Environmental Information System
INDIA

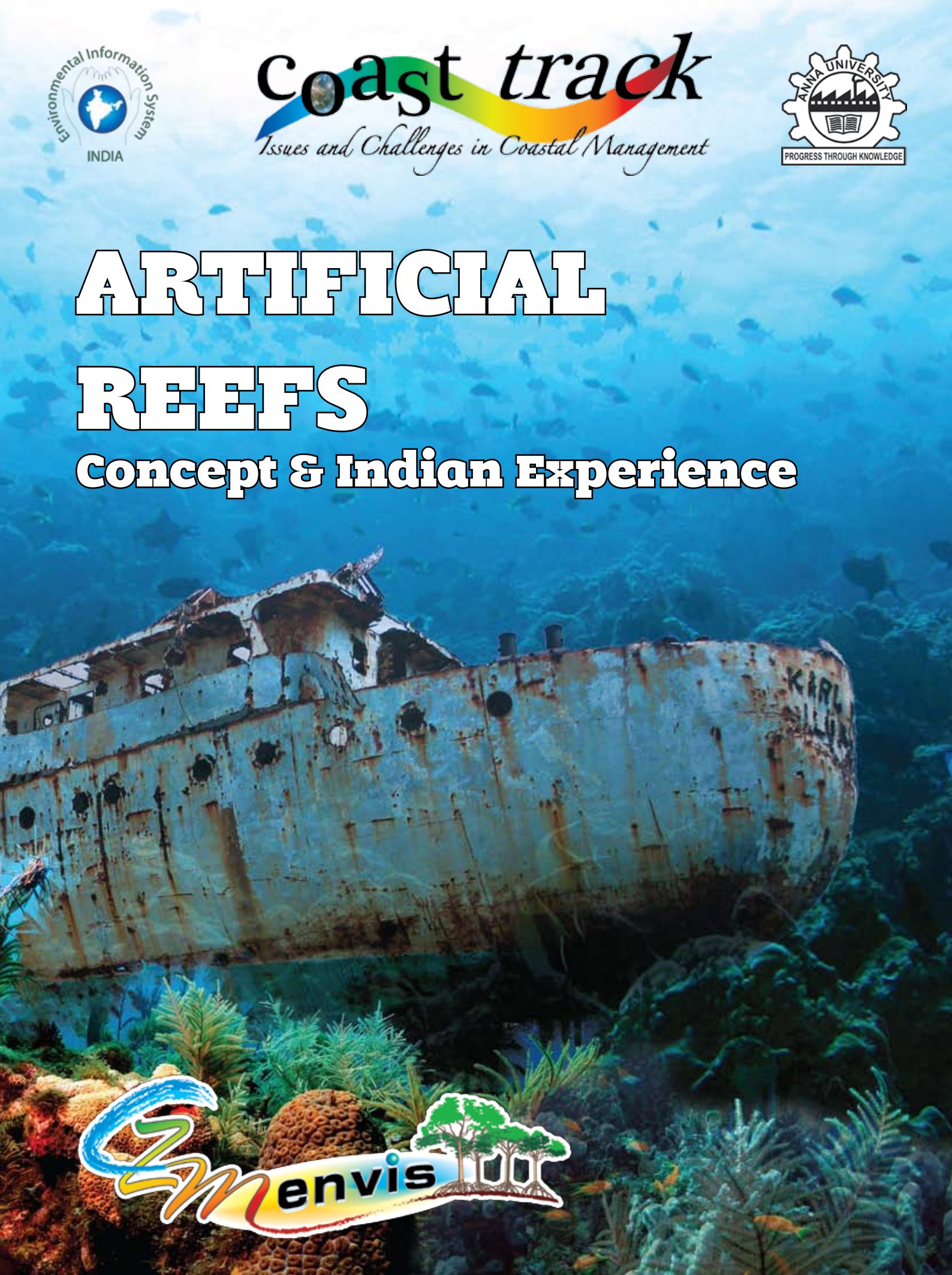
coast track

Issues and Challenges in Coastal Management

ANNA UNIVERSITY
PROGRESS THROUGH KNOWLEDGE

ARTIFICIAL REEFS

Concept & Indian Experience



ENVIS - MoEF Newsletter on Coastal Zone Management and Coastal Shelterbelts

Vol.9 (2) July - September 2010

Coastal Updates

Coastal Updates
from ENVIS COAST, Anna University, Chennai

Home

Post-monsoon study at Adyar Eco Park from next week

Mar 23 2011 — admin @ 10:35 am

Category: News Clippings

Source: The Hindu, 23.03.2011

Post-monsoon study at Adyar Eco Park from next week

Invasive seaweed poses threat to coral colonies in Gulf of Mannar

Further damage can be contained by continuous monitoring, manual eradication

Bill to protect fisherfolk's traditional rights on anvil

70-lakh people will get security of dwelling, marine resources

Staff Reporter

Beaches littered with garbage post-festival

150 tonnes of garbage left on Marina; the litter on Elliots beach and parks amounts to 100 tonnes

K.Lakshmi and Lilly Thomas

Environmental activists say sustained efforts must be made to create awareness of the need to keep public places clean

OPERATION CLEAN-UP: *The removal of waste from the Marina beach in progress on Tuesday.* – PHOTO: K. V. SRINIVASAN

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Coast track

Issues and Challenges in Coastal Management

Coastal zones are dynamic interfaces between land and water and are common locations of high-density development. Coasts are subjected to frequent natural hazards; including flooding, storm impacts, coastal erosion, and tsunami inundation. It is however, constantly adjusting to changes in wave and tide processes and sediment supply. As a result, the position of the coastline advances and retreats. This is a natural and expected process on sandy shorelines.

Coastal managers are frequently faced with serious erosion of sandy coasts. Although possible causes of erosion could be natural processes (i.e. action of waves, tides, currents, sea level rise, etc.), human impacts (i.e. sand mining and coastal engineering works) overwhelmingly contribute to shoreline changes. Countermeasures for coastal erosion control function depend on coastal geomorphology, coastal processes and sediment transport. As an immediate solution to prevent coastal erosion, hard coastal protection structures such as ripraps, seawalls, groynes and breakwaters are used extensively. In modern times, artificial reef structures are increasingly utilized as submerged breakwaters, providing wave attenuation for shoreline erosion control plus habitat enhancement.

Geosynthetic turf reinforcement mats or Geotubes, provide a low-cost alternative to hard armor on eroding critical areas and are effective bioengineering systems for shoreline stabilization. This issue of ***Coast track*** provides an overview of the various available methods for shore stabilization and coastal erosion control, with special emphasis on the alternative solutions, novel materials and systems, and various design implementations in Indian coasts.

Editor

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Cover Design & Layout
S.A.Swamynathan
Senior Programme Officer

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Srikals Graphics
Chennai

CONTACT

Prof. R. Ramesh
Director
Institute for Ocean Management
Anna University Chennai
Chennai - 600025 INDIA

Phone : + 91 44 2230 0108
2220 0159
2220 3408
Fax : + 91 44 2220 0158
Email : iom@envis.nic.in
rramesh_au@yahoo.com
ramesh@annauniv.edu

Important websites

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ARTIFICIAL REEFS

AHANA LAKSHMI, RAMESH R, PURVAJA R
Institute for Ocean Management, Anna University, Chennai

WHAT IS A REEF?

The term 'reef' is used to describe any structure, usually naturally formed, lying beneath the surface of water. Some are formed because of rocks or sand that gets aggregated over time. The best known, of course, are the natural assemblages - coral reefs and oyster reefs that have developed over long periods of time. Over time, such a reef, especially a coral reef, develops into a complex ecosystem because of the creation of a large number of niches that can be occupied by a variety of animals. What is interesting is that all major taxonomic levels are present – from single celled algae to varieties of invertebrates, fish, reptiles and mammals. In fact, coral reefs are referred to as the rainforests of the sea because of the high biodiversity that is found in such areas.

In addition to being rich in biodiversity, coral reefs are also important in the shoreline protection services they offer, especially from natural hazards. The calm lagoons inside reefs and behind mangroves are immediately evident on tropical coastlines but there is relatively little scientific data to show this. Reefs act as breakwaters and this important role is recognized by the importance accorded to the channels through them which allow safe passage to the lagoon and shore for fishing, navigation and recreational activities, particularly in bad weather. In the Gulf of Mannar, Tamil Nadu, the shore is protected by the reefs – the waves hit the reefs and subside in force before reaching the shore. This protective action is recognized in only a few places. For example, in Sri Lanka, after the 2004 Indian Ocean tsunami, it was found that at Hikkaduwa where a hotel is protected by coral reefs that the local communities nurture, there was relatively little damage and few deaths compared to the areas north where the reefs are considerably damaged especially due to coral mining. The mechanical processes that are involved in shore protection are complex but in general, the amount of energy dissipation also depends on the continuity of the reef.

ARTIFICIAL REEFS – THE CONCEPT

An artificial reef is a human-made underwater structure, typically built for the purpose of promoting marine life in areas of generally featureless bottom or where existing natural reefs have been destroyed. Artificial reefs may also serve to improve hydrodynamics for surfing or to control beach erosion. However, it as fish aggregating devices that artificial reefs have been extensively promoted.

ARTIFICIAL REEFS AS FISH AGGREGATING DEVICES

Experienced fishermen know that fish often flock near submerged objects such as rocks or even sunken shipwrecks on which marine plants and animals may grow or provide shelter for some fish and invertebrates. Shark hunters of Thuthoor, Kanyakumari, who fish along the entire Indian coast know locations of sunken ships and hook sharks and other fish from the waters around these wrecks.

The same principle is used in the construction of artificial reefs. Two approaches are possible: natural materials such as logs or other locally available material can be used where funding may be a problem. The second approach is to fabricate specially designed structures. Various materials ranging from concrete to plastic pipes have been used in the construction of artificial reefs – usually such structures are 'finished' with local materials such as bamboo and coir. While artificial reefs, in most case, are meant to serve as fish attracting or aggregating devices, in some cases they have been installed to prevent trawling and destruction of bottom habitat.

Artificial reefs have been listed as a special replicable technological model for rural application by the Department of Science and Technology, Government of India.

Benefits: The Artificial Reef/ Fish Aggregating Device (AR/FAD) offers the following benefits:

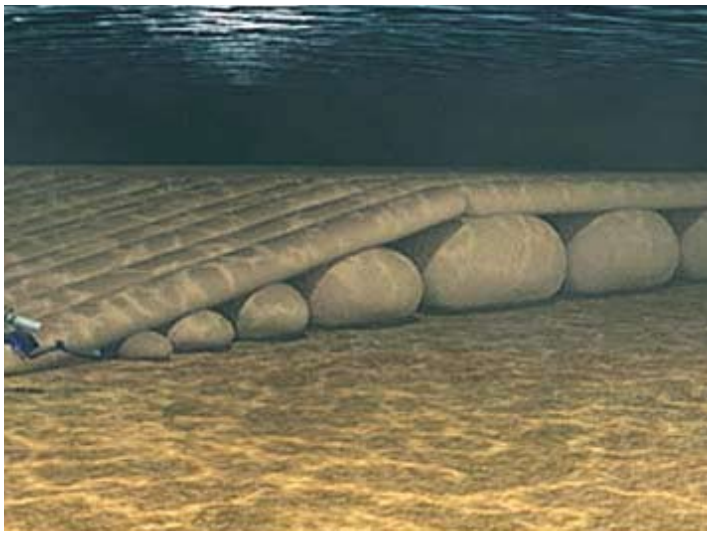
- Fishermen's catch, and thus income, increases by 50-150%.
- Minimises drudgery, searching time and hazards for fishermen.
- Increases variety of catch since different species of fish (including predatory fish and those from deeper waters) converge at the AR/FAD.
- Reduces fuel-consumption of mechanized fishing boats.
- Provides excellent environment and substratum for marine plant life and other organisms to proliferate thus producing further links in the food chain.
- Use of HDPE-based structure with concrete anchors and buoys make the AR/FAD long lasting and capable of aggregating fishes inhabiting all levels. Helps demarcate territorial waters for traditional fishermen and assists in enforcing the Marine Fishing Regulation Act.

Science for Equity, Empowerment and Development (SEED) Division, DST
http://www.scienceandsociety-dst.org/agriculture.htm

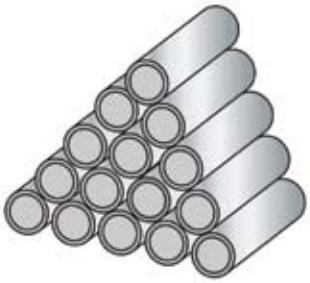
THE INDIAN EXPERIENCE

In the Trivandrum Kanyakumari coast, artificial reefs were first laid out in the late 80s and early 90s. In Thumba, Kannanthura and Puthiyathura villages, triangular concrete modules were laid at a depth of 12 to 14 fathoms, and in Adimalathura, bamboo modules were used at 14 fathoms, with financial and technical support from the Trivandrum based Programme for Community Organisation (PCO). In Puthiiyathura, the modules were laid out near a natural reef so it could help regenerate the reef. Between 1988 to 1994, artificial fish habitats were laid in a number of villages in Trivandrum – Marianad, Thumba, Kannanthura, Valiathura, Adimalathura, Puthiyathura, Paruthiyoor and Kollemcode.

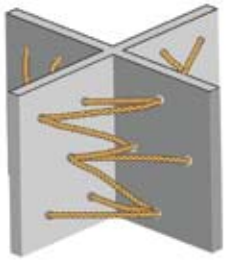
In Kanyakumari, despite the coastline having a number of rock outcrops, fishermen have been laying artificial reefs. In Mulloorthara and Enayam, reefs were laid out under financial and technical assistance from SIFFS, an NGO that also played a major role in laying reefs with common ownership in the Trivandrum area[1].



[1]TRINet Newsletter, December 2010: http://www.trinet.in/?q=node/648



PIPES (KEEP THE ENDS OPEN)



FERRO CEMENT AND COIR

STACKING

MIXING (EG. COCONUT STUMPS BOULDERS AND WELL RINGS)

ARTIFICIAL REEFS AS COASTAL PROTECTION STRUCTURES

Artificial surfing reefs have been created for surfing, coastal protection, habitat enhancement and coastal research. The world's first attempt was made in El Segundo, near Los Angeles, in California. Subsequently, attempts were made off the coast of Western Australia and in other places around the world such as Bournemouth, England. These reefs generally resemble 'submerged breakwaters". The idea is that they dissipate wave energy and thus make swimming and surfing safer. They are less intrusive on the coastal landscape.

- The world's largest artificial reef was created by the purposeful sinking of the aircraft carrier USS Oriskany off the coast of Pensacola, Florida, in 2006
- The second-largest artificial reef will be the USNS Hoyt S. Vandenberg, a former World War II era troop transport that served as a spacecraft tracking ship after the war.

ARTIFICIAL REEFS[2]

Appropriate locations	Exposed dunes of high ecological and landscape value.
Effectiveness	Causes lee side accretion, but least effective during storm surge conditions. Unlimited structure life.
Benefits	Natural processes are only partly disrupted, allowing dunes to stabilise. Rocks create new intertidal habitat.
Problems	May cause navigation hazard. Visually intrusive at low tide. Disrupt amenity use of beach.

Many of the artificial reef structures are designed using concrete, HDPE and geosystems, and are often patented – such as reefballs and aquareef. For example, off the Dominican coast, the technology of 'reef ball' was used. These are a collection of mound shaped hollow structures about 1.2m tall, 1.5m at the base and weighing close to 2000kg installed at depths of 1.2-2.0m so that the structures were well below

[2] Coastal and Sea Erosion, http://saarc-sdmc.nic.in/pdf/coastel.pdf

the mean water level of that area[3]. Soon after the installation, the shoreline was hit by hurricanes but the reef balls were not damaged. It was found that there was a significant increase in beach width and elevation along the project shoreline. Geosystems are another major group where geotextile systems such as bags or mattresses or tubes or other specially designed containers are filled with sand or mortar and have gained popularity in recent years because of their simplicity in placement and constructability.

A geotextile is defined as any permeable textile material that is used with foundation, soil, rock, earth, etc to increase stability and decrease wind and water erosion. Geotextiles have been around for hundreds of years – they used to be made of natural fibres, fabrics or vegetation, and were used mainly to stabilize roads especially on unstable soil. Today, they are usually made from polypropylene or polyester.

THE INDIAN EXPERIENCE

Geotextiles to address coastal erosion issues have been tried in many places in India such as Goa and Puri, and most recently in Kerala. The 110-metre long reef is located about 100m away from the shoreline at Kovalam. Geo-textile bags measuring about 30m in breadth and filled with sand were stacked on the seabed to build the 'soft reef' and was commissioned in May 2010. The reef was built using funds allocated for tsunami rehabilitation and became the cause of a lot of friction in the local coastal communities as it was the tourism potential that was targeted in this case. According to NGOs such as KSMTF and Tourism Concern, the fishing communities said that their shore seine nets were yielding damaged portions of the artificial reef rather than the fish. However, according to the company (ASR), "halfway through monsoon season, Kovalam Multi-Purpose Reef is working to protect Lighthouse Beach in Kovalam, India. The visual

Individual Reef Ball *(Source: http://www.artificialreefs.org/Photogallery/qatarnew/negative0021.jpg)*

[3] Harris, Lee E. Artificial Reef Structures for Shoreline Stabilization and Habitat Enhancement. Proceedings of the 3rd International Surfing Reef Symposium, Raglan, New Zealand, June 22-25, 2003. p176-178

results are encouraging and consistent with ASR's modeled beach salient predictions[4]".

A similar problem has been noted in Goa as well where floating debris is supposed to have damaged the geotube[5]. It is important to take cognizance of these shortcomings while designing and positioning the geotube structures. In addition, the actual understanding of the functional design of these structures needs further improvement but may be just adequate for these structures to be considered as serious alternatives for coastal protection . A Rs.223-crore sustainable coastal protection and management programme funded by Asian Development Bank (ADB) is being implemented in Ullal, Karnataka. Approximately 70 such reefs will be placed in Ullal in about 200 metre area in a 'V' shape. The reefs break sea waves taller than a particular height, letting only low intensity ones to pass through. Sources also said that ASR Limited, a New Zealand-based marine consulting and research company providing environmental, engineering and advanced computer modelling expertise across Asia-pacific, Europe and America, has been appointed as consultants. The work on "Ullal coastal erosion and inlet improvement sub project" is expected to begin by December or January 2011 and it is expected to be completed by 2013-14. In the second phase, works on other erosion-prone areas like Mukka-Sasihithlu (DK), Paduvari (Udupi), Devbagh and Pavinkuruve (Uttara Kannada) will be taken up[6].

CONCLUSIONS

While there are a number of studies on the biodiversity related aspects of artificial reefs, only a few have investigated the hydraulic or engineering aspects of artificial reefs . It has been found that processes governing shoreline response to submerged structures, such as artificial surfing reefs, are different from those associated with emergent offshore breakwaters. Unlike the case of emergent offshore breakwaters, where shoreline accretion (salient development) is expected under all structural/environmental conditions, the principal mode of shoreline response to submerged structures can vary between erosive and accretive, depending on the offshore distance to the structure . In addition, artificial reefs that are supposed to serve multiple purposes need to be evaluated carefully for their environmental as well as social impacts before a decision is taken about their placement.

[4] ASR. Kovalam Multi-Purpose Reef Update, July 2010. http://blog.asrltd.com/home/2010/7/28/kovalam-multi-purpose-reef-update-july-2010.html [5] Hegde, A.V., 2010. Coastal Erosion and Mitigation Methods – Global State of Art. Indian Journal of Geo-Marine Sciences, 39(4): 521-530

[6] Ronald Anil Fernandes, 2010. Artificial reefs to protect coast. http://www.deccanherald.com/content/110917/artificial-reefs-protect-coast.html Nov 7, 2010.

ARTIFICIAL REEFS FOR THE BETTERMENT OF FISHERIES LIVELIHOOD - THE TAMILNADU EXPERIENCE

Dr. H. MOHAMAD KASIM
Former Principal Scientist, Madras Research Centre of C.M.F.R.I., Chennai – 600 028

It is a well established fact that most of the fishery resources of the inshore waters are exposed to higher fishing pressure, since almost 90% of the fishing effort is being spent in these waters along the Indian coasts and Tamil Nadu is not an exception to this. Further, Tamil Nadu being one of the oldest maritime states with long history of fishing expertise, has aptly come with the mitigation measures such as the reconstruction of the ecosystem with an aim to increase the biological production of the inshore waters. One of the options under this is to install a series of artificial reefs along the coast to increase the complexity of ecological niche, thereby providing adequate space for various marine organisms to settle and thrive on well on the bottom floor. This will improve the population of other living resources mostly various fishery resources which occupy the higher level in the food web and lead to an increase in fish production from these areas.

CONCEPT

Biological production in the sea is three-dimensional and is different from that on land, which is only two-dimensional. In addition to length and breadth the third dimension height is also added to increase the

total spread area for enhancing various biological activities such as settlement of sedentary flora and fauna, which in turn attract many visitors either for feeding or resting in the shelter. When artificial reef modules are provided with complexity of holes and crevices, in course of time some of the visitors become residents and start living in the artificial reef itself. The artificial reef gradually matures into a full-fledged ecosystem supporting these residents by providing feeding, breeding and nursery grounds, all in one place. This naturally leads to the enhancement of the biological resources in area where the artificial reef is deployed.

TRADITIONAL ARTIFICIAL FISH HABITATS

The concept of artificial reef is very old as indicated by the fact that way back in 1924, Hornell first described the traditional artificial fish habitats on the Coromandel coast. The traditional practices of dumping the branches of trees weighted with rocks as anchors referred to as Mullam in Tamil, and the coconut fronds, tied at 1 m intervals along a rope, like a bottle-brush, suspended from a float and anchored to the sea bed with a weight, called Kambi in Tamil are still in vogue in some parts of the coasts of Tamil Nadu, where fishery with hooks and line is prevalent. They serve as a Fish Aggregating Device (FADs) and they are fished using four catamarans from four corners, using a square lift-net (bag net) Mada valai or Ida valai in Tamil. These simple structures are rather temporary, serving for a short period of about three months.

Tamil Nadu's fishermen have an amazing traditional knowledge and experience on artificial reefs and fish aggregating devices. Time tested and panchayat approved traditional system called Seppaadu, wherein specified areas of the coastal waters are traditionally used, for installing artificial fish habitats, by specified fishing families of the nearest village is being practiced even now. The reef material extensively used are the trees and branches of the Tiger bean Delonix elata called Konnu maram or Vadanarayana maram in Tamil. Customary belief of the fishermen is that the bark of this tree emits a sour smell when it rots in the seawater and this acts as a fish-attractant. This is supported by a report that the chemical analysis of this bark yielded amino acid L-asparagine, aspartic acid and sucrose acetate, which are known to be fish-attractants. It is amazing to know that the fishermen knew through experience

that the rocky reefs called Paarai in Tamil, and slushy or muddy areas called Cheru in coastal waters are biologically and fisheries-wise more productive than barren sandy area called Tharai in Tamil. Further, they know well that the vegetative reef materials used by them are bio-degradable and are eco-friendly. One of the limitations is that these materials are short-lived, warranting recurring costs for the poor fishermen.

MODERNIZATION

Moving from the traditional materials such as tree logs and fronds, fishermen subsequently deployed different types of scrap materials like old car tyres, well rings, cement hollow blocks, etc.,as artificial reefs. However, these were either carried away by the water currents or displaced by the trawl operations. Hence there arose the need to create more permanent structure.

Prof. Sanjeeva Raj of Madras Christian College has described how the fishermen of Neelankarai, a fishing hamlet on the south of Chennai, deployed 150 concrete well rings of about 60 cm in diameter and 30 cm in height, skillfully laid down to the sea floor along two polythene ropes, as beads on strings, to a depth of about 20 to 25 m, two km away from the shore, calling it as the technology of the Modern Artificial Reefs (Naveena mullom). The well rings formed a rough pyramid, with a circular base of about 4 m in diameter, and about 1.5 m in height at the apex. It is reported that the reef continued to exist even 7 years after deployment yielding heavy catches, proving that the older the reef, the more productive it becomes.

RECENT EXPERIENCES

Deployment of artificial reefs at eleven sites along the coasts of six maritime districts of Tamil Nadu and monitoring those habitats was entrusted with CMFRI during 2006-2009 by the Fisheries Department of the Government of Tamil Nadu. CMFRI has successfully implemented the project with active participation of the fishermen and the impact of the artificial reefs on various aspects such as the maturation process of the reefs by underwater videography, the improvement in the fish catch for the reef areas, socio-economic betterment etc., were also studied in detail for the first time in India. Participatory Learning Action Network and Training (PLANT) a Non Government Organisation, working for the socio-economic betterment of the fishermen community along the Tamil Nadu coast has deployed three artificial reefs in Pulicat area and three more at different places under the technical supervision of the author. The first one was off Sathankuppam with the funding from Ford Foundation under the co-ordination of Covenant Centre for Development, Madurai. The second one is off Vairavankuppam with funding from Chennai Water Desalination Limited located at nearby Minjur. The third one is at Light house kuppam with the funding by Fisheries Department, Government of Tamil Nadu under the technical guidance of Central Marine Fisheries Research Institute. Three more artificial reefs were deployed by PLANT under the technical guidance of the author

with funding by TN Fisheries Department through CMFRI, at Chinna Neelankarai, Mallipattinam and Arockiapuram. While the fabrication and deployment of artificial reefs by the Tamil Nadu Fisheries Department was out sourced to private contractors, PLANT was guided by CMFRI to fabricate and deploy the artificial reef structures with the active participation of the fishermen at the four sites where the artificial reefs were deployed under the funding of Fisheries Department. The objectives were to increase the surface area of the sea bottom to enhance settlement of sessile organisms and in turn increase the biodiversity. Now the artificial reef areas are found to be the suitable site for the breeding of many colourful ornamental fishes and some of the large sized fishes. The site also provides an alternative fishing ground for the fishermen at all times by enhancing fish production. This will improve the socio-economic conditions of the fishers.

SPECIES SUCCESSION AND FISH ASSEMBLAGE

After 1 year of deployment the quantity of settlement of the flora and fauna has increased manifold in thickness. Standing stock biomass of sessile epibenthos from artificial reefs in Vellapatti and Vembar was 2,468 to 3,919 g/m² on horizontal surfaces and 4,218 to 7,726 g/m² on vertical surfaces. An average sessile biomass was estimated to be 1,838 g/m² on the exposed outside surface of concrete reef structures and 3,318 g/m² on the protected interior of the reef structure along the Palk bay and Bay of Bengal. Owing to this, the reef structures seem to have attained the appearance and functional ability of a natural reef. The abundance of small and big fishes has increased. Big sized fishes like diagramma, a variety of grouper, sea bass, rock cods, snappers and a large variety of carangids have been found to occur in a number of groups. Sea anemones, sea cucumbers, starfishes, chanks and clams were found to be in good abundance. The artificial reef structures have transformed into a suitable environment for breeding and egg laying of squid, cuttlefish and a variety of finfish. The polyps of the soft and hard corals have started settling gradually one after another in this favourable environment.

SOCIO-ECONOMIC BENEFITS

The study on the socio-economic status of the fishermen of the beneficiary villages revealed that the fishermen conducted fishing always with hooks and line in most of the places and they used gillnets also to a considerable extent. A variety of fishes such as big sized carangids, groupers, rock cods, snappers, diagramma, seer fish, seabass, barracuda, crabs, prawns, lobsters, squids and cuttlefishes were caught in good quality. Assured fish catch from the artificial reef areas even during the lean fishing season in Chinnandikuppam near Chennai has socially helped to wean them away from the practice of rice brewing, a crude method of liquor preparation by a few fishermen as an alternative income source, which often resulted in petty quarrels and resultant law and order problem in the fishing village.

The Sathankuppam fishermen have maintained the details of fish catch from the artificial reef area and the revenue realised was nearly Rs.9,00,000 during the first year after the deployment indicating that the payback period is less than one year as the cost of the reef was only Rs.5 lakhs. On an average 206.9 t of fish were caught from a single artificial reef out of the 11 artificial reef deployed in addition to an estimated annual average catch of 1548.1 t from the non-artificial reef areas of the fishing village. The hooks & line contribution was 70.65 t and the rest 136.25 t by gillnets from the reef area. Annual average gross income was Rs.110.45 lakhs and the net income was Rs. 98.9 lakh after deducting the operational cost, opportunistic cost, depreciation of craft, gear and the artificial reef structures (11.55 lakhs per annum) from the gross income.

It is quite possible to realize a high net income as the resource enhancement in the artificial reef area is reported to be 23 times to as high as 4000 time at different locations all over the world. Since the whole community is participating in installing the artificial reef, the entire community has the right to fish at the reefs through custom evolved fishing practice. This incidentally strengthens the community to build up the solidarity of the fishing village community, without any disparity between the richer and poorer fishermen, within the village. The fringe benefit for the traditional fishermen is that the artificial reefs may help to prevent the operation of mechanised trawlers in the area where the artificial reef structures are deployed and this will minimize the long-standing enmity between traditional fishermen and mechanised trawler operators in sharing the fishing ground.

PALK BAY EXPERIENCE

The traditional fishermen of Sethubava Chathiram and the adjacent fishing villages could harvest, on an average, 1 or 1.5kg of prawns from their "Kalamkatti valai", a type of fixed bag net operated in the shallow waters to catch fish and prawn by taking advantage of the tidal action. After the deployment of the artificial reefs at 3 sites namely, Vallavanpattinam and Kollikkadu in Thanjavur district and Eripurakkarai in Nagapattiman district, all located adjacent to each other, the prawn catch gradually increased to as high as 6 kg per net per operation. The income generation among the traditional fishermen along this coast increased fourfold after the artificial reefs deployment in this area.

CONFLICT REDUCTION

In Thanjavur district, the mechanised trawl fishermen of Palk Bay vehemently opposed the deployment of artificial reef in the near shore waters off Vallavanpattinam, Kollukkadu and Eripurakkarai as the reef structure was seen to be an impediment for the operation of pair trawls. However, the traditional fishermen wanted the reefs to be deployed in the near shore waters. This conflict was brought to the District Collector for redressal and it was resolved by the Revenue Divisional Officer who presided over the hearing that the reefs to be deployed at the sites to be identified by the mechanised trawl operators. After the establishment of the artificial reefs, the mechanised trawlers started fishing very close to the reefs on the seaward side and some operated their trawl nets on top of the reefs like a pelagic trawl by shortening the warp rope and increasing the trawl speed to harvest the schools of fish hovering on top of the reefs. Consequently, when the fourth reef was to be deployed from the Machilipattinam , the mechanised trawl operators volunteered and deployed the reef structures at the site selected by the SCUBA divers of CMFRI and this clearly indicates that the mechanised trawl fishermen also benefitted from the artificial reefs of the nearby waters.

BENEFITS OF ARTIFICIAL REEF

The benefits of artificial reefs are the availability of fish at all times day and night. The fish are of high quality and very fresh as the fish are caught mostly by hooks and line and gillnets and the journey time to and from the fishing ground is very short. The short distance to the fishing ground in the reef area helps the fishermen to save fuel and journey time. The reduction in the fuel consumption indirectly helps to fight global warming through a humble reduction in emission. Fishermen without motorized craft also can reach the fishing ground with the help of sail or oars. Reefs reduce or prevent bottom trawling in the area and almost serve as a mini Marine Protected Area. They help in the restoration of the ecosystem through rejuvenation of the flora and fauna of the area concerned. Economic returns are excellent and lead to an improvement in the socio economic conditions of the fishermen community. By all means artificial reef is an excellent intervention for better conservation and enhancement of our biological resource in general and fishery resources in particular.

Laying the artificial reef at Kovalam - Preparation of Geomat

Moving the Geomat to the location

Geomat placement

Geomat placement and filling

Filled bags of sections A & B and section C geomat

Images are courtesy of the author

Aerial view of the reef

Underwater view of the filled bags

Kovalam multi-purpose reef

The multipurpose artificial reef installed off the beach here has emerged as an innovative form of coastal protection, helping to improve the tourist potential of the State.

The reef has demonstrated its potential to protect the severely eroding coast from the waves unleashed by the monsoon. Resort owners and hoteliers are excited at the prospect of an extended tourist season.

Installed between the lighthouse and the Edakkal rocks off the beach, the reef has been able to protect the beach by mimicking natural reef structures and working in concert with nature.

Being off-shore and submerged, there is no visual impact. Within months, the reef has been able to stabilise the famed beach and make it wider on the lighthouse side by cushioning the impact of the waves.

Kovalam Multi-Purpose Reef continues to show encouraging results during monsoon season as predicted by sediment transport modeling. Demonstrating that Multi-Purpose Reefs provide substantial coastal erosion prevention.

Kovalam Multi-Purpose Reef is an innovative solution for coastal protection and the beach retreat problems experienced in India. Thirty percent of India's mainland population lives on the coast and relies on the health and security of the coastal environment. In Kerala, some 600 km of coastline is encased by 400 km of rock walls, leading to accelerated beach retreat.

Multi-Purpose Reefs have the following benefits

- Protect the coast by dissipating wave energy
- Provide marine habitat
- Create a recreational amenity
- Promote socioeconomic prosperity

Source:http://blog.asrltd.com/home/tag/kovalam-multi-purpose-reef

TIDBITS

Indian Navy ship to be immortalised as artificial reef

New Delhi, July 8 (IANS) A decommissioned Indian Navy ship has become part of an environmental project to showcase the country's marine life - offering adventure tourists opportunities for underwater tours of the vessel. The ship, which has been sunk off the Karnataka coast in the Arabian sea, will serve as an artificial reef and over time become a natural home to weeds, sea plants, fishes and other creatures of the sea.

The ship, Seaward Defence Boat T-54, had guarded the country's maritime borders for 23 years from the time it was commissioned in September 1982.

The 162-tonne vessel, also known as 'The Ever Vigilant', was sunk off Karwar Port Jan 30. Prior to this, it was brought for "final preparations" to Karwar, where the Indian Navy is developing a major base.

The electrical wiring and the communication system were removed from the ship and traces of oil cleaned from the fuel tanks. The ship was then towed out, mines were fitted on the vessel and detonated, causing it to sink.

"The mines exploded and sea water rushed into the compartmets. After two blasts, the ship started sinking slowly - stern first and then the bow," an official said.

A survey conducted by a diver revealed the vessel was nestled on the seabed.

The area has initially been opened to professional divers as the underwater visibility has to improve to about six metres before it is possible to view the ship from glass-bottomed boats. The ship will also promote scuba diving as a sport.

Being a first of its kind of project for the Indian Navy, a lot of deliberation had gone into the identification of the site, and the planning and execution of the project. "The weapon systems and most of the ship's machinery were removed after it was decommissioned. For the project, relevant parts of the ship which had to be cut away to give access were carefully photographed and demarcated," an official said describing the preparations before the ship was sunk.

"Moreover, in view of the strict naval guidelines for dismantling and cleaning the ship, all potential contaminants that could adversely effect marine life were removed to make T-54 as environmentally safe as possible," the official added.

Source: http://www.thaindian.com/newsportal/uncategorized/indian-navy-ship-to-be-immortalised-as-artificial-reef_10068912.html#ixzz1JaVrvWQ4

Shipwreck as an artificial reef and its comparison with natural reef from, Car Nicobar Island, India

Yogesh Kumar, J.S. [1] and Raghunathan, C. [2]

[1] JRF
[2] Officer In-Charge

Zoological Survey of India, Andaman and Nicobar Regional Centre, Port Blair, Andaman and Nicobar Islands

ABSTRACT

Coral reefs are one of the most ancient and dynamic ecosystem of the world. It provides

sanctuary to a myriad of marine life and protecting the coastline from erosion. But nowadays destruction of marine environments caused by human and natural reasons has been made fishing activities unsuccessful. The main reason for this is the sharp decline in the stocks, and catch trend is also declining fast. Keeping this in mind many countries have started establishment of artificial reefs. Scientists believe that, artificial reefs have positive effects on stocks and sea production. Additional benefits can include the local increase in species diversity and abundance and enhance fisheries by the incorporation of specific habitat.

These functions also increase amenity in the form of a snorkeling, diving and fishing location. Present study was conducted on man-made submerