine science, also known as oceanography, encompasses a broad range of topics related to the Earth's oceans and seas. It includes the study of marine ecosystems, ocean currents, waves, geophysical fluid dynamics, plate tectonics, and the geology of the sea floor, as well as the chemical and physical properties of the ocean. Given the vastness of marine science, an important topic that has garnered significant attention is the impact of climate change on coral reefs.

Abstract:

Coral reefs, often referred to as the rainforests of the sea, are among the most biodiverse and productive ecosystems on Earth. They provide critical habitat for marine life, support fishing and tourism industries, and offer natural protection against coastal erosion. However, these vital ecosystems are facing an existential threat from climate change. The increasing temperatures of ocean waters have led to widespread coral bleaching events, which occur when corals expel the symbiotic algae living in their tissues due to stress, losing their colour and main source of nutrition

Introduction:

The phenomenon of coral bleaching has become more frequent and severe over the pastfew decades. As

global temperatures rise, the delicate balance between corals and their symbiotic algae is disrupted. This relationship is crucial for the health of the coral, as the algae provide corals with food through photosynthesis, while the corals provide the algae with a protected environment and the compounds necessary for photosynthesis.

The Science of Bleaching:

When corals are stressed by changes in temperature, light, or nutrients, they may expel the algae, leading to a paler or completely white appearance, hence the term "bleaching." While bleached corals are not dead and can recover if conditions return to normal, prolonged bleaching can result in coral mortality. This has dire consequences for the marine ecosystem, as many species depend on the complex structure of coral reefs for shelter and food.

Climate Change and Ocean Warming:

The primary driver of recent coral bleaching events is global climate change, specifically the warming of the ocean's surface temperature. The

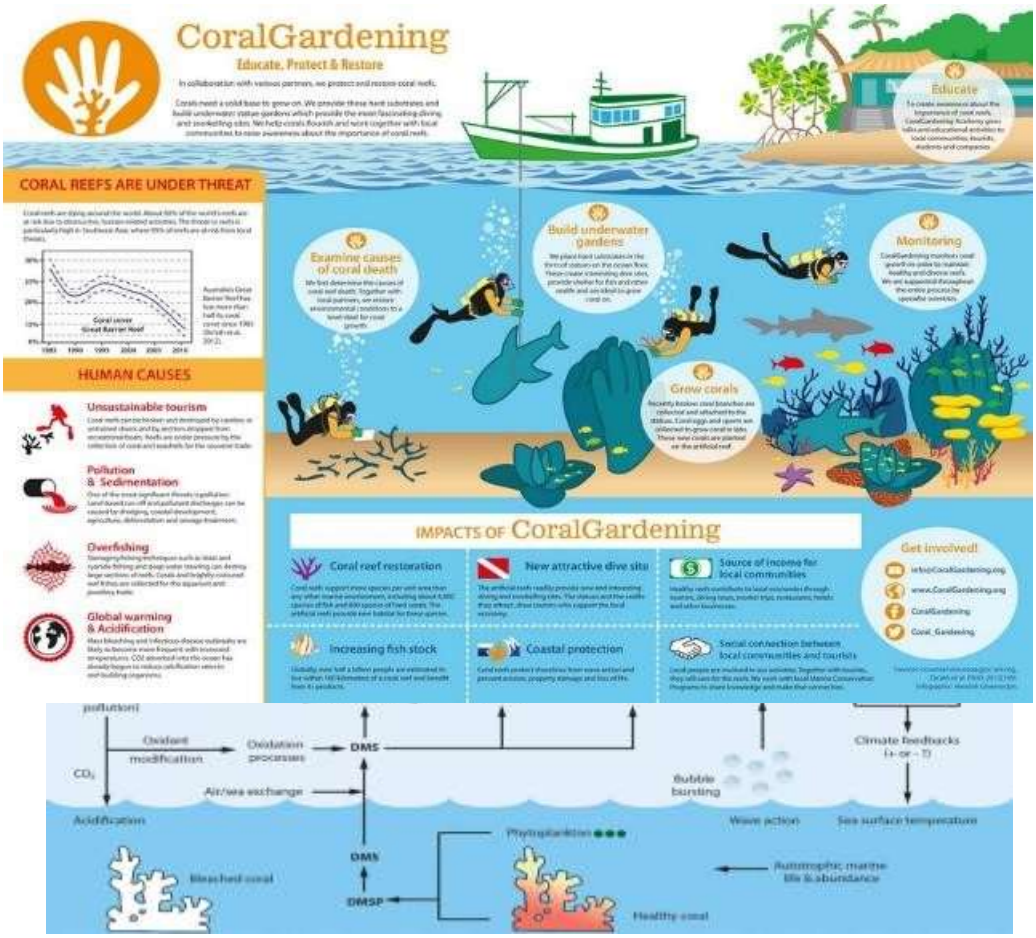
Intergovernmental Panel on Climate Change (IPCC) has reported that even with significant reductions in greenhouse gas emissions, many of the world's coral reefs are at risk of significant degradation.

Impacts and consequences:

The loss of coral reefs has profound implications for biodiversity, fisheries, and coastal communities. Reefs support approximately 25% of all marine species, and their decline could lead to the loss of thousands of species that depend on them for survival. Additionally, the economic impact on fishing and tourism industries is substantial, with billions of dollars at risk.

Conservation Efforts:

Efforts to protect and conserve coral reefs are underway, including the establishment of marine protected areas, restoration projects, and policies to reduce overfishing and pollution. Scientists are also researching ways to make corals more resilient to warming waters, including selective breeding and genetic modification.



Conclusion:

The bleaching of coral reefs is a clear indicator of the broader impacts of climate change on marine ecosystems.

Immediate and concerted global action is required to reduce greenhouse gas emissions and limit global warming. Protecting coral reefs is not just about conserving a single ecosystem; it is about maintaining the health of the entire ocean and the livelihoods of millions ofpeople around the world.

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This article is a fictional representation of a scholarly article one might find on the topic of marine science and the impact of climate change on coral reefs. It is designed to provide an overview of the issue and highlight the importance of marine science in understanding and addressing environmental challenges.

Effects of Sea Level Rise and Climate Changes on Coastal Habitat

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Rising sea levels may have longterm effects on the coastal area's sustainable community and important environment, which includes mangroves, salt marshes, and coral reefs. According to a 2001 assessment by the "Inter Governmental Panel on Climate Change (IPCC)," the coastal environment is the most dynamic interface on Earth, supporting the most variety of productive ecosystems, and it is located where land and sea meet. Humans began to utilize every part of the coastal region, and as a result, the natural environment began to see a surge in urbanization and tourism. Deforestation, fertilizer runoff from agricultural land, and untreated sewage pose serious threats to both human health and coastal habitat. The "coastal squeeze," which results in wild birds and wader species being in problematic conditions in mudflats and marshes, is what causes habitat loss. The mangrove forest is useful in preserving wetlands that are conducive to plant growth because it can withstand the momentum of increasing sea levels and prevent a cataclysm through the vertical rearing of sediments.By 2050 and 2100, the sea level is expected to rise by 16 and 32 cm, respectively, according to the M.S. Swaminathan Research Foundation. There are 73 coastal locations in the country, and "sea level rise" due to "climate change" poses a major threat to those areas. 593 coastal districts, or 17% of the nation's total population, were included in a 2017 report by the India Government's "Central Water Commission (CWC)" titled "A Report on Problem of Salinization of Land in Coastal Areas of India and Appropriate Protection Measures." Coastal sea level rise affects more than seven million families that depend on fishing and farming along the shore.

Many studies claim that "global warming" poses a threat to the survival of a significant section of the Sundarbans. In 1973, the area's water body covered about 411,640 acres. The storm "Ayla" in May 2009 caused the largest rises in water bodies in 47 hectares of Sundarban, and from 1973 to 2010, the percentage of land occupied by water bodies (52.42 percent) was the highest.Climate shift and sea level riserelated sea level rise has recently drawn alarming attention from throughout the world. An investigation in this area has produced a substantial body of scientific evidence. The SLR grew faster from 1993 to 2003, averaging 3.1 mm, than the 1.8 mm average annual growth from 1961 to 2003. According to geological data, the sea level has been rising at an average rate of 0.1–0.2 millimeters each year during the past 3000 years. The

mechanisms and feedback of climate, even.

Mankind has had a detrimental effect on the ecosystem and biodiversity of the Indian coast. Such "vulnerability" is the outcome of a coastal process brought about by the union of human and environmental forces. This topic has seen a number of research that compute the vulnerability to sea level rise at various geographic scales. However, it is still unclear how climate change can impact sea level rise and their combined sensitivity to species, even with proper methodologies.

Endangered Marine Mammals in India

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Introduction

Relatively few nations have national legislation protecting endangered and threatened species in place, despite the global reduction in the variety of marine animals. For marine endangered and threatened species to be effectively conserved, a suitable legal framework with specific goals and regulations in line with the current scientific data is essential. This essay examines the Russian Federation's institutional instruments and legal framework for the preservation of marine endangered and threatened species. Federal laws and legally binding international agreements, such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar), are significant legislative tools in this regard. Additionally, a plan of action and a strategy for the preservation of biological variety were created. In addition, the Red Book of the Russian Federation (RBRF) and other regional Red Books are the most crucial resources for the preservation and defence (Das 2022)of marine endangered and vulnerable species. Both the Russian Federation's criminal law and code of administrative crimes specify who is responsible for harming any of the species listed in the RBRF and their habitat. The last section's findings and gaps were emphasized, among other things, the fact that law currently has a limited capacity to consider the effects of climate change. Considering the very small number of publications devoted to the study of this kind ofthe effects and/or consequences on the status of the marine endangered and threatened species of the conservation methods and tactics discussed in this study.

Marine Mammals

The majority of people have a particular place in their hearts for marine animals because of their intellect, visibility, and frequent contacts with people. It makes sense that marine mammals receive more protection overall than the majority of other marine creatures. Still, a variety of human endeavours continue to have an impact on them. The largest global concern to marine mammals is their unintentional entanglement in fishing gear, or "bycatch," which results in the deaths of hundreds of thousands of animals annually. When entangled in a fishing line or net, porpoises and small whales frequently perish because they are unable to surface to breathe. Even enormous whales can become entangled and end up injured, exhausted, or even killed by hauling nets or other gear over great distances. The North Atlantic right

whale, one of the most endangered marine species, dies largely from entanglements in fishing gear.

Only a few countries currently permit hunting for purposes other than subsistence, despite the fact that commercial harvesting has historically played a significant role in the dramatic decreases in marine mammal populations. Nevertheless, each year, hunters kill hundreds of thousands of seals, whales, and other marine animals, and many more die from subsistence fishing.

Marine animals are sensitive to ship traffic at sea, especially in places congested with commercial and recreational boats, much as people are to traffic on the streets. Each year, these kinds of encounters cause injuries or deaths to several hundred animals.

In crowded East Coast corridors, ship hits are a major source of death for North Atlantic right whales, which are under threat. However, in Florida's shallow seas, boats regularly collide with manatees, another endangered species. Indirect consequences of climate change, new disease introduction, and ecological changes like algal blooms are among other potential reasons of marine animal death.Several thousand more fatalities might be brought on by these variables annually.

Pollution may disrupt marine life's ability to reproduce, worsen its health, and ultimately cause it to die, even though it seldom kills marine life directly. These animals, especially the long-lived ones, can collect chemicals in their tissues from pesticides, fertilizers, medications, and other elementsingesting marine debris and being entangled in plastic waste can be major additional causes of death.

Noise from shipping, oil and gas exploration, ocean drilling, naval operations, oceanographic and geophysical research, and related activities can also affect marine animal populations. Over the past decade, there has been a great deal of media attention focused on marine animal deaths that occur in close proximity to naval activities and geophysical research boats. Unfortunately, there is a dearth of information about the physiology of marine mammals, particularly baseline data on hearing, which makes evaluating the possible biophysical effects of noise on marine animals challenging.

Degradation or loss of the natural habitat of many endangered species is another cause that is common to reductions in these species. Thus, maintaining or restoring a species' natural environment is crucial to its successful recovery.

Classification of Endangered Marine Mammals in India:

The marine mammals are one of the important biotic constituents of marine environment. The marine mammals of India are comprised of whales, dolphins and dugongs. The following mammals are highly endangered due to natural and anthropogenic activities; the mammals are Gangetic River Dolphin (Platanistagangetica), Dugong (Dugong

dugon), Humpback Dolphin (Sousa spp.), Irrawaddy Dolphin (Orcaellabrevirostris) and Whale species. In this present study, we are discussing about the list of endangered species, characters and its risk factors.

Gangetic River Dolphin:

Taxonomy:

Kingdom : Animalia
Phylum : Chordata
Class : Mammalia
Order : Cetartiodactyla
Family : Platanistidae
Genus *:Platanista*
Species *:P.gangetica (Lebeck, 1801)*

Distribution

P. gangetica historically distributed in major river systems (Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu) of India, Nepal and Bangladesh between longitudes 77^{o} E and 89^{o} E. Rocky barriers, dams, barrages, shallow water, and fast currents prevented upstream movement of the species in India and Nepal. But currently, the species restricted to disjunct stretches in India's Ganga-Brahmaputra-Barak river system, Nepal's Karnali, SaptaKoshi and Narayani river systems, and Bangladesh's Meghna, Karnaphuli and Sangu river systems. According to the recent study in the Ganga River Basin, the species recorded from the main stream of Ganga River followed by the tributaries, Ghaghra, Kosi, Gandak, Chambal, Rupnarayan, and Yamuna.

Characteristics, Habitat and Behaviour

A long thin snout, rounded belly, stocky body and large flippers are characteristics of the Ganges river dolphin. The species has a slit similar to a blowhole on top of its head, which acts as a nostril. Females are larger than males and give birth once every two to three years to only one calf. The calves have chocolate brown skin at birth, while the adults have grey-brown smooth, hairless skin.

The Ganges river dolphins can only live in freshwater and are essentially blind. They hunt by emitting ultrasonic sounds waves that bounce off of fish and other prey. They are frequently found alone or in small groups; generally, a mother and calf travel together. The dolphin has the peculiarity of swimming on one side so that its flipper trails the muddy bottom. It is understood that this behaviour aids them in finding food. Being a mammal, the Ganges river dolphin cannot breathe in water and must surface every 30-120 seconds. Because of the sound it produces when breathing, the animal is popularly referred to as 'Susu'. Although not well studied, the movement of the Ganges river dolphin follows seasonal patterns. It is observed that animals travel upstream when the water level rises, and from there enter smaller streams.

Major Threats:

- Unintentional killing through entanglement in fishing gear.
- Poaching for dolphin oil, used as fish attractant and for medicinal purposes.
- Habitat destruction due to

development projects (e.g. water extraction and the construction of barrages, high dams and embankments), pollution (industrial waste and pesticides, municipal sewage discharge and noise from vessel traffic) and overexploitation of prey mainly due to the widespread use of non-selective fishing gear.

- Fragmented populations created by dams and barrages have degraded downstream habitat and created impoundments with high sedimentation and altered assemblages of fish and invertebrate species.

Dugong (Dugong dugon):

Taxonomy:

Kingdom : Animalia
Phylum : Chordate
Class : Mammalia
Order : sirenia
Family : dungongidae
Genus : dugong
Species : D.dugong

Habitat

Unlike their mostly freshwater cousins, manatees, dugongs are primarily marine mammals. Dugongs generally inhabit shallow waters, remaining at depths of around 10 m, although they occasionally dive to depths of 39 m to feed. These shallow areas are typically located in protected bays, wide mangrove channels and in sheltered areas of inshore islands. Seagrass beds consisting of phanerogamousseagrasses, their primary source of nourishment, coincide with these optimal habitats. Dugongs, however, are also observed in deeper water where the continental shelf is broad, neritic and sheltered. Dugongs use different habitats for different activities. For example, tidal sandbanks and estuaries that are quite shallow, are potential areas suitable for calving. Another example of specialized habitats are lekking areas, which are only used during mating season. (Lawler, et al., 2002; Marsh, et al., 2002; Whiting, 2008)

In a study off the coast of Australia, near Darwin, a pair of dugongs was captured in and tracked frequenting rocky reef habitats. Aerial surveys also showed that most dugongs in that region were found associated with a rocky reef. Because habitats of this kind have relatively low spatial coverage, dugongs actively select them. However, it is not known why dugongs frequently seem to forage in these areas, as there is no seagrasses on these reefs and they are not known algae consumers. (Lawler, et al., 2002; Marsh, et al., 2002; Whiting, 2008)

Physical Description

Dugongs are large, solid mammals with short, paddle-like front flippers and a tail with a straight or concave perimeter that is used as a propeller. Their tail differentiates them from manatees, the tail of which is paddle-shaped. Dugong fins resemble those of dolphins, but unlike dolphins, dugongs lack a dorsal fin. Females have mammary glands under the fins from which their calves suckle. Adult dugongs weigh from 230 to 400 kg and can range from 2.4 to 4 m in length.

Their thick skin is brownish-grey, and its color can vary when algae grows on it. Tusks are present in all dugongs, but they are usually only visible through the skin in mature males, whose tusks are prominent, and in old females. Their tusks are projections of the incisor teeth. There are no other external physical differences between sexes, as they are monomorphic. Their ears have no flaps or lobes but are nonetheless very sensitive. Dugongs are suspected to have high auditory accuity to compensate for poor eye sight. Their snout is rather large, rounded over and ends in a cleft. This cleft is a muscular lip that hangs over the down-turned mouth and aids the dugong in its foraging of sea grass. Dugongs have a down-tipped jaw which accommodates the enlarged incisors. Sensory bristles that cover their upper lip assist in locating food. Bristles also cover the dugong's body. Paired nostrils, used in ventilation when the dugong surfaces every few minutes, are located on top of the head. Valves keep them shut during dives. (Anderson, 1984; Lawler, et al., 2002; Odell, 2003; Spain, et al., 1977; "ARKive. Images of Life on Earth.", 2003)

The only other species known in the family Dugongidae is *Hydrodamalisgigas* (Steller's sea cow), hunted to extinction in 1767, just 36 years after their discovery. They were similar in appearance and color to dugongs but were substantially larger, with a body length of 7 to 10 m and weight between 4,500 and 5,900 kg. (Anderson, 1984; Lawler, et al., 2002; Odell, 2003; Spain, et al., 1977; "ARKive. Images of Life on Earth.", 2003)

Reproduction

The mating behavior of dugongs varies slightly with location. For example, in a mating herd in Moreton Bay, off the coast of Queensland, males take part in aggressive competitions for females in oestrous. In comparison, dugongs in South Cove in Western Australia display a mating behavior similar to lekking. A lek refers to a traditional area where male dugongs gather during mating season to participate in competitive activities and displays that attract females. As these lekking areas lack resources necessary to females, they are drawn to the area only to view the males' displays. Male dugongs defend their territories, and they change their behavioral displays to attract females. After attracting females, male dugongs proceed through several phases in order to copulate. The "following phase" occurs when groups of males follow a single female, attempting to mate with her. The "fighting phase" occurs after, consisting of splashing, tail thrashing, rolls and body lunges. This can be violent, as witnessed by scars observed on the body of females and on competing males from their protruding tusks. The "mounting phase" occurs when a single male mounts a female from underneath, while more males continue to vie for that position. Hence, the female is mounted several times with the competing males, almost guaranteeing conception. Dugongs are thus polyandrous. ("Australian Government Great Barrier Reef Marine Park

Authority", 2002; Lawler, et al., 2002; Marsh, et al., 2002; Wursig, et al., 2002)

Mating System

Female dugongs reach sexual maturity at 6 years of age and may have their first calf between the ages of 6 and 17. Males reach sexual maturity between 6 and 12 years of age. Because breeding occurs year-round, males are always waiting for a female in oestrous. The reproductive rate of dugongs is very low, and they only produce one calf every 2.5 to 7 years depending on location. This may be due to the long gestation period, which is between 13 and 14 months. At birth, calves are about 30 kg in weight, 1.2 m in length, and very vulnerable to predators. Calves nurse for 18 months or longer, during which time they do not stray far from their mother, often riding on their mother's back. Despite the fact that dugong calves can eat seagrasses almost immediately after birth, the suckling period allows them to grow at a much faster rate. Calves mature between 6 and 9 years of age for both genders.n. Once mature, they leave their mothers and seek out potential mates. ("Australian Government Great Barrier Reef Marine Park Authority", 2002; Lawler, et al., 2002; Marsh, et al., 2002; "ARKive. Images of Life on Earth.", 2003)

Female's dugongs invest considerable time and energy in raising calves and are the primary caregivers of their young. Mothers and calfs form a bond which is strengthened throughout the long suckling period of the calf, which is up to 18 months, as well as physical touches that occur during swimming and nursing. Each female spends about 6 years with their calf. During the first 1.5 years, mothers nurse their calf and demonstrate how to feed on seagrasses. The next 4.5 years, or until the calf reaches maturity, are spent feeding together and bonding. In their early years, calves do not travel far from their mother as they are easy prey for sharks, killer
whales and crocodiles. (Lawler, et al., 2002; Marsh, et al., 2002; "ARKive. Images of Life on Earth.", 2003; Wursig, et al., 2002)

Lifespan/Longevity

Dugongs have lifespans of 70 years or more in the wild, which is estimated by counting the growth layers that make up a dugong's tusks. However, they are prone to a extensive array of parasites and diseases, some of which are infectious. Dugongs are difficult to keep in captivity due to their specialized diet, which is expensive to provide as the specific type of seagrasses cannot be grown in captivity. Calves are rarely seen in captivity because they suckle for about 18 months after birth. Only one orphaned calf has ever been successfully introduced into captivity in Australia. (Lawler, et al., 2002; Marsh, et al., 2002)

Behavior

Dugongs are a very social species and are found in groups varying from 2 to 200 individuals. Smaller groups usually consist of a mother and calf pair. Although herds of two hundred dugongs have been seen, they

are uncommon as seagrass beds cannot support large groups of dugongs for extended periods of time. Dugongs are a semi-nomadic species. They may migrate long distances in order to find a specific seagrass bed, but they may also inhabit a single range for most of their life. Traveling is driven by the quantity and quality of their primary food source, seagrass. If a certain seagrass bed is depleted, they move on to the next one.

Because dugongs are usually found in turbid water, they are difficult to observe without disturbing them. When disturbed, they rapidly and furtively move away from the source. They are quite shy, and when approached cautiously, they investigate diver or boat at a long range but hesitate to come any closer. Because of this and their difficulty to maintain in captivity, little is known regarding the behavior of dugongs. (Anderson, 1984; Lawler, et al., 2002; Marsh, et al., 2002; Spain, et al., 1977; Wursig, et al., 2002)

Communication and Perception

Dugongs are very social creatures, occurring in mother and calf pairs to herds of 200 individuals. Communication is therefore vital among individuals in this species. The two primary methods of communication this species uses are sound and vision. Much like dolphins, dugongs use chirps, whistles, barks and other sounds that echo underwater in order to communicate. Each sound has its own amplitude and frequency that characterizes the signal, which implies a possible purpose. For example, “chirp-squeaks” have frequencies between 3 and 18 kHz and last for about 60 ms.These "chirp-squeaks" were observed in dugongs foraging on the sea floor for vegetation and when patrolling territories. Barks are used in aggressive behavior and trills in movements that seem to be displays. In order to hear the ranges of sound, dugongs have developed exceptional hearing, which they use more than their sight. (Anderson and Barclay, 1995; Lawler, et al., 2002; Marsh, et al., 2002; Wursig, et al., 2002)

Visual communication is a useful source of communication when dugongs are in close contact. During breeding season, males perform lekkingbehavior, a physical display in a specific location to draw in females with which to mate. The vision of dugongs, however, is quite poor and they rely on other senses to create a mental map of their surroundings. Dugongs also utilize their sense of smell. They have an elementary olfactory system that allows them to sense chemicals in their environment to a certain degree. This can be used to detect other dugongs, or most likely, for foraging. They can smell aquatic plants and can therefore determine where the next feeding ground should be or where to proceed on their feeding furrow. (Anderson and Barclay, 1995; Lawler, et al., 2002; Marsh, et al., 2002; Wursig, et al., 2002)

Touch is another sense that dugongs use in order to communicate. They have sensatory bristles all over their body, including many on their lip, which help detect vibrations from their surrounds. This allows dugongs to

forage more efficiently as they can sense the seagrass against their bristles. This is particularly useful as it complements their poor eyesight. Mothers and calves also engage in physical communication, such as nose touching or nuzzling that strengthens their relationship. Mothers are almost always in physical contact with their calf, the calf either swimming beneath the mother by the fin or riding on top of her. Calve may even on occasion reach out a fin to touch their mother to gain reassurance. (Anderson and Barclay, 1995; Lawler, et al., 2002; Marsh, et al., 2002; Wursig, et al., 2002)

Food Habits

Dugongs are primary consumers and the only completely herbivorous marine mammals. They consume seagrass, particularly of the families Potamogetonaceae and Hydrocharitaceae in the genera *Halophila* and *Halodule*. They prefer seagrasses that are low in fiber, high in available nitrogen, and are easily digestible for better nutrient absorption. Their long intestine aids the digestion of seagrass. They also have a low metabolism. When seagrass is scarce, dugongs also eat marine algae. They are speculated to supplement their diet with invertebrates such as polychaete worms, shellfish and sea squirts which live in seagrasses. (Lawler, et al., 2002; Marsh, et al., 2002; Spain, et al., 1977; "ARKive. Images of Life on Earth.", 2003).Humpback Dolphin (*Sousa* spp.):

Kingdom : Animalia
Phylum : Chordata
Class : Mammalia
Order : Artiodactyla
Family : Delphinidea
Genus *:sousa*

Humpback dolphins are found in relatively shallow nearshore waters throughout their range which includes most of the coastlines in Australia, Africa and Asia. Their dependence on nearshore habitats brings them into contact with many types of human activities, putting them at risk from fisheries entanglement, boat traffic, pollution, and habitat loss. However, this habitat selection also makes them easy to observe from shore. There are four recognized species of humpback dolphins with very little overlap between their ranges: the, **Indo-Pacific humpback dolphin** (*Sousa chinensis*), the **Indian Ocean humpback dolphin** (*S. plumbea*) the **Atlantic humpback dolphin** (*S. teuszi*) and the **Australian humpback dolphin** (*S. sahulensis*) (Society for Marine Mammalogy 2017). Because they tend to be relatively shy, and less active than the bottlenose dolphins with which they often share territory, this species is not often the primary target of dolphin watching tours. However, they can be encountered in nearshore waters, and in some areas, like Hong Kong, and the Musandam Peninsula of Oman, they are the stars of the show.

Distribution

Humpback dolphins are limited in their range from the West coast of Africa in the West to the coast of China and the east coast of Australia in the

East and are always found in shallow nearshore waters. The four different species have distinct geographic ranges as follows:

Atlantic humpback dolphins are native to: Angola, Benin, Cameroon, Congo (Republic); Congo (Democratic Republic); Côte d'Ivoire, Equatorial Guinea ; Gabon ; The Gambia; Ghana; Guinea; Guinea Bissau; Liberia; Mauritania; Nigeria; Senegal; Sierra Leone, Togo; Western Sahara

Indian Ocean humpback dolphins are native to: Bahrain; Bangladesh; Comoros; Djibouti; Egypt, Eritrea; India; Iran; Iraq; Israel; Kenya; Kuwait; Madagascar; Mayotte; Mozambique; Myanmar; Oman; Pakistan; Qatar; Saudi Arabia; Somalia; South Africa; Sri Lanka; Sudan; Tanzania; UAE; Yemen.

Indo-Pacific humpback dolphins are native to: Bangladesh; Brunei Darrusalam;
Cambodia; India; Indonesia; Malaysia; Myanmar (Burma); People's Republic of China; Philippines; Singapore; Taiwan (Republic of China); Thailand; VietnamAustralian humpback dolphins are native to: Australia and Papua New Guinea.

Biology and Ecology

Humpback dolphins seem to be fairly adaptable in their diet, with studies from South Africa, Hong Kong, Australia and Oman revealing a variety of fish species, and sometimes crustaceans, squids, octopus and cuttlefish in the stomachs of by-caught or stranded animals (Barros, 2004). Humpback dolphins use a variety of feeding techniques, including partially stranding themselves on shore while chasing fish (Parra, 2017). In some locations, humpback dolphins are also known to follow fishing trawlers in order to opportunistically feed on discarded and escaped fish (Jefferson, 2016).

Irrawaddy Dolphin (Orcaellabrevirostris):

Taxonomy:

Kingdom : Animalia
Phylum : Chordata
Class : Mammalia
Order : Artiodactyla
Infraorder : Cetacea
Family : Delphinidea
Genus *:Orcaella*
Species : Orcaellabrevirostris

The humpback dolphin is a coastal dolphin that can be found along the coast of Africa and India south to Australia, areas differing for separate varieties. The humpback dolphin has a hump ahead of the dorsal fin, as well as a careen on a ventral side. The dorsal fin of the humpback dolphin is to some degree falcate. The pectoral fins are considerably small and the tail flukes have a well-defined median notch. On each side of the jaw there are 30 to 34 small coned-shaped teeth.

Newborn calves are a cream or pearl shade of white, much like that of an adult beluga whale, whereas the adults have a more dull off-white coloring from the tail to the snout. Their flanks are dark gray, and their stomachs are a lighter gray. Adults can reach from 1.8 to 2.6 metres (5 ft 11 in to 8 ft 6 in) and weigh in the range of 100 to

139 kilograms (220 to 306 lb).

Diet

The humpback dolphin's main diet consists of mullet and other fish, though the feeding habits are widely unknown, as this animal is not widely known itself.

Taxonom

- *Genus SousaS. chinensis (Indo-Pacific humpback dolphin)*
- *S. plumbea* (Indian Ocean humpback dolphin)
- *S. teuszii* (Atlantic humpback dolphin)
- *S. sahulensis* (Australian humpback dolphin)

By the mid-2000s, most authorities accepted just two species—the Atlantic and the Indo-Pacific. However, in his widely used systematic account, Rice identified three species, viewing the Indo-Pacific as two species named simply the Indian and Pacific. The dividing line between the two (sub)species is taken to be Sumatra, one of the Indonesian islands; however, intermixing is thought to be inevitable.

Further, Australian cetologist Gr aham Ross writes "However, recent morphological studies, somewhat supported equivocally by genetic analyses, indicate that there is a single, variable species for which the name *S. chinensis* has priority".

Humpback dolphins found in Chinese waters are locally known as Chinese white dolphins. See that article for specific issues relating to that subspecies which corresponds to the Pacific humpback dolphin in Rice's classification.

In late 2013, researchers from the Wildlife Conservation Society and the American Natural History museum proposed classification of the Indo-Pacific humpback dolphin into three species based on morphological and genetic analysis. Their research indicates that at least four species make up the genus *Sousa*: the Atlantic humpback dolphin (*S. teuszii*), two species of Indo-Pacific humpback dolphin (*S. plumbea* and *S. chinesis*), and a fourth, new species of Indo-Pacific humpback dolphin found off northern Australia, a distinction with potential to guide conservation efforts for the species.

Conservation

S. teuszii is listed on Appendix Iand Appendix II (along with *S. chinensis)*of the Convention on the Conservation of Migratory Species of Wild Animals (CMS). It is listed on Appendix I as this species has been categorized as being in danger of extinction throughout all or a significant proportion of its range and CMS Parties strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them. It is listed on Appendix II as it has an unfavourable conservation status or would benefit significantly from international co-operation organised by tailored agreements.

In addition, the Atlantic humpback dolphin is covered by the Memorandum of Understanding

Concerning the Conservation of the Manatee and Small Cetaceans of Western Africa and Macaronesia.

Whale Species:

Kingdom : Animalia
Subkingdom : Bilateria
Infrakingdom : Deuterostomia
Phylum : Chordata
Subphylum : Vertebrata
Infraphylum : Gnathostomata
Superclass : Tetrapoda
Class : Mammalia
Infraclass : Eutheria
Order : Cetartiodactyla
Suborder : Mysticeti and Odontoceti

Habitat and diet:

Whales are found worldwide, in all oceans and adjoining seas, as well as certain lakes and river systems. Toothed whales eat fish, octopus, squid, and crustaceans like shrimp. Baleen whales eat krill (tiny shrimplike creatures) and zooplankton (tiny animals), strained from huge seawater. Gray whales suck up mud from the ocean floor and strain out the small worms and crustaceans that live there

Life span

Some species are thought to live more than 100 years.

Young

Gestation: 9 to 17 months, depending on species

Number of young at birth: 1

Age of maturity: Females, 4 to 28 years; males, 4 to 35 years, depending on species

Life Span:

Some species are thought to live more than 100 years

Young:

Gestation: 9 to 17 months, depending on species

Number of young at birth: 1

Age of maturity: Females, 4 to 28 years; males, 4 to 35 years, depending on species

Size:

Length: Longest - blue whale *Balaenoptera musculus*, 70 feet (21 meters); shortest - Hector's beaked whale *Mesoplodonhectori*, 4.5 feet (1.4 meters)

Weight: Heaviest - blue whale, 63 tons (64.4 tonnes); lightest - Hector's beaked whale, 105 pounds (48 kilograms)

Discussion

Various human activities, including fishing, whale watching, vessel crashes, noise pollution, habitat change or loss, and auditory disturbance, provide a direct and indirect hazard to marine mammals6. As a result, the IUCN Red List now does not include 37% of marine mammals Nevertheless, the species-level nor the global levels of marine animal sensitivity to global warming have been evaluated. Here, we demonstrated using a species-level trait-based approach that even under a strong mitigation which, based on the CMIP5 simulations, would still leave many marine mammal species spread across the northern hemisphere and belonging to different taxonomic groups extremely vulnerable to global warming . Marine animals are under risk from

both direct and indirect human activities, such as fishing, whale watching, ship wrecks, noise pollution, habitat loss or alteration, and auditory disturbance64. Consequently, 37% of marine mammals are currently included on the IUCN Red List). However, no assessment has been done on the global or species-level susceptibility of marine animals to global warming. Here, we showed using a species-level trait-based method that many marine mammal species distributed throughout the northern hemisphere and belonging to various taxonomic groups would still be highly vulnerable to global warming even under a strong mitigation scenario which was based on the CMIP5 simulations.

As evidenced by the findings of previous studies that concentrated on a variety of terrestrial and marine organisms the marine mammals that are most vulnerable to climate change typically exhibit marked specialization in feeding and habitat, as well as smaller or fragmented geographic ranges (e.g., the walrus Odobenusrosmarus and the dugong Dugongdugon). For many of the marine species most vulnerable to climate change, such as the beluga whale Delphinapterus leucas and the polar bear Ursus maritimus, reliance on sea ice also appears to be a common denominator.

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Marine Fisheries

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Fisheries science and management play crucial roles in sustaining aquatic ecosystems and meeting the global demand for seafood. Fisheries science involves the study of fish population, their behavior and the dynamics of aquatic environment. This knowledge is effective, fisheriesstock at sustainable levels while considering ecological balance. In fisheries science, researchers employ various methods, including population modeling, tagging studies and genetic analysis, to understand fish population and their interactions with the environment. These Studies provide insights into fish migration pattern, reproduction cycles, and the impact of environmental factors on fish health. Fisheries management involves implementing strategies to ensure the responsible and sustainable use of aquatic resources. One key aspect is establishing and enforcing fishing regulations, such as catch limited and seasonal closures, to prevent overfishing and preserve fish population.Collaborative efforts between scientists, policymakers and the fishing industry are crucial for the success of these measures.

Technological advancements, such as satellite tracking and data analytics, have enhanced the precision of fisheries management. Real time monitoring allows authorities to adjust regulations promptly based on the latest information, contributing to adaptive and effective management strategies.Integrated approaches, including ecosystem based management, consider not only the target species but also the broader

ecological content. This involves understanding the interdependence of various species and their roles in maintaining a healthy ecosystem. By adopting holistic approaches, fisheries management can address the complex interaction with aquatic environment and promote long term sustainability.

Climate change poses additional challenges to fisheries science and management rising sea temperatures, ocean acidification and altered ocean current an impact fish and migration patterns. Adapting management strategies to these changing conditions is essential for safeguarding both fish populations and the livelihoods of those dependent on the fishing industry.International cooperation is a crucial for managing fisheries that span multiple jurisdictions. Overfishing in one region can have cascading effects on ecosystem and economics worldwide. Sustainable managementrequires collaboration between nations to establish and enforce shared conservation measures.

Fisheries science is the academic discipline of managing and understanding fisheries. It is a multidisciplinary science, which draws on the disciplines of limnology, oceanography, freshwater biology, marine biology, meteorology, conservation, ecology, population dynamics, economics, statistics, decision analysis, management, and many others in an attempt to provide an integrated picture of fisheries.In some cases new disciplines have emerged, as in the case of bioeconomics and fisheries law. Because fisheries science is such an all-encompassing field, fisheries scientists often use methods from a broad array of academic disciplines.Over the most recent several decades, there have been declines in fish stocks in many regions along with increasing concern about the impact of intensive fishing on marine and freshwater biodiversity.

The goal of fisheries management is to produce sustainable biological, environmental and socioeconomic benefits from renewable aquatic resources. Wild fisheries are classified as renewable when the organism 5ths of interest (e.g., fish, shellfish, amphibians, reptiles and marine mammals) produce an annual biological surplus that with judicious management can be harvested without reducing future productivity.Fishery management employs activities that protect fishery resources so sustainable exploitation is possible, drawing on fisheries science and possibly including the precautionary principle.In conclusion, fisheries science and management are integral components of preserving aquatic biodiversity and ensuring a sustainable supply of seafood. By combining scientific research, technological innovation, international collaboration we can work towards a future where fisheries thrive in balance with the natural environment.

Genetic Diversity in Marine Species

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Introduction

Genetic diversity is the biological variation that occurs within species. It makes it possible for species to adapt when the environment changes. Genetic diversity is particularly important under rapid environmental change, such as in the Baltic sea. The proportion of genetic diversity due to population subdivision rises from 1.6% in marine species to 3.7% in anadromous and to 29.4% in freshwater species. Likewise the level of genetic differentiation measured with mitochondrial DNA is lower in marine than freshwater fishes.

Measuring Genetic Diversity

Gel electrophoresis coupled with histochemical staining of specific proteins was developed in the 1960s and became the most widely used method for measuring genetic variation in natural populations. The gel phenotypes are easy to interpret and there are computer programmes available for data analyses. Most surveys of genetic diversity in marine species have used proteins, and diversity is measured as the average heterozygonus at a single gene locus.Invertebrates generally have higher levels of genetic diversity than vertebrates as measured by protein electrophoresis. Within the vertebrates amphibia have the highest and leleosts the lowest levels of genetic diversity.

The ecological significance of these findings have been debated for marine species. Marine invertebrates show wide variation in levels of genetic diversity. In 26 species of mollusc heterozygosities range from 2 to 32%. The crustacea have lower levels of genetic diversity ranging from 0.4 to 10.9% in 44 species of decapod from 0.8 to 6.4 % in six species of tropical stomatopod from the gulf of Carpentaria and from 0.6 to 3.33% in 13 species of australasian prawns in mulley and letter 1980. In marine leleostsheterozygosities range from in the anglerfishes *lophiuslitulor* and *L. Piscatorius*, liparistanakai and three species of cottidaeto more than 17% in the pelagic *cololabrissaira* and costal *Fundulusheteroclitus*. The mean heterozygosity for 106 marine species was 5.5% within high levels in clupeiformes, atheriniformes and pleuronectiformes and low levels in gadiformes and scorpaeniformes. Elasmobranchs have low

heterozygosities.

Criptic Species

Several allozyme studies have revealed cryptic species in coastal fisheries and have shown that resources considered to be single taxa consist of two or more species. Examples of cryptic species have been found in squid, octopus, bivalves, swellfishes, silversides, lizard fishes, bone fishes, and small pelagics.

Pollution Indused Genetic Species

The effects of pollution on coastal resources are often dramatic with mass mortalities in local stocks, reduction in species diversity, and changes in species composition.Most examples of pollution induced genetic changes are for species with limited dispersal abilities; molluscs may be recruited from outside the area of pollution but the juvenile and adult stages are sessile.Laboratory studies on molluscs and crustacea have demonstrated differential survival of allozyme genotypes exposed to heavy metals. Similar changes in gene frequencies have been detected in marine organisms exposed to crude-oil, some studies have also found no evidence for genotypic selection in *Mytilusedulis* exposed to low concentrations of oil in Norwegian fjords.

Life History Characters:

Most marine fishes and invertebrates are iteroparous, reproduce over several years, whereas the Pacific salmon, genus Oncorhynchus, are semelparous, reproducing once in their lifetime. Many species are highly fecund and the life history includes a dispersive phase. However, there are considerable interspecific variations in lifespan and fecundity, and many of the widely distributed species exhibit long spawning seasons with the time of spawning varying latitudinally. In the pink salmon *Onorhynchusketa* the time of return for spawning has a genetic component. In the European scallop *Pectenmaximus* transplant experiments have demonstrated a genetic component to spawning period and there are intra-stock differences for this character. Size at sexual maturity varies between intraspecific stocks in skate *Raja radiata*.American plaice *Hippoglossoidesplatessoides*. Herring *Clupeaharengus* and European plaice *Pleuronectesplatessa* show geographic variations in fecundity and cod *Gadusmorhua* intraspecific differences in age at maturity.

Analysis of Groundwater Quality from Kanyakumari to Nagercoil, Tamilnadu, India.

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Abstract

Groundwater is the main source of water in the arid and semi-arid environment which fulfills the requirement of different beneficial-uses drinking, domestic, and irrigation particularly for the rural population.Kanyakumari Districts is one of the smallest districts in the state having an area of 1584 square kilometer, of which 1541.3 square kilometer falls in rural area and the remaining part falls in urban area. The district lies between 77˚06'36"E and 77˚36'E longitude and 8˚05'24"N and8˚35'24"N latitude. The coastal line extends over 58 Kms and is almost regular except for some points and land projecting into the sea at Kanyakumari.Groundwater samples were collected as grid from at 20 locations during the post monsoon seasons in the year 2021. The quality evaluation of existing groundwater resources is vital and its quantity for the optimal utilization and maintenance. Groundwater quality depends on the quality of recharged water, atmospheric precipitation, inland surface water and on sub-surface geochemical processes. Liquid water has weak absorption bands at wavelengths of around 750 nm which because it appears to have a blue color. This can easily be observed in a water-filled bath or wash-basin whose lining is white. Large ice crystals, as in glaciers, also appear blue. The physical parameters taken into consideration are color, odor, turbidityand temperature. The chemical parameters taken into consideration are hydrogen ion consideration (pH), specific conductance (EC), total dissolved solids (TDS), total hardness (TH) and all major cations and anions. They are analyzed for various physicochemical parameters in the laboratory. Calcium (Ca) and Magnesium (Mg) were determined titrimetrically using standard EDTA; Chloride (Cl) was determined by standard $AgNo_3$ titration; Bicarbonate (HCO_3) was determined by titration with H2SO4; Sodium (Na) and Potassium (K) were determined by Flame photometer; Sulphat (SO_4) was determined by spectrophotometric turbidimetry. The study area of Ramanathapuram groundwater quality indicate that it was not contaminated in many areas by the reported parameters. The reason for contamination of some place of Ramanathapuram is due to saline water intrusion to contaminated the groundwater. The study area is always under stress due to increasing population and more demand for water resources.

Keywords: Groundwater quality, Drinking and irrigation purpose, Suitability health risk assessment, Sensitivity analysis.

Introduction

Ground water is a very valuable natural resource for the economic development and secure provision of potable water supply in both urban and rural environments (Ghezelsofloo and Ardalan, 2012; Wakode et al. 2014). Nowadays groundwater pollution has become one of the most serious problems throughout the world. Urbanization, industrialization and agricultural activity affecting groundwater quantity and quality (Tiwari et al. 2015; Rubia and Jhariya, 2015; Khan and Jhariya, 2016). Water pollution threats human health, economic development and social success (Wakode et al. 2014; Tiwari et al. 2015). The Goal 6 of the UN Sustainable Development Goals (SDG), in particular, recognizes the importance of achieving "universal and equitable access to safe and affordable drinking water for all" by the year 2030. As such, the problem of water insecurity is essentially two-faced. First, owing to a rapid expansion of population and industrialization, primary water demands are rising by leaps and bounces, and consequently the existing sources are gradually becoming inadequate and unreliable. Second, due to severe deterioration of water quality, available water resources are increasingly becoming unsuitable or even dangerous for human consumption (Saraswat et al. 2016).

In general, both surface and groundwater can be used to meet the demands for potable water, when it is treated sufficiently to meet the prescribed standards (Bauder et al. 2011). Nonetheless, traditionally groundwater is preferred over surface water because of its reliability during extreme weather situation, namely droughts/floods, lesser contamination and relatively lower treatment costs. More specifically, due to the lesser probability of bacterial contaminations, groundwater serves as a popular and reliable source that can be consumed with little or even without any treatment. In India, for instance, around 80% of the rural population and more than 50% of the urban population directly depend on groundwater for the domestic water consumption (Biswas et al. 2014).

Study area

The Kanyakumari district has been selected for the present study. It is present at the bottom most part of India. It is one of the most popular districts of Tamil Nadu. The study area is surrounded by Kerala state in western part, Tirunelveli district of Tamil Nadu at Northern part, Indian Ocean at Southern part, Bay of Bengal at Eastern part and the South West part is covered by Arabian Sea. Kanyakumari Districts is one of the smallest districts in the state having an area of 1584 square kilometer, of which 1541.3 square kilometer falls in rural area and the remaining part falls in urban area. The district lies between 77˚06'36"E and 77˚36'E longitude and 8˚05'24"N and8˚35'24"N latitude. The coastal line extends over 58 Kms and is almost regular except for some points and land projecting into the sea at Kanyakumari.

Nagercoil city and its surroundings commonly called as

"Nanjilnadu" has an average elevation of about 13 m above the mean sea level. Sandwiched between the Arabian Sea and the Western Ghats, the city is surrounded by hills, lush green paddy field, and sandy beaches on western sides. Nagercoil has a pleasant, tough humid climate for major part of the year. The average annual rainfall of this district, 70 years is 1,448.6 mm. The normal annual rainfall of the district varies from about 826 to 1456mm. A general overall view of rainfall pattern recorded in the different rainfall stations indicate that the precipitation varies from 764.30 to 208.30 mm. Most of the rainfall occurs during NE and SE monsoon periods. The contribution of southwest monsoon and northeast monsoon are 37.16 and 37.18 % of the annual rainfall, respectively (Bhagavathi Perumal and Thamarai 2008b). The temperature data indicate higher and lower temperatures prevailed during monsoon period.

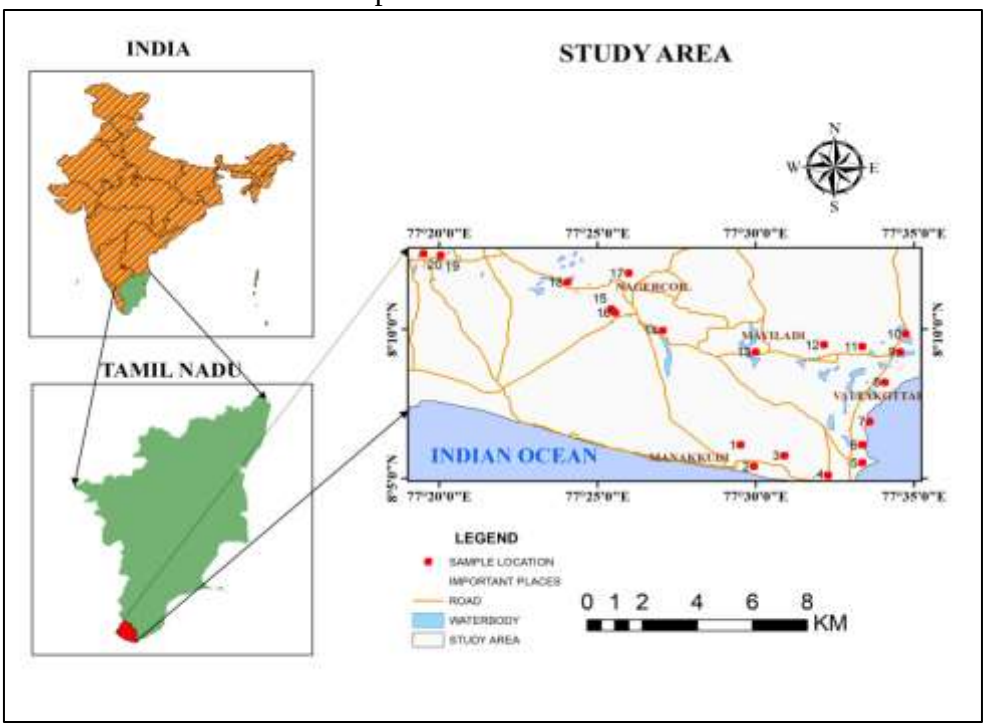


Fig. The map shows the sample location of the study area

Material and Methods

This chapter describes the methods of sample collection and analytical procedure adopted for analysis of groundwater samples of Kanyakumari district using different analytical methods. To evaluate the impact of contaminants on groundwater of Kanyakumari district, water samples were collected from 20 different selected sites in February 2021.To assess the level of groundwater contamination, sampling of groundwater done from hand pumps and bore wells located in residential and agricultural areas, as per the standard procedure. The samples were collected

in acid-washed polyethylene bottle. During sample collection and transportation of water samples to the laboratory, all necessary precautions were taken. Bottles first washed with dilute nitric acid than thrice with water. Before sample collection bottles were rinsed thrice with water to be sampled and then samples were collected. Electrical conductivity (EC) and hydrogen ion concentration (pH) were determined on the field itself using digital meters.

Groundwater samples of various locations were analyzed for determination of degree of pollution with respect to the following physiochemical parameters and heavy metals opted for investigation.

- P^H
- EC (Electrical conductivity)
- TDS (Dissolved solids)
- Calcium
- Magnesium
- Sodium
- Potassium
- Chloride
- Bicarbonate
- Sulphate
- Nitrate
- Fluoride

The groundwater samples collected to the field and samples were analyzed in the laboratory forconcentrations of major ions. They are analyzed for various physicochemical parameters in the laboratory. Calcium (Ca) and Magnesium (Mg) were determined titrimetrically using standard EDTA; Chloride (Cl) was determined by standard $AgNo_3$ titration; Bicarbonate (HCO_3) was determined by titration with HCL; Sodium (Na) and Potassium (K) were determined by Flame photometer; Sulphate (SO_4) was determined by spectro photometric turbidimetry. The After completion of the analysis of major ions, the ion balance error was calculated. In general, the ion balance error was within 10%. All concentrations are expressed in milligrams per liter (mg/l), except pH, EC and TDS. The EC concentrations were expressed in µs/cm and TDS concentrations were expressed in ppm.

The spatial analysis of various physicochemical parameters was carried out by using GIS contouring methods with Q GIS. The inverse distance weighted (IDW) interpolation techniques have been used for preparing the spatial distribution maps for each physicochemical parameter. The spatial distribution map of the pH, EC, TDS, TH, cations (Ca^{2+}, Mg^{2+}, Na^+ and K^+) and anions (Cl^-. HCO_3^-, SO_4^-, NO_3^- and F^-).

Results and discussions

The Groundwater quality data were shown in Table.4.1 during the year of 2021. Groundwater quality in the Kanyakumari district with the help of Q-GIS data were interpolated for the spatial distribution map. The spatial structures were also identified interpolating the scattered data, in order tohave temporal series of spatially continuous maps of the parameters. We used Inverse Distance to a power

gridding method as a smoothing interpolator. In this method data are weighted during interpolation such that the manipulation of one point relative to other declines with the distance. In particular, we use a quadratic law for computation of the weight, and a low value for smoothing parameters.

Table. Physical and Chemical parameters of water samples

S.No	Sample Locations	Physical Parameters			Chemical Parameters (ppm)					
		pH	EC(µS/cm)	TDS(ppm)	Ca	Mg	Na	K	Cl	HCO3
1	Manakudi	8.23	2900	1450	30	40	155	25	1070	124
2	Keezha Manakudi	7.99	1002	503	5	15	66	8	350	53
3	Ponnarvilai	8.36	271	205	5	20	64	6	60	42
4	Kovalam	8.08	1557	790	5	35	207	19	360	158
5	Poongulathuvilai	8.24	960	577	5	50	65	6	380	64
6	Swaminathapram	7.78	1285	703	10	30	47	4	570	35
7	Kalluvilai	8.31	362	330	5	20	30	4	210	53
8	Vattakotai	8.05	122.9	211.4	5	10	32	4	130	22
9	Anjugramam	8.18	661	430	5	30	58	5	220	106
10	Visvanathapuram	8.15	991	497	5	10	45	3	280	149
11	Azhagappapuram	8.35	564	281	5	15	46	3	140	67
12	Azhagappapuram	8.46	531	266	5	10	82	8	50	105
13	Mylaudy	7.8	916	456	5	20	125	12	180	106
14	Susinthiram	7.56	724	364	5	25	66	6	200	53
15	Nagercoil	7.46	360	249	5	45	38	3	120	31
16	Nagercoil	7.2	1010	507	5	50	136	12	270	28
17	Nagercoil	7.9	1284	640	5	60	100	11	350	104
18	Kattayanvilai	7.99	55.8	107.9	5	20	28	5	30	15
19	Mottavilai	6.52	1161	579	5	45	23	3	460	37

20	Eraniel	7.29	87.1	173.4	5	40	41	5	60	14
Minimum		6.52	55.8	107.9	5	10	23	3	30	14
Maximum		8.46	2900	1450	30	60	207	25	1070	158
Average		7.89	840.24	465.97	6.5	29.5	72.7	7.6	273	68.3

Hydrogen Ion Concentration

pH is the measure of hydrogen ion concentration value in water which indicates whether a solution is acidic, neutral or basic. The pH required has to be in the range of 6.5–8.5 for the drinking purpose (BIS, 2009). The pH of the groundwater samples lies between 6.5 and 8.4 indicates that the underground water in this area is ideal for agricultural as well as domestic purposes.The pH of water changes with the production of hydrogen or hydroxyl ion during different chemical reactions. It is noticed that water with low pH is tend to be toxic and with high degree of pH it is turned into bitter taste.

Table. Drinking water quality standards WHO (2004) and BIS (2012)

Parameters	WHO (2004)		BIS (2012)	
	Acceptable limit	Permissible limit	Acceptable limit	Permissible limit
Ph	7.0-8.5	9.2	6.5-8.5	
EC			-	-
TDS	500	1500	500	2000
Ca^{2+}	75	200	75	200
Mg^{2+}	50	150	30	100
Na^{+}	-	200	-	-
K^{+}	-	500	-	-
Cl^{-}	200	600	250	1000
HCO_3^{-}	-	600	250	1000
SO_4^{2-}	200	400	200	400
NO_3^{-}	-	45	45	No relaxation

Unit: concentrations are in mg/L except EC (µS/cm), and pH.

Table.pH – Limiting values with respect to BIS standard

S.NO	pH – Limiting values	Prtability	Percentage of samples%
1	<6.5	Non-Potable	Nil
2	6.5-8.5	Potable	100
3	>8.5	Non-Potable	Nil

Electrical Conductivity

Electrical conductivity (EC) is a measure of water capacity to convey electric current and importance to salinity; which greatly affects the taste. Chemically pure water has a low electrical conductivity, indicating that it is a good insulator. It directly related to concentration of ionized substances in water and may also be related to problems in excessive hardness EC is expressed in terms of the specific electrical conductivity, which is defined as the reciprocal of electrical resistance in Ohm (Q), in relation to a water cube of edge length 1 cm at 25°C. Electrical conductivity is the capacity of electrical current that passes through the water. The most desirable limit of EC in drinking water is prescribed as 1,500 µS/cm.EC rich in center of the study area. The open and bore well EC results.

Table.EC - Limiting values

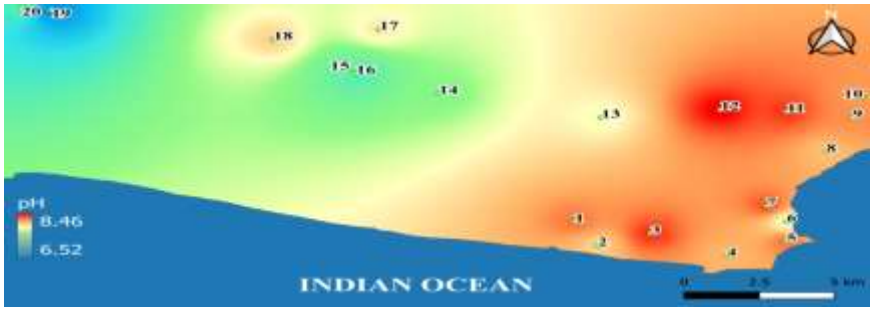
S.NO	EC-Limiting values	Portability	Percentage of samples%
1	<750	Good	50
2	750-4000	Medium	50
3	>4000	Poor	Nil

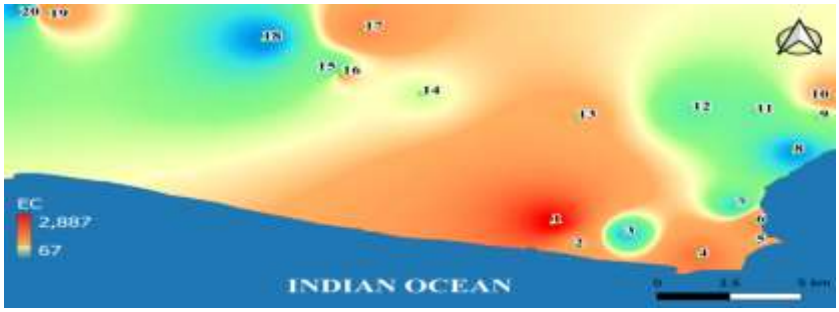
Total Dissolved Solids (TDS)

Total dissolved solids (TDS) refer to the total amount of all inorganic and organic substances including minerals, salts, metals, cations or anions that are dispersed within a volume of water. The principal constituents are usually the cations calcium, magnesium, sodium and potassium and the anions bicarbonate, chloride, nitrate and sulphate in groundwater. The concentration of Total Dissolved Solids ranges from 107.9 to 1450 mg/l with an average of 465.97 mg/l.TDS rich in some place in center part of the study area. The limiting values of TDS.

Table.TDS – Limiting values

S.NO	TDS-Limiting values	Portability	Percentage of samples%
1	<500	Good	65
2	500-2000	Medium	35
3	>2000	Poor	Nil





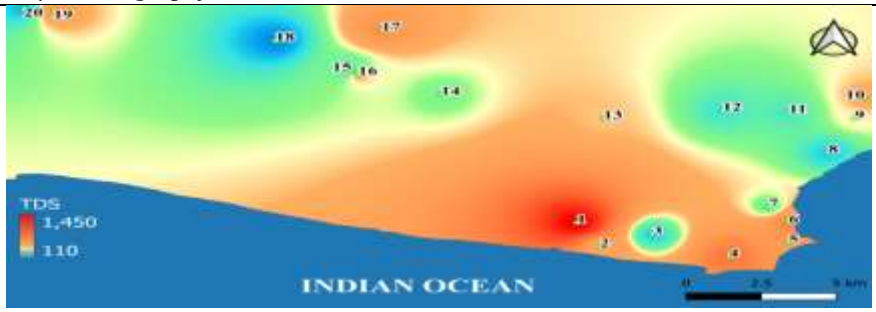


Fig.Spatial distribution of pH, EC and TDS in the groundwater

calcium (Ca)

Calcium is one of the most abundant substances in the water. The high concentration of calcium ions can cause abdominal ailments and is undesirable for domestic use as it causes encrustation and scaling (Kumar et al. 2014). It is produced as a result of dissolution processes of sedimentary rocks (calcite, aragonite, limestone, dolomite and gypsum) and from weathering of igneous rocks like (pyroxene, amphibole and plagioclase feldspar).Calcium rich in some place in center part of the study area. About 95% calcium in human body stored in bones and teeth.Most samples fall within the acceptable and allowable limit, only three samples fall above the WHO's limitation values.

Table. Calcium limiting values

S.NO	Calcium limiting values	Portable	Percentage of sample%
1	<75	Acceptable limit	100
2	75-200	Allowable limit	Nil
3	>200	Not Potable	Nil

Magnesium (Mg)

Magnesium ions are smaller than sodium and calcium ions and it is one of the necessary elements for plants and animals. Magnesium is also found in igneous rocks and minerals such as (olivine, pyroxene and amphiboles) and metamorphic rocks such as (serpentine and talc). It is an essential for proper functioning of living organisms and found in minerals like dolomite, magnesite etc. Human body contains about 25g of magnesium (60% in bones and 40% in muscles and tissues) (Ramesh and Balakumaran 2018).The higher concentration of the magnesium due to rock water interaction and rest of the portion was observed in downstream portion. The limiting values for magnesium are given in Table.4.7. Magnesium rich some of the place in north side.Magnesium concentration ranges from 10 to 60 mg/l. The Magnesium concentration was more in sample 1 and 3, the spatial distribution map.

Table. Magnesium limiting values

S.NO	Magnesium limiting values	Potable	Percentage of samples%
1	<30	Acceptable limit	50
2	30-100	Allowable limit	50

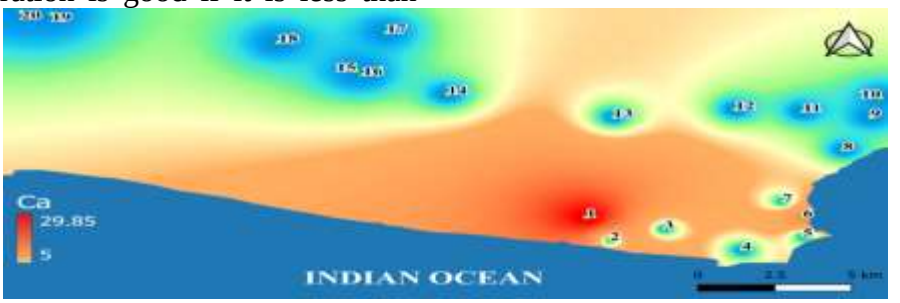
3	>100	Not potable	Nil

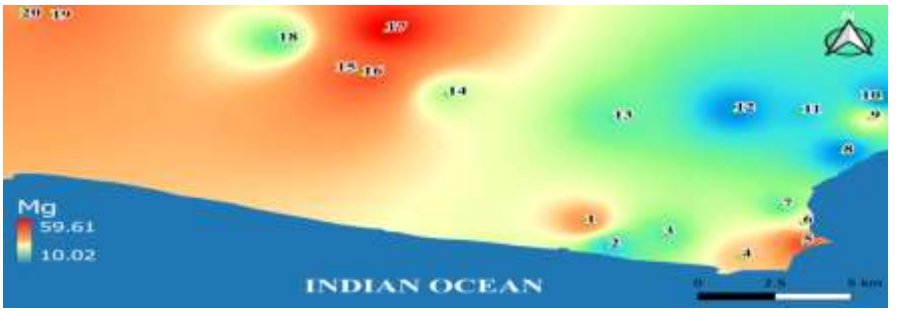
Sodium (Na)

Sodium is a metallic element and found in less quantity in water. The source of sodium in groundwater and comes from erosion of alkalinity feldspar and evaporation rocks and from ionic exchange of clay minerals. Human activities can have significant influences on the concentration of sodium in ground and surface water. Proper quantity of sodium in human body prevents many fatal diseases like kidney damages, hypertension, headache etc.., (Ramesh and Balakumaran 2018). Sodium concentration is good if it is less than 250 mg/l (WHO, 1996) concentration. Sodium is found to be the most abundant ion in the groundwater of the study area. Sodium rich in center part of the study area. The open well sodium concentration in the groundwater of the study area ranged from 23 to 207 mg/l, with an average value of 72.7 mg/l.

Table. Sodium limiting values

S.NO	Sodium limiting values	Potable	Percentage of sample%
1	<200	Acceptable limit	95
2	>200	Not Potable	5





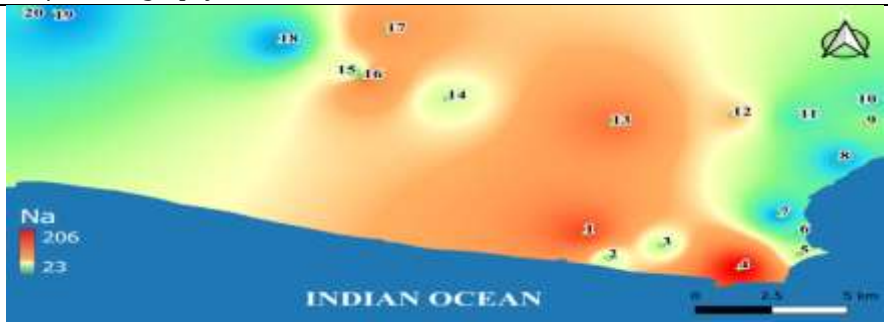


Fig.Spatial distribution of Ca, Mg and Na in the groundwater

Potassium (K)

Potassium is slightly less common the sodium in igneous rocks but more abundant in all sedimentary rocks. The main source of potassium is the products formed by weathering of igneous minerals like (orthoclase, biotite and feldspathoid leucit) and sedimentary rocks. Potassium is an essential element for plants and animals; however, high concentration may be harmful to human nervous and digestive systems due to its laxative effects. Potassium deficient in rare but may led to depression, muscle weakness, heart rhythm disorder etc.

Table.Potassium limiting values

S.NO	Potassium limiting values	Potable	Percentage of sample%
1	<10	Acceptable limit	75
2	>10	Not Potable	25

Chloride (Cl)

The source of chloride in groundwater is from dissolution of sedimentary rocks particularly evaporates like halite and sylvite and ancient sea water entrapped in sediments. Chloride is also abundant in the minerals found in igneous rocks like apatite, feldspathoid and sodalite. Chloride is also obtained from the dissolution of salts of hydrochloric acid as NaCl, $NaCO_2$ and added through industrial and domestic waste water, sewage, sea water etc. Excess chloride (>250 mg/l) imparts a salty taste to water. High chloride concentration affects the aesthetic property of water including taste and renders it unsuitable for drinking purpose.

Table. Chloride limiting values

S.NO	Chloride limiting values	Potable	Percentage of samples%
1	<250	Acceptable limit	55
2	>250	Not potable	45

Bicarbonate (HCO_3)

Bicarbonate ions are considered the source of water alkalinity. Alkalinity is the ability of water for interaction with ion of hydrogen. CO_2 gas in the atmosphere or in the soil dissolved in water is the principal source of bicarbonate, in addition to solution of carbonate rocks and oxidation of organic matter. It is the standard alkaline constitute found almost all surface and groundwater

bodies and therefore affects alkalinity and hardness of water. Mostly bicarbonates are soluble in water i.e., bicarbonate of magnesium and calcium etc, is the main causes of hardness of water. The hard water is not suitable for drinking purpose and causes the gastro diseases.

Table.Bicarbonate range values

S.NO	Bicarbonate limiting values	Potable	Percentage of samples%
1	<500	Acceptable limit	100
2	>500	Non potable	Nil

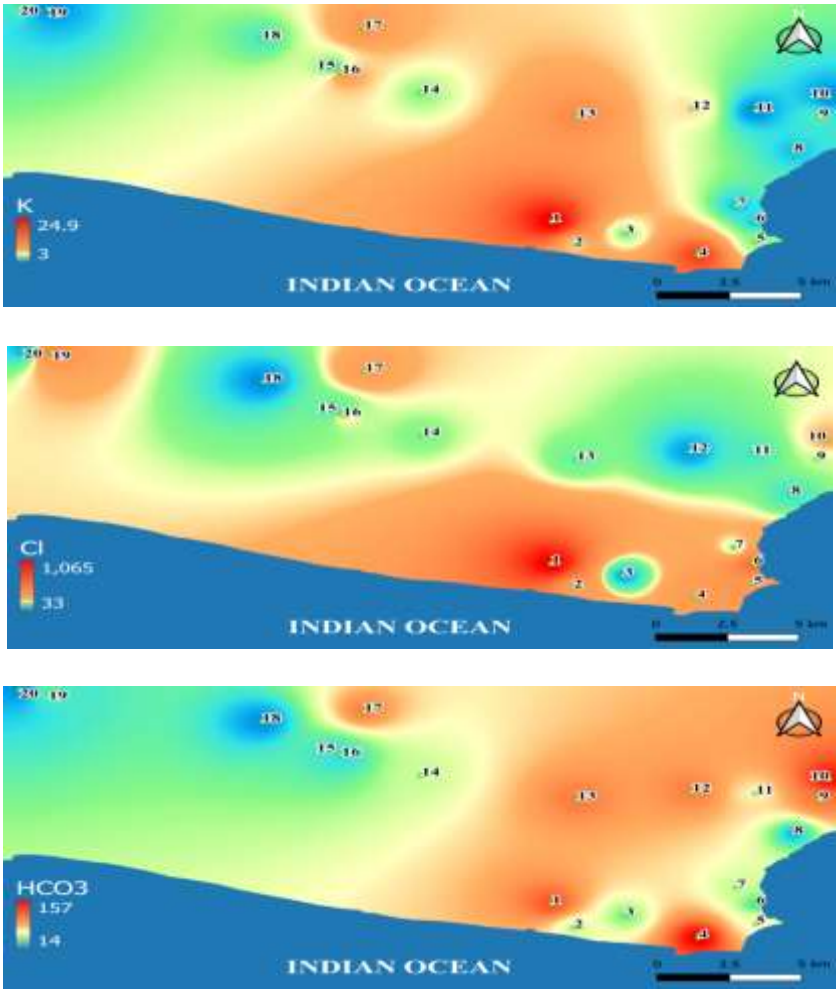


Fig.Spatial distribution of K, Cl and HCO3 in the groundwater

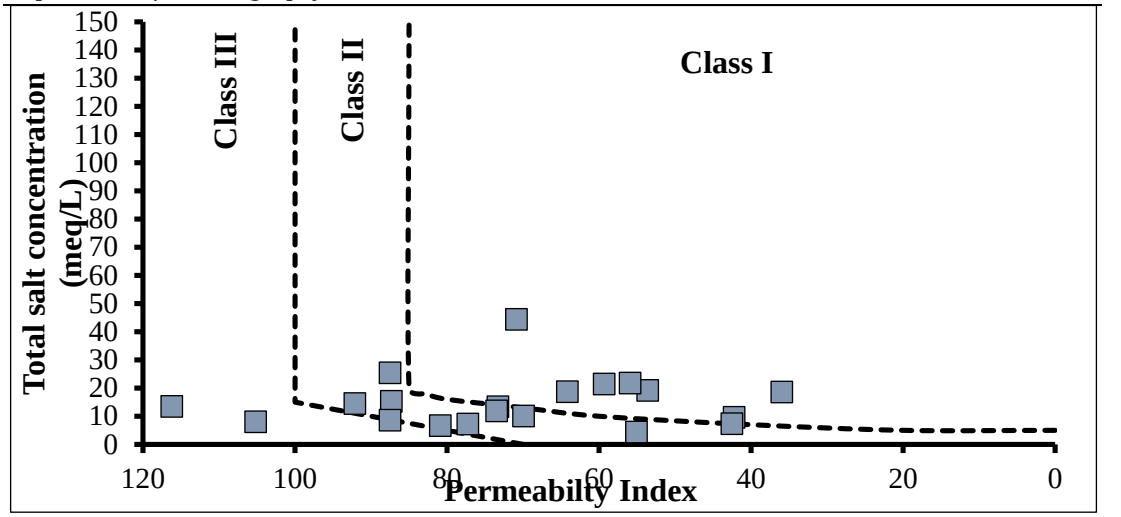


Fig.Suitability of groundwater for irrigation based on permeability index in the study area.

Permeability Index (PI)

Permeability index developed by Doneen in 1964 is important parameters that influence the quality of water for irrigation. Soil permeability is affected or reduced by long term use of irrigation water containing high salts (Sing and Sing 2008). A criterion for assessing the suitability of water for irrigation was based on PI water and can be classified as class I class II and class III orders. Class I and class II water was categorized as good for irrigation purpose with 90% or more maximum permeability. Class III water was unsuitable with 10% of maximum permeability. The PI of the groundwater samples ranges 40% of samples of the study area belongs to class I, 50% of samples of the study area belongs to class II and 10% of samples fall in class III. The increased % of groundwater samples under class II are due to dilution and subsequent lower values of PI.

Sodiam Percentage (%) Diagram

Sodium considered as the main factor for determine groundwater suitability for agricultural purposes. Irrigation water containing large amounts of sodium is of special concern because, it reduces soil permeability and porosity as well as increases the hardness of soil, thus will affect the plant growth or stunted growth. Presence of sodium is usually expressed in terms of Na% and is calculated by the formula (Ramesh 2018). The classification of groundwater for irrigation was grouped based on sodium percentage as Very good (<20%), Good (20-40%), Permissible (40-60%), Doubtful (60-80%) and Unsuitable (>80%). Based on Na% the value <60% is suitable for irrigation purposes and >60% is unsuitable.

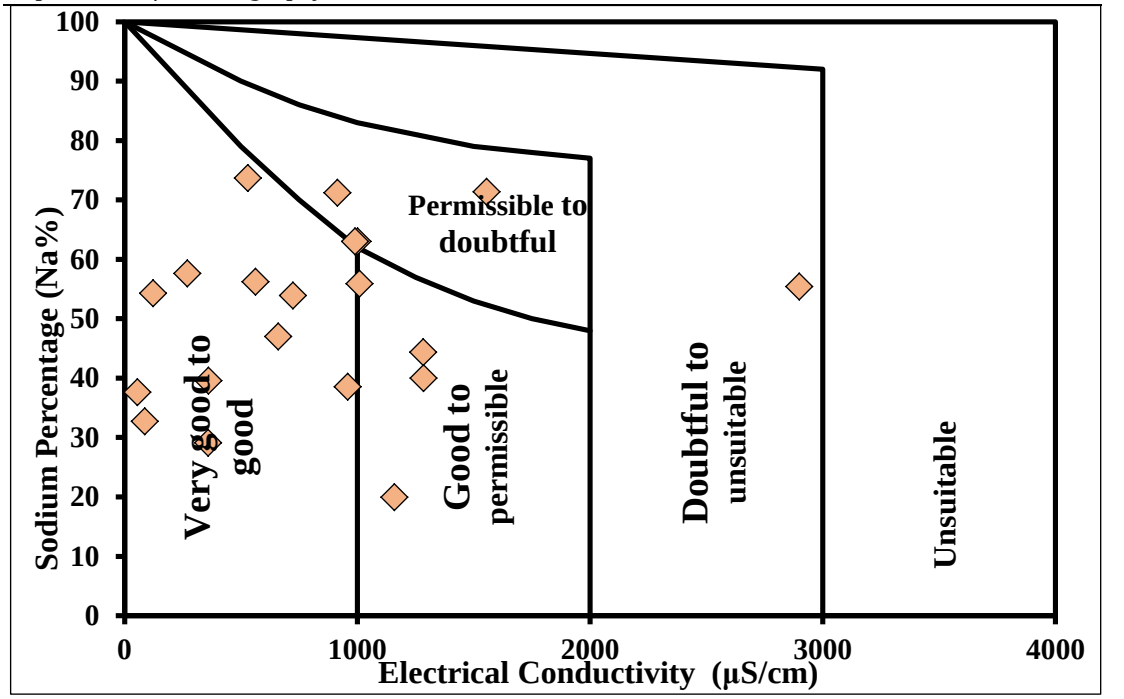


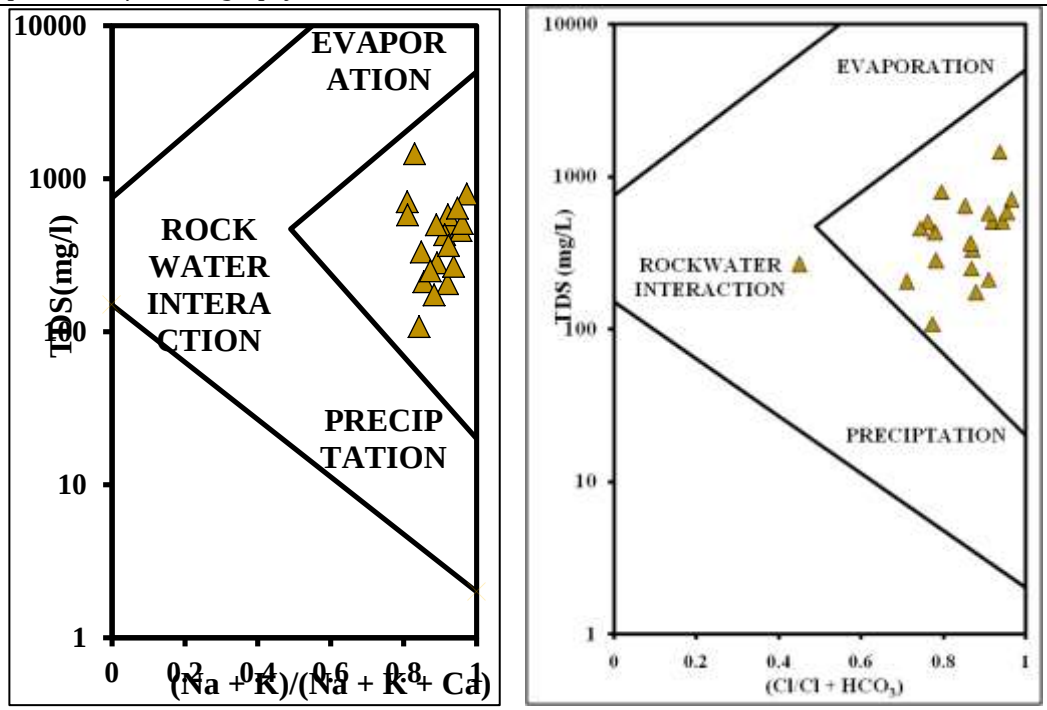
Fig. Suitability of groundwater for irrigation based on Na% in the study area.

Gibbs Diagram

Gibbs diagram is widely used to establish the relationship of water composition and aquifer lithological characteristics. Three distinct fields such as precipitation dominance, evaporation dominance and rock–water interaction dominance areas are shown in the Gibbs diagram (Gibbs, 1970). The predominant samples fall in the rock–water interaction and evaporation field of the Gibbs diagram (Fig. 4.6). The rock–water interaction field indicates the interaction between rock chemistry and the chemistry of the percolated waters under the subsurface conditi

Ussl Wilcox Diagram

The best measures of a water likely effect on soil permeability, soil structure and create toxic conditions for plant growth is the water SAR considered together with its EC. The US salinity diagram which is based on the integrated effect of EC (salinity hazard) and SAR (alkalinity hazard) has been used to assess the water. The results of the study revealed that SAR of the water samples varied from 1.0 to 10.



Mechanisms governing groundwater chemistry (after Gibbs, 1970)

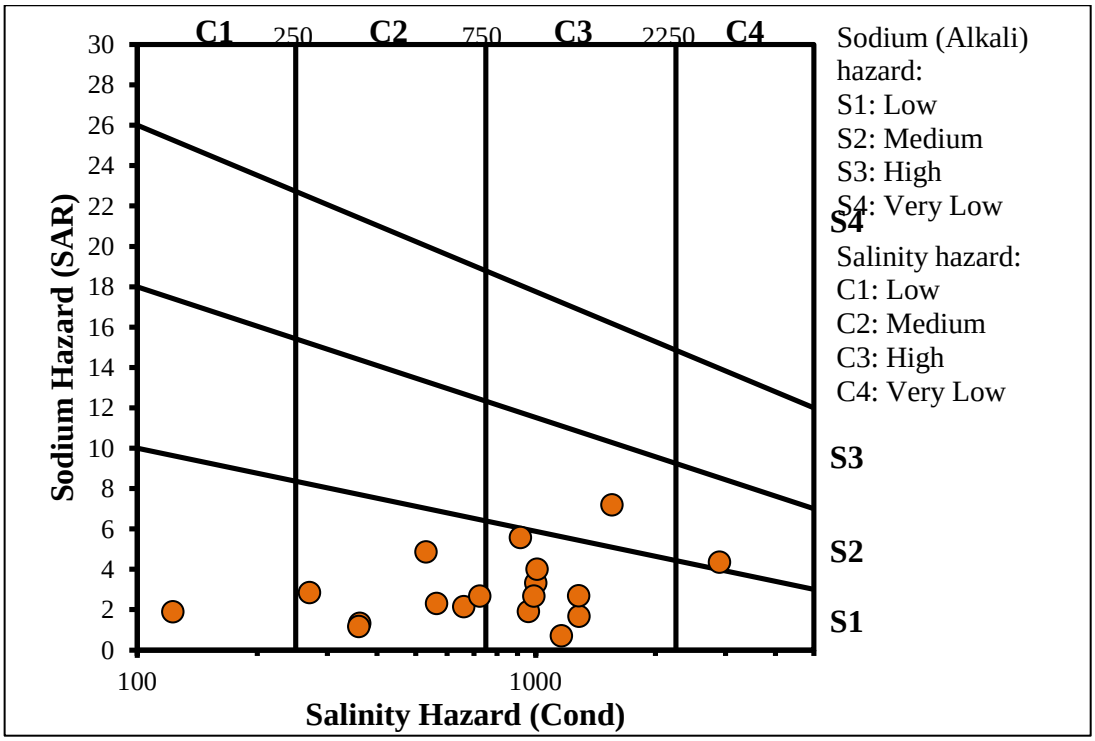


Fig. Suitability of groundwater for irrigation based on sodium and salinity

hazard

conclusions

The study area of Kanyakumari groundwater quality was not contaminated in many areas, as indicated by the reported parameters. The reason for contamination of some place of Kanyakumari is due to saline water intrusion to contaminated the groundwater. The study area is always under stress due to increasing population and more demand for water resources. The hydro geochemical analysis of the study reveals that the groundwater is fresh to brackish and moderately high to hard. Statistical analyses demonstrate that the abundance of cations is in the order: Na^{+} >Mg^{2+}>Ca^{2+} >K^{+}, while the abundance of anions is in the order: Cl >$HCO3^{-}$. Na and Cl are dominant ions among the studied cations and anions. Among the different parameters analyzed, it was seen that EC, Total hardness, pH was in the BIS permissible limits in most of the samples. The concentration of calcium ion is within the acceptable limit for drinking purpose except few locations. 95% of the groundwater samples have exceeded the acceptable limit for sodium. Magnesium ion concentration is within the acceptable and allowable limit for drinking purpose. 75% of the groundwater samples have exceeded the acceptable limit of Potassium (K). 55% of the groundwater samples have exceeded the acceptable limit of Chloride (Cl). 100% of the groundwater samples have exceeded the acceptable limit of Bicarbonate. According to Gibbs diagram, the predominant samples fall in the rock–water interaction dominance and evaporation dominance field.

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Seawater Quality and Desalination Process to Improve the Quality Aspects from Mallipattinamto Uchipuli, Tamil Nadu, India

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Abstract

Various industrial and developmental activities in recent times have resulted in increasing the pollution level and deteriorating the water quality. Water shortages and unreliable water quality are considered major obstacles to achieve sustainable development and improvement in the quality of life.Ramanathapuram is located between 9° 05' and 9° 50' North of Latitude and between 78° 10' and 79° 27' East of Longitude. Ramanathapuram is situated in South-eastern part of Tamil Nadu and it is something in dumper shape.The Pudukkottai district is characterized by an undulating topography with residual hills in the northern, western and southern parts, where as in the eastern part of the district is a flat terrain consisting of alluvial plains.Some physical parameter like seawater temperature, pH, Density and electrical conductivity, total hardness was measured directly in the field using portable multi parameter analyzer. Parameters like TSS and TDS determined gravimetrically and samples for salinity and chlorine were been collected in polyethyelene bottles. The sea water samples are collected in the field and were analyzed in the laboratory for the concentration of major ions. They are analyzed for the physico-chemical parameters in the laboratory. Chlorine (Cl) was determined standard $AgNo_3$ titration. The EC concentrations were expressed in µs/cm and TDS concentrations were expressed in ppm.The quality of water used for drinking purpose depends on the chemical, radiological and biological contents of the water. In the present study the quality of water with respect to major ions was estimated.The geochemical study reveals that the present water quality of the coastal region of **Attangarai** has almost near to ideal conditions possibly due to absence of any significant anthropogenic impact on the coast. Whereas at the Mallipattinam, Manamelkudi, Kottaipattinam, Mimisal, SundarapandianPattinam, Thondi, Uppur, Devipattinam, Uchipuli has water quality of high degree of anthropogenic impact.

Keywords: Groundwater quality, Salinity, physico-chemical parameters of the seawater samples.

Introduction

Water is a vital resource for the existence of living being on the earth surface and is necessary for economic and social development. Only about

0.5% of the overall global water is available as fresh water while seawater accounts for about 97% of them. Because of the high salinity of the ocean water and the significant costs associated with seawater desalination, most of the world population ‘s water supply has traditionally come from freshwater sources – groundwater aquifers, rivers and lakes (Voutchkov et al., 2016).In many parts of the world, huge amount of fresh water is required for agricultural, industrial and domestic uses. However, changing climate patterns combined with the growing of world population, the need for fresh water is increasing. Some 700 million people don ‘t has access to enough clean water. In 10 years, the number is expected to explode to 1.8 billion. World water resources are mainly salty (97.5%) and fresh water (2.5%). Salty water is found in oceans, seas and some lakes while fresh water is either stored underground (30%) or in the form of ice / snow covering mountainous regions, Antarctic and Arctic (70%) but only 0.3% is accessible by humans (Bigas, 2013). The world’s water consumption rate is doubling every 20 years, outpacing by two times the rate of population growth. The availability of good quality water is on the decline and water demand is on the rise.

Study area

Pudukkottai District is located in the central part of Tamil Nadu State and it lies between 9^{o} 50′ to 10^{o} 40′ North latitudes and 78^{o} 25′ to 79^{o} 15′ East longitudes. It forms a part of the Survey of India (SOI) topographic sheets of 58 J/9, 10, 11, 14, 15, 16, 58 N/2, 3, 4 and 58 O/1&2 of 1:50,000 scale. The district is wide spread with an aerial extent of about 4,663 sq.km. Pudukkottai District is bounded on the northeast and east by Thanjavur district, On the southeast by the Palk Strait, on the Southwest by the Ramanathapuram and Sivaganga districts and Northwest by Tiruchirappalli. Mineral resources are identified in hard rocks as well as in sedimentary deposits found here. The important minerals found in the area are Feldspar, Quartz, Multi - colored Granite, Biotite Garnet, Biotite Gneisses and River sand. Multi coloured granite deposits exhibits yellow, pink, green or white colour background with less wave patterns. These granites have great national and international markets.

Ramanathapuram is located between 9° 05' and 9° 50' North of Latitude and between 78° 10' and 79° 27' East of Longitude. Ramanathapuram is situated in South-eastern part of Tamil Nadu and it is something in dumper shape. 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. It covers the geographical area of 4175.00 Sq. km.The eastern portion of the Ramanathapuram district consists of rocks formed in beds of shallow lakes and coastal backwaters where the salt and mud brought by the rivers are deposited. The sedimentary rocks extend into the whole of Tiruvadanai,

Ramanathapuram and Mudukulattur taluks. They contain limestones. Limestone of different grades, clays, euchres, gypsum, graphite and limonite sands are the minerals of economic value found in the district.

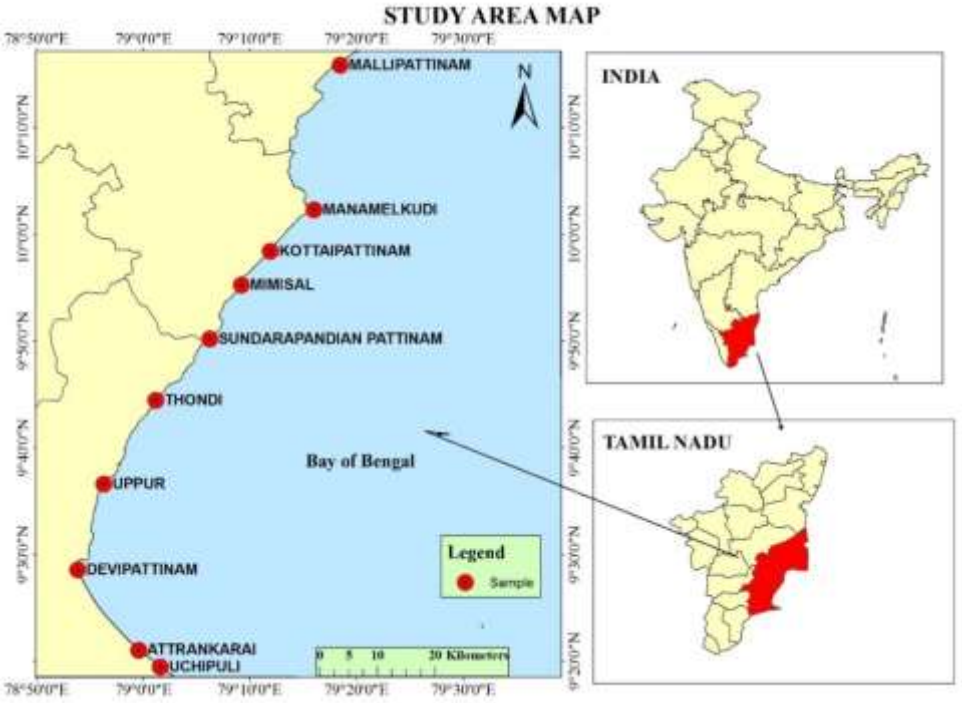


Figure. This map shows the Location of the study area

Material and Methods

Some physical parameter like seawater temperature, pH, Density and electrical conductivity, total hardness was measured directly in the field using portable multi parameter analyzer. Parameters like TSS and TDS determined gravimetrically and samples for salinity and chlorine were been collected in polyethyelene bottles. The physico- chemical exchange reactions take place at surface of lithogenic and organic particles at boundaries, such as air -sea or water sediment interfaces. The rapid chemical reactions frequently occur in transition layers between oxic and anoxic environment. The obtained data were subjected to different statistical analysis for their acceptance. Therefore, the significance of spatial variation was also taken. To Analyze the seawater for the quality detection and to improve the quality aspect for the desalination process near shore by following the procedure. The samples were collected in acid-washed polyethylene bottle. During sample collection and transportation of water samples to the laboratory, all necessary precautions were taken (Brown et al. 1974). Bottles first washed with dilute nitric acid than thrice with DM water. Before sample collection bottles were rinsed thrice with water to be sampled and then samples were collected.

Electrical conductivity (EC) and hydrogen ion concentration (pH) were determined on the field itself using digital meters.

The seawater samples which are taken in various locations are analyzed for the determination of quality of water with respect to the following physicochemical parameters.

- P^H
- EC (Electrical conductivity)
- TDS (Dissolved solids)
- TSS (Total Suspended Solids)
- Temperature
- Density
- Salinity
- Chlorine

The sea water samples are collected in the field and were analyzed in the laboratory for the concentration of major ions. They are analyzed for the physico-chemical parameters in the laboratory. Chlorine (Cl) was determined standard $AgNo_3$ titration. The EC concentrations were expressed in µs/cm and TDS concentrations were expressed in ppm.

The suitability of water for drinking purpose was studied with the help of analytical procedures which were being adopted by APHA, TRIVEDI and Goel. From the obtained data, different statistical analyses for their cumulative acceptability. Significance of spatial and temporal variations was compared by using single factor ANNOVA. Correlation coefficients analysis was also performed to find out relationship between various water quality parameters within a sampling site.

The spatial analysis of various physicochemical parameters was carried out by using GIS contouring methods with Q GIS. The inverse distance weighted (IDW) interpolation techniques have been used for preparing the spatial distribution maps for each physicochemical parameter. The spatial distribution map of the pH, EC, TDS, TH, TSS, cation (Cl^-).

Results and discussions

The Seawater quality data were shown in Table.4.1 during the year of 2020. Seawater quality in the Pudhukottai and Ramanathapuram district with the help of Q-GIS data were interpolated for the spatial distribution map. The spatial structures were also identified interpolating the scattered data, in order to have temporal series of spatially continuous maps of the parameters. We used Inverse Distance to a power gridding method as a smoothing interpolator. In this method data are weighted during interpolation such that the manipulation of one point relative to other declines with the distance. In particular, we use a quadratic law for computation of the weight, and a low value for smoothing parameters.The quality of water used for drinking purpose depends on the chemical, radiological and biological contents of the water. In the present study the quality of water with respect to major ions was estimated. The various parameters analyzed were compared with the standard guideline values as suggested by the Bureau of Indian Standard (BIS 2012) and World

Health Organisation (WHO) for drinking water quality.

Table. Physical and Chemical parameters of water samples

S. No	SAMPLE LOCATIONS	Physical Parameters								Chemical Parameters (ppm)
		pH	EC (µS/cm)	TDS (ppm)	Density	Salinity	Temp	TSS	Total hardness	Cl
1	MALLIPATTINAM	8.48	28600	14300	1.018	25000	30.7	0.5986	22	14.7
2	MANAMELKUDI	8.48	27900	13900	1.018	25000	30.7	0.5986	22	14.7
3	KOTTAIPATTINAM	8.25	27300	13600	1.018	25000	30.7	0.5986	22	14.7
4	MIMISAL	8.56	26100	12900	1.018	25000	30.7	0.5986	22	14.7
5	SUNDARAPANDIAN PATTINAM	8.38	24500	12400	1.018	25000	30.7	0.5986	22	14.7
6	THONDI	8.72	28200	13900	1.018	25000	30.7	0.5986	22	14.7
7	UPPUR	8.63	23400	11700	1.018	25000	30.7	0.5986	22	14.7
8	DEVIPATTINAM	8.69	27100	13500	1.018	25000	30.7	0.5986	22	14.7
9	ATTRANKARAI	7.58	19500	9700	1.018	25000	30.7	0.5986	22	14.7
10	UCHIPULI	8.94	21100	12500	1.018	25000	30.7	0.5986	22	14.7

Experimental Procedure

pH was measured in the field itself because the pH of the sample can change due to carbon dioxide from the air dissolving in the sample water. A Systronics pH meter of 0.01 readability was used for the measurement of pH.

Electrical conductivity (EC) was measured with Systronics conductivity meter. 0.01M KCl solution was used as the standard reference solution.

Total Dissolved Solvents (TDS) also measured with Systronics conductivity meter.

Hydrogen Ion Concentration

pH is the measure of hydrogen ion concentration value in water which indicates whether a solution is acidic, neutral or basic. The pH required has to be in the range of 6.5–8.5 for the drinking purpose (BIS, 2009). The pH of the groundwater samples lies between 7.61 and 8.53 indicates that the underground water in this area is ideal for agricultural as well as domestic purposes. The pH of water changes with the production of hydrogen or hydroxyl ion during different chemical reactions. It is noticed that water with low pH is tend to be toxic and with high degree of pH it is turned into bitter taste. The pH values of the groundwater samples ranged from 6.8 to 8.25 neutral to alkaline nature. The hydrogen ion concentration (pH) in the water samples varies from 7.14 to 8.15 with an average of 7.53. pH is rich in north side. As per the WHO standards, all the sample season fall within the recommended limits (6.5 to 8.5) for human consumption.

Table.Drinking water quality standards WHO (2004) and BIS (2012)

Parameters	WHO (2004)		BIS (2012)	
	Acceptable limit	Permissible limit	Acceptable limit	Permissible limit
Ph	7.0-8.5	9.2	6.5-8.5	

EC			-	-
TDS	500	1500	500	2000
Ca^{2+}	75	200	75	200
Mg^{2+}	50	150	30	100
Na^{+}	-	200	-	-
K^{+}	-	500	-	-
Cl^{-}	200	600	250	1000
HCO_3^{-}	-	600	250	1000
SO_4^{2-}	200	400	200	400
NO_3^{-}	-	45	45	No relaxation

Unit: concentrations are in mg/L except EC (µS/cm), and pH.

Table.pH – Limiting values with respect to BIS standard

S.NO	pH – Limiting values	Portability	Percentage of samples%
1	<6.5	Non-Potable	Nil
2	6.5-8.5	Potable	100
3	>8.5	Non-Potable	Nil

Electrical Conductivity

Electrical conductivity (EC) is a measure of water capacity to convey electric current and importance to salinity; which greatly affects the taste. Chemically pure water has a low electrical conductivity, indicating that it is a good insulator. It directly related to concentration of ionized substances in water and may also be related to problems in excessive hardness EC is expressed in terms of the specific electrical conductivity, which is defined as the reciprocal of electrical resistance in Ohm (Q), in relation to a water cube of edge length 1 cm at 25°C. Electrical conductivity is the capacity of electrical current that passes through the water. The most desirable limit of EC in drinking water is prescribed as 1,500 µS/cm.EC rich in center of the study area. The open and bore well EC results.

Table.EC - Limiting values

S.NO	EC-Limiting values	Portability	Percentage of samples%
1	<750	Good	55
2	750-4000	Medium	45
3	>4000	Poor	Nil

Open well and bore well samples EC values ranged from 164 to 3330 µs/cm (average of 1136µs/cm). As per the WHO (1984) standard.

Total Dissolved Solids (TDS)

Total dissolved solids (TDS) refer to the total amount of all inorganic and organic substances including minerals, salts, metals, cations or anions that are dispersed within a volume of water. The principal constituents are usually the cations calcium, magnesium, sodium and potassium and the anions bicarbonate, chloride, nitrate and sulphate in groundwater. The concentration of Total Dissolved Solids ranges from 176 to 1670 mg/l with an average of 611mg/l. TDS rich in some place in center part of the study area.

Total Hardness

The total hardness of the water is the traditional measure of the capacity of water to react with soap, hardwater requiring considerably more soap to produce lather. Hardwater often produces a noticeable deposit of precipitate in containers. It is not caused by a single substance but by a variety of dissolved polyvalent metallic ions, predominantly calcium and magnesium cations, although other

cations, (e.g. aluminium, barium, iron, manganese, strontium, and zinc) also contribute. Hardness is most commonly expressed as milligrams of calcium carbonate equivalent per liter. Water containing calcium carbonate at concentration is generally considered as

- Soft - below 60mg/l,
- Moderately hard - 60-120 mg/l,
- Hard – 120-180 mg/l,
- Very hard - More than 180 mg/l,

Although hardness is caused by cations, it may also be discussed in terms of carbonate (temporary) and Non carbonate (permanent) hardness.

Estimation of Total Hardness of The Given Sample

1. Take a tare value of paper (empty paper) before weighing the sample.
2. Take EDTA Disodium salt of about 8.422g.
3. Then take Ammonium chloride of about 3.5g.
4. Take Ammonium solution of about 28.5ml.
5. Then mix the liquid Ammonium solution with Ammonium Chloride and make up into 50ml with the distilled water.
6. Now mix EDTA with 1000ml of distilled water and stir it well.
7. Take 20ml of Burette solution from 1000ml of Distilled water mixed with EDTA.
8. Add 1ml of sea water with 1ml of Ammonium buffer.
9. Then take 18ml of Distilled water in a beaker.
10. Then mix 18ml of distilled water with titrated solution.
11. Take EBT and sodium chloride (NaCl) and mix it well and use it as an indicator in the process.
12. Add a pinch of indicator to the solution, then the solution will change its color.
13. At the end there will be a change of **wine-red color** to **steel blue color.**

Chloride

For the chloride titration 4.791g of Ag NO_3 (Silver Nitrate) added to the distilled water and make up to 1000ml.Take 5g of potassium chromate, dissolved in the 100 ml of distilled water. Take 2ml of K_2CrO_4 solution added to 10ml of the sample and titrated against AgNO3solution till the colour changed to reddish brown. Repeat the titration for the 15 samples and note the values.

Saliinity

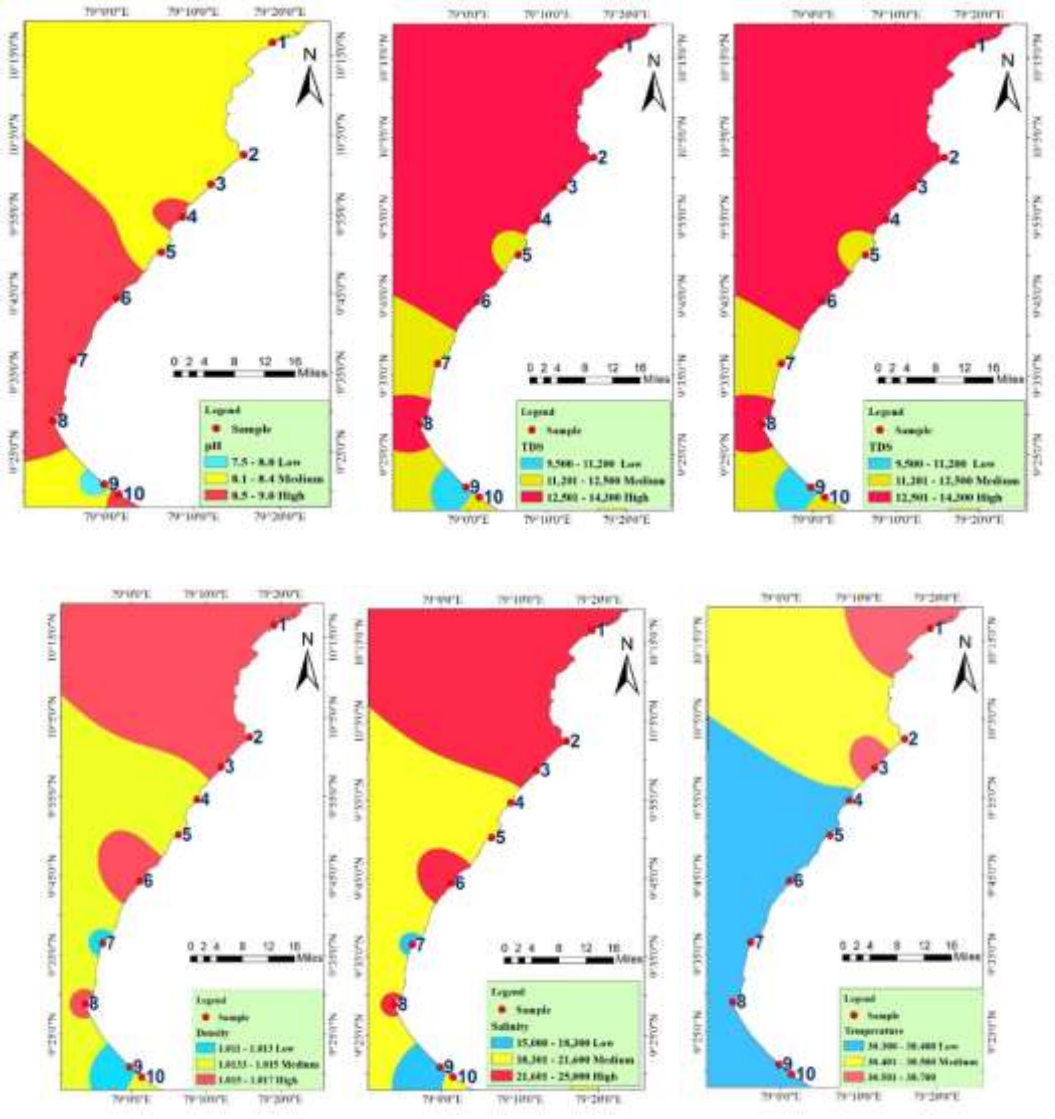
The content of dissolved salts in sea water is usually expressed as salinity, S% a convection which approximates to the weight in grams, of the solids obtained from 1Kg of seawater, when the solids have been dried to constant weight at 480^0 C, the organic matter completely oxidized the bromide and iodide replaced by an equivalent amount of chloride, and chloride and carbonates converted to oxides. Ocean water contains slightly more salts (halides, carbonates, and bicarbonate) than is expressed by its

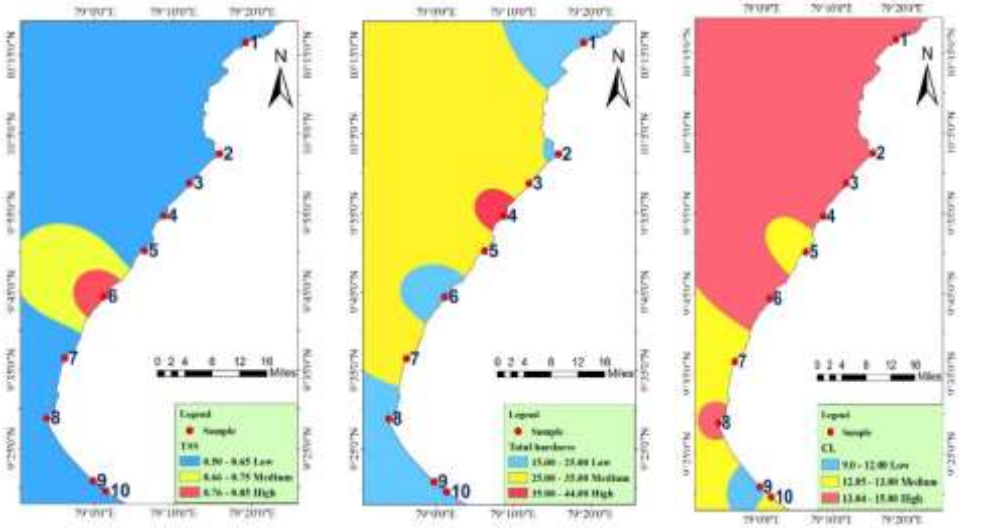
salinity value. The salinity is defined in terms of chlorinity by the Knudsen equation,

S%= 0.030 + 1.08050 Cl%

This equation is solely a definition and has no universal applicability in any practical chemical sense.

Figures. Spatial distribution maps





Conclusions

The geochemical study reveals that the present water quality of the coastal region of **Attangarai** has almost near to ideal conditions possibly due to absence of any significant anthropogenic impact on the coast. Whereas at the Mallipattinam, Manamelkudi, Kottaipattinam, Mimisal, SundarapandianPattinam, Thondi, Uppur, Devipattinam, Uchipuli has water quality of high degree of anthropogenic impact. Hence **Attangarai** region has less amount of human activity with contact of river channel (Vaigai) the quality of water in this region is not much affected with marine organism. By the admixing of the freshwater and seawater, the ratio of quality of water is better than another region. I hereby suggest that **Attrangarai** region is comparatively more suitable for implanting the desalination plant because the TDS, Density and Chlorine content in this region is very less when compared to other samples.

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Identification of Seawater Intrusion Based on Water Quality in Ramanathapuram Coastal Zones, Tamilnadu, India.

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Abstract

Groundwater is the main source of water in the arid and semi-arid environment which fulfills the requirement of different beneficial-uses drinking, domestic, and irrigation particularly for the rural population.Ramanathapuram district is lies between 9° 05' and 9º 50' North Latitude and 78º 10' and 79º 30' East Longitude.Groundwater samples were collected as grid from at 20 locations during the post monsoon seasons in the year 2021. The quality evaluation of existing groundwater resources is vital and its quantity for the optimal utilization and maintenance. Groundwater quality depends on the quality of recharged water, atmospheric precipitation, inland surface water and on sub-surface geochemical processes. Liquid water has weak absorption bands at wavelengths of around 750 nm which because it appears to have a blue color. This can easily be observed in a water-filled bath or wash-basin whose lining is white. Large ice crystals, as in glaciers, also appear blue. The physical parameters taken into consideration are color, odor, turbidityand temperature. The chemical parameters taken into consideration are hydrogen ion consideration (pH), specific conductance (EC), total dissolved solids (TDS), total hardness (TH) and all major cations and anions. They are analyzed for various physicochemical parameters in the laboratory. Calcium (Ca) and Magnesium (Mg) were determined titrimetrically using standard EDTA; Chloride (Cl) was determined by standard $AgNo_3$ titration; Bicarbonate (HCO_3) was determined by titration with H2SO4; Sodium (Na) and Potassium (K) were determined by Flame photometer; Sulphat (SO_4) was determined by spectrophotometric turbidimetry. The study area of Ramanathapuram groundwater quality indicate that it was not contaminated in many areas by the reported parameters. The reason for contamination of some place of Ramanathapuram is due to saline water intrusion to contaminated the groundwater. The study area is always under stress due to increasing population and more demand for water resources.

Keywords: Groundwater quality, Drinking and irrigation purpose, Suitability health risk assessment, Sensitivity analysis.

Introduction

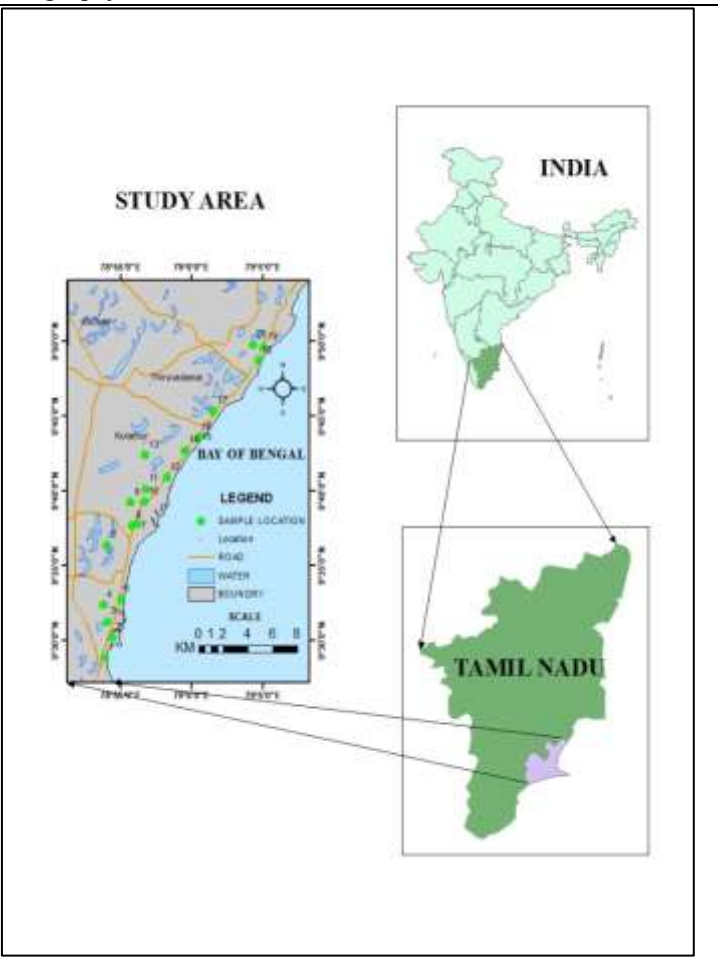
Water is a major source for agriculture and drinking. The reason at which the water quality gets affected

due to excess pumping, urbanization, industrial waste and reduction of water level in the aquifer etc. More than sixty percent of total world's population lives in coastal regions (Tomaszkiewicz et al. 2014).Since the beginning of the twenty-first century, the availability of surface water (rivers and lakes) is reduced by deficit rainfall due to global climate change, rapid urbanization, and industrial developments, which induced the need for the identification of groundwater potential zone (Metwaly et al. 2012; Selvametal., 2015; Gnanachandrasamy et al. 2018).Groundwater is an alternate resource to the surface water that is available throughout the year for extraction, subjected to the specific groundwater condition (Prabakaran et al. 2020).However, the identification of potential groundwater zones is very complicated due to the heterogeneity of underlying formations. Many techniques have evolved by the hydrogeologists to find the groundwater potential beneath the earth surface. Electrical resistivity method is a traditionally used technique in different parts of the world (Jatau et al. 2013; Fadeleetal. 2013; Ravindran et al. 2018).Sea water intrusion is the movement of saline water into fresh water aquifers. Most often it is caused by ground-water pumping from coastal wells or from construction of navigation channels or oil field canals. Pumping of fresh water from an aquifer reduces the water pressure and intensifies the effect, drawing salt water into new areas. When freshwater levels drop, saltwater intrusion can proceed inland, reaching the pumped well. To prevent this, more and more countries adopt extensive monitoring schemes and numerical models to assess temporal and spatial extent sea water intrusion in conjunction with groundwater recharge and discharge schemes.Adekunle et al (2008), Brian et al (2005),Adrian Werner et al (2011) and Oddmund etal (1994) has reported the effects and vulnerability index of seawater intrusion which mainly helps to know the status of intrusion in the aquifer. Many scientists have been working on simulation of sea water intrusion across the globe including India (Huyakorn et al, 1997; Putti & Paniconi,1995; Das & Datta, 2000; Sarva Mangala, 2011).Seawater intrusion is a natural phenomenon driven by the density difference between freshwater and seawater, but the extent of intrusion has been largely aggravated by the extraction of groundwater. The study of seawater intrusion has a long history. The latest review studies have been documented in North America (Barlow and Reichard 2010; Bear et al. 1999), Australia (Werner 2010), Europe (Custodio 2010), South America (Bocanegra et al. 2010), Africa (Steyl and Dennis 2010) and the island countries of the Pacific Ocean (White and Falkland 2010).Changes in the hydrology of the coastal zone can cause degradation of groundwater quality through the landward movement of seawater, a process referred to as seawater intrusion (SI). In recent years, a number of publications have considered the extent, rate, and time scales of SI associated with sea level

rise (SLR) [e.g., Werner and Simmons, 2009; Watson et al., 2010; Webb and Howard, 2010; Chang et al., 2011; Werner et al., 2012; Lu and Werner, 2013]. The transient SLR-SI studies of Watson et al. [2010] and Chang et al. [2011] reported an overshoot phenomenon, whereby the freshwater-saltwater interface temporarily extended farther inland than the eventual post-SLR steady state interface location. Sand-tank modeling by Morgan et al. [2013a]Seawater intrusion is a natural phenomenon driven by the density difference between freshwater and seawater, but the extent of intrusion has been largely aggravated by the extraction of groundwater. The study of seawater intrusion has a long history. The latest review studies have been documented in North America (Barlow and Reichard 2010; Bear et al. 1999), Australia (Werner 2010), Europe (Custodio 2010), South America (Bocanegra et al. 2010), Africa (Steyl and Dennis 2010) and the island countries of the Pacific Ocean (White and Falkland 2010).

Study area

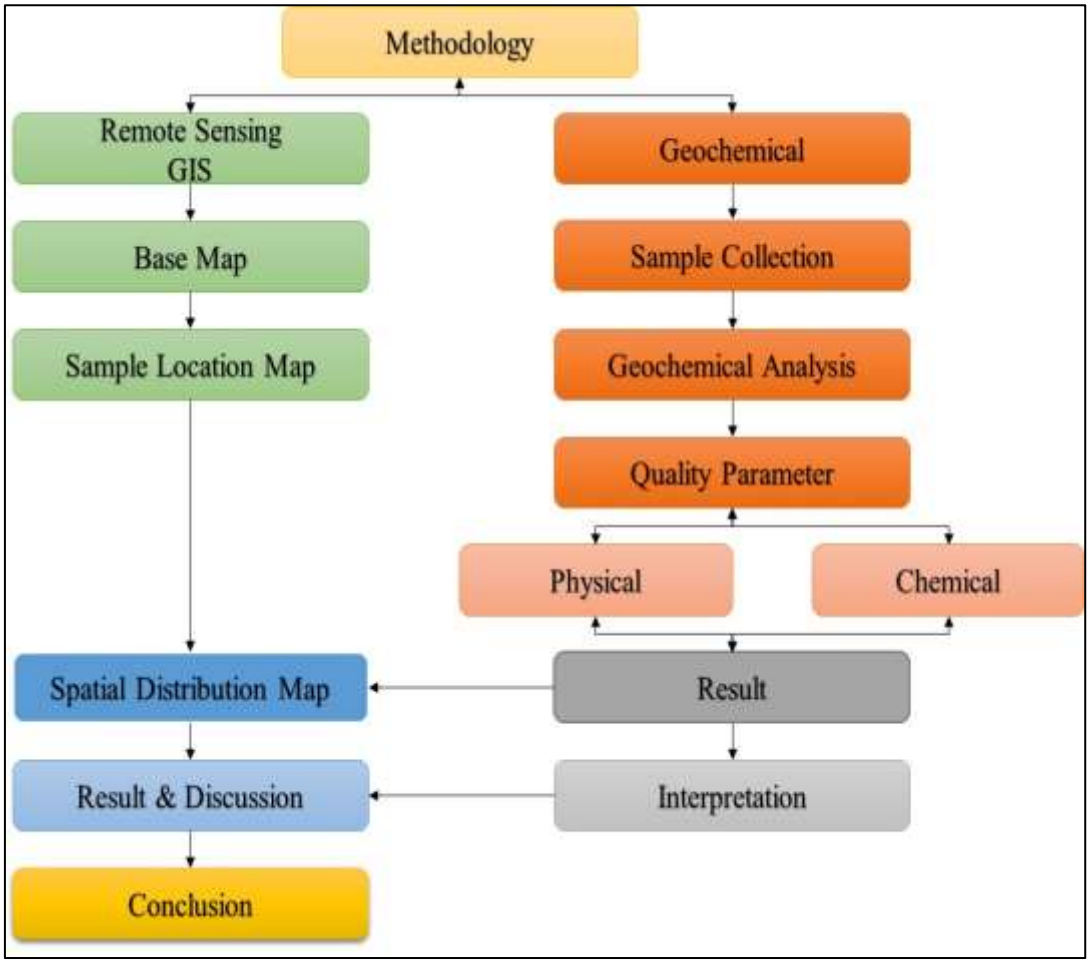
Ramanathapuram district is lies between 9° 05' and 9º 50' North Latitude and 78º 10' and 79º 30' East Longitude. The district receives the rain under the influence of both southwest and northeast monsoon. Ramanathapuram district comprises 7 taluks, 11 blocks and 2362 villages. Ramanathapuram District has an area of 4123 km^2. 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 Viruthunagar District. The district contains the Pamban Bridge, an east-west chain of low islands and shallow reefs that extend between India and the island nation of Sri Lanka. As of 2011, Ramanathapuram district has a population of 1,353,445. Most of the area is covered by the unconsolidated sediments. The northeast monsoon chiefly contributes to the rainfall in the district. Most of the precipitation occurs in the form of cyclonic storms caused due to the depressions in Palk Strait. The southwest monsoon rainfall is highly erratic and summer rains are negligible. The annual normal rainfall (1970-2000) of Ramanathapuram district is 821 mm. Three projections of rainfall over Ramanathapuram for the periods 2010-2040 (2020s), 2040-2070 (2050s) and 2070- 2100 (2080s) with reference to the baseline (1970- 2000) indicate an increase of 0.1%, 1.0% and 1.0% respectively.The district a Tropical climate. The period from May to June is generally hot and dry.



Material and Methods

This chapter describes the methods of sample collection and analytical procedure adopted for analysis of groundwater samples of Ramanathapuram district using different analytical methods. To evaluate the impact of contaminants on groundwater of Ramanathapuram district, water samples were collected from 20 different selected sites in January 2021.

Flow Chart for Methodology



To assess the level of groundwater quality, sampling of groundwater done from hand pumps and bore wells located in residential and agricultural areas, as per the standard procedure. The samples were collected in acid-washed polyethylene bottle. During sample collection and transportation of water samples to the laboratory, all necessary precautions were taken (Brown et al. 1974). Bottles first washed with dilute nitric acid than thrice with DM water. Before sample collection bottles were rinsed thrice with water to be sampled and then samples were collected. Electrical conductivity (EC) and hydrogen ion concentration (pH) were determined on the field itself using digital meters.

Results and discussions

The quality of water used for drinking purpose depends on the chemical, radiological and biological contents of the water. In the present study the quality of water with respect to major ions was estimated. The various parameters analysed were compared with the standard guideline values as suggested by the Bureau of

Indian Standard (BIS 2012) for drinking water quality and World Health Organization (WHO 2004) (Table 2) to evaluate the suitability of groundwater in the study area for human consumption.The Groundwater quality data were given in Table 3. All the data were interpolated for the spatial distribution with the help of GIS. The spatial structures were also identified interpolating the scattered data, in order to have spatially continuous maps of the parameters. We used Inverse Distance to a power gridding (IDW) method as a smoothing interpolator. In this method data are weighted during interpolation such that the manipulation of one point relative to other declines with the distance. In particular, we use a quadratic law for computation of the weight, and a low value for smoothing parameters.

Table - Drinking water quality standards WHO (2004) and BIS (2012)

Parameters	WHO (2004)		BIS (2012)	
	Acceptable limit	Permissible limit	Acceptable limit	Permissible limit
PH	7.0-8.5	9.2	6.5-8.5	
EC			-	-
TDS	500	1500	500	2000
Ca^{2+}	75	200	75	200
Mg^{2+}	50	150	30	100
Na^{+}	-	200	-	-
K^{+}	-	500	-	-
Cl–	200	600	250	1000
HCO_3^{-}	-	600	250	1000

Table - Results of water quality parameters

S. No	VILLAGE NAME	Physical Parameters			Chemical Parameters (ppm)					
		pH	EC(µS/cm)	TDS(ppm)	Ca	Mg	Na	K	Cl	HCO_3
1	Devipattinam	8.32	3390	1680	10	50	420	50	920	174
2	Muththyregunathapuram	8.39	817	408	15	10	112	16	210	38
3	Sampai	7.98	3360	1680	10	20	400	40	1040	145
4	Pappanenthal	8.3	2290	1130	45	10	300	32	550	150
5	Thirupallakudi	8.43	4240	1450	5	5	400	50	810	135
6	Kaavanoor	8.56	715	356	10	5	52	5	230	45
7	Kadaloor	7.91	1869	931	10	5	132	15	660	65
8	Ciththurvadi	8.35	386	193	5	5	53	7	80	41
9	Melachetththanendhal	8.39	1005	505	5	0	150	18	230	80

10	Puthukadu	7.47	6900	3450	10	10	400	46	2740	10
11	A. Manakudi	8.07	3760	1880	5	0	420	54	1080	159
12	Puthupattinam	7.81	8040	4020	15	15	500	62	3290	45
13	Thiruvetriyur	8.05	6950	3020	5	5	600	84	1920	207
14	Soliyakudi	8.26	3150	1570	20	15	350	48	930	190
15	Namputhalai	8.38	2140	1070	5	15	300	36	560	124
16	Thondi	8.39	4650	2310	15	10	550	98	1310	121
17	Velangudi	8.42	1080	540	10	0	148	18	260	96
18	Pasipattinam	8.21	1145	571	10	10	126	22	310	53
19	Thithnandathanam	8.3	615	307	10	5	24	6	160	76
20	Marungoor	7.93	2860	1430	5	15	240	40	910	122

Hydrogen Ion Concentration (pH)

pH of groundwater is important in determining the hydrological processes. Processes such as carbon absorption, ion exchange, and flocculation may be affected by pH. The pH of water indicates its quality and provides information regarding types of geochemical equilibrium or solubility calculations (Hem, 1985). A taste of the acidity of water is pH, which is a measure of the hydrogen ion concentration. The pH scale ranged from 0 to 14. In general, water with a pH indicates neutral water < 7 is considered acidic and with a pH > 7 is considered basic. A one-unit change in pH represents a 10-fold difference in hydrogen ion concentration. The pH of the water was taken by pH meter in the field. The hydrogen ion concentration (pH) in the water samples varies from 7.18 to 8.06 with an average of 7.62. As per the WHO and BIS standards, all the samples fall within the recommended limits which are 6.5 to 8.5 for human consumption (Table 4.3). The spatial distribution map of pH shows that southern and central part of the study area is affected by higher pH values.

Table. pH Limiting values with respect to BIS standard

S.NO	pH – Limiting values	Potability	Percentage of samples%
1	<6.5	Non-Potable	Nil
2	6.5-8.5	Potable	100
3	>8.5	Non-Potable	Nil

Electrical Conductivity (EC)

Electrical conductivity is an important indicator of water quality assessment. EC of water is an indirect measure of its dissolved constituents. EC is expressed in terms of the specific electrical conductivity, which is defined as the reciprocal of electrical resistance

in Ohm (Q), in relation to a water cube of edge length 1 cm at 25°C. This may be due to the effluents from the industries as well as the domestic sewages are directed into the study area and also the saline water intrusion from the sea. The open and bore well EC results.

Table. EC Limiting values

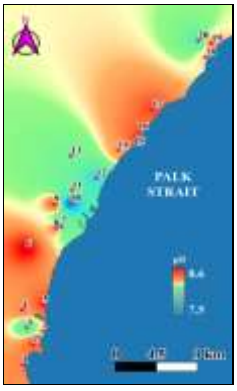
S.NO	EC-Limiting values	Portability	Percentage of samples%
1	<750	Good	50
2	750-4000	Medium	50
3	>4000	Poor	Nil

Total Dissolved Solids (TDS)

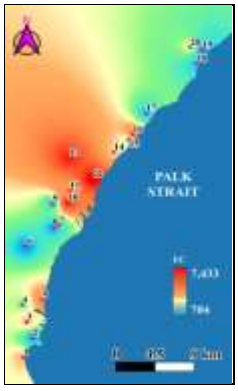
Total dissolved solids (TDS) refer to the total amount of all inorganic and organic substances including minerals, salts, metals, cations and anions that are dispersed within a volume of water. The principal constituents are usually the cations (calcium, magnesium, sodium and potassium) and the anions (carbonate, bicarbonate, chloride and sulphate) in groundwater. The concentration of Total Dissolved Solids ranges from 270 to 7280mg/l with an average of 1888.2mg/l. Classification shows that 40 % of samples were saline i.e. with high soluble salts and hence groundwater in few areas unsuitable to be used for agricultural and domestic purposes and will cause major health hazard. The limiting values of TDS are given in Table 4.5 and high TDS concentration is found in the southern part and in the coastal tracts which may due to the sea water intrusion.

Table. TDS Limiting values

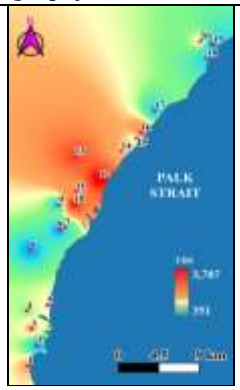
S.NO	TDS-Limiting values	Portability	Percentage of samples%
1	<500	Good	40
2	500-2000	Medium	45
3	>2000	Poor	15



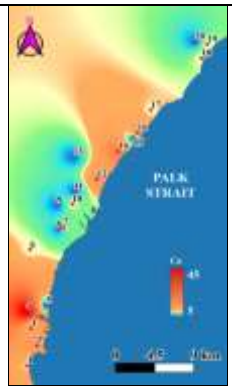
Hydrogen Activity (pH)



Electrical Conductivity (EC)



Total Dissolved Solids (TDS)



Calcium (Ca)

Calcium (Ca)

Calcium concentration ranges from 16 to 452.8 mg/l (average of 119.04 mg/l). The groundwater samples were estimated with high calcium hardness with respect to the recommendation of WHO (75–200 mg/l), which accounts for the existence of calcium rich minerals such as gypsum, limestone, etc. Calcium is the second dominate ion in the groundwater of the study area. Most samples fall within the acceptable and allowable limit, only 20 % samples fall above the WHO limitation values are shown in Table 4.6. If the presence of calcium is more in drinking water, it will cause formation of renal calculi (Kidney stones). The calcium concentration was high in both open and bore well at Pappanenthal and Soliyakudi.

Table. Calcium limiting values

S.NO	Calcium limiting values	Portable	Percentage of sample%
1	<75	Acceptable limit	85
2	75-200	Allowable limit	15
3	>200	Not Potable	Nil

Magnesium (Mg)

Magnesium concentration ranges from 4 to 256 mg/l (average of.61.5 mg/l). Magnesium is the third dominating ion in the groundwater of the study area. The desirable limit of magnesium in drinking water is 30 mg/l WHO and BIS standard. The higher concentration of the magnesium due to rock water interaction and rest of the portion was observed in downstream portion. The limiting values for magnesium are given in Table 4.7. The Magnesium concentration was more in sample 1 and 3 which are Devipattinam and Sampai in Southern areas.

Table.Magnesium limiting values

S.NO	Magnesium limiting values	Potable	Percentage of samples%
1	<30	Acceptable limit	80
2	30-100	Allowable limit	20
3	>100	Not potable	Nil

Sodium (Na)

Sodium amount present in earth relatively small but significant number of dissolved solids originating from the weathering of the rocks and soils, and from the dissolving lime, gypsum and other salt sources as water flows over or percolates through them. Sodium concentration is good less than 200 mg/l WHO (2004) concentration. Sodium is found to be the most abundant ion in the groundwater of the study area. The open well sodium concentration in the groundwater of the study area ranged from 45 to 1200 mg/l, with an average value of 318.5 mg/l shown in the Table 4.8 and the higher values are found in Southern parts as similar to the other cations.

Table. Sodium limiting values

S.NO	Sodium limiting values	Potable	Percentage of sample%
1	<200	Acceptable limit	65
2	>200	Not Potable	35

Potassium (K)

Potassium is nearly as abundant as sodium in igneous rocks and metamorphic rocks but its concentration in groundwater is one tenth or even one hundredth of sodium. The potassium is derived from silicate minerals like Orthoclase, Microcline, Nephelene, Leucite and Biotite. Among the cations, potassium occupies the last position in the order of abundance in the groundwater of the study area. Potassium concentration ranges from 3 to 300 mg/l with average of 70.55 mg/l. Potassium concentration is good if it is less than 10 mg/l for domestic water (WHO, 2004) and BIS (2012) standard. Potassium content in water more than 10 ppm is indicative of pollution.

Table. Potassium limiting values

S.NO	Potassium limiting values	Potable	Percentage of sample%
1	<10	Acceptable limit	60
2	>10	Not Potable	40

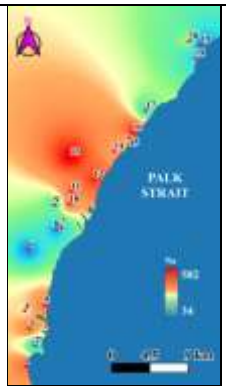
Chloride (Cl)

Chloride concentration ranges from 18 to 6027 mg/l and an average of 611.8mg/l. It is due to replacement of hydroxide to chloride in the hornblende biotite gneissic rocks (Kuroda and Sandell, 1953). Based on the WHO and BIS standards, ten samples fall in not potable zone given in Table 4.10. Chlorides are not directly involved in corrosion, but they accelerate of corrosion of steel and aluminum. In the investigation area, high concentration is found in the southern part may be due to the sea water intrusion.

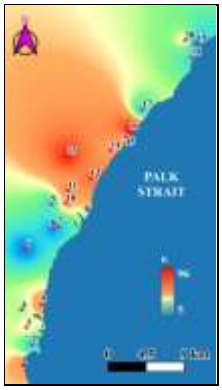
Table. Chloride limiting values

S.NO	Chloride limiting values	Potable	Percentage of samples%
1	<250	Acceptable limit	70
2	>250	Not potable	30

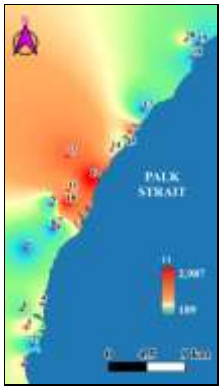
Magnesium (Mg)



Sodium (Na)



Potassium (K)



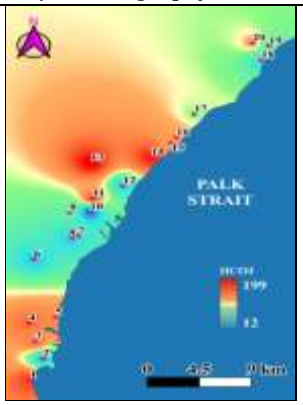
Chloride (Cl)

Bicarbonate (HCO_3)

The observed HCO_3values in the groundwater samples range from 72 to 576 mg/l with average of 228.2 mg/l (Table 4.11). Bicarbonate is the dominant anion in the majority of the samples, except in few groundwater samples collected near the coast.

Table. Bicarbonate range values

S.NO	Bicarbonate limiting values	Potable	Percentage of samples%
1	<500	Acceptable limit	95
2	>500	Non-potable	5



Bicarbonate (HCO_3)

Hydrochemical Facies

Trilinear plotting systems are used to study water chemistry and quality (Piper 1944). On conventional trilinear diagrams sample values for three cations (Calcium, Magnesium and Alkali metals- Sodium and Potassium) and three anions (Chloride, Sulfate, Bicarbonate and carbonate) are plotted relative to one another. These ions are generally the most common constitutions in unpolluted groundwater. Fundamental interpretations of the chemical nature of water samples are based on the location of the sample ion values. Determining the nature and distribution of hydrochemical facies can provide insight into how groundwater quality changes within and between aquifers. In the HCO_3–Cl–SO_4 anion triangle shows groundwater samples plotted between the bicarbonate type and chloride type end member and Sulfate (SO_4) is not present in any significant proportion.

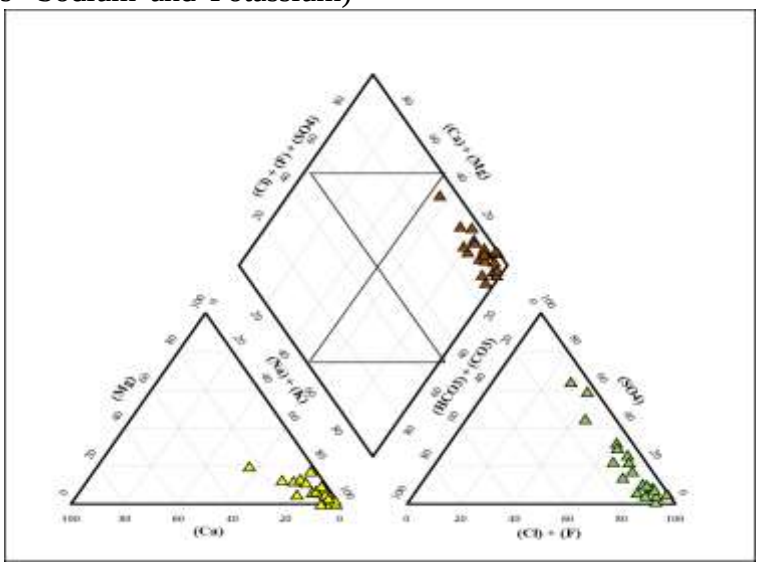


Figure. Pipper plot for Hydrochemical Facies

Gibbs Plot

In addition to Piper diagram, Gibbs plots were also used to gain better insight into hydrochemical processes such as precipitation, rock water interaction and evaporation on groundwater chemistry in the study area (Fig. 8). Gibbs (1970) demonstrated that if TDS is plotted against Na/ (Na + Ca) and Cl/Cl + HCO_3, this would provide information on the mechanism controlling the chemistry of waters. The distribution of samples on the Gibbs plots shows that majority of them falls

in the rock dominant region and the surrounding rock materials plays a key role in concentration of major cations and anions. Figure 8 displays that groundwater samples were plotted mostly in the evaporation zone and few samples in the rock water interaction zone.

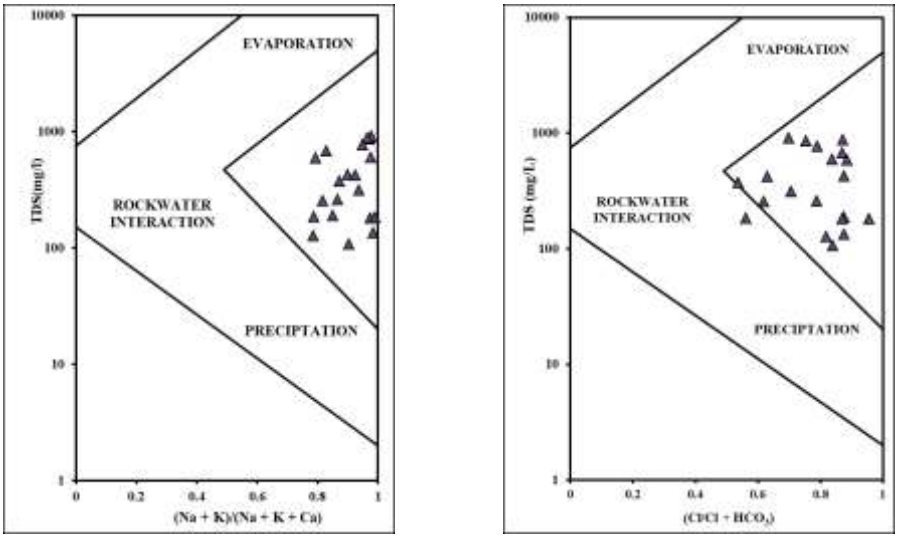


Figure. Mechanism governing ground water chemistry (after Gibbs, 1970)

Chadha's Plots

Chadha proposed hydrochemical diagram which is used to interpret the hydrochemical processes occurring in the study area to determine the evolution of two different cations and anions hydro-geochemical processes. Data has been converted to percentage reaction values (milli equivalent percentages) and expressed as the difference between alkaline earths (Ca + Mg) and alkali metals (Na + K) for cations, and the difference between weak acidic anions (HCO_3+CO_3) and strong acidic anions (Cl+SO_4). The hydrochemical processes suggested by Chadha are indicated in each of the four quadrants of the graph and broadly summarized as:**Field 1:** Ca-HCO_3 type of recharging waters, **Field 2:** Ca-Mg-Cl type of reverse ion-exchange waters, **Field 3:** Na-Cl type of end-member waters (seawater), **Field 4:** Na-HCO_3 type of base ion-exchange waters.

CL^-/HCO_3 – Ratio

The salinisation amount in the groundwater can be classified using the Cl^-/HCO_3 - ratios (Revelle 1941). The Cl^-/ HCO_3 - ratio was computed for the groundwater samples of the study area and given in Table 4.15 and Fig 10. The groundwater samples in the study area having 25 % of less than 0.5 Cl^-/HCO_3 ratios are not affected by salinization. 70 % groundwater samples in the study area are in slight to moderate salinity affected range. However, 5% the values of Cl^-/HCO_3- high indicate the strongly seawater intrusion. It may be due to

some other anthropogenic activities such as intrusion from domestic sewage or possibly due to uncontrolled agricultural practices.

Table. Cl/HCO_3 ratio

Cl / HCO_3-ratio	**Classification**	**Sample Numbers**	**Total number of samples**	**Percentage (%)**
< 0.5	Not affected			
0.5 – 6.6	Moderately affected			
> 6.6	Severely affected			

Irrigation Water Suitability

The irrigation suitability of ground water has been attempted based on the study of US Salinity diagram (Wilcox) classification electrical conductivity (EC), Sodium Adsorption Ratio (SAR), Percent Sodium (% Na), Permeability index (PI).

Us Salinity Diagram (Wilcox Plot)

Classification of water for irrigation water quality based on EC after Richards classification (Raghunath 1987) is given in Table 16 which shows that no samples were good, 78% were within permissible limit and 25 % of samples exceeded the permissible limits. Spatial variation in EC of groundwater (Fig. 4b) indicates that the groundwater quality was good to permissible in the central part of the study area while it is unsuitable for irrigation in the southeastern parts.

Table. EC Limiting values for irrigation water quality

Sr. No	**EC-limiting values**	**Portability**	**Percentage of samples**
1	<200	Good	Nil
2	750 – 4000	Medium	75
3	> 4000	Bad	25

The sodium alkali hazard or Sodium Absorption Ratio (SAR) of water is an indicator of sodium hazard in irrigation water. SAR values can indicate the extent to which water tends to enter into cation exchange reaction in soil. As per Richard, 1954, the computed SAR values show that all the samples are excellent and good (Table 4.17). SAR values are plotted against the corresponding EC values on the US salinity diagram (Richards 1954) are shown in Fig 11.

Table. Irrigation quality of groundwater based on SAR

Sr. No	**Range**	**Classification**	**Percentage of samples**
1	< 10	Excellent	85
2	10 – 18	Good	15
3	18 – 26	Doubtful	-
4	> 26	Unsuitable	-

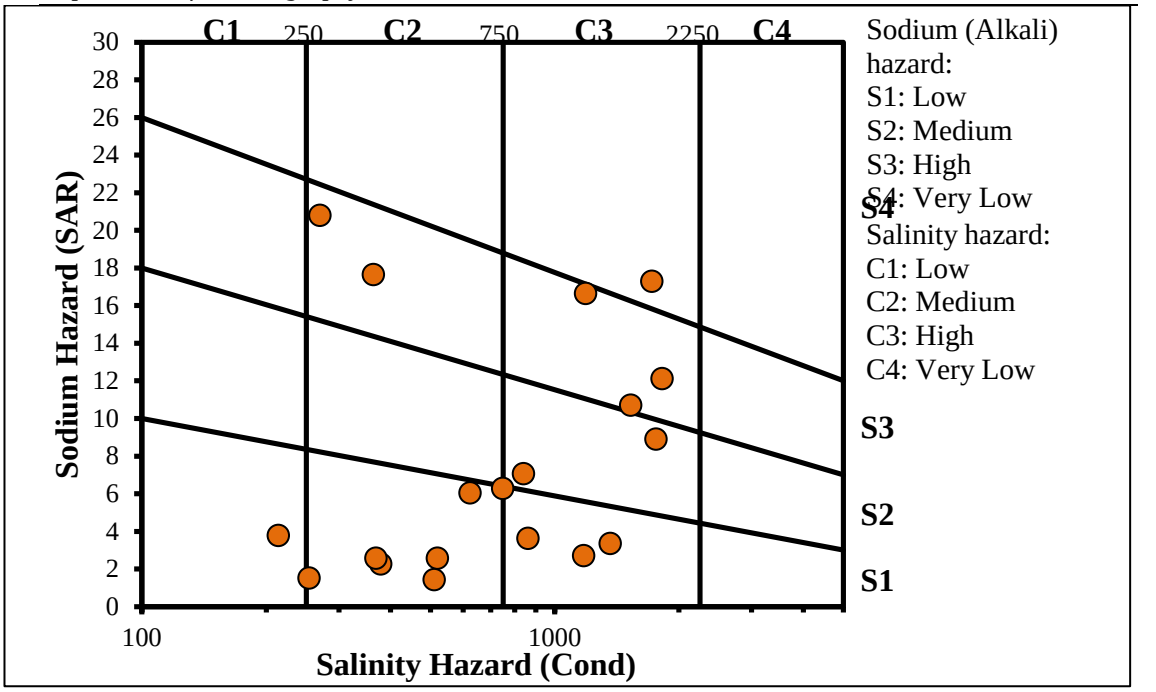


Figure. Suitability of groundwater for irrigation based on sodium and salinity hazard

Percent Sodium (%Na)

The % Na is used to assess the ground water quality, because a higher level of sodium in irrigation water may increase the exchange of sodium content of irrigated soil and affect soil permeability, structure and create toxic condition for plants. Based on the relative proportions of cation concentration, samples come under good to permissible categories and can be used for irrigation on almost all types of soil.Na% is in the mostly good (10 %) to permissible (65 %) class, respectively, and 25 % of samples falls under doubtful range (Table 4.18). Na% plotted against the total concentration of ions represented by Wilcox (1955) diagram (Fig. 12) indicates that most of the groundwater samples were good to permissible. Few groundwater samples were doubtful and unsuitable for irrigation.

Table. Irrigation quality of groundwater based on percent sodium

Sr. No	Range	Classification	Percentage of samples
1	< 20	Excellent	-
2	20 – 40	Good	10
3	40 – 60	Permissible	65
4	60 – 70	Doubtful	25
5	> 80	Unsuitable	-

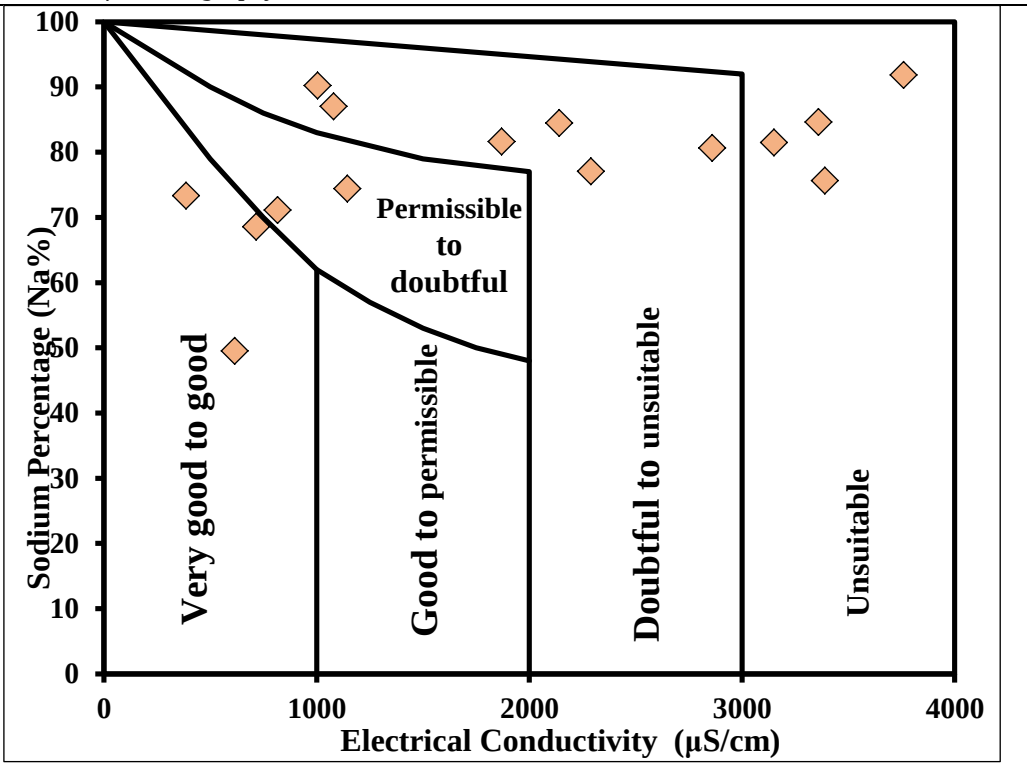


Figure. Suitability of groundwater for irrigation based on Na%

Permeability Index (PI)

Permeability of soil is affected by the long-term use of water and is influenced by, calcium, magnesium, sodium and bicarbonate concentration in the water. PI plotted against total salt concentration (Doneen 1964) is used to classify (Fig. 13) the suitability of irrigation water quality into three classes based on permeability-class I, II and III.

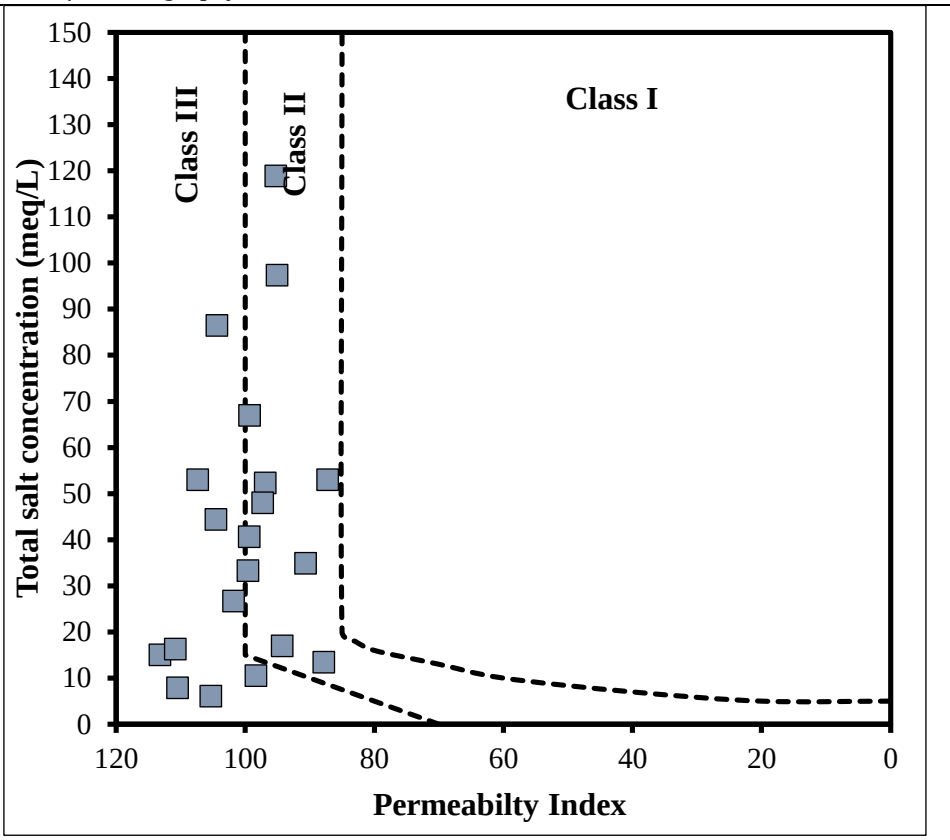


Figure - Suitability of groundwater for irrigation based on permeability index.

Table - Irrigation quality of groundwater based on permeability index

Water class	Percentage of samples	Type of water
Class I	65	Very good water quality >75 % of maximum soil permeable
Class II	20	Good water quality 75 % of maximum soil permeable
Class III	15	Moderate water quality < 75 % of maximum permeable

Most of the 65 % groundwater samples of the study area fall in class I type which indicates that it is suitable for irrigation purpose and 20 % samples were in class II which is permissible. 15% ground water samples without using the irrigation purpose in the Class III.

Conclusions

Groundwater quality of the study area was analysed to understand its suitability for drinking, domestic and irrigation purposes. The concentration of physiochemical constituents in the water samples was compared with the World Health Organization (WHO) and Bureau of Indian Standards (BIS) to know the suitability of water for drinking. The average pH of groundwater is 8.01 which indicate its alkaline nature and average EC value is 2697.55µs/cm, reveals that most of the water samples are non-potable. The TDS observed is ranges between 193 and 4020 mg/l with 30 % of potable water quality when compared to BIS

guideline values. The major cation order abundance is Na > Ca > Mg >K and the major anions is in the order of HCO_3> Cl > SO_4. Both the major cations and anions found as higher concentration in southern parts of study area as shown spatial distribution maps. From the cationic and anionic triangular fields of Piper diagram, it is observed that 100% of groundwater samples fall into the no dominant type; conversely, 80 % of these groundwater samples fall into the NaCl type, and other 15 % into the dominant mixed of Ca-Mg-Cl type and 5 % into the Ca-Cl type facies. NaCl type is higher due to the salinity of groundwater which is the resultant of mixing of fresh water with relict saline water.The Gibb's plot indicates that most of the groundwater samples fall outside the plot and few of the water samples fall in the rock-water interaction and evaporation which is mainly regulated by mixing of high saline water. In Chadha's plot is 80 % majority of the samples are found in field 3 (Na–Cl type, seawater), indicating Na–Cl groundwaters with typical seawater mixing and they are mostly confined to the coastal areas. The Cl–/HCO_3 ratio of 70 % groundwater samples in the study area are in slight to moderate salinity affected range and 5% values of Cl–/HCO_3 - mostly indicates the strong seawater intrusion. Based on the analysis, most of the coastal area at many locations is moderately affected to seawater intrusion, making the water unsuitable for drinking purposes.

Determinations various irrigation water quality parameters such as sodium adsorption ratio (SAR), sodium percentage (Na%) and permeability index (PI) revealed that most of the samples are also unsuitable for irrigation. According to the quality classification of irrigation water proposed by Wilcox and US salinity classification, most samples fall in the permissible to doubtful range for irrigation purpose. It was also observed that the quality of groundwater was not suitable for drinking purpose in coastal area. The groundwater of this region shows that they are chiefly affected by seawater intrusion and in most of the places they are unsafe for irrigation and domestic purpose which is also due to the influence of anthropogenic activities like salt pans and agriculture.

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A Study of Grain Size Analysis of Marine Sediments from Thondi to Mandapam, Tamilnadu, India

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Abstract

The coastal line of India extending over 7516 km is quite variable, both in form and nature. Tamil Nadu has a coastal line of 1076 km with continental shelf area of 41,500 km^2. As geomorphology deals with surficial deposit, their form, size and material association with other factors, it has become very necessary to study the morphology. Grain size analysis is used to describe the nature of clastic sediments. It is the fundamental property of sediment particles affecting their transport and deposition. Geologist uses information of sediment grain size to study the trends in surface processes related to the dynamic conditions of transportation and deposition. Engineers use grain size to study the sample permeability under load, geo-chemist use grain size to study kinetic reactions and the affinities of the fine-grained particles and contaminants and hydrologist use to study the movement of sub surface fluids. The coastal zone of Tamilnadu is endowed with varied landscape such as beaches, backwaters, deltas, lagoons, mangroves and coral reef ecosystems. The coastal stretch of nearly 940km long has many major rivers draining into the Bay of Bengal and these rivers bring in considerable sediments. This will add more useful evidences on the possible causes and the controlling factors of sediments distribution and deposition in a sedimentary basin. The study of grain size of beach sands will help us to understand such interaction. Taking into account the paramount importance and utility value of grain size of sediments.

Keywords- coastline, skewness, standard deviation, mean, grain size.

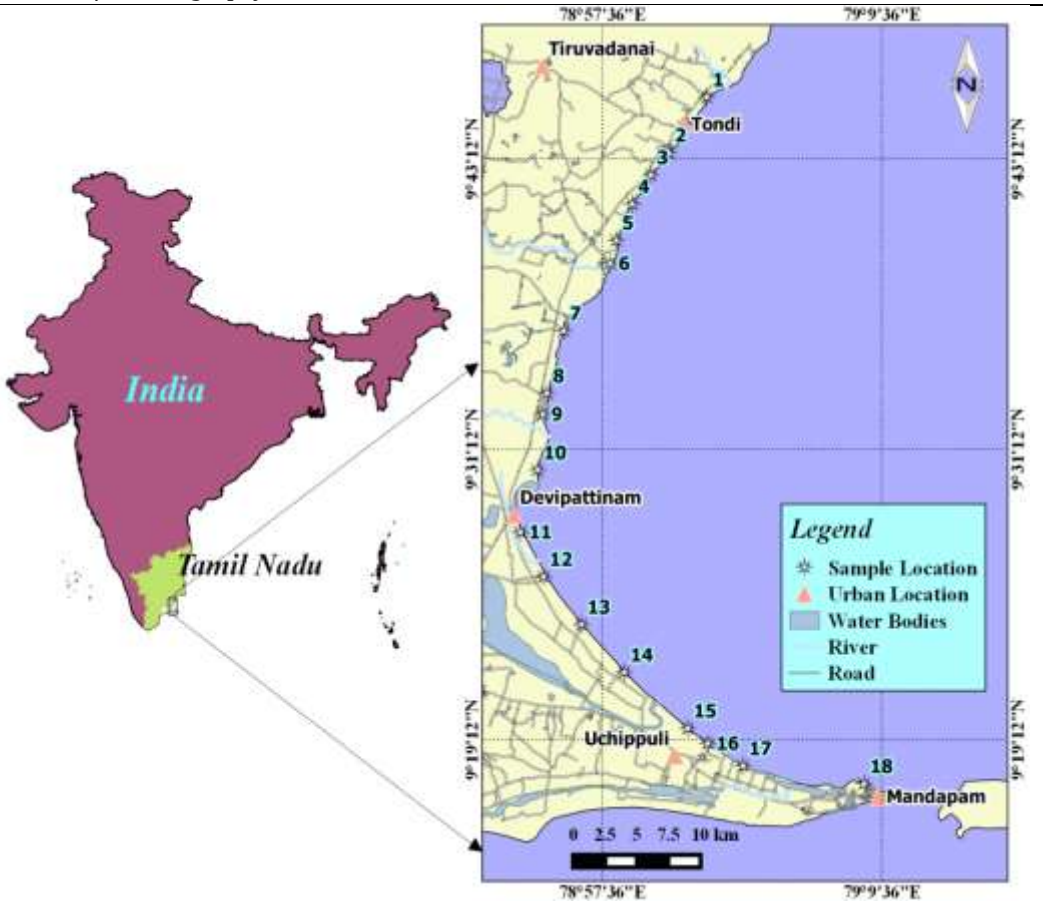
Introduction

The coastal line of India extending over 7516 km is quite variable, both in form and nature. Tamil Nadu has a coastal line of 1076 km with continental shelf area of 41,500 km^2. Grain size parameters are being used as indicators of sediment size distribution and depositional environments. Different statistical parameters have been proposed to discriminate depositional environments. Because of the variety of statistical parameters and lake of correlation between them empirical approaches utilizing principal component analysis has been developed. The present work includes the generation of basic data on textural parameters and statistical measures mean, standard deviation, skewness, kurtosis etc. Grain size studies of beach sediments provide wealth of information on the intrinsic properties of sediments and their depositional environment. Sedimentology of beach

sediments plays a vital role in documenting the depositional history of a region. Sedimentologists are particularly concerned with three aspects of particle size: (a) Techniques for measuring grain size and expressing it in terms a grade scale, (b) Methods for quantifying grain size data and presenting them in a graphical or statistical form and (c) The genetic significance of these data. The size of particles is directly dependent on the type of environment setting, transporting agent, length and time during transport and depositional conditions. Grain size is related to a multitude of external factors acting on a local or regional scale. For example, the coastal and marine setting, grain size is related to the bathymetry and geometry of the basin, nutrient regime, biogeochemical oceanography, coastal processes, net sediment inputs from land sources and outputs. Grain size analysis is often part of the basic, initial set of analytical laboratory procedures scientists conduct upon sediment samples and sediment cores are recently collected in the field. The purpose of such analysis is (a) obtain a deeper understanding of paleo-environmental features or modern environmental impacts, (b) reconstruct the past sediment transport histories, depositional conditions, or sediment provenance and (3) analyze in a catastrophic event such as a tsunami or hurricane deposits.The coastal zone of Tamilnadu is endowed with varied landscape such as beaches, backwaters, deltas, lagoons, mangroves and coral reef ecosystems. The coastal stretch of nearly 940km long has many major rivers draining into the Bay of Bengal and these rivers bring in considerable sediments. This will add more useful evidences on the possible causes and the controlling factors of sediments distribution and deposition in a sedimentary basin. The study of grain size of beach sands will help us to understand such interaction. Taking into account the paramount importance and utility value of grain size of sediments.

Study Area

The study area lies between Thondi to Mandapam in the Palk Strait of Bay of Bengal, over a length of about 80km located between the latitude09°44′29″ to 09°16′79″ N and longitude 79°01′14″ to 79°10′56″ E.



S.NO	LOCATION	LATITUDE	LONGITUDE
01	Thondi	N 09° 73' 816"	E 79° 01' 9"
02	Thondi	N 09° 73' 4"	E 79° 01' 655"
03	Karangadu	N 09°64' 083"	E 78° 95' 583"
04	Uppur	N 09° 60' 801"	E 78° 60' 108"
05	Palanivalasai	N 09° 41' 941"	E 78° 91' 843"
06	Athiyuth Beach	N 09° 40' 878"	E 78° 93' 78"
07	Pudhuvalasai	N 09° 39' 831"	E 78° 94' 628"
08	Panaikulam	N 09° 38' 27"	E 78° 96' 135"
09	Alagankulam Beach	N 09° 36' 765"	E 78° 96' 135"
10	Alagankulam Beach	N 09° 37' 015"	E 78° 97' 283"
11	Attangarai	N 09° 34' 933"	E 78° 97' 517"
12	Attangarai	N 09° 34' 941"	E 78° 99' 215"
13	Uchipuli Beach	N 09° 32' 34"	E 79° 02' 688"
14	Ariyaman Beach	N 09° 29' 928"	E 79° 06' 755"
15	Ariyaman Beach	N 09° 29' 878"	E 79° 06' 67"
16	Mandapam	N 09° 28' 406"	E 79° 16' 433"
17	Mandapam	N 09° 28' 425"	E 79° 16' 445"
18	Mandapam	N 09° 27' 983"	E 79° 16' 972"

Grain Size Analysis

Mean

It presents the average size of the total distribution of sediments. The nature of sediments and its depositional basin can be explained by mean values. The mean size of the sediment depends on the energy, duration of the depositing medium, composition and durability of the grains. The availability of grains of various size is another important controlling factors. It is influenced by the parameter like velocity of transporting agent, shape and specific gravity, composition, durability and resisting nature of the sediments and the amount of tossing during transportation.

Standard Deviation

It is also the resultant character of sediments controlled by size, shape and specific gravity of the sediment. The standard deviation values of the sediments of the region ranges from 0.37φ to 2.18φ. Out of the 18 samples, 4 samples have standard deviation values from 0.37φ to 0.50φ which indicating that the sediment are well sorted in characteristics, 11 sample have value from 0.50φ to 0.71φ indicating moderately well sorted in characteristics, 1 sample have value from o.71φ to 1.00φ indicating moderately sorted in characteristic, 2 samples have value from 1.00φ to 2.00φ indicating poorly sorted in characteristics.

Skewness

Skewness measures the asymmetry of the particle distribution. It is used to determine the symmetry of the central part of the distribution. It is a significant parameter in delineating environment, since it is sensitive to sub population mixing. The single source of sediment like beach sands, aeolian sands are tend to have fairly normal curves but the multiple source show pronounced skewness and kurtosis.

Kurtosis

The kurtosis values of sediments ranges from 2.2 to 18.8. Out of 18 samples 1 sample have kurtosis value in very platykurtic. 2 samples have kurtosis value in mesokurtic. 13 samples have kurtosis value in leptokurtic. 2 samples have kurtosis value in very leptokurtic. The Kurtosis is the ratio between the sorting of either extremes and to the central portion of distribution. If the central portion is better sorted than the extreme, the frequency curve is said to be excessively peaked or leptokurtic. It is function of internal sorting or distribution. In contrast, if the extremes are better sorted than the central portion of the frequency curve, then it is called flat peaked or platykurtic.

Depositional Environment

Binary plot between the different sensitive textural parameters throw light on information regarding the depositional environment of sedimentation and demarcate the fields of overlapping of coarsely related depositional environment. Sedimentalogist have attempted to use scatter graph of grain size parameters to distinguish between different depositional settings, via bivariate plots, which are based on the assumption that

these statistical parameter's reliability reflects differenced in the fluid-flow mechanisms of sediments transportation and deposition.

The mainly composed of well sorted and leptokurtic. In skewness against kurtosis is plotted.

Result And Discussion

The grain size distribution has clearly shown the existence of marked changes in the grain size and the mode of admixture of different environment sediments. The parameters used to describe the particle size distribution fall into four primary groups: those are the mean, standard deviation (sorting), skewness and kurtosis. Generally Standard deviation and Skewness are considered to be the indicators, which are environmentally sensitive while the mean is a reflection of the competency of transport mechanism. The textural attributes of sediments, viz. mean, standard deviation, skewness and kurtosis are widely used to reconstruct the depositional environment of sediments (Angusamy and Rajamanikam 2006). Correlation between size parameters transport processes/depositional mechanism of sediments has been established by exhaustive studies from many modern and ancient sedimentary environments. The sediments samples collection in 18 different locations in which fifteen sample are unimodel and other three are bimodal. The 15 samples are mostly composed of medium sand. It also exhibits mostly unimodel distribution of sediments having their peak at φ unimodel with a characteristic unimodel nature. The beach sand show well sorted nature. From this pattern, it is inferred that sorting is directly proportional to the size of the sediments. The grain size parameters of the study area and statistical properties of grain sizes and its interpretations the standard deviation of most of the samples emerged very well sorted too poorly sorted. Mean values indicating fine sand to medium sand. The positive skewness suggests the addition of fine sediment probably by Aeolian activity. The skewness values having very coarse skewed to symmetrical. The kurtosis values are having very platykurtic to leptokurtic in nature.

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Investigation of Seawater to Reduce the Salinity Level Aspects from Devipattinam to Sundarapandianpattinam, Ramanathapuram District, Tamil Nadu, India

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Abstract

Water is one of the universal substances, which is used alike by all the living species to sustain the life. Clean and plentiful water provides the foundation for prosperous life and communities.It is estimated that by 2025, there will be 3 billion people in the world facing water shortage, and 40 countries and regions are in a serious shortage of fresh water. To solve the global water shortage problem, instead of only focusing on saving water, converting other types of wateWater shortages and unreliable water quality are considered major obstacles to achieve sustainable development and improvement in the quality of life. The water demand in the country is increasing fast due to progressive increase in the demand of water for irrigation, rapid industrialization, population growth and improving life standards. r resources into freshwater should also be considered as a long-term open-source plan.Desalination is referred to as a potable water recovery method that removes dissolved solids/salts from brackish or saline water. Desalination is a nature-inspired process of salt removal as water evaporation over the sea surface and ice formation are some examples.As a definition, desalination is a general term for the process that removes dissolved salts from water. However, freshwater is defined as containing less than 1000 mg/L of salts or total dissolved solids (TDS).Evidence of this trend can be observed in the evolution of the average specific capital cost over time of the three desalination technologies with the highest level of technological maturity and market uptake: multi-effect distillation (MED), multi-stage flash (MSF) distillation, and reverse osmosis (RO).

Keywords -water, desalination,irrigation,distillation,osmosis.

Introduction

The world's water reserves are abundant, at 1.45 billion cubic kilometres, but freshwater accounts for only 2.5 percent of them.This tiny amount, more than 70 percent is locked up in Antarctic and Arctic ice caps, and with inaccessible mountain glaciers and frozen snow cover, 87 percent is unusable. Humans can use only freshwater resources rivers, lakes, and groundwater, which account for 0.26% of the earth's total water volume. The freshwater resources in the world are not only in short supply but also extremely unbalanced in regional distribution. By region, nine countries - Brazil, Russia, Canada, China, the

United States, Indonesia, India, Colombia, and Congo - account for 60 percent of the world's freshwater resources. About 1.5 billion people in 80 countries and regions, representing 40 percent of the world's population, are short of fresh water, and about 300 million people in 26 countries are critically short of water. It is estimated that by 2025, there will be 3 billion people in the world facing water shortage, and 40 countries and regions are in a serious shortage of fresh water. To solve the global water shortage problem, instead of only focusing on saving water, converting other types of water resources into freshwater should also be considered as a long-term open-source plan. Because of the high salinity of the ocean water and the significant costs associated with seawater desalination, most of the world population ‘s water supply has traditionally come from freshwater sources – groundwater aquifers, rivers and lakes (Vouch et al., 2016). In many parts of the world, huge amount of fresh water is required for agricultural, industrial and domestic uses. However, changing climate patterns combined with the growing of world population, the need for fresh water is increasing. Some 700 million people don’t have access to enough clean water. In 10 years, the number is expected to explode to 1.8 billion.

Desalination Method

Desalination is a nature-inspired process of salt removal as water evaporation over the sea surface and ice formation are some examples. Owing to a lower density of ice than water, excessive salt gets expelled during the ice-formation process (referred to as desalination). Plant and animals also provide some examples of desalination. Mangroves and Willow are some well-known plant examples. Mangroves grow in the sea, absorb seawater, and expel salt through their leaves and roots. Willows are intentionally grown in seawater or other salty lands. These plants have the capability to absorb salts and other contaminants. Some animals, especially seabirds like gulls and pelicans, have a gland that distils water. These seabirds drink seawater and sneeze the brine. There are various types of desalination processes, but the basic principle of operation is similar.As a definition, desalination is a general term for the process that removes dissolved salts from water. However, freshwater is defined as containing less than 1000 mg/L of salts or total dissolved solids (TDS). During World War II, it was felt that desalination technology should be developed to convert saline water into usable water, where fresh water supplies were limited. Subsequently, The Saline Water Act-I was passed by Congress in 1952 to provide federal support for desalination. The U.S. Department of the Interior, through the Office of Saline Water (OSW) provided funding during the 1950’s and 60’s for initial development of desalination technology, and for construction of demonstration plants (Krishna, 2014). In recent years, with improvements in technology, desalination processes have developed to a large extent during the latter half of the 20^{th} century and

continue to undergo technological improvements even at the present time.

Study Area

Ramanathapuram is located between 9° 05' and 9° 50' North of Latitude and between 78° 10' and 79° 27' East of Longitude. Ramanathapuram is situated in South-eastern part of Tamil Nadu, it is something in dumper shape. 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. It covers the geographical area of 4175.00 Sq. km. The eastern portion of the Ramanathapuram district consists of rocks formed in beds of shallow lakes and coastal backwaters where the salt and mud brought by the rivers are deposited. The sedimentary rocks extend into the whole of Tiruvadanai, Ramanathapuram and Mudukulattur taluks. They contain limestones. Limestone of different grades, clays, euchres, gypsum, graphite and limonite sands are the minerals of different grades, clays, euchres, gypsum, graphite and limonite sands are the minerals of economic value found in the district.The district a Tropical climate. The period from May to June is generally hot and dry. The weather is pleasant during the period from December to January. Usually, mornings are more humid than afternoons. The relative humidity is on an average between 79 and 84%. The minimum temperature is 25.7°C and mean, maximum daily temperature is 30.6°C respectively.

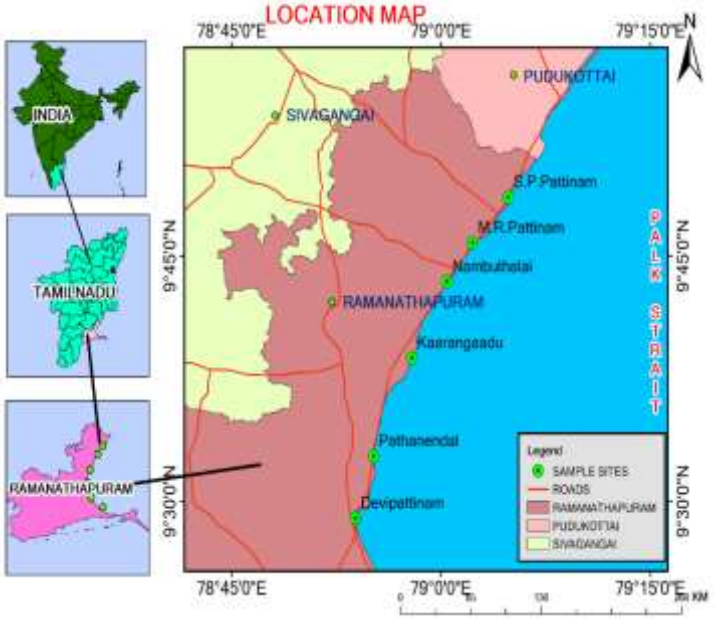
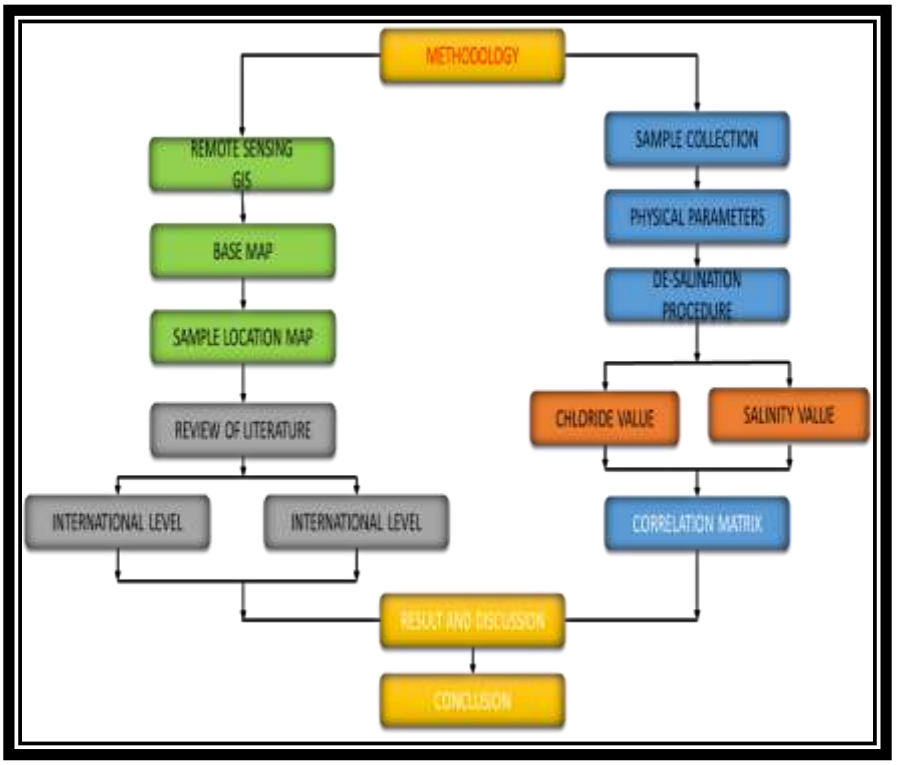


Fig. The map shows the study area.

Methodology This chapter describes the

methods of sample collection and analytical procedures adopted for investigation of sea water samples of Ramanathapuram district using different analytical methods. To investigate the sea water salinity level of Ramanathapuram district, water samples were collected from 12 different selected sites in February 2023.

Flow Chart for Methodology



The table shows the sea water samples collected in Ramanathapuram District.

SAMPLE NO	LOCATION	LATITUDE	LONGITUDE
1	**Devipattinam**	9.482	78.897
2	**Pathanendal**	9.505	78.914
3	**Thiruppalaikudi**	9.546	78.919
4	**Uppur**	9.609	78.935
5	**Kaarangaadu**	9.645	78.965
6	**Puduppattinam**	9.679	78.975
7	**Nambuthalai**	9.723	79.007
8	**Thondi**	9.735	79.017
9	**M.R. Pattinam**	9.763	79.037
10	**Dhamodhiran Pattinam**	9.792	79.068
11	**Pasippattinam**	9.809	79.080
12	**Sundarapandian Pattinam**	9.835	79.102

Examination Of Samples

The seawater samples which are taken in various locations are analyzed for the determination of quality of water

with respect to the following physiochemical parameters.

- PH
- EC (Electrical Conductivity)
- TDS (Total Dissolved Solids)
- Turbidity
- Salinity
- Hardness
- Calcium
- Magnesium
- Chloride
- Sodium
- Potassium

Chemical Analysis of Water Sample

The water samples collected at the field and samples were analyzed in the laboratory. They are analyzed for various physiochemical parameters in the laboratory. Calcium (Ca) and Magnesium (Mg) were determined titrimetrically using standard EDTA; Chloride (Cl) was determined by standard AgNO3 titration; Sodium (Na) and Potassium(K) were determined by Flame Photometer. All concentrations are expressed in milligrams per liter (mg/l), except pH, EC, and TDS. The EC concentrations were expressed in µs/cm and TDS concentrations were expressed in ppm.

Spatial Analysis

The spatial analysis of various physiochemical parameters was carried out by using GIS contouring methods with ArcGIS software. The inverse distance weighted (IDW) interpolation techniques have been used for preparing the spatial distribution maps for each physiochemical parameter. The spatial distribution map of the pH, EC, TDS. Cations (Ca^{2+}, Mg^{2+}, Na^{+} and K^{+}) and anions (Cl^{-}).

Result and Discussion

Result of the seawater quality data were shown below during the year of Feb 2023. Sea water quality in the Ramanathapuram district with the help of Arc-GIS data were interpolated for the spatial distribution map. The spatial structures were also identified interpolating the scattered data,in order to have temporal series of spatially continuous maps of the parameters. The data used to create the Inverse Distance to a power gridding method as a smoothing interpolator. In this method, data are weighed during interpolation such the manipulation of one point relative to other declines with the distance. In particular, we use a quadric law for computation of the weight, and a low value for smoothing parameters. The physical and chemical parameters of the sea water samples were carried to prepare a spatial distribution map in IDW method using Arc GIS 10.8 software. The values are also plotted and shown in the form of graph for all the physical and chemical parameters.

Salinity Reducing Aspects

The sea water samples were collected, and it was taken to undergo for the De-salination process using the starch powder. The experiment was carried out without any instruments. The initial and the final value of the chloride and the salinity values were noted and the difference % were plotted in pie-chart. The final value of salinity

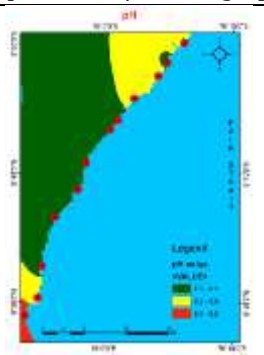
shows a difference from the initial value of salinity of the sea water sample.

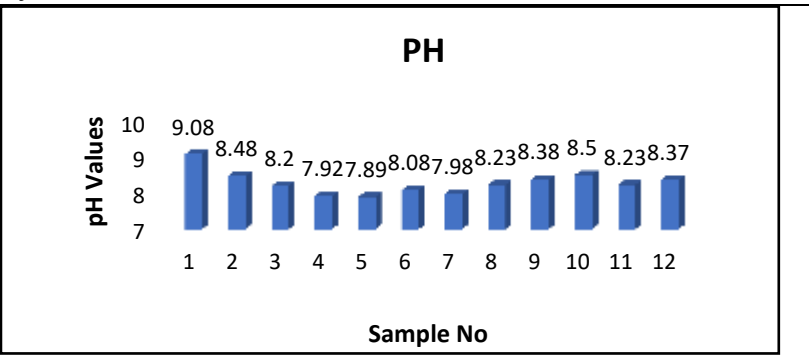
Table.The table shows the Physical and Chemical parameters of Sea water samples.

S. No	SAMPLE LOCATIONS	Physical Parameters			Chemical Parameters (ppm)						
		pH	EC (µS/cm)	TDS (ppm)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Cl (mg/l)	So_4 (mg/l)	Salinity (ppt)
1	Devipattinam	9.0	38571.4	11.4	275	1200	40000	3600	14000	7000	25293.1
2	Pathanendal	8.4	37685.2	11.4	175	1225	37000	4150	13800	6500	25014.36
3	Thiruppalaikudi	8.2	37714.3	11.6	240	775	39000	3700	14400	5500	26015.76
4	Uppur	7.9	39250.2	11.7	185	975	36800	5200	13200	6800	24894.25
5	Kaarangaadu	7.8	59142.9	12.6	280	890	59000	6200	22000	9600	39746.3
6	Puduppattinam	8.0	50456.3	10.9	165	820	39800	3900	14600	5400	24965.21
7	Nambuthalai	7.9	41857.1	11.3	190	1070	42500	4050	13600	7500	24570.44
8	Thondi	8.2	39285.7	10.8	345	740	37100	5010	13200	6400	23485.21
9	M.R. Pattinam	8.3	38285.7	11.4	200	800	38500	4000	13400	6900	24209.11
10	Dhamodhiran Pattinam	8.5	40156.5	10.6	480	525	43200	4820	14800	7100	25458.38
11	Pasippattinam	8.2	37285.8	11.4	240	885	38000	3800	13200	6700	23487.78
12	Sundarapandian Pattinam	8.3	39786.2	11.2	270	705	46400	3900	14200	6900	29372.1

Hydrogen Ion Concentration

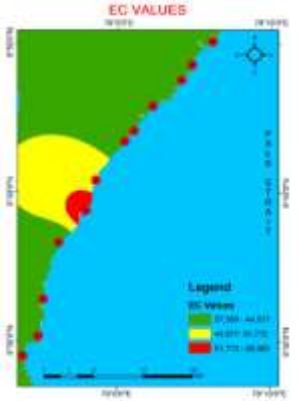
pH is the measure of hydrogen ion concentration value in water which indicates whether a solution is acidic, neutral, or basic. The pH required has to be in the range of 6.5–8.5 for the drinking purpose (BIS, 2009). The pH of warer samples lies between 7.85 and 9.08 indicates that the water in this area is alkaline in nature.The pH of water changes with the production of hydrogen or hydroxyl ion during different chemical reactions. It is noticed that water with low pH tends to be toxic and with high degree of pH it is turned into bitter taste. The pH values of the water samples ranged from 7.89 to 9.08 neutral to alkaline nature.The hydrogen ion concentration (pH) in the water samples varies from 7.89 to 9.08 with an average of 8.03.

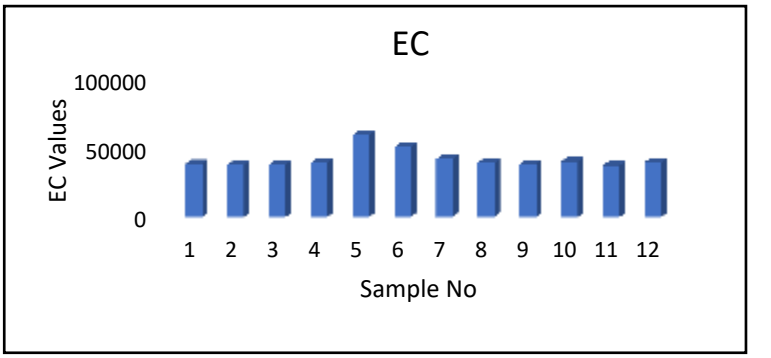


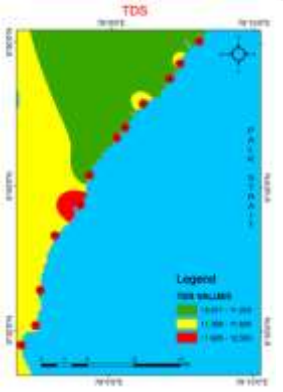


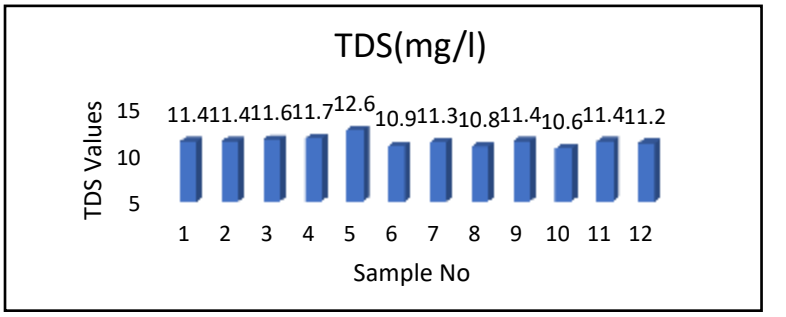
Electrical Conductivity (Ec)

Electrical conductivity (EC) is a measure of water capacity to convey electric current and importance to salinity, which greatly affects the taste. Chemically pure water has a low electrical conductivity, indicating that it is a good insulator. It directly related to concentration of ionized substances in water and may also be related to problems in excessive hardness EC is expressed in terms of the specific electrical conductivity, which is defined as the reciprocal of electrical resistance in Ohm (Q), in relation to a water cube of edge length 1 cm at 25°C. Electrical conductivity is the capacity of electrical current that passes through the water.









Total Dissolved Solids (Tds)

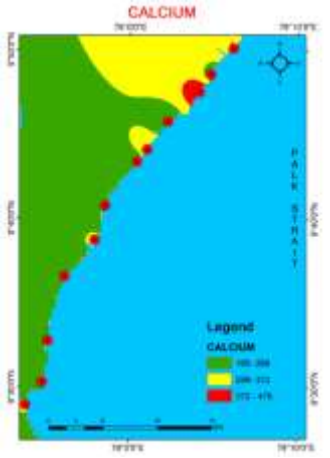
Total dissolved solids (TDS) refer to the total amount of all inorganic

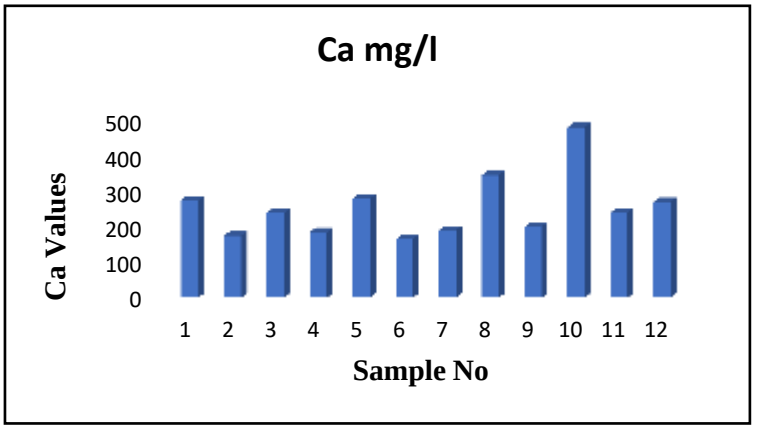
and organic substances including minerals, salts, metals, cations or anions that are dispersed within a volume of water. The principal constituents are usually the cations calcium, magnesium, sodium and potassium and the anions bicarbonate, chloride, nitrate, and sulphate in groundwater. The concentration of Total Dissolved Solids ranges from 10.6 to 12.6 mg/l with an average of 11.2 mg/l. The limiting values of TDS are given in Table.4.5 and Fig4.1.

Chemical Parameters

Calcium (Ca)

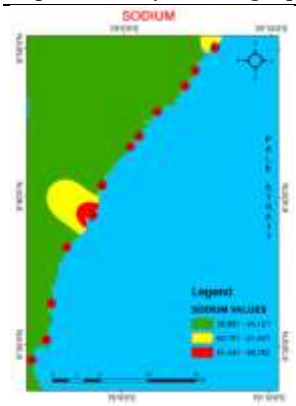
Calcium is one of the most abundant substances in the water. The high concentration of calcium ions can cause abdominal ailments and is undesirable for domestic use as it causes encrustation and scaling (Kumar et al. 2014). It is produced as a result of dissolution processes of sedimentary rocks (calcite, aragonite, limestone, dolomite and gypsum) and from weathering of igneous rocks like (pyroxene, amphibole and plagioclase feldspar). About 95% calcium in human body stored in bones and teeth. The Ca values ranges from 165 to 480 mg/l with an average of 280 mg/l.All the samples fall within the not potable limit, Spatial distribution map shows on Fig.4.7.

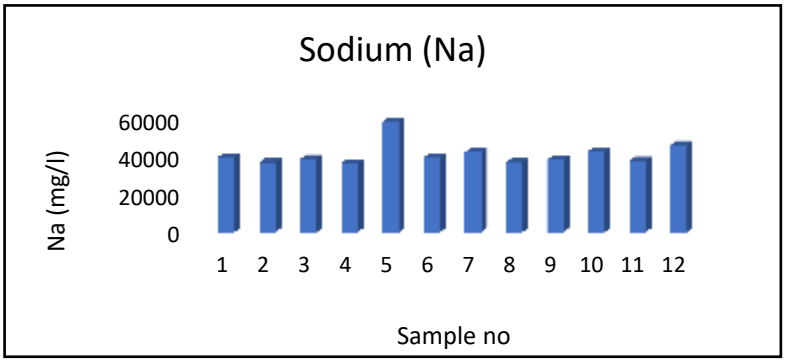




Sodium (Na)

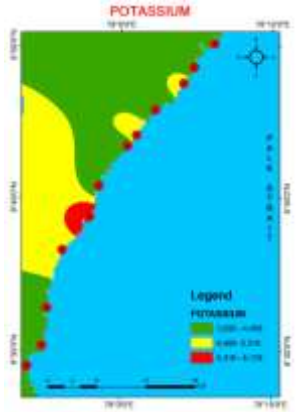
Sodium is a metallic element and found in less quantity in water. The source of sodium in groundwater and comes from erosion of alkalinity feldspar and evaporation rocks and from ionic exchange of clay minerals. Human activities can have significant influences on the concentration of sodium in ground and surface water. Proper quantity of sodium in human body prevents many fatal diseases like kidney damages, hypertension, headache etc.., (Ramesh and Balakumaran 2018). Sodium concentration is good if it is less than 250 mg/l (WHO, 1996) concentration. The Na value ranges from 36800 to 59000 mg/l with an average of 42500 mg/l. The spatial distribution map shown in the Fig.4.1

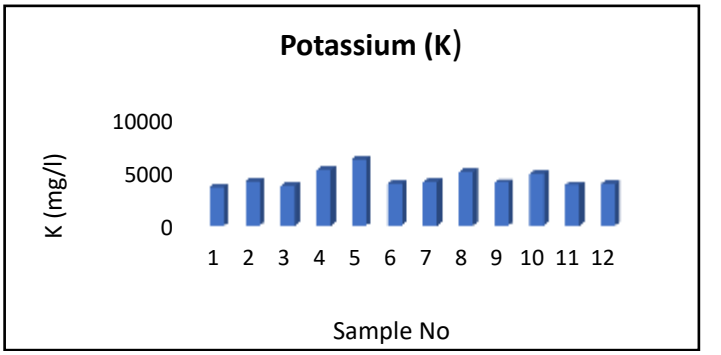




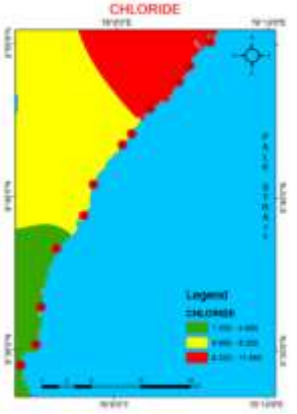
Potassium (K)

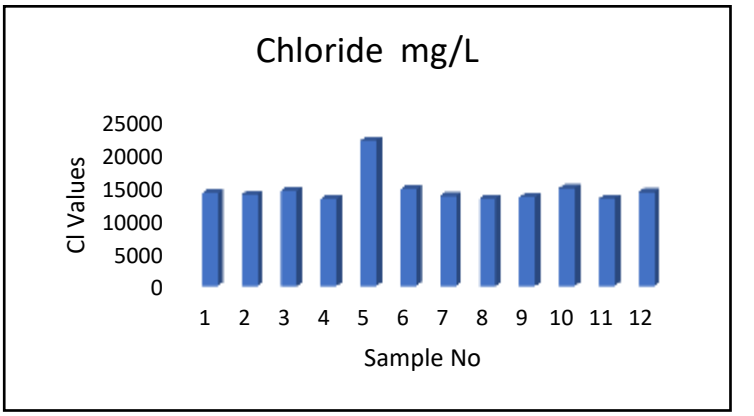
Potassium is slightly less common the sodium in igneous rocks but more abundant in all sedimentary rocks. The main source of potassium is the products formed by weathering of igneous minerals like (orthoclase, biotite and feldspathoid leucit) and sedimentary rocks. Potassium is an essential element for plants and animals; however, high concentration may be harmful to human nervous and digestive systems due to its laxative effects. Potassium deficient in rare but may led to depression, muscle weakness, heart rhythm disorder etc. The elements present in plants material and are lost from agricultural soil by crop harvesting and removal as well as leaching and runoff on organic residues (Ramesh and Balakumaran, 2018).Potassium concentration is good if it is less than 10 mg/l for domestic water (WHO, 1996). Potassium concentration ranges from 3600 to 6200 mg/l. Potassium classification is done in accordance with European standards. The spatial distribution map shown in the Fig 4.13.





Chloride (Cl)

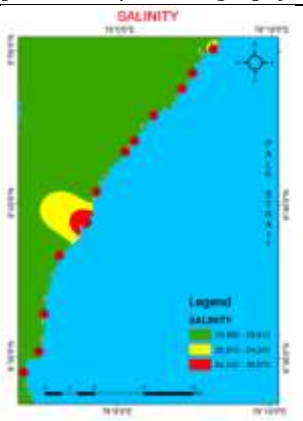


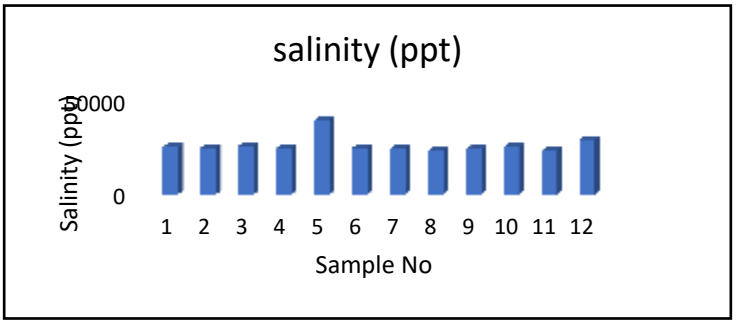


The source of chloride in groundwater is from dissolution of sedimentary rocks particularly evaporates like halite and sylvite and ancient sea water entrapped in sediments. Chloride is also abundant in the minerals found in igneous rocks like apatite, feldspathoid and sodalite. Chloride is also obtained from the dissolution of salts of hydrochloric acid as NaCl, $NaCO_2$ and added through industrial and domestic wastewater, sewage, sea water etc. Excess chloride (>250 mg/l) imparts a salty taste to water. High chloride concentration affects the aesthetic property of water including taste and renders it unsuitable for drinking purpose. The Chloride value ranges from 13200 to 22000 mg/l with an average of 14500 mg/l. Chloride spatial distribution map is shown in Fig.4.15.

Salinity

The salinity of sea water is expressed as a ratio of salt (in grams) to liter of water. In sea water there is typically close to 35 grams (predominantly sodium Na and chloride cl ions) of dissolved salts in each liter. It is written as 35%. The normal range of ocean salinity ranges between 33-37 grams per liter. Highly saline water ranges from 10000 ppm to 35000 ppm. By the way, ocean water contains about 35000 ppm of salt. The average density at the surface is 1.025 kg/lAlthoughthe vast majority of seawater has a salinity of between 31 and 38 g/kg, that is 3.1-3.8%, seawater is not saline throughout the world. The salinity ranges from 23485 to 39746 ppt.The spatial distribution map shoes in the fig 4.19.





Desalination Using Starch

Research have shown that hydroxyl groups that are present in carbohydrates can coordinate with metal cations. There has also been an effort to prove the existence of such a complex formation between the hydroxyl of carbohydrates and cation through electrophoresis. In solution containing cations, carbohydrates were shown to migrate towards the cathode thus highlighting the presence of a complex formation with the cation. This method was also used for electrophoretic separation of carbohydrates. The ionic radii of the cations were found to play a crucial role in affecting the tendency of forming complex with a carbohydrate. Researchers found that the most suitable ionic radius for complex formation is 100-110 pm. Sodium has an approximate ionic radius of 102 pm while magnesium has an ionic radius of 72 pm. This explains why the starch containing materials are efficient at removing salt from water. The poor efficiency of low starch content materials like peanuts and soya bean at removing salt from water also supports this hypothesis. When only sand was used (as a control), no reduction in salinity was observed, thus eliminating the possibility of sand removing salt from water. Amylopectin having lager hydroxyl units' bonds with sodium more effectively than starch as confirmed from our experimental data.

Experimental De-Salination Procedure

Calibration of initial salinity:

- The salinity level was calculated by the chloride value after finding the chloride value used as titration method.
- The initial salinity of the water sample is calculated with the chloride value using the salinity formula.

Column packing for continuous de-salination:

- A continuous desalination method is adopted using a column pipe of length 10 cm and radius 1.25 cm.
- The starch powder was taken and those are used for packing the column pipe.
- At the bottom of the column, a small piece of cotton is fitted.

- Above that, a very fine layer of sand is used to restrict the contact between the cotton and leaves or peels.
- The small quantity of starch powder is then used to fill the column so that the length of the column is 10 cm.
- Finally, the column is packed with another small piece of cotton at the top.

Continuous desalination using starch powder:

- Saline water with initial salinity of 20 ppt is poured in the column pipe.
- The rate of flow of water is fixed to 1 drop per minute/0.05 mL per minute.
- The water is collected in a beaker.

Determination of Salinity:

- The collected water sample from the desalination method was treated to the salinity measurement.
- The collected water was analysed for the final salinity level.

Chloride Concentration

Table shows the Chloride concentration after desalination process.

Sample no	Initial chloride value (mg/l)	Final chloride value (mg/l)	chloride difference %
1	14000	10200	27.14
2	13800	9990	27.60
3	14400	10100	29.86
4	13200	9970	24.46
5	22000	10650	51.59
6	14600	10325	29.28
7	13600	9980	26.62
8	13200	9960	24.54
9	13400	9870	26.34
10	14800	10400	29.72
11	13200	9970	24.74
12	14200	10350	27.11

Salinity Concentration

Fig. Table shows the salinity concentration after desalination process.

Sample no	Initial salinity (ppt)	Final salinity (ppt)	salinity Difference %
1	25293.10	18427	27.1
2	24931.77	18231	26.9
3	26015.76	18247	29.9
4	23847.78	17964	24.7
5	39746.30	19240	51.6
6	26377.09	17998	31.8
7	24570.44	18030	26.6
8	23847.78	17895	25.0
9	24209.11	17831	26.3

10	26738.42	18568	30.6
11	23847.78	18012	24.5
12	25654.43	18653	27.3

Conclusion

Based on the observations, it can be concluded that salinity of sea water level can be removed using only naturally occurring materials without the application of any energy or chemical reagents. It was worthy to note that starch was most effective in desalination and the continuous desalination using starch column was more fruitful.It is interesting to note that food items with high starch content are more efficient at desalination.

The advantages of this technique are.

- No chemical reagents are needed,
- No energy is required,
- It is eco-friendly,
- It is cost-effective,
- It is simple and efficient.

The development of such a green technique will simplify the water softening process and desalination without any damage to the environment; removing permanent hardness and desalination with eco-friendly materials is thus likely to become a widespread method in the near future. A biofilter can be made very efficiently to desalinate water and use it for household purposes like bathing, watering plants, washing and many more domestic purposes.About 97 percent of Earth's water is in the ocean, less than one percent of all the water on Earth is fresh. Instead of not using the sea water completely, it can be mixed with normal water in the ratio of 1:5 and used for daily needs, industrial usages, agricultural purposes, domestic purposes etc.The diluted sea water cannot be utilized for drinking, but can be used for domestic purposes like

- Vessel washing
- Watering lawns and Gardening
- Flushing toilet
- Septic tank cleaning and so on.

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Grain Size Analysis of Beach Sediments from Tharuvaikulam to Periasamypuram, Thuthukudi District, Tamilnadu, India

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Abstract

Thoothukudi is a port town situated in the Gulf of Mannar about 125 km (78 mi) North of Cape Commorin and its environs form part of the coastal belt which forms a continuous stretch of the flat country relieved here and there by small rock outcrops. The region, surrounding Thoothukudi is liberally dotted with rain fed tanks. Red soils found on the southern side of the Thoothukudi town are composed quartz and variable quantities of fine red dry dust. The port is an all-weather one.The coastal zone of the Tharuvaikulam to Periasamypuram, Thoothukudi district, Tamil Nadu is endowed varied landscape divided as sandy beaches, deltas, lagoons, back waters.The grain size analysis test is the performed to determine the percentage of each size of grain that is contained within a soil sample, and the results of the test can be used to produce the grain size distribution curve. This information is used classify the soil and to predict its behavior.Costal evolution varies generally with respect to both time and location.Impotent variables include tectonic setting, sediment supply, sea-level change, and the wave and tidal processes that characterize each region.Objectives of the present study, to study the textural parameters, analyze the grain size , prepare the coastal geomorphology map and to find the mode of Transportational and Depositional history.

INTRODUCTION

The coast of Tamil Nadu is a portion of the Coromandel Coast in the Bay of Bengal and Indian Ocean, and it is situated on the southeast coast of the Indian Peninsula. It is the nation's second-longest coastline, after Gujarat, at 1076 kilometres. Along with Kanniyakumari, Chennai forms the southern tip of the Indian Ocean, Bay of Bengal, and Arabian Sea. Chennai is the capital of the state and a significant commercial and industrial hub in the nation. It also has a marine boundary in the Gulf of Mannar with Sri Lanka via the Palk strait. The 14 districts that make up the coastal corridor are home to 15 significant ports and harbours, as well as lakes, river estuaries, and sandy beaches.Thoothukudi is a port town situated in the Gulf of Mannar about 125 km (78 mi) North of Cape Commorin and its environs form part of the coastal belt which forms a continuous stretch of the flat country relieved here and there by small rock outcrops. The region, surrounding Thoothukudi is liberally dotted with rain fed tanks. Red soils found on the

southern side of the Thoothukudi town are composed quartz and variable quantities of fine red dry dust. The port is an all weather one. The bay formed by the Hare Island, Devils point and the main land gives ample protection to the lighters from monsoonal weather. The beach of Thoothukudi is featured with calm breeze and very low waves giving an image of a big river.

STUDY AREA

The study area between Tharuvaikulam to Periasamypuram, Thuthukudi District, Tamil Nadu, India. over length of area's covered 40 km. located between Latitude N 8º53'31'' to N 9º2'51''and Longitude E 78°10'33'' to E 78°19'43''. The area is covered survey of India.

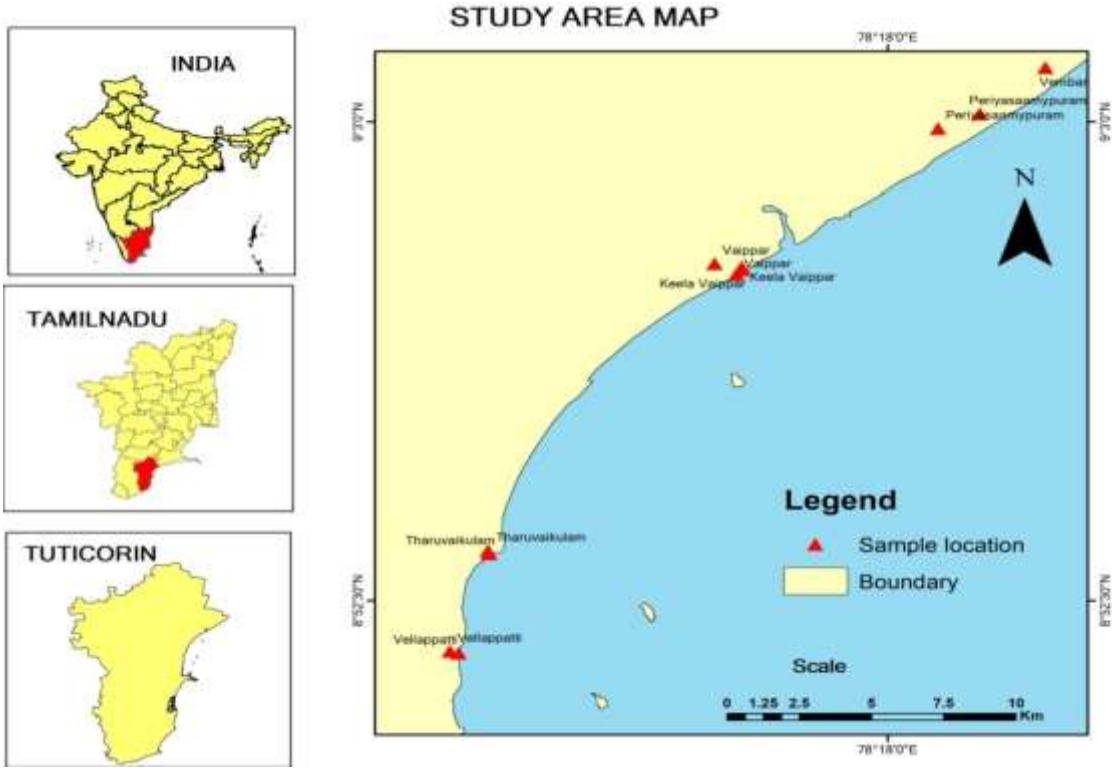


Fig 1.1.The figure shows the study area map

Physiography and Climate of the Study Area

Its maximum temperature is 41ºC and the minimum is 26ºC. The climate is conducive for agriculture and horticulture. Thoothukudi comes under low rainfall region. The normal rainfall of the district is 662.2 mm. South west monsoon accounts for 9%, north east monsoon for 65%, winter being 9% and summer being 17% of total rainfall. Thoothukudi depends mainly on north east monsoon rains, which are brought by the troughs of low pressure developing in south Bay of Bengal between October and December.

Geology of the Area

Thoothukudi district represents a well-developed litho package of meta-sedimentary sequence inter banded with charnockite Group of rocks. The rock types exposed are of quartzite, calc-granulite, garnet-biotite-sillimanite gneiss, garnet quartzo-feldspathic gneiss and garnet-biotite-cordierite gneiss belonging to Khondalite Group of rock. Charnockite and pyroxene Granulite are the Charnockite Group. Hornblende-biotite gneiss belongs to Migmatitic Complex. Besides, basic intrusive (pyroxenite) and acid intrusive (granite) are noticed. The younger intrusive are represented by pegmatite and quartz veins. Evidence of development of incipient / patchy charnockite along the shear plane is noticed in the district along the Western Ghat high hills.

Rock type found in the area belong to the Khondalite and Charnockite groups and Migmatite Complex of Easter Ghats Super group (Archaean Age),which are unconformably overlain by Tertiary and Quaternary sediments. Garnet-biotite-sillimanite gneiss, quartzite, calc-granulite and limestone of Khondalite group with epidiorite occurring as narrow linear bands. Charnockite group is represented by acid variants. These rock types occur as xenoliths within the Migmatite Complex occupies a major part of the area, comprising medium grained hornblende-biotite gneiss and garnet-biotite gneiss. Gypsum, limestone, beach sand, kankar and shell limestone are the Economic minerals of the district.

- Hard Rocks - 73%
- Sedimentary Rocks - 27%

Crystalline Limestone, Multi color dimension stone, rough stone/gravel, garnet and ilmenite sand are notable economic importance minerals of found in Thoothukudi District. Minor occurrences of Quartzite are also reported in the district. Mining activities based on rough stone (mostly charnockite) are majorly concentrated in Thoothukudi, Kovilpatti, Ettayapuram, Sathankulam,OttapidaramTaluks in the district under operation for production of construction materials and earth fill as gravel.

The multi color dimension stones occurring at Ottudanpatti in KovilpattiTaluk, Erachi in EttayapuramTaluk and Pasuvanthanai, Keelamangalam in OttapidaramTaluk are recorded in the district which actively mined by private miners. Crystalline Limestone occurring as bands in Sivalarpatti, Maniyakkaranpatti, Arasoor and MelaVenkatachalapuram mined by M/s Ramco Cements and M/s. India Cements Ltd, in recent years. Rich deposits of garnet and ilmenite sand occurs along the coast part of ThiruchendurTaluk, in Thoothukudi district. Kayalpatnam, Manappadu, Vaippar, Madhavankurichi, Vembar, Periyasamypuram and Padukkapathu areas show notable garnet and ilmenite sands occuurrences. At present the following mining/quarry leases are in existence in Thoothukudi Districtt.

Coastal Protection Initiatives

Islands of the Thoothukudi region act as bio shields in this village along with the coral and sea grass beds. The impact of tsunami was comparatively less in this district. Moreover, manual protection by making sea walls has been done in several areas noticeably in Thirespuram.

Thoothukudi district is situated in between latitude 8.8100°N, 78.1400°E with an area of 4621 sq.km. Agriculture is the main occupation and 70% of the people depend on it. Out of the total area of 470724 ha, 178623 ha are under the cultivation of different crops which is nearly 38% of total area of the district. The important food crops in the district are paddy, cholam, cumbu, ragi, varagu, samai and commercial crops like cotton, chilly, sugarcane and groundnut. Four of the 21 islands of Gulf of Mannar occur along Tuticorin coast. These islands are surrounded by a thick coral and seagrass cover which act as a bio shield. Erosion has been severe in these islands because of coral mining activities which happened before 2004 Indian Ocean tsunami along with sea level rise. Thamiraparani, the only river of the district. It originates from rises in Agasthiyamalai of the Western Ghats, flows through Srivaikundam and Thiruchendurtaluks and joins the sea at Punnakayl in Srivaikundamtaluk. The district has a wide coastal length of 163.5 km. The Gulf of Mannar Marine National Park area of Thoothukudi district includes estuaries, mudflats, beaches and forests of the near shore environment. Coral restoration, seagrass restoration and mangrove restoration activities are carried out successfully in this district.

Water Resources:

Thamiraparani river which rises in Agasthiyamalai of the western ghats, flows through Srivaikundam and Thiruchendurtaluks and joins the sea at Punnakayl in Srivaikundamtaluks. Pambayar and Manimuthar are the chief tributaries of Tamiraparani, which pass through the district. The Malattar and Uppodai flowing in Kovilpattitaluk are drainage courses. Tamiraparani and Manimutharu are the catchment areas of river basins, which have their place of origin in the Pothigaimalai. The former has a length of 120 km and the latter has a length of 98 km Pabanasam dam, Manimutharu dam and Eppodumvernam dam are built in the district.

Methodology

The collected 10 samples were kept in a hot air over at 60ºC remove the moisture content and they treated for sedimentlogical analysis such as sedimentary structure. The bulk representatives sand dominant samples were taken. After the coning and quartering method, they were subjected to dry sieving. The following flow chart shows the methodology adopted in the current study.

Sieve Analysis

The collected 10 beach samples were cleaned and then 100gm of sediments were sieved for 20 minutes with the help of mechanical Ro tap sieve shaker and the sieve sets were arranged in the descending order of the

grain size and sieved at half phi interval following Carver (1971) machine by using a stack of quarter phi, such as 25, 35,45,60,80,120,170,230 and pan in ASTM sieves. Each fraction was weighed and the size parameters were calculated by using Folk and Ward (1968).

Rusult and Discussion

Frequency Curve

Frequency curve exhibits the pictorial representation of actual weight percentage of different fraction of sediments. The peakness of fraction and uniformity of sediments can be inferred from it.

The frequency curves of sediments of study area are shown in fig. showing some of the sample ploy-model distribution with peaks between 1.5 to 2.0 phi and 2.0 to 2.5 phi indicating dominance of the coarse sand.

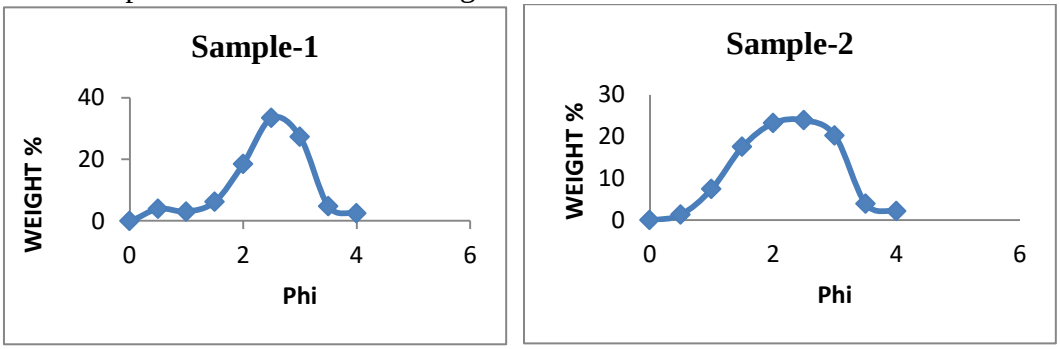
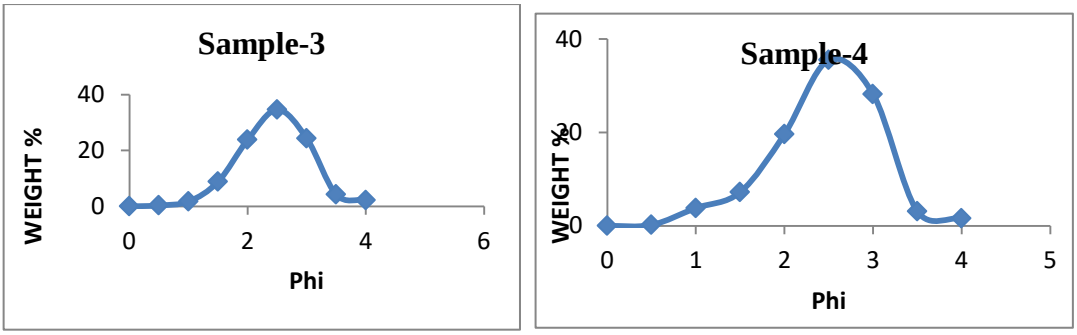
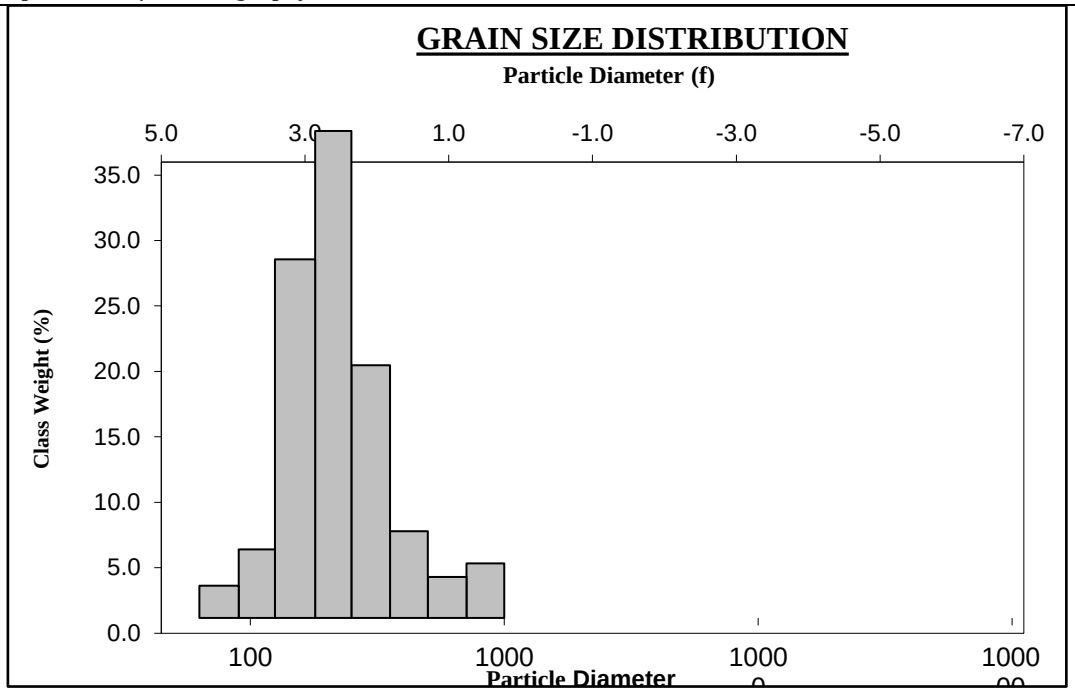


Figure 1.2 Frequency Curve of Sample



Histogram

The histogram is widely used to represent grain size it is simply a bar diagram in which weight percentage of sample in each size is plotted as rectangle bar by conversion grain size plotted on the particle diameter (x axis) and class weight percentage on the (y axis).



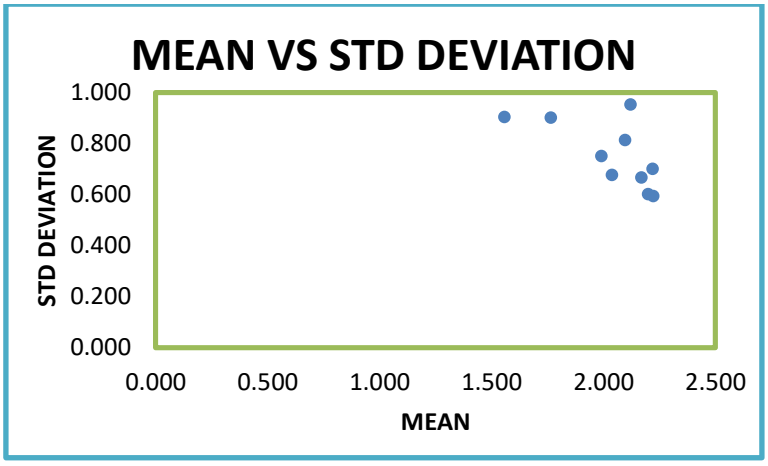


Figure 2.1 MEAN VS STD DEVIATION

VISHER'S DIAGRAM

Visher (1969) established the effective use of log probability curves for determining the environment of deposition of sediments using three types of sub population namely traction, saltation and suspension. The quantification of these three sub population from the mode of distribution and from the nature of frequency curve also helped the delineation of environment.

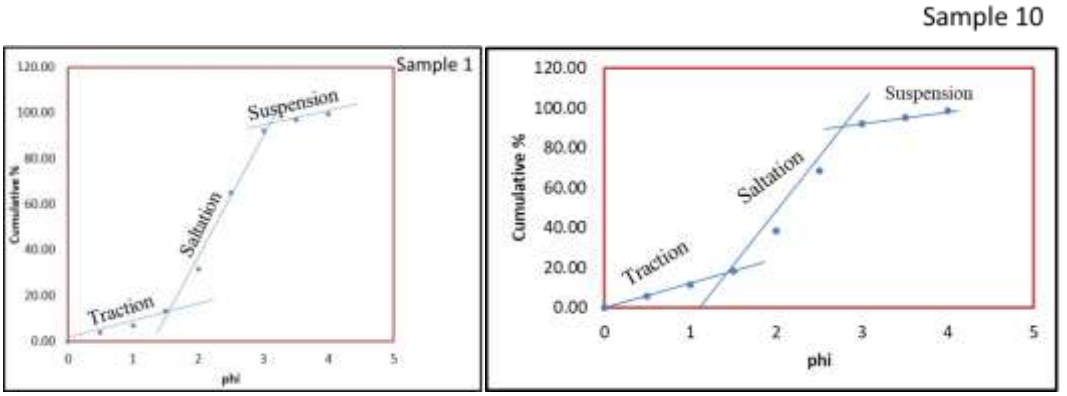
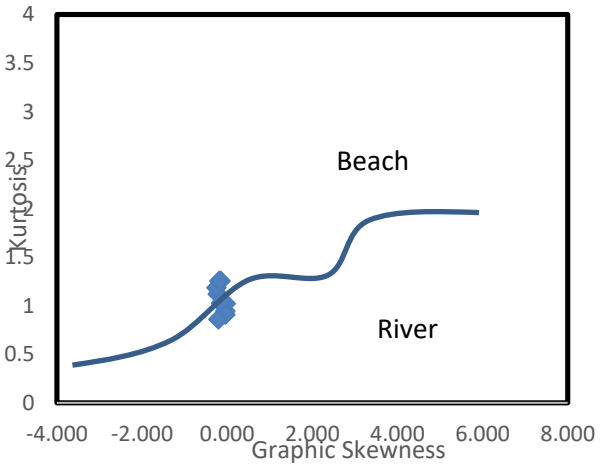


Figure shown the Visher's diagram of Sample



The Figure shows the Bi variant plot graphic skewnessvs kurtosis

Conclusion

Cumulative curves help to find out the statistical data of mean, skewness, kurtosis, standard deviation of the study area of coastal sediments. The sediments are find to medium sand. The mean value of the sands are 1.769 to 697.2. median value is the size for which half of the particles by weight are coarser to half finer.

Standard deviation of study area ocean sediment shows the range from 1.3553 to 1.998 which falls on the category on moderately well sorted. The skewness class of the coastal sediments of study area skewed skewnesswith in the range from -0.002 to 0.268, which fall in the category of symmetrical to coarse skewed. The coastal sediment of the study area shows generally, the standard deviation, mean, skewness, -0.153 to -0.176, kurtosis 1.253 to 1.254 which are represented as moderately sorted, symmetrical, mesokurtic to leptokurtic.

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Study of Heavy Mineral Concentration in Geomorphological Landforms between Arcottuthurai and Velankanni, East Coast Tamilnadu, India

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Abstract

The study of grain size of sediments helps to understand the transportation history and the environment of deposition. The study of grain size of beach sand is useful for delineation of various micro environments of coasts. The coasts have been constantly undergoing changes due to forward and backward movement of materials the sediments has a great importance in reconstructing the transportation history of sediments from the source are to site of deposition, the present study is to analysis the grain size of beach sands from Pushbavanam, Vettaikaraniruppu and Velankanni.The coastal zone of selected areas within Nagapattinam is endowed with varied landscape such as sandy beaches, estuaries, cliffs, dunes, and beach ridges. The coastal stretch of nearly 28.8 km long has many major rivers draining into the Bay of Bengal and these rivers bring in considerable sediments. Thus, the fluvial and marine interactions in the coastal zone are common in the area and this determines the sedimentation and erosion pattern of a shoreline. The study of grain size of beach sands will help us naturally to understand such interaction.The objectives of the present study are to understand the different types of coastal geomorphological landforms of the study area, to understand grain size characteristics of beach sands and to study the heavy mineral percentage.

Introduction

Examining the grain size of sediments aids in comprehending the transportation history and deposition environment. Analyzing the grain size of beach sand is valuable for characterizing different microenvironments along coastlines. Coastal areas continuously undergo alterations due to the movement of materials, and sediment plays a crucial role in reconstructing the transportation history from the source to the deposition site. The current investigation focuses on analyzing the grain size of beach sands in Pushbavanam, Vettaikaraniruppu, and Velankanni. Beach sediments predominantly consist of sandy deposits, exhibiting a diverse grain size distribution due to abrupt changes in their deposition process, sorting, and concentration of heavy minerals. Heavy minerals in beach sands are detrital minerals with a specific gravity higher than the standard (usually 2.85), often occurring as a major component. Heavy minerals are diagnostic indicators of

sandstone provenance, and provide crucial information on sediment transport pathways, sand body distribution and paleogeography. Heavy minerals are also useful guides to the extent of burial diagenesis of reservoir sandstones. Stratigraphic changes in heavy mineral assemblages enable the construction of a heavy mineral correlation framework. Heavy mineral stratigraphy can be used to complement bio stratigraphic methods or as a stand-alone method in barren sequences such as continental red beds. The heavy mineral analytical technique was pioneered by Mathur, (1992). Until the 1950s heavy minerals were studied as a tool for stratigraphic correlation, particularly the oil field areas. Heavy minerals are now studying to determine source rocks as the origin of many heavy minerals is limited to certain rock types. Besides these, the heavy minerals are also of great value in studying transportation and weathering history of sediments, and paleogeography's studies.

For the present study, representative samples were selected from two cores (DNR-58 & 61) for heavy mineral distribution, abundance and interpreting provenance characteristics. The composition of sandstones and conglomerates reflects the character of sedimentary provenance and the nature of sedimentary processes. The important minerals identified are magnetite, ilmenite, zircon, tourmaline, rutile, garnet and sphere. These minerals have been classified into three groups, namely (i) ultra-stable (ii) moderately stable and (iii) opaque minerals constituent of accessory mineral.

Study Area

The study area falls in Nagapattianamdistrict of the Indian state of the Tamil NaduThe study area precisely falls on the Pushbavanam, Vettaikaraniruppu and Velankanni of Nagapattianamtaluk covering 10°27' 10°40' E and 79°51' 79°51'N.

Methodology

A total number of 15 sediment samples were collected from three areas (Pushbavanam, Vettaikaraniruppu and Velankanni). Five samples were collected from each location. Samples were collected from high tide area, low tide area, beach ridges, estuaries, dunes and cliffs.Collected samples are stored in polythene bag and then they were labeled according to the sampling location which was measured by hand held GPS.

The samples were dried in hot air oven at 60°C to remove the moisture. From the dried samples, 100 gm of the samples were taken by repeated coning and quartering to ensure the uniformity and avoid errors in analyses of heavy mineral separation.

Though the grain size may influence heavy mineral composition, usually fine to medium grained sands yield the optimum heavy mineral assemblages. Sieving was carried out in ASTM at ½ĭ interval. The sieve sets, stacked in descending order of their sizes, were shaken using mechanical sieve shaker continuously for about 20 minutes.

General Considerations

The separation of heavy mineral is performed by means of high-density liquids. There is a considerable difference in densities between the lighter and heavier minerals. According to this density variation, the higher density (heavy mineral) will sink and the lower density (lighter mineral) will float. Various heavy liquids were used for heavy mineral separation. They are Bromoform (2.89 gm/cc), Tetra bromomethane (2.96) Methylene iodide (3.32) and cleric solution (4.24). These heavy liquids are of high density and highly toxic. There is also non-toxic sodium polytungstate used as heavy liquid for heavy mineral separation. The washing liquids suitable for removing heavy liquids from the grains are carbon tetra chloride, benzene alcohol and acetone.

Result and Discussion

Heavy Mineral Analysis

Heavy mineral study is mainly used to understand the nature of provenance, which has supplied the sediments to the depositional basin and dispersal pattern (Krumbein and Pettijohn, (1984); Okade, (1960); Pettijohn and Blatt; (1985) and Yagishita (1985). They are also useful in evaluating digenetic history as well as the pre erosional weathering and tectonic history of the source area. In the early day much interest was restricted in Government and academic surveys.

The heavy minerals (Ilmenite, Rutile, Monazite, Sillimaniteetc) have been economically extracted from a number of placers. In SrilankaIllmenite and Zircon placers have been prospected by Preussag and Cylone mineral sand from 1958. In 43 vibrocoresseveral with64-90 percent heavies identified unto 10m. Reserves were estimated up to 0.95 to 1.34 million tons (Meyer; 1993). The reserves were proved to be 50 million tons (MT) of Ilmenite, 0.9 MT of rutile and 4 MT of zircon. Sediments from a limited area between Malacca and Australia government authorities RWTH Aachen and AMR (Frankfurt) successfully carried out the search for heavy minerals in the eastern Australian coast. In six limited areas of the German Bight, the surface sediments were found to contain 3,000- 38,000 tons of zircon and 11,000- 28,000 tons of Ilmenite.

The heavy mineral are often mixed with unstable minerals like Pyroxenes, Amphiboles, garnets etc. Garnet is sometime segregated during weathering, transport and deposition. They can occur hundreds of kilometers away from the source and still may be economically viable concentration. Concentration of Illmenite of Monazite occurs in Cylone coast of Pulmoddai.

Heavy minerals are considered to be on useful tool for evaluating the provenance of sediments. Krynine (1946) has made out utility value of tourmaline for deciphering the provenance of sediments. Van Andel and Pool (1960) have shown in concentration of zircons only in fine grained sediments. Hubert (1962) has used chemically resident minerals like zircon, tourmaline and rutile as ZTR index to interpret the maturity of the

sediments. Hand (1967) has used differences in settling velocity of light and heavy minerals fraction to distinguish Aeolian and beaches sands. (Shift to provenance) Before heavy minerals are utility for provenance study three prime conditions should be satisfied, such as uniform grain size, similar hydraulic equivalence and chemical stability of the heavies. Taking these factors in to account, heavy minerals being used as the best criteria for determining the provenance by many earlier works like Tomita (1954), Poldervaart (1955), Force (1980) and Beiersdorfet.al., (1980), Luepke (1980). Post Tsunami rebuilding of beaches and the texture of sediments, Placer mineral deposits were studied by G Victor Rajamanickam (2001). Light minerals of beach sediments were studied by Anil Cherian (2004).Distribution and Assemblages of Heavy mineral were studied by Solai. A (2009), Saravanan.S (2010).

LOCATION	LANDFORMS	MEDIUM	FINE	V.FINE	TOTAL
Pushbavanam	High Tide	0.025g	0.830g	25.662g	26.517
Pushbavanam	Low Tide	0.023g	0.429g	0.636g	1.088
Pushbavanam	Estuary	0.027g	0.052g	0.326g	0.405
Pushbavanam	Beach Ridges	0.026g	2.732g	9.052g	11.81
Vettaikaraniruppu	High Tide	0.122g	0.880g	27.003g	28.005
Vettaikaraniruppu	Low Tide	0.122g	0.522g	0.621g	1.265
Vettaikaraniruppu	Beach Ridges	0.236g	5.722g	17.301g	23.259
Velankanni	High Tide	0.274g	11.074g	29.882g	41.23
Velankanni	Low Tide	0.155g	2.845g	6.45g	9.45
Velankanni	Dune	0.521g	18.320g	32.339g	51.18
Velankanni	Cliff	1.055g	27.335g	42.45g	70.84

Weight Percentage Distribution of Heavy Minerals

OPTICAL PROPERTIES OF HEAVY MINERALS

The various salient features of the heavy minerals observed in this study are enumerated below.

Epidote

It occurs mostly as platy and equant grains and subrounded .It is identified by its pistachio green colour ,higher relief, higher refractive index, pale green to dark brown pleochroism, uni-directional cleavage, conchoidal to sub conchoidal fracture, inclined extinction angle (Z ^ C = 0°-5°), ringed interference colour and biaxial negative with needle interference figure.

Garnet

Detrital garnet is commonly irregular in shape. The garnets are mainly identified by its high relief, colourless with etched surfaces .These etched garnets show the inclusion of opaques and other solid inclusions .Well rounded colourless garnet are also noticed Subrounded garnets with linear cracks are also observed .Subrounded garnet with inclusions of solid materials are also common. A few dark pink garnets show smooth surfaces Colourless garnets show strong etching features all along the surfaces.

Glaucophane

It has some characteristic

properties like irregular to prismatic shape, solid inclusions, etching marks, subrounded and elongated nature, moderate relief, higher refractive index, sky blue colour, blue to violet pleochroism, imperfect amphiboliccleavage, uneven fracture, bluish interference colour, oblique extinction (Z ^ C = 8° - 10°) length slow, biaxial negative and moderate birefringence. It is differentiated from actinolite and tremolite by its pleochroism.

Hornblende

It is prismatic flaky in nature. It has green and brown colours, moderate relief, higher refractive index, yellow to green pleochroism, amphibolic cleavage, second order interference colour, inclined extinction (Z ^ C = 13° - 23°) (Occasionally shows straight extinction in its basal section), length slow and biaxial negative.

Hypersthene

It is identified by its grey-green colour, prismatic shape, high relief, higher refractive index, green to brown pleochroism, two directional cleavage, straight extinction and biaxial negative. Etched, subrounded (Plate 12.4), hypersthene with well-developed two sets of cleavages are also noticed (Plate 7.6-7.9).

Kyanite

It is found to be with elongated prismatic bladed nature, high relief, higher refractive index, colourless and blue colour. The pleochroism is rarely seen in it. The cleavage, present at right angles to the grain. It is also noticed in prismatic shape with fluid and solid inclusions ((Plate 12.2), subrounded with etched surfaces .It also possesses inclined extinction (Z ^ C = 20° - 25°), biaxial negative sign and moderate birefringence.

Muscovite

It is found to often occur as flaky nature, but occasionally tabular grains. It has low relief, lower refractive index, absence of pleochroism, perfect basal cleavage, second order interference colour, biaxial negative and good interference figure.

Rutile

It is prismatic in habit but sometimeseuhedral shape is also noticed. It possesses high relief, very higher refractive index, blood red to reddish brown colour, weak pleochroism (Various shades of reddish brown), imperfect cleavage, blood red interference colour, straight extinction, length slow and uniaxial positive sign.

Sillimanite

The distinguishing properties of sillimanite are scaly, fibrous or prismatic nature, irregular termination of grains, moderate relief, higher refractive index, colourless nature absence of pleochroism, perfect cleavage, irregular fracture, higher order interference colour, biaxial positive sign and moderate birefringence.

Staurolite

Staurolite is occurring in prismatic nature. They are identified

under microscope by its golden yellow colour well developed cleavage and high relief. Some of the staurolite grains are stumpy in nature. Birefringence is moderate under the cross nicols. Optically it is biaxial positive. Some of the prismatic staurolite grains shows straight extinction and second order interference colour. Quartz and garnet inclusions are commonly noticed in the staurolite grains.

Topaz

It is generally prismatic or irregular in nature and it also possesses high relief, glassy appearance, colourless, absence of pleochroism, lack of cleavage, conchoidal fracture, straight, extinction, biaxial positive and higher order interference colour. It shows bluish tinge in fractured edges.

Tourmaline

It is identified from the prismatic nature, brown to dark brown pleochroism, high relief, high order of interference colour, uniaxial and length fast characters. Some tourmalines show prismatic shape and inclusions of solid and fluid and with strongly etched surfaces .They are three types of different coloured tourmalines namely, brown, yellow and green .The brown coloured variety is found in prismatic forms.

Tremolite

It has been distinguished by its prismatic nature, high relief, higher refractive index, colourless and jagged edges ,absence of pleochroism, amphibolic cleavage, jagged edges, low extinction angle (X ^ a = 3° - 10°) length slow, biaxial negative sign and strong birefringence.

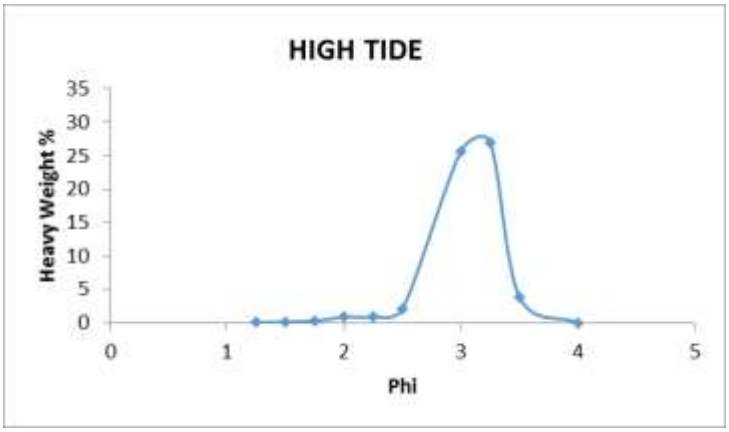
Zircon

Varieties of zircon namely, euhedralcoloured and broken with opaque inclusions (are identified. The sheared surface of the grain has shown irregular cracks .But all are having common characteristics properties like high relief, very higher refractive index, yellowish colour ,absence of pleochroism, imperfect cleavage, conchoidal fracture, higher order white interference colour, uniaxial positive and strong birefringence. The core of zircon grain is foggy and cloudy in appearance due to clustering of inclusions. The common inclusions found in zircons are gas filled cavities ,and tourmaline .Zircon with outgrown nature is shown in Plate.

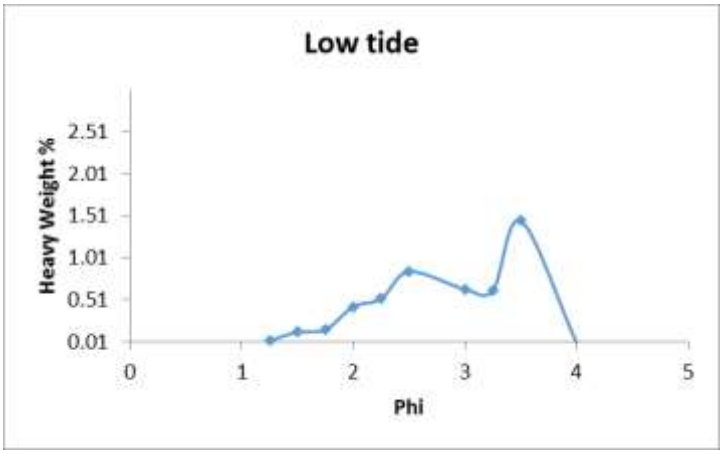
Heavy Mineral of Weight Percentage

Below start shown in heavy mineral weight percentage frequency curve in Pushbavanam, Vettaikaraniruppu, Velankanni.

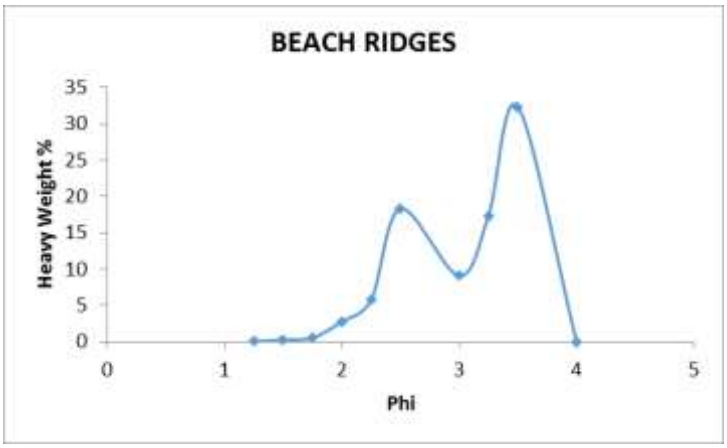
1) High Tide Weight Percentage



2) Low Tide Weight Percentage



3) Beach Ridges Weight Percentage



Conclusion

The extensive littoral lowland of the coastal area of southern Tamilnadu has been studied in order to understand the quaternary geomorphic landforms. As the study area 30km long the present work is one of reconnaissance type and the outcome is a summary of details of landscape of this part of the coast with a description of local geomorphology and sedimentation pattern.

The study are covers the geomorphic landforms in micro level because of the beach width and settlements. Hence, it is concluded that the heavy mineral distribution play a role and factors indicate that the low energy environment. Study area is economically not viable.

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Mercury Pollution in Oceans

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Marine Mercury Pollution has harmful effects on marine environment and marine organisms and its threat to human health and to know about the tripled levels of Mercury in the oceans and it's distribution to deep trenches.Mercury pollution in the marine environment presents a significant threat to aquatic ecosystems worldwide. Industrial activities, including mining and manufacturing, contribute to the release of mercury into water bodies, where it accumulates in fish and shellfish. This bioaccumulation poses a serious risk to human health when consuming contaminated seafood. Understanding the sources and impacts of mercury pollution is crucial for developing effective mitigation strategies to safeguard marine life and human well-being.

Mercury is a naturally occurring element that is found in air, water and soil. Exposure to mercury even small amounts may cause serious health problems, and is a threat to the development of the child in uteri and early in life. Mercury may have toxic effects on the nervous, digestive and immune systems, and on lungs, kidneys, skin and eyes. When mercury increases in amount of number the pollution occurs I which is responsible for the deterioration. This is how mercury pollution occurs and its effect on the population.In oceanic waters, mercury mainly occurs in the forms of Hg^0, Hg^{2+}, MeHg, and diMeHg and in colloidal form. In marine waters, mercury forms compounds with chlorine($HgCl_3^-$ and $HgCl_4^{2-}$) to a greater extent than oxides, as is the case in freshwaters. Mercury also poses hazards to people's health because it enters the food chain by accumulating in the tissue of fish and other animals in the form of methyl mercury. This highly toxic substance can cause a variety of health conditions such as impeded brain development in children and cardiovascular diseases in adults

In this context the mercury plays an important role in the humans health that pose a threat in form that it can be responsible for many problems for the Human being.Marine mammals such as dolphins, whales and seals are particularly susceptible to mercury contamination at the topmost food chain. High levels of mercury in these animals can lead to reproductive failure, behavioural changes, and even death It also pose a Massive threat to Marine Environment which is Very dangerous to the Marine Mammals that can be affected by the mercury pollution.

Industrial processes such as small-scale gold mining and coal burning emit mercury into the atmosphere. In gold mining, miners use liquid mercury to soak up gold from ore, then vaporize the toxic metal while

leaving the gold behind. Burning coal releases mercury naturally contained in the fuel. Once in the atmosphere, the metal can travel for months and thousands of kilometres until rain deposits it into oceans. There, bacteria help convert it to the neurotic methyl mercury. The methyl mercurythen travels up the food chain, ultimately accumulating in fish. These are the major factors that affect the mercury pollution in oceans which plays an important role in Marine Environment.

SEAWEEDS

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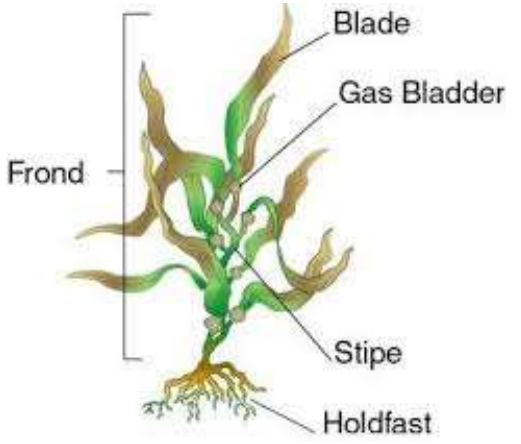

Seaweeds, also known as macroalgae, areabundant sources of various vital bioactive components with a wide range of biological functions. They are sold commercially and are primarily used in the food industry, pharmaceuticals, cosmeceuticals andotherrelated industries. The diverse biological activities linked with bioactive compounds obtainedfromseaweedshavethepotentialtoexpandtheirhealthbenefitvalueinthefoodandpharmaceutical industries. Studies revealed that seaweeds have the potential to be used ascomplementarymedicineduetoitsvarietyofbiologicalpropertiesthathavebeenshowntobetherapeuticforhealthanddisease management,suchasantibacterial,anticoagulant,anticancer, antidiabetic, antiestrogenic, antihypertensive, antihyperlipidemic, antifungal, anti-inflammatory,antioxidant,antiobesity,antiviral,immunomodulatory,neuroprotective,thyroid stimulant, tissue healing properties, and many more. Although seaweeds are generally beneficial tohumans,they may still pose possible healthrisks due to high iodine concentration and exposure to heavy metal sand arsenic concentrations. However, information on this topic is still limited. This review covers the genera lstructureandcharacteristics of seaweeds, bioactive components and properties ofseaweed, possible risk factors of seaweeds, and applications of seaweeds.

Seaweeds, or known as macroalgae, are marine photosynthetic, non-flowering plant-like organisms that are categorized into three major groups depending on their predominantpigmentcompositions,whicharegreen(Chlorophyta),brown(Ochrophyta),andred(Rhodophyta) seaweeds. They can be found all across the world'scoastlines, from the warm tropics to the freezing and icy Polar Regions.Seaweeds are commercially sold, with approximately 83% of its total global production is fordirecthuman consumption.They arecommonly consumedinAsiancountriesasfresh,dried,orasingredientsinpreparedfoods.Theremaining percentage isused asa source of phycocolloids extracted for the application infood,cosmetic, medical andotherrelatedindustries.Thereare221s

peciesofseaweedsareutilizedintotal, with145 speciesused forfoodand 101species usedfor phycocolloid synthesis.

Sinceancienttimes, natural products have played a significant role indiagnosing, treating, and preventing numerous ailments. The therapeutic characteristics ofchemical compounds in natural products are optimized and augmented for human medicalapplications. The plant-based and herbal medications generated fromnaturalresourcesthatareconsideredpure, healthy, and safe have grownin popularity over the years. As a result, several herbal-based pharmaceutical sources are now commercially accessible and offered as an alternative therapy and dietarysupplement to treat various illnesses. In addition, the availability of novel metabolites withdiverse uses such as cosmeceuticals, nutraceuticals, agrochemicals, medicals,and other relevant chemical industries has stimulated marine drug research inrecent years. It has been considered that the marine ecosystem is anexcellent source of natural compounds with several functions. Seaweedsare marine plant organisms capable of producing a wide range of active metabolites with awide range of medical applications, which they also use to defend themselves against otherinvading species. As results of these novel metabolites, seaweed has become one of the most important sources of naturalcomponentsusedinpharmaceuticals, and accounting for 30% of the global market in 2018. It was expected to begreaterthan USD 10,486.8 billion.

Seaweeds are also employed in aquaculture as probiotics, animal feed additive, fertilizer, and as water purifier. In this context, the goalof this article is to provide general information about seaweeds, including their biologicalfeatures, potential therapeutic properties, potential risk factors, and some of the extraction methods used.Furthermore,duetotheirdistinctmetabolitecontents,thisstudyalsoinvestigates the relevance and applications of seaweeds as major marine bioresources innumerousindustries.Based on their photosynthetic pigments, seaweeds are classified into three categories:brown (Ochrophyta or Class Phaeophyta), green (Chlorophyta), and red (Rhodophyta). Thereare around 10,000 seaweed species, including about 2000 brown, 1500 green, and 6500 redseaweeds. Furthermore, seaweeds areclassifiedusingmoleculartechniquesbasedonevolutionaryprocesses.Some seaweeds employ holdfast, a root-like structure used only for anchoring, to attach themto the ocean floor. Other seaweeds, such as floating seaweeds, may have floating or air sacs thatmaintain them above the water's surface and expose them to sunlight for photosynthesis. Anotherseaweed component is stipe, a stem-like structure that holds the blades to the water's surface. Bladesare primary photosynthetic leaflike flattened parts that absorb sunlight. Furthermore, thallus refers tothe fundamental or advanced body-like structure of seaweeds that can conduct photosynthesis with allits parts.

With an average depth of 5 km, the water surface covers more than 70% of the earth'ssurface, to which seawater accounts for more than 90% of all water onthe planet earth. Moreover, oceans support floating forests with abroad range of marine animals and plants, where the marinevegetation is more primordialand diversified than the terrestrial vegetation. Algae are photosyntheticplant-like creatures that are the sole primary producers in the oceans,with a photosynthetic efficiency (PE) that is 6–8% greater than that of terrestrial plants (1.8–2.2%). Seaweeds, also known as marinemacroalgae or edible macroalgae, are benthic marine algae that thrive in brackish or saltwaterenvironments found in shallow and open water up to 180m deep. They are the most numerous marine vegetation and one of the essentialbiomass producers in the ocean that gives food and shelter to aquatic life. However, the distribution of seaweeds in the marine environment is limited only to thelittoral and sublittoral zones. They may befound to adepthwhere0.01%photosyntheticlight isaccessible.

MARINE FOSSILS

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Introduction

The earth's oceans have long been shrouded in mystery, hiding the secrets of ancient life beneath their depths. Marine fossils, remnants of organisms that once thrived in the vast expanses of water, serves as windows into the distant post. These fossilised treasures unlock stories of evolution, adaptation and the ever changing landscapes of our planet.Marine fossils encompass a staggering array of life forms, from microscopic plankton to massive marine reptiles. The ocean, covering more than 70% of Earth's surface, has been a cradle of evolution, nurturing a plethora of species throughout geological time. Fossillized shells, skeletons and imprints provide glimpses into the astonishing diversity that has characterized marine life over Million of years.

Evolutionary Insights

Studying Marine fossils offers scientists invaluable insights into the evolutionary journey life on earth. By examining the intricate details of ancient organism, researchers can trace the development of different species, observe adaptations to changing environment and unravel the complex relationship with ecosystem. Marine fossilis contribute crucial evidence to the broader Narrative of life's evolution, helping us piece together the puzzle of our biological history.

Fig 1: Fossilis

Index fossilis and geological time scale

Certain Marine fossilis known as index fossilis, play a vital role in dating and correlating rock layers. These fossilis have a wide geographical distribution and relatively short existence in geological time, making them valuable markers for dating the age of rocks. Through the study of marine fossils, geologists can construct

timelines of Earth's history, chartingThe rise and fall of species and major geological events.

Fig 2: Geological Time Scale

Ancient climate records

Marine fossils also serve as record of past climates. For example, the composition of fossilized marine organisms can indicate the temperature and chemicalComposition of ancient oceans. By analyzing these clues, scientists can reconstruct past Climate conditions, offering insights into the earth's climate history and aiding our understanding of current climate change.

Preservation challenges and conservation

Despite their significance, marine fossilis face threats from human activities activities such as over collection, habitat destruction, climate change.Conservation efforts are crucial to preserving these reliefs of the past for future generations. Proper management of fossilis sites, ethical collecting practices, and public awareness campaigns contribute of the protection of these scientific treasurers.

Conclusion

Marine fossils stand as silent witness to the eons of Earth's history,roviding a glimpse into the evolution and diversity of life in the oceans. These fossilis not Only enrich our understanding of the past but also offer valuable insights into the present and future of our planet. As we continue to explore the mysterious hidden within marine Fossils, we embark on a journey through time, unraveling the profound connections between life, the oceans and the ever changing face of our dynamic planet.

Marine metagenomics

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Marine metagenomics is a rapidly developing field that studies the collective genomes of all the microbes in a marine environment. This includes bacteria, archaea, and viruses. By studying these genomes, we can learn about the incredible diversity of life in the ocean, as well as the genes and functions that these microbes encode.Metagenomics is a powerful tool that allows us to peek into the fascinating world of microorganisms in their natural environment.Instead of focusing of individual species, it delves into the collective genetic material of entire microbial communities living in a specific environment,like soil,wateretc.Metagenomics allows direct access to the collective genetic pool of microbial communities in an environment without the need for culturing individual organisms.There are many potential benefits to studying marine metagenomics. Marine microbes produce a wide variety of natural products, many of which have potential applications in medicine, industry, and agriculture. By studying marine metagenomes we can identify and isolate these novel compounds.Marine microbes play a critical role in ocean ecosystems, from cycling nutrients to breaking down pollutants. By studying their genomes, we can better understand how they function and how they respond to environmental changes.Marine microbes can be used to clean up oil spills and other environmental disasters. By studying their genomes, we can develop new and more effective bioremediation strategies.

The vast and unexplored depths of the ocean hold a treasure trove of biodiversity, teeming with unique and fascinating creatures. Hidden amongst this diversity lies a hidden gema plethora of novel enzymes with immense potential to revolutionize various industries. These marine novel enzymes are proteins produced by microorganisms living in the ocean's diverse ecosystems, from sun-drenched coral reefs to the crushing depths of hydrothermal vents. These enzymes possess unique properties that allow them to thrive in extreme environments, such as high pressure, salinity, and temperature. Enzymes can be used to break down complex molecules into simpler ones, making them ideal for industrial processes like biofuel production, food processing, and textile manufacturing. Marine enzymes have shown promise in developing new drugs and medical treatments, with potential applications in areas like cancer therapy, antibiotic development, and bioremediation.Novel enzymes can be employed for bioremediation purposes, degrading pollutants and cleaning up contaminated

environments.However, harnessing the power of these marine enzymes comes with a challenge with the vast majority of marine microorganisms are uncultivable in a lab setting. This means that traditional methods for enzyme discovery, which rely on isolating and growing microorganisms, are often ineffective.This is where metagenomics steps in. This powerful approach bypasses the need for culturing by directly extracting and analyzing the genetic material from environmental samples. By sequencing this environmental DNA or metagenome, scientists can access the collective genomes of all the microorganisms present in that sample, including the uncultivable ones.

Identify genes encoding for novel enzymes with unique properties.Express these genes in other organisms, such as bacteria or yeast, for large-scale production of the desired enzymes.Characterize the properties of the enzymes, such as their activity, stability, and substrate specificity.By leveraging the power of metagenomics, scientists are unlocking the vast potential of marine novel enzymes. This exciting field is still in its early stages, but it holds immense promise for the future of various industries and our understanding of the ocean's hidden treasures.Environmental samples will be collected, their DNA extracted, sequenced and generating millions of short DNA fragments. These fragments are then computationally assempled into larger contigs, representing portions of microbial genomes. Bioinfomartic tools identify putative protein-coding genes within the contigs and predict their functions based on sequence similarity to known enzymes.Libraries containg metagenomic DNA fragments are expressed in host organisms like *E.coli* and their activity against various substrates is screened to identify enzymes with desired properties.

Lipases and esterases have been the subject of extensive research in the past, with numerous eDNA libraries being screened to identify new enzymes capable of hydrolyzing or synthesizing ester bonds. These enzymes find applications in various industries such as detergent, food, pulp and paper, diagnostics, therapeutics, biodiesel production, and biopolymer synthesis. Oxidoreductases encompass a diverse group of enzymes that find various applications in the pharmaceutical and food industries, as well as in bioremediation. Among the recently discovered oxidoreductases are five soil-derived dioxygenases with potential in bioremediation, as well as the first metagenome-sourced d-amino acid oxidase that has the potential to assist in the biosynthesis of the antibiotic intermediate of 7-aminocephalosporanic acid from cephalosporin C. Additionally, multi-copper oxidases (MCOs), enzymes with a wide range of activity on both phenolic and non-phenolic substrates, are of interest for their ability to degrade lignocellulose biomasses. Some of the exciting discoveries made using the metagenomic approach, a cold-adapted lipase from Arctic sea ice bacteria that can break down fats at low

temperatures; potentially revolutionizing cold-washing detergents.A highly thermostable enzyme from deepsea hydrothermal vents can withstand high temperatures making it ideal for industrial processes like biofuel production. A novel antibiotic produced by marine bacteria, offering a potential weapon in the fight against antibiotic-resistant bacteria.These are just a few examples of the incredible potential that lies within the unexplored depths of the ocean. As we continue to investigate deeper into the world of marine metagenomics, we can expect to uncover even more groundbreaking discoveries that will benefit human and our planet.

What is Mercury Pollution and its Effects in Oceans?

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Introduction

Mercury pollution in the marine environment presents a significant threat to aquatic ecosystems worldwide. Industrial activities, including mining and manufacturing, contribute to the release of mercury into water bodies, where it accumulates in fish and shellfish. This bioaccumulation poses a serious risk to human health when consuming contaminated seafood. Understanding the sources and impacts of mercury pollution is crucial for developing effective mitigation strategies to safeguard marine life and human well-being.

What is Mercury pollution?

Mercury is a naturally occurring element that is found in air, water and soil.Exposure to mercury – even small amounts – may cause serious health problems, and is a threat to the development of the child in uteri and early in life.Mercury may have toxic effects on the nervous, digestive and immune systems, and on lungs, kidneys, skin and eyes.When mercury increases in amount of number the pollution occurs which is responsible for the deterioration.This is how mercury pollution occurs and it's effect on the population.

Where does it come from?

In oceanic waters, mercury mainly occurs in the forms of Hg0, Hg2+, MeHg, and diMeHg and in colloidal form (Morel et al. 1998). In marine waters, mercury forms compounds with chlorine ($HgCl_3^-$ and $HgCl_4^{2-}$) to a greater extent than oxides, as is the case in freshwaters (Mason and Fitzgerald 1993).

What Is Mercury's Part in Human Health?

Mercury also poses hazards to people's health because it enters the food chain by accumulating in the tissue of fish and other animals in the form of methyl mercury. This highly toxic substance can cause a variety of health conditions such as impeded brain development in children and cardiovascular diseases in adults

In this context the mercury plays an important role in the humans health that pose a threat in form that it can be responsible for many problems for the Human being.

How Does Marine Environment Affected?

Marine mammals such as dolphins, whales and seals are particularly susceptible to mercury contamination as their at the topmost food chain. High levels of mercury in these animals can lead to reproductive failure, behavioural changes, and even death

Aquatic organisms readily absorb methylmercury, which is then

bioaccumulated and biomagnified within the aquatic food chain .It also pose a Massive threat to Marine Environment which is Very dangerous to the Marine Mammals that can be affected by the mercury pollution.This means that the higher up the food chain an organism is, the more concentrated the levels of methylmercury will be in its tissues

Why is Mercury pollution tripled in the oceans ?

Industrial processes such as small-scale gold mining and coal burning emit mercury into the atmosphere. In gold mining, miners use liquid mercury to soak up gold from ore, then vaporize the toxic metal while leaving the gold behind. Burning coal releases mercury naturally contained in the fuel. Once in the atmosphere, the metal can travel for months and thousands of kilometres until rain deposits it into oceans. There, bacteria help convert it to the neuroticmethyl mercury. The methyl mercury then travels up the food chain, ultimately accumulating in fish.

These are the major factors that affect the mercury pollution in oceans which has been important role in mercury pollution.

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NANOPARTICLES FROM MARINE ORGANISM

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Marine bio-nanotechnology is an exciting and upcoming area of research.The biologically diverse marine environment has a great promise for nanoscience and nanotechnology. Marine organisms produce remarkable nanoparticles of 1-100nm size which constitute nano-fabric structure such as seashells,pearls and fish bones.Diatoms and sponges are constructed with nanostructured cover of silica and coral reef with calcium arranged in remarkable architecture.Dolphinsand whales have rough skin surface due to presence of nano- ridges.These ridges enclose a pore size of 0.2 µm which is below the size of marine fouling organisms and hence,there is no attachment of bio-foulers. In spite of great potential,the marine bio-nanotechnology has limited research work.Most of the studies on biosynthesis of Nanoparticles have been restricted to terrestrial organisms.

Nanoparticles are classified into major type viz.organic and inorganic Nanoparticles. Carbon nanoparticles are called the organic nanoparticles, magnetic nanoparticles, nobel metalnanoparticle (platinum, gold and silver) andsemiconductor nanoparticles (titanium dioxide and zinc oxide) are grouped as inorganic nanoparticles. Inorganic nanoparticles are increasingly used in drug deliver due to their distinctive features such as ease of use, good functionality ,biocompatibility, ability.Use of chemical and physical method in the synthesis is of nanoparticles is very expensive and cumbersome. The chemical and physical method in the synthesis lead to the presence of some toxic chemicals absorbed on the surface that may have adverse effects applications, so there is a growing need to develop environmentally being nanoparticles. Researchers have used biological extract for the synthesis of nanoparticles, by adopting simple protocols, involving in the process.

Microorganisms such as bacteria, cyanobacteria, actinomycetes, yeast, fungi and algae are used to synthesis nano-particals such as gold, silver, calcium, silicon, iorn, gypsum, and lead, in nature either inside or outside cell.At present, microbial methods in the synthesis of nanomaterials of varying compositions are extremely limited and confined to metals, some metal sulfide and very low oxides. All these are restricted to the microorganisms of terrestrial origin. Recently, coastal plants are used to synthesis nanoparticles. The brown seaweed *Sargassumwightii* is reportedly capable of synthesizing gold nanoparticles with a size ranging between 8 and 12nm. An important potential benefit of the synthesis is that

the nanoparticlsare quite stable. Fish oil of nutraceutical value and the presence of permissible limit of silver nanoparticles in the oil might enhance its efficacy an idea that may open many avenues the field of nanotechnology. The use of cod liver fish oilis shown to produce silver nanoparticle, as reducing agent as well as surfactant. Presence of carboxyl ions and amine group in the fish oil triggers in situ generation of organically capped silver nanoparticles. Nanoparticles have a greater surface area per weight than larger particles and this properly makes them to be more reactive to certain other molecules and they used or being evaluated for use in many fields.Quantum dots are the crystalline nanoparticles used to identify the location of cancer cells in the body.Gold nanoparticles allow heat from infrared laser to detect cancer tumors.With the huge biological resources, still marine organisms becoming a largest untapped reservoir for nanoparticles synthesis.

COASTAL EROSION

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Coastalerosionistheprocessbywh ich localsea levelrise, strongwaveaction, and coastal flooding wear down or carry away rocks, soils,and/orsandsalongthecoast.Destruct ive waves erode through four main processes; Hydraulic action,compression, abrasion and attrition. Image credit: Jeff Hansen, U.S.Geological Survey. Hydraulic action is the sheer force of water crashingagainst the coastline causing material to be dislodged and carried awaybythesea.Coastal erosion is the process by which rising sea levels, storms, andother phenomena wear down or carry away the rocks, land, and sandmaking up a coastline. This process causes the loss of tens of thousandsof acres of land in the U.S. each year, as well as hundreds of millions ofdollarsinproperty.

There are three common forms of coastal erosion control methods.These three include: soft-erosion controls, hard-erosion controls, andrelocation.In order to mitigate the coastal erosion, the coastal protections arebroadly classified as soft and hard solutions and also combination ofboth.Softsolutionsarevegetation,beach nourishment,sandbypassing,floodproofi ng,sandduneformation,zoning,retreat etc..,Hard structural/engineering options use structures constructed on thebeach(seawalls,groynes,breakwaters/ artificialheadlands)orfurtheroffshore (offshore breakwaters). These options influence coastalprocesses tostoporreducetherateofcoastalerosion.R elocation of infrastructure any housing farther away from the coast isalso an option. The natural processes of both absolute and relative sealevel rise and erosion are considered in rebuilding. Depending on

factorssuchastheseverityoftheerosion,as wellasthenaturallandscapeoftheproperty , relocation could simply mean moving inland by a shortdistance or relocation can be to completely remove improvements froman area. A coproduction approach combined with managed retreat hasbeen proposedasa solutionthatkeepsinmindenvironmentalj ustice.

MARINE LIVE FEED

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Figure A: Artemia

Figure B: copepod

Artemia

Artemia, the brine shrimp, is an excellent live food for cultivable aquatic species. It is in greatdemand for use in shrimp hatcheries, fish hatcheries and ornamental fish culture farms. *Artemia* can withstand habitats whose salinity levels range from 10 to 340 g L^{-1}, withfluctuating ionic compositions and temperatures *Artemia franciscana* is a native strain from America, originating in the San Francisco Bay, California and the Great Salt Lake, Utah The brine shrimp, Artemia spp., in marine fish larviculture from Since no artificial feed formulation is yet available to completely substitute for Artemia, *P. Sorgeloos et al (2001)* Feeding live prey to young fish larvae still remains essential in commercial hatchery operations. However, the variability of enrichment studied in one Artemia strain (Great Salt Lake, Utah, USA) by the ICES Working Group on Mass Rearing of Juvenile Fish, showed a high variability in fatty acid bioaccumulation under laboratory or commercial conditions. Nowadays, various enrichment emulsions have been formulated differing in the fatty acid composition of their triglycerides. In this respect, the traditional formulations rich in EPA have been replaced by new products rich in DHA and arachidonic acid. To reduce the risks for oxidation of these fatty acids, higher concentrations of vitamin E are incorporated into the emulsions. Also, vitamin C has been incorporated in booster formulations that increase the level of ascorbic acid in Artemia to 2000 ppm. All these changes in the formulation of the enrichment diets offer more possibilities to cover the needs of different species and help to reduce problems related to diseases, stress resistance, malformation, and pigmentation in numerous fish species.

The Comparison of growth and survival of white shrimp post larvae

(*Litopenaeus vannamei*) fed dried Artemia biomass versus four commercial feeds and three crustacean meals, *Naege et al (2004)* The use of dried Artemia biomass meal as an exclusive feed for post larval white shrimp (*Litopenaeus vannamei*) was compared with four commercial feeds and three crustacean meals in a series of trials. Post larvae (PL1–PL6) were stocked at a density of 1.5– 2.5/litres in 16 tanks (100 litres volume) and fed, ad libidum, five times a day, over 23–29 days. Feeding post larval shrimp with dried Artemia biomass resulted in a significantly larger size than feeding with three of the commercial feeds, and the crustacean meals. There was no significant size difference observed in animals fed with Artemia biomass and the commercial 'Golden Pearls' feed for post larvae, however the coefficient of variation among the size of the 'Golden Pearls' fed animals was significantly higher. The weight increase of animals fed with Artemia biomass was higher than in animals fed with all the tested feeds. The survival rate was not significantly different in animals fed with Artemia flakes from 'Salt Creek', 'Bio-Marine', 'Golden Pearls' and Artemia biomass. Results suggest that dried Artemia biomass is a well-suited feed for post larval *L. vannamei*.

COPEPODS

The term copepod is used to describe small crustacean species that are found in the majority of aquatic environments. Copepods can be found in both the upper waters and bottom of oceans and freshwater bodies, as well as swamps, bogs, ponds, and other wet habitats. Copepods constitute an important zooplankton species. The Improvement of copepod nutritional quality as live food for aquaculture from for thepurpose of first-feeding fish larvae in hatcheries, a sufficient quantity of live food is necessary, and nutrient enrichment can enhance the nutritional value of the live food organisms. *Nadiah W Rasdi et al* (2014) for the majority of marine fish larvae, using live food organisms is essential, particularly during their initial eating. Copepods are the main food source for marine fish larvae in the ocean, yet hatchery production methods for copepods as live food are still in their infancy. Copepods differ from other live food species (such as rotifers) in their food ingestion and digestive systems, therefore the nutrition enrichment techniques using emulsion oil that work for rotifers do not work for copepods. This review focuses on how copepod diet can be altered to change the nutritional makeup of copepods before feeding them to fish larvae. The review makes a connection between copepod nutrition changes and nutrient delivery, and it offers recommendations for enhancing copepod nutrition in hatcheries.

The Suitability studies of the copepod, *Acartia clausi* as a live feed for Seabass larvae (*Lates calcarifer* Bloch): Compared to traditional live-food organisms with special emphasis on the nutritional value, *Rajkumar et al* (2006) While the artificial propagation of Asian seabass, *Lates calcarifer* (Bloch), in captivity by induced breeding methods is standardized under

Indian conditions, standardization is still needed for the raising of larvae and nurseries, including the use of appropriate nursery foods, in order to improve growth and survival rates.

The nutritional quality of cultured copepods was assessed by comparing its proximate makeup, amino acid composition, and fatty acid composition. The live feed organisms' fatty acid profiles revealed that a *clausi* is a good source of omega-3 fatty acids. A *clausi* had a total n − 3 fatty acid content of 33.94. The maximum survival rate of seabass larvae fed with A, *clausi* was found to be 58.13%, whereas the lowest survival rates were recorded by larvae given Rotifer and Artemia nauplii, respectively, at 39.93% and 41.62%. There were significant differences (Pb0.05) in the final carcass composition of the larvae of *L. calcarifer* fed different live-food species among the dietary regimens. The fatty acid composition of thedietary treatments was somewhat reflective of the fatty acid composition of the dietary treatments.

Live feed is a vital component of aquaculture, as it plays a significant role in the growth and development of fishes and shrimps used for ornamental and cultural purposes. Because of high protein content in live feed, and also enhance the fish's colour pigment, and promotes quick growth. Therefore, live feed is essential for the successful culture of fish and shrimp species, it was introduced as a biomass culture in certain places.

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Mineral Identification Study in the Lateritic Soil of Karaikudi Taluk, Sivagangai District, Tamil Nadu

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Abstract

The study aims to identify the laterite as the rock, and as a source of aluminium ore. Later, during the first half of the twentieth century, Pedologists got interested in the study of laterite About a kilogram of each laterite sample was weighted and put in a paper bag and transferred to the oven for drying at 60^0 C for more than 9 hours. Samples were removed from the oven and cooled. A mass of 100 kg of the samples were pulverized to 300 microns (150 meshes) using pulverizer (Agate Motor). 1) Optical properties. 2) Properties depend on hardness. 3) Properties depend on the structure and morphology of the phase. 4) Texture that are some characteristic of some phases when they occur in association with certain other phases. The technique used in this study is X-Ray diffraction for the identification of mineral present in the lateritic subsurface sediment. The following minerals are infer from the XRD diffractogram of each sample. The most common minerals found in the samples of study area are Celestite, Quartz, Chlorite, Glauconite, Sanidine, Microcline, Albite, Orthoclase, Oligoclase, Muscovite, Hypersthene, Enstatite, Tremolite, Tourmaline, Staurolite, Goethite, Magnetite, Siderite, Garnet, Halite, Marcasite, Aragonite, Laumonite, Zoisite and Carnallite. The mineral composition of the lateritic soil mainly depends on the parent rock. Main constitutions of lateritic soil are Quartz, oxides of Aluminium, Iron, etc, The pyroxene and Amphibole group of minerals present in the samples of the study area indicates that they tend to break down to the formation of Chlorite and these minerals alter quickly into ferruginous substances like Goethite. Quartz does not seems to be greatly subject to alteration in the zone of primary occurrences.Geochemistry and Clay mineral analysis of the samples reveals the precise occurrence of mineral presence and deposition of environment. It will be carried out in near future.

Keywords: Laterite, Minerology, XRD, Geochemistry & Environment

Introduction

The rocks and minerals make up the earth. Minerals are the building blocks for making rocks, and a rock is made up of one or more minerals. The word "Mineral" is used in many different ways. The definition for the mineral is preferred by geologists is that A naturally occurring, inorganic, solid,

crystalline substance which has a fixed structure and a chemical composition which areformed naturally by geological processes, this excludes man-made substances e.g. synthetic diamonds, organic substances e.g. chitin, and substances without a fixed composition which are classified as mineraloids e.g. volcanic glass (obsidian).

Initially, Geologistwere interested in the study of laterite as the rock, and as a source of aluminium ore. Later, during the first half of the twentieth century, Pedologists got interested in the study of laterite , as the upper parts of laterite profile were referred to as ”soil forming “, and the recorded it as there domain of investigation occurrence of laterite at the surface was believed to be due to the removal soil soon , those who described laterite as a rock attributed this by saying that it was a weathered or altered rock or, it was the product of alteration or weathering of an original rock.Laterite is one of the most widespread rocks in India

Study Area

The study area falls in Sivagangai district of the Indian state of the Tamil Nadu. It is bounded by Pudukkottai district on the Northeast, Tiruchirapalli district on the North, Ramanathapuram district on South East, Virudhunagar district on South West and Madurai District on the West.Sivaganga district has 9 taluks in 2 revenue division, Manamadurai, kalayarkovil, Sivaganga, Thiruppuvanam, Singampunari, Ilayangudi total of 6 under Sivagangai revenue division and Devakottai, Karaikudi, Tiruppattur of 3 under Devakottai revenue division. The study area precisely falls on the villages Kallangudi, Kalanivasal and Oyyakondansiruvayal of Karaikudi taluk covering 10^0 00’- 10^0 06’ N – 078^0 41’- 078^0 45’ E. The study area map in Fig 1.1

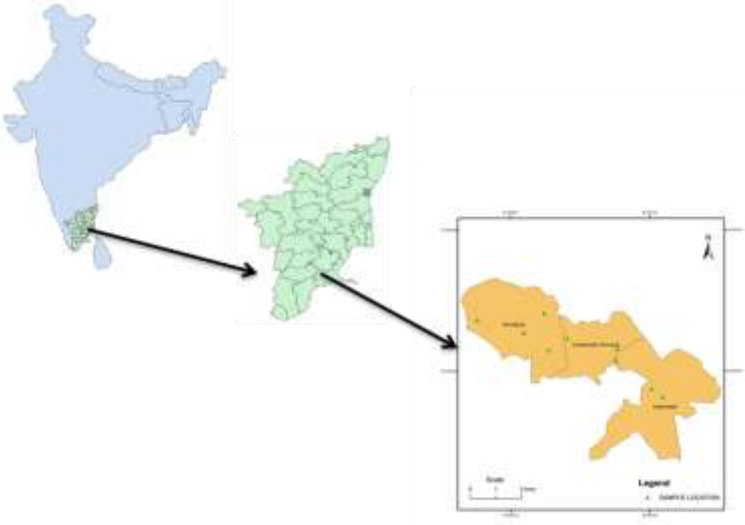

Fig 1.1 The Study Area Map

Mineral Identification Techniques

The primary aspects of a person who studying mineral must do identify and categorize the specific mineral. There are over 4,000 known minerals, and approximately 80-100 new ones are discovered each year and each of those minerals has a unique set of physical properties. These include color, streak, hardness, luster, diaphaneity, specific gravity, cleavage, fracture, magnetism, solubility, and many more. These physical properties are useful for identifying minerals. However, they are much more important in determining the potential industrial uses of the mineral. *A particular mineral can be identified by its unique crystal structure and chemistry.* Laboratory techniques needed to determine these properties. Minerals can be identified by their physical characteristics. The physical properties of minerals are related to their chemical composition and bonding. There are many different types of both qualitative and quantitative chemical analyses are available and specific techniques are chosen based on the goal of the research and the characteristic of the sample being studied.

The quantitative parts of the chemical analytical studies are broadly divided into the following categories 1) Wet Chemical analysis. 2) Powder or Wet Spectroscopy. 3) In situ Spectroscopy. There are three basic types of wet chemistry A) Gravimetric B) Volumetric C) Calorimetric. There are multiple types of spectroscopic techniques that can be used to study the characteristic of elements that compose minerals. The techniques includes (Inductive coupled plasma(ICP) spectrometry, Atomic absorption spectroscopy, X- ray fluorescence, X-ray diffraction, Electron probe micro-analysis(EPMA), Scanning electron microscope(SEM), Mass spectrometry-Secondary ion mass spectrometry (SIMS), Thermal ionization mass spectrometry(TIMS), Multicollector mass spectroscopy, Photon induced gamma emission(PIGE), Photon induced x-ray emission(PIXE), Neutron activation analysis(NAA), Raman spectroscopy and visible & infrared techniques). The qualitative properties of value in mineral are categorizes into four major groups 1) Optical properties. 2) Properties depend on hardness. 3) Properties depend on the structure and morphology of the phase. 4) Texture that are some characteristic of some phases when they occur in association with certain other phases. The technique used in this study is X-Ray diffraction for the identification of mineral present in the lateritic subsurface sediment.

Methodology

Sample Treatment and Analytical Procedure

About a kilogram of each laterite sample was weighted and put in a paper bag and transferred to the oven for drying at 60^0 C for more than 9 hours. Samples were removed from the oven and cooled. A mass of 100 kg of the samples were pulverized to 300 microns (150 meshes) using pulverizer (Agate Motor).

X-Ray Diffraction Techniques

X-ray diffraction is a valuable tool in determining the mineralogy of sedimentary rocks. The XRD technique takes a sample of the material is powdered and placed on a special plate. A beam of x- rays hits the sample at a very slowly increasing angle while an electronic detector rotates around it and records the x-rays bouncing off of the sample. This process produces an x-ray diffraction pattern which appears on a computer screen as a series of peaks of different height. These peaks correlate mathematically with atomic spacings between planes of atoms in the mineral crystal and are a direct result of the crystalline structure. The computer stores this pattern. X-ray diffractometers consist of three basic elements: an X-ray tube, a sample holder, and an X-ray detector. X-rays are generated in a cathode ray tube by heating a filament to produce electrons, accelerating the electrons toward a target by applying a voltage, and bombarding the target material with electrons. When electrons have sufficient energy to dislodge inner shell electrons of the target material, characteristic X-ray spectra are produced.. The specific wavelengths are characteristic of the target material (Cu, Fe, Mo, and Cr). Filtering, by foils or crystal monochrometers, is required to produce monochromatic X-rays needed for diffraction. Copper is the most common target material for single-crystal diffraction, with CuK_α radiation = 1.5418Å. These X-rays are collimated and directed onto the sample. As the sample and detector are rotated, the intensity of the reflected X-rays is recorded.

When the geometry of the incident X-rays impinging the sample satisfies the Bragg Equation, constructive interference occurs and a peak in intensity occurs. A detector records and processes this X-ray signal and converts the signal to a count rate which is then output to a device such as a printer or computer monitor. X-ray powder diffractogram. Peak positions occur where the X-ray beam has been diffracted by the crystal lattice. The unique set of d-spacings derived from this patter can be used to 'fingerprint' the mineral. The geometry of an X-ray diffractometer is such that the sample rotates in the path of the collimated X-ray beam at an angle θ while the X-ray detector is mounted on an arm to collect the diffracted X-rays and rotates at an angle of 2θ. The instrument used to maintain the angle and rotate the sample is termed a *goniometer*. For typical powder patterns, data is collected at 2θ from ~3° to 110°, angles that are preset in the X-ray scan. The interpretation technique or software used in this study is Origin pro version 8.

Result and Discussion

Laterite

Laterite is a weathering product of rocks, extensively developed in semi-humid and humid intertropical regions .It is rich in secondary oxides of iron, aluminium or both, with or without quartz and clays, but devoid of primary silicates.It is porous and shows vermicular structure. Laterite was first reported by Francis Hamilton

Buchanan, a medical officer in the service of the East India Company, from Angadipuram in Kerala, while on a journey through the countries of Mysore, Canara and Malabar (Buchanan, 1807) he observed a type of weathered material used of building, which was an indurate clay full of cavity and pores, containing a large quantity of iron in the form of red and yellow ochre.A global study of laterite has revealed a wide variety of laterite of which Buchanan's laterite is only one type.

Fermor (in fox, 1936) characterized Buchanan's laterite as 'lithomargic laterite 'and even in part as 'lithomargic' while the high level laterite of the Deccan were termed as the finished products- fully formed laterite. It is invariably a surface formation like soil and is found covering a wide variety of rocks in form of a sheet. It is in process of formation even during the present day. Typical laterite is porous and like-clay, generally soft and can be cut into blocks of different sizes with a spade, but becomes hard on exposures .The exposed surface is generally dark brown in colour .When broken, the rock is mottled with various shades of red, brown and yellow .It generally gives place to lithomargic clay at depth .It is a widely used building stone in the coastal belts and in parts of Malnad. Compositionally,it is a mixture of hydrated oxide of iron and aluminium admixed with clay .The alumina-rich varieties are classified as bauxites and form the ore from which metal aluminium is extracted .Some of the laterite covering the iron formations along the Western Ghats and Malnad show rich concentration of manganese and iron and are exploited as ore of these metals.

Although in its vesicular appearance and flat-lying character, it closely resembles Deccan Trap and in fact, occurs as a distinct cover over the traps, it is not an igneous rock but is produced by alteration of both igneous as well as sedimentary rocks. Quite often it is detrital in origin. The only three which flourishes on these laterite patches is cashew and is extensively cultivated in the coastal belt.(Geology of Kerala, Geology of Karnataka, Geology of Andhrapradesh- GSI publications).

Xrd Analysis

Based on the 2 theta position and the d- spacing value of each sample given in the doc file (Appendix 1) is matched to correspondence value in the reference data (Appendix 2). It is to be noted that an exact correspondence does not occur in the reference data. (Roy.C.Lindholm).

The following minerals are infer from the XRD diffractogram of each sample. The most common minerals found in the samples of study area are ***Celestite, Quartz, Chlorite, Glauconite, Sanidine, Microcline, Albite, Orthoclase, Oligoclase, Muscovite, Hypersthene, Enstatite, Tremolite, Tourmaline, Staurolite, Goethite, Magnetite, Siderite, Garnet, Halite, Marcasite, Aragonite, Laumonite, Zoisite and Carnallite.*** The following table 4.1 briefly shows the presence of

each minerals in ten Samples of the study area. The Figure 2.1. – 2.2shows each sample's Raw Data, Smoothed Data and Mineral Data in the XRD pattern.

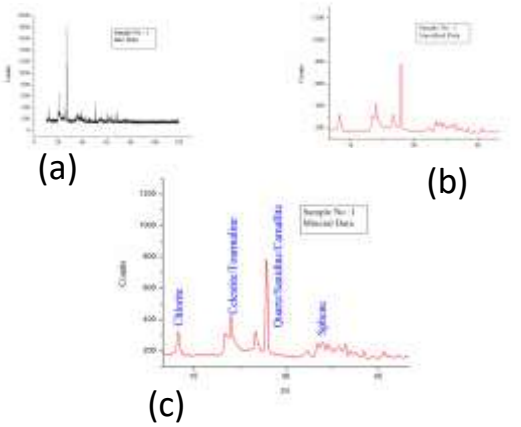

Fig – 2.1 (a) Shows the Raw data (b) Smoothed data (c) Mineral Data

Sample No	List Of Identified Minerals
1	Chlorite, Celestite, Tourmaline, Quartz, Sanidine and Carnallite.
2	Microcline, Tremolite, Celestite, Quartz, Glauconite and Garnet.
3	Celestite, Hypersthene, Quartz and Zoisite.
4	Celestite, Glauconite and Sanidine.
5	Staurolite, Celestite, and Halite.
6	Celestite, Tremolite, Albite, Quartz, Chlorite and Magnetite.
7	Laumonite, Enstatite, Goethite and Celestite.
8	Glauconite, Zoisite, Celestite and Staurolite.
9	Chlorite, Staurolite, Muscovite, Quartz, Sanidine, Siderite and Aragonite.
10	Orthoclase, Marcasite, Oligoclase, Quartz and Sanidine.

Table 2.1 Comparison of XRD data for Sample No: 1

DATA FOR STANDARD			CALCULATED FOR SAMPLE 1			NAME OF THE MINERAL
2θ	d(Å)	I/I_1	2θ	d(Å)	I/I_1	
12.55 93	7.04815	11.54	12.38	7.150	10	Chlorite
			21.00	4.230	10	Celestite
21.0693	4.21669	28.18	21.00	4.220	70	Tourmaline
			26.66	3.343	100	Quartz
			26.79	3.328	100	Sanidine
26.8533	3.32013	100	26.84	3.322	100	Carnallite
39.6935	2.27077	11.28	39.65	2.273	30	Sphene

Table 2.2 Comparison of XRD data for Sample No: 1

CONCLUSION

Based on the observation in the interpreted data it is obvious that the following few minerals which are quantitatively dominant in the study area.

- Celestite, Quartz, Chlorite, Glauconite, Sanidine

- The following minerals are found less in the collected samples of the

study area.

- Orthoclase , Oligoclase , Microcline ,Muscovite.
- Hypersthene, Tremolite, Enstatite. Tourmaline, Staurolite
- Goethite Magnetite Siderite. Aragonite Marcasite Laumonite Zoisite.

- The mineral composition of the lateritic soil mainly depends on the parent rock. Main constitutions of lateritic soil are Quartz, oxides of Aluminium, Iron, etc,
- The pyroxene and Amphibole group of minerals present in the samples of the study area indicates that they tend to break down to the formation of Chlorite and these minerals alter quickly into ferruginous substances like Goethite
- Chlorite originate from the low grade metamorphic rock and as products of the early alteration of primary minerals containing Fe and Mg rich minerals. Colonel V.O. Fagoyinbo, A.J.Adeola, 2017 suggest that Chlorite dissolved typically leaving a solid residue of iron oxide and oxyhydroxides like Goethite.
- Quartz does not seems to be greatly subject to alteration in the zone of primary occurrences.
- Geochemistry and Clay mineral analysis of the samples reveals the precise occurrence of mineral presence and deposition of environment. It will be carried out in near future.

MERCURY POLLUTION IN OCEANS

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Marine Mercury Pollution has harmful effects on marine environment and marine organisms and its threat to human health and to know about the tripled levels of Mercury in the oceans and it's distribution to deep trenches. Mercury pollution in the marine environment presents a significant threat to aquatic ecosystems worldwide. Industrial activities, including mining and manufacturing, contribute to the release of mercury into water bodies, where it accumulates in fish and shellfish. This bioaccumulation poses a serious risk to human health when consuming contaminated seafood. Understanding the sources and impacts of mercury pollution is crucial for developing effective mitigation strategies to safeguard marine life and human well-being.

Mercury is a naturally occurring element that is found in air, water and soil. Exposure to mercury even small amounts may cause serious health problems, and is a threat to the development of the child in uteri and early in life. Mercury may have toxic effects on the nervous, digestive and immune systems, and on lungs, kidneys, skin and eyes. When mercury increases in amount of number the pollution occurs I which is responsible for the deterioration.

This is how mercury pollution occurs and its effect on the population. In oceanic waters, mercury mainly occurs in the forms of Hg 0, Hg 2+ , MeHg, and diMeHg and in colloidal form. In marine waters, mercury forms compounds with chlorine (HgCl 3 − and HgCl 4 2−) to a greater extent than oxides, as is the case in freshwaters. Mercury also poses hazards to people's health because it enters the food chain by accumulating in the tissue of fish and other animals in the form of methyl mercury. This highly toxic substance can cause a variety of health conditions such as impeded brain development in children and cardiovascular diseases in adults

In this context the mercury plays an important role in the humans health that pose a

threat in form that it can be responsible for many problems for the Human being. Marine mammals such as dolphins, whales and seals are particularly susceptible to mercury contamination at the topmost food chain. High levels of mercury in these animals can lead to reproductive failure, behavioural changes, and even death It also pose a Massive threat to Marine Environment which is Very dangerous to the Marine Mammals that can be affected by the mercury pollution.

Industrial processes such as small-scale gold mining and coal burning emit mercury into the atmosphere. In gold mining, miners use liquid mercury to soak up gold from ore, then vaporize the toxic metal while leaving the gold behind. Burning coal releases mercury naturally contained in the fuel. Once in the atmosphere, the metal can travel for months and thousands of kilometres until rain deposits it into oceans. There, bacteria help convert it to the neurotic methyl mercury. The methyl mercury then travels up the food chain, ultimately accumulating in fish.

These are the major factors that affect the mercury pollution in oceans which plays an important role in Marine Environment.

SEAWEEDS

S.MANISHA

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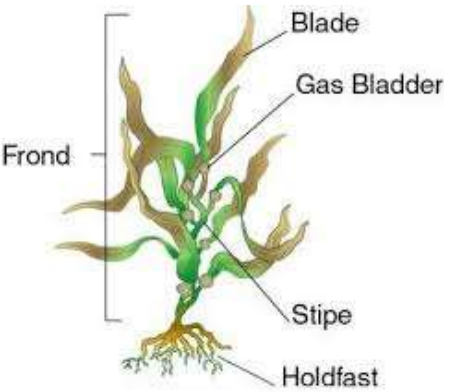
Seaweeds, also known as macroalgae, are abundant sources of various vital bioactive components with a wide range of biological functions. They are sold commercially and are primarily used in the food industry, pharmaceuticals, cosmeceuticals, and other related industries. The diverse biological activities linked with bioactive compounds obtained from seaweeds have the potential to expand their health benefit value in the food and pharmaceutical industries. Studies revealed that seaweeds have the potential to be used as complementary medicine due to its variety of biological properties that have been shown to be therapeutic for health and disease management, such as antibacterial, anticoagulant, anticancer, antidiabetic, antiestrogenic, antihypertensive, antihyperlipidemic, antifungal, anti- inflammatory, antioxidant, antiobesity, antiviral, immunomodulatory, neuroprotective, thyroid stimulant, tissue healing properties, and many more. Although seaweeds are generally beneficial to humans, they may still pose possible health risks due to high iodine concentration and exposure to heavy metals and arsenic concentrations. However, information on this topic is still limited. This review covers the general structure and characteristics of seaweeds, bioactive components and properties of seaweed, possible risk factors of seaweeds, and applications



of seaweeds.

Seaweeds, or known as macroalgae, are marine photosynthetic, non-flowering plant-like organisms that are categorized into three major groups depending on their predominant pigment compositions, which are green (Chlorophyta), brown (Ochrophyta), and red (Rhodophyta) seaweeds. They can be found all across the world's coastlines, from the warm tropics to the freezing and icy Polar Regions. Seaweeds are commercially sold, with approximately 83% of its total global production is for direct human consumption. They are commonly consumed in Asian countries as fresh, dried, or as ingredients in prepared foods. The remaining percentage is used as a source of phycocolloids extracted for the application in food, cosmetic, medical and other related industries. There are 221 species of seaweeds are utilized in total, with 145 species used for food and 101 species used for phycocolloid synthesis.

Since ancient times, natural products have played a significant role in diagnosing, treating, and preventing numerous ailments. The therapeutic characteristics of chemical compounds in natural products are optimized and augmented for human medical applications. The plant-based and herbal medications generated from natural resources that are considered pure, healthy, and safe have grown in popularity over the years. As a result, several herbal-based pharmaceutical sources are now commercially accessible and offered as an alternative therapy and dietary supplement to treat various illnesses. In addition, the availability of novel metabolites with diverse uses such as cosmeceuticals, nutraceuticals, agrochemicals, medicals, and other relevant chemical industries has stimulated marine drug research in recent years. It has been considered that the marine ecosystem is an excellent source of natural compounds with several functions. Seaweeds are marine plant organisms capable of

producing a wide range of active metabolites with a wide range of medical applications, which they also use to defend themselves against other invading species. As results of these novel metabolites, seaweed has become one of the most important sources of natural components used in pharmaceuticals, accounting for 30% of the global market in 2018. It was expected to be greater than USD 10,486.8 billion.

Seaweeds are also employed in aquaculture as probiotics, animal feed additive, fertilizer, and as water purifier. In this context, the goal of this article is to provide general information about seaweeds, including their biological features, potential therapeutic properties, potential risk factors, and some of the extraction methods used. Furthermore, due to their distinct metabolite contents, this study also investigates the relevance and applications of seaweeds as major marine bioresources in numerous industries. Based on their photosynthetic pigments, seaweeds are classified into three categories: brown (Ochrophyta or Class Phaeophyta), green (Chlorophyta), and red (Rhodophyta). There are around 10,000 seaweed species, including about 2000 brown, 1500 green, and 6500 red seaweeds. Furthermore, seaweeds are classified using molecular techniques based on evolutionary processes. Some seaweeds employ holdfast, a root-like structure used only for anchoring, to attach them to the ocean floor. Other seaweeds, such as floating seaweeds, may have floating or air sacs that maintain them above the water's surface and expose them to sunlight for photosynthesis. Another seaweed component is stipe, a stem-like structure that holds the blades to the water's surface. Blades are primary photosynthetic leaflike flattened parts that absorb sunlight. Furthermore, thallus refers to the fundamental or advanced body-like structure of seaweeds that can conduct photosynthesis with all its parts.

With an average depth of 5

km, the water surface covers more than 70% of the earth's surface, to which seawater accounts for more than 90% of all water on the planet earth. Moreover, oceans support floating forests with a broad range of marine animals and plants, where the marine vegetation is more primordial and diversified than the terrestrial vegetation. Algae are photosynthetic plant-like creatures that are the sole primary producers in the oceans, with a photosynthetic efficiency (PE) that is 6–8% greater than that of terrestrial plants (1.8– 2.2%). Seaweeds, also known as marine macroalgae or edible macroalgae, are benthic marine algae that thrive in brackish or saltwater environments found in shallow and open water up to 180m deep. They are the most numerous marine vegetation and one of the essential biomass producers in the ocean that gives food and shelter to aquatic life. However, the distribution of seaweeds in the marine environment is limited only to the littoral and sublittoral zones. They may be found to a depth where 0.01% photosynthetic light is accessible.

Marine metagenomics

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Marine metagenomics is a rapidly developing field that studies the collective genomes of all the microbes in a marine environment. This includes bacteria, archaea, and viruses. By studying these genomes, we can learn about the incredible diversity of life in the ocean, as well as the genes and functions that these microbes encode. Metagenomics is a powerful tool that allows us to peek into the fascinating world of microorganisms in their natural environment. Instead of focusing of individual species, it delves into the collective genetic material of entire microbial communities living in a specific environment, like soil, water etc. Metagenomics allows direct access to the collective genetic pool of microbial communities in an environment without the need for culturing individual organisms. There are many potential benefits to studying marine metagenomics. Marine microbes produce a wide variety of natural products, many of which have potential applications in medicine, industry, and agriculture. By studying marine metagenomes we can identify and isolate these novel compounds. Marine microbes play a critical role in ocean ecosystems, from cycling nutrients to breaking down pollutants. By studying their genomes, we can better understand how they function and how they respond to environmental changes. Marine microbes can be used to clean up oil spills and other environmental disasters. By studying their genomes, we can develop new and more effective bioremediation strategies.

The vast and unexplored depths of the ocean hold a treasure trove of biodiversity, teeming with unique and fascinating creatures. Hidden amongst this diversity lies a hidden gem a plethora of novel enzymes with immense potential to revolutionize

various industries. These marine novel enzymes are proteins produced by microorganisms living in the ocean's diverse ecosystems, from sun-drenched coral reefs to the crushing depths of hydrothermal vents. These enzymes possess unique properties that allow them to thrive in extreme environments, such as high pressure, salinity, and temperature. Enzymes can be used to break down complex molecules into simpler ones, making them ideal for industrial processes like biofuel production, food processing, and textile manufacturing. Marine enzymes have shown promise in developing new drugs and medical treatments, with potential applications in areas like cancer therapy, antibiotic development, and bioremediation. Novel enzymes can be employed for bioremediation purposes, degrading pollutants and cleaning up contaminated environments. However, harnessing the power of these marine enzymes comes with a challenge with the vast majority of marine microorganisms are uncultivable in a lab setting. This means that traditional methods for enzyme discovery, which rely on isolating and growing microorganisms, are often ineffective. This is where metagenomics steps in. This powerful approach bypasses the need for culturing by directly extracting and analyzing the genetic material from environmental samples. By sequencing this environmental DNA or metagenome, scientists can access the collective genomes of all the microorganisms present in that sample, including the uncultivable ones.

Identify genes encoding for novel enzymes with unique properties. Express these genes in other organisms, such as bacteria or yeast, for large-scale production of the desired enzymes. Characterize the properties of the enzymes, such as their activity, stability, and substrate specificity. By leveraging the power of metagenomics, scientists are unlocking the vast potential of marine novel enzymes. This exciting field is still in its early stages, but it holds immense promise for the

future of various industries and our understanding of the ocean's hidden treasures. Environmental samples will be collected, their DNA extracted, sequenced and generating millions of short DNA fragments. These fragments are then computationally assempled into larger contigs, representing portions of microbial genomes. Bioinfomartic tools identify putative protein-coding genes within the contigs and predict their functions based on sequence similarity to known enzymes. Libraries containg metagenomic DNA fragments are expressed in host organisms like *E. coli* and their activity against various substrates is screened to identify enzymes with desired properties.

Lipases and esterases have been the subject of extensive research in the past, with numerous eDNA libraries being screened to identify new enzymes capable of hydrolyzing or synthesizing ester bonds. These enzymes find applications in various industries such as detergent, food, pulp and paper, diagnostics, therapeutics, biodiesel production, and biopolymer synthesis. Oxidoreductases encompass a diverse group of enzymes that find various applications in the pharmaceutical and food industries, as well as in bioremediation. Among the recently discovered oxidoreductases are five soil-derived dioxygenases with potential in bioremediation, as well as the first metagenome-sourced d-amino acid oxidase that has the potential to assist in the biosynthesis of the antibiotic intermediate of 7-aminocephalosporanic acid from cephalosporin C. Additionally, multi-copper oxidases (MCOs), enzymes with a wide range of activity on both phenolic and non-phenolic substrates, are of interest for their ability to degrade lignocellulose biomasses. Some of the exciting discoveries made using the metagenomic approach, a cold-adapted lipase from Arctic sea ice bacteria that can break down fats at low temperatures, potentially revolutionizing cold-washing detergents. A highly thermostable enzyme from deepsea hydrothermal

vents can withstand high temperatures making it ideal for industrial processes like biofuel production. A novel antibiotic produced by marine bacteria, offering a potential weapon in the fight against antibiotic-resistant bacteria. These are just a few examples of the incredible potential that lies within the unexplored depths of the ocean. As we continue to investigate deeper into the world of marine metagenomics, we can expect to uncover even more groundbreaking discoveries that will benefit human and our planet.

What is Mercury Pollution and its Effects in Oceans?

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Introduction

Mercury pollution in the marine environment presents a significant threat to aquatic ecosystems worldwide. Industrial activities, including mining and manufacturing, contribute to the release of mercury into water bodies, where it accumulates in fish and shellfish. This bioaccumulation poses a serious risk to human health when consuming contaminated seafood. Understanding the sources and impacts of mercury pollution is crucial for developing effective mitigation strategies to safeguard marine life and human well-being.

What is Mercury pollution?

Mercury is a **naturally occurring element** that is found in air, water and soil.Exposure to mercury – **even small amounts – may cause serious health problems,** and is a threat to the development of the child in uteri and early in life.Mercury may have **toxic effects on the nervous, digestive and immune systems,** and on lungs, kidneys, skin and eyes.When mercury increases in amount of number the pollution occurs which is responsible for the deterioration.This is how mercury pollution occurs and it's effect on the population.

Where does it come from?

In oceanic waters, mercury mainly occurs in the forms of Hg0, Hg2+, MeHg, and diMeHg and in colloidal form (Morel et al. 1998). In marine waters, mercury forms compounds with chlorine ($HgCl_3^-$ and $HgCl_4^{2-}$) to a greater extent than oxides, as is the case in freshwaters (Mason and Fitzgerald 1993).

Water

Mercury polluted water

What Is Mercury's Part in Human Health?

Mercury also poses hazards to people's health because it enters the food chain

by accumulating in the tissue of fish and other animals in the form of methyl mercury. This highly toxic substance can cause a variety of health conditions such as impeded brain development in children and cardiovascular diseases in adults

In this context the mercury plays an important role in the humans health that pose a threat in form that it can be responsible for many problems for the Human being.

How Does Marine Environment Affected?

Marine mammals such as dolphins, whales and seals are particularly susceptible to mercury contamination as their at the topmost food chain. High levels of mercury in these animals can lead to reproductive failure, behavioural changes, and even death
Aquatic organisms readily absorb methylmercury, which is then bioaccumulated and biomagnified within the aquatic food chain .It also pose a Massive threat to Marine Environment which is Very dangerous to the Marine Mammals that can be affected by the mercury pollution.This means that the higher up the food chain an organism is, the more concentrated the levels of methylmercury will be in its tissues

Why is Mercury pollution tripled in the oceans ?

Industrial processes such as small-scale gold mining and coal burning emit mercury into the atmosphere. In gold mining, miners use liquid mercury to soak up gold from ore, then vaporize the toxic metal while leaving the gold behind. Burning coal releases mercury naturally contained in the fuel. Once in the atmosphere, the metal can travel for months and thousands of kilometres until rain deposits it into oceans. There, bacteria help convert it to the neurotic methyl mercury. The methyl mercury then travels up the food chain, ultimately accumulating in fish.

These are the major factors that affect the mercury pollution in oceans which has been important role in mercury pollution.

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NANOPARTICLES FROM MARINE ORGANISM

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Marine bio-nanotechnology is an exciting and upcoming area of research. The biologically diverse marine environment has a great promise for nanoscience and nanotechnology. Marine organisms produce remarkable nanoparticles of 1-100nm size which constitute nano-fabric structure such as seashells, pearls and fish bones. Diatoms and sponges are constructed with nanostructured cover of silica and coral reef with calcium arranged in remarkable architecture. Dolphins and whales have rough skin surface due to presence of nano- ridges. These ridges enclose a pore size of 0.2 µm which is below the size of marine fouling organisms and hence, there is no attachment of bio-foulers. In spite of great potential, the marine bio-nanotechnology has limited research work. Most of the studies on biosynthesis of Nanoparticles have been restricted to terrestrial organisms.

Nanoparticles are classified into major type viz. organic and inorganic Nanoparticles. Carbon nanoparticles are called the organic nanoparticles, magnetic nanoparticles, nobel metal nanoparticle (platinum, gold and silver) and semiconductor nanoparticles (titanium dioxide and zinc oxide) are grouped as inorganic nanoparticles. Inorganic nanoparticles are increasingly used in drug deliver due to their distinctive features such as ease of use, good functionality, biocompatibility, ability. Use of chemical and physical method in the synthesis is of nanoparticles is very expensive and cumbersome. The chemical and physical method in the synthesis lead to the presence of some toxic chemicals absorbed on the surface that may have adverse effects applications, so there is a growing need to develop environmentally being nanoparticles. Researchers have used biological extract for the synthesis of nanoparticles, by adopting simple

protocols, involving in the process.

Microorganisms such as bacteria, cyanobacteria, actinomycetes, yeast, fungi and algae are used to synthesis nano-particals such as gold, silver, calcium, silicon, iorn, gypsum, and lead, in nature either inside or outside cell. At present, microbial methods in the synthesis of nanomaterials of varying compositions are extremely limited and confined to metals, some metal sulfide and very low oxides. All these are restricted to the microorganisms of terrestrial origin. Recently, coastal plants are used to synthesis nanoparticles. The brown seaweed *Sargassum wightii* is reportedly capable of synthesizing gold nanoparticles with a size ranging between 8 and 12nm. An important potential benefit of the synthesis is that the nanoparticls are quite stable. Fish oil of nutraceutical value and the presence of permissible limit of silver nanoparticles in the oil might enhance its efficacy an idea that may open many avenues the field of nanotechnology. The use of cod liver fish oilis shown to produce silver nanoparticle, as reducing agent as well as surfactant. Presence of carboxyl ions and amine group in the fish oil triggers in situ generation of organically capped silver nanoparticles. Nanoparticles have a greater surface area per weight than larger particles and this properly makes them to be more reactive to certain other molecules and they used or being evaluated for use in many fields. Quantum dots are the crystalline nanoparticles used to identify the location of cancer cells in the body. Gold nanoparticles allow heat from infrared laser to detect cancer tumors. With the huge biological resources, still marine organisms becoming a largest untapped reservoir for nanoparticles synthesis.

MARINE FOSSILS

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Introduction

The earth's oceans have long been shrouded in mystery, hiding the secrets of ancient life beneath their depths. Marine fossils, remnants of organisms that once thrived in the vast expanses of water, serves as windows into the distant post. These fossilised treasures unlock stories of evolution, adaptation and the ever changing landscapes of our planet. Marine fossils encompass a staggering array of life forms, from microscopic plankton to massive marine reptiles. The ocean, covering more than 70% of Earth's surface, has been a cradle of evolution, nurturing a plethora of species throughout geological time. Fossillized shells, skeletons and imprints provide glimpses into the astonishing diversity that has characterized marine life over Million of years.

Evolutionary Insights

Studying Marine fossils offers scientists invaluable insights into the evolutionary journey life on earth. By examining the intricate details of ancient organism, researchers can trace the development of different species, observe adaptations to changing environment and unravel the complex relationship with ecosystem. Marine fossilis contribute crucial evidence to the broader Narrative of life's evolution, helping us piece together the puzzle of our biological history.

Fig 1: Fossilis

Index fossilis and geological time scale

Certain Marine fossilis known as index fossilis, play a vital role in dating and correlating rock layers. These fossilis have a wide geographical distribution and relatively short existence in geological time, making them valuable markers for dating the age of rocks. Through the study of marine fossils, geologists can construct timelines of Earth's history, charting The rise and fall of species and major geological events.

Fig 2 :Geological Time Scale

Ancient climate records

Marine fossils also serve as record of past climates. For example, the composition of fossilized marine organisms can indicate the temperature and chemical Composition of ancient oceans. By analyzing these clues, scientists can reconstruct past Climate conditions, offering insights into the earth's climate history and aiding our understanding of current climate change.

Preservation challenges and conservation

Despite their significance,

marine fossilis face threats from human activities activities such as over collection, habitat destruction, climate change. Conservation efforts are crucial to preserving these reliefs of the past for future generations. Proper management of fossilis sites, ethical collecting practices, and public awareness campaigns contribute of the protection of these scientific treasurers.

Conclusion

Marine fossils stand as silent witness to the eons of Earth's history, roviding a glimpse into the evolution and diversity of life in the oceans. These fossilis not Only enrich our understanding of the past but also offer valuable insights into the present and future of our planet. As we continue to explore the mysterious hidden within marine Fossils, we embark on a journey through time, unraveling the profound connections between life, the oceans and the ever changing face of our dynamic planet.

COASTAL EROSION

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Coastal erosion is the process by which local sea level rise, strong wave action, and coastal flooding wear down or carry away rocks, soils, and/or sands along the coast. Destructive waves erode through four main processes; Hydraulic action, compression, abrasion and attrition. Image credit: Jeff Hansen, U.S. Geological Survey. Hydraulic action is the sheer force of water crashing against the coastline causing material to be dislodged and carried away by the sea. Coastal erosion is the process by which rising sea levels, storms, and other phenomena wear down or carry away the rocks, land, and sand making up a coastline. This process causes the loss of tens of thousands of acres of land in the U.S. each year, as well as hundreds of millions of dollars in property.

There are three common forms of coastal erosion control methods. These three include: soft-erosion controls, hard-erosion controls, and relocation. In order to mitigate the coastal erosion, the coastal protections are broadly classified as soft and hard solutions and also combination of both. Soft solutions are vegetation, beach nourishment, sand bypassing, flood proofing, sand dune formation, zoning, retreat etc.., Hard structural/engineering options use structures constructed on the beach (seawalls, groynes, breakwaters/artificial headlands) or further offshore (offshore breakwaters). These options influence coastal processes to stop or reduce the rate of coastal erosion. Relocation of infrastructure any housing farther away from the coast is also an option. The natural processes of both absolute and relative sea level rise and erosion are considered in rebuilding. Depending on factors such as the severity of the erosion, as well as the natural landscape of the property, relocation could simply mean moving inland by a short distance or relocation can be to completely remove improvements from an area. A coproduction approach combined with managed retreat has been proposed as a solution that keeps in mind environmental justice.

MARINE LIVE FEED

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Figure A: Artemia

Figure B: copepod

Artemia

Artemia, the brine shrimp, is an excellent live food for cultivable aquatic species. It is in great demand for use in shrimp hatcheries, fish hatcheries and ornamental fish culture farms. Artemia can withstand habitats whose salinity levels range from 10 to 340 g L−1, with fluctuating ionic compositions and temperatures Artemia franciscana is a native strain from America, originating in the San Francisco Bay, California and the Great Salt Lake, Utah The brine shrimp, Artemia spp., in marine fish larviculture from Since no artificial feed formulation is yet available to completely substitute for Artemia, P. Sorgeloos et al (2001) Feeding live prey to young fish larvae still remains essential in commercial hatchery operations. However, the variability of enrichment studied in one Artemia strain (Great Salt Lake, Utah, USA) by the ICES Working Group on Mass Rearing of Juvenile Fish, showed a high variability in fatty acid bioaccumulation under laboratory or commercial conditions. Nowadays, various enrichment emulsions have been formulated differing in the fatty acid composition of their triglycerides. In this respect, the traditional formulations rich in EPA have been replaced by new products rich in DHA and arachidonic acid. To reduce the risks for oxidation of these fatty acids, higher concentrations of vitamin E are incorporated into the emulsions. Also, vitamin C has been incorporated in booster

formulations that increase the level of ascorbic acid in Artemia to 2000 ppm. All these changes in the formulation of the enrichment diets offer more possibilities to cover the needs of different species and help to reduce problems related to diseases, stress resistance, malformation, and pigmentation in numerous fish species. The Comparison of growth and survival of white shrimp post larvae (Litopenaeus vannamei) fed dried Artemia biomass versus four commercial feeds and three crustacean meals, Naege et al (2004) The use of dried Artemia biomass meal as an exclusive feed for post larval white shrimp (Litopenaeus vannamei) was compared with four commercial feeds and three crustacean meals in a series of trials. Post larvae (PL1–PL6) were stocked at a density of 1.5 – 2.5/litres in 16 tanks (100 litres volume) and fed, ad libidum, five times a day, over 23–29 days. Feeding post larval shrimp with dried Artemia biomass resulted in a significantly larger size than feeding with three of the commercial feeds, and the crustacean meals. There was no significant size difference observed in animals fed with Artemia biomass and the commercial 'Golden Pearls' feed for post larvae, however the coefficient of variation among the size ofthe 'Golden Pearls' fed animals was significantly higher. The weight increase of animals fed with Artemia biomass was higher than in animals fed with all the tested feeds. The survival rate was not significantly different in animals fed with Artemia flakes from 'Salt Creek', 'Bio-Marine', 'Golden Pearls' and Artemia biomass. Results suggest that dried Artemia biomass is a well-suited feed for post larval L. vannamei.

COPEPODS

The term copepod is used to describe small crustacean species that are found in the majority of aquatic environments. Copepods can be found in both the upper waters and bottom of oceans and freshwater bodies, as well as swamps, bogs, ponds, and other wet habitats. Copepods constitute an important zooplankton species. The Improvement of copepod nutritional quality as live food for aquaculture from for the purpose of first-feeding fish larvae in hatcheries, a sufficient quantity of live food is necessary, and nutrient enrichment can enhance the nutritional value of the live food organisms. Nadiah W Rasdi et al (2014) for the majority of marine fish larvae, using live food organisms is essential, particularly during their initial eating. Copepods are the main food source for marine fish larvae in the ocean, yet

hatchery production methods for copepods as live food are still in their infancy. Copepods differ from other live food species (such as rotifers) in their food ingestion and digestive systems, therefore the nutrition enrichment techniques using emulsion oil that work for rotifers do not work for copepods. This review focuses on how copepod diet can be altered to change the nutritional makeup of copepods before feeding them to fish larvae. The review makes a connection between copepod nutrition changes and nutrient delivery, and it offers recommendations for enhancing copepod nutrition in hatcheries. The Suitability studies of the copepod, Acartia clausi as a live feed for Seabass larvae (Lates calcarifer Bloch): Compared to traditional live-food organisms with special emphasis on the nutritional value, Rajkumar et al (2006) While the artificial propagation of Asian seabass, Lates calcarifer (Bloch), in captivity by induced breeding methods is standardized under Indian conditions, standardization is still needed for the raising of larvae and nurseries, including the use of appropriate nursery foods, in order to improve growth and survival rates. The nutritional quality of cultured copepods was assessed by comparing its proximate makeup, amino acid composition, and fatty acid composition. The live feed organisms' fatty acid profiles revealed that a clausi is a good source of omega-3 fatty acids. A clausi had a total n − 3 fatty acid content of 33.94. The maximum survival rate of seabass larvae fed with A, clausi was found to be 58.13%, whereas the lowest survival rates were recorded by larvae given Rotifer and Artemia nauplii, respectively, at 39.93% and 41.62%. There were significant differences (Pb0.05) in the final carcass composition of the larvae of L. calcarifer fed different live-food species among the dietary regimens. The fatty acid composition of the dietary treatments was somewhat reflective of the fatty acid composition of the dietary treatments. Live feed is a vital component of aquaculture, as it plays a significant role in the growth and development of fishes and shrimps used for ornamental and cultural purposes. Because of high protein content in live feed, and also enhance the fish's colour pigment, and promotes quick growth. Therefore, live feed is essential for the successful culture of fish and shrimp species, it was introduced as a biomass culture in certain places.

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SCHOOL OF MARINE SCIENCES

The Department of Oceanography and Coastal Area Studies is the only one of its kind in Tamil Nadu and it was established in the year 1998 with the vision to conserve the marine resources for sustainable development and to cater to the requirement of manpower generation in the field of marine research, technology and industries. The Department is situated in a satellite campus extending over 13 acres at Thondi about 60 km away from the main campus. The Department is spread along the wave front having the facility of boat landing jetty. The Department has talented, motivated and well-trained staff members with expertise on multi-disciplinary aspects *viz*., Geological, Physical, Chemical and Biological Oceanography, Marine biotechnology, Marine microbiology, and Marine pharmacology. Our University is distinctly projecting Oceanography as the course admitting graduates from various disciplines so that the country will have skilled manpower to concentrate on the future requirements in the sphere of marine science and marine engineering. Later, during 2017the department has bifurcated in to Department of Geology with the vision to create highly competent professionals in Geology who contribute to the academia and industry by undertaking innovative research, making inventions and developing new technology and to collaborate with Western Universities and utilise the experience and expertise of international subject experts for the progress of students followed to that, the Department of Fisheries Sciences is established during 2018 with the vision to encourage sustainable fisheries and robust aquaculture practices for the constant supply of high-quality fish for everyone that complements the economic prosperity of the fishery business. Prof. S. Ravikumar, Head, Department of Oceanography and Coastal Area Studies is the Chairperson of the School of Marine Sciences, Alagappa University, Karaikudi.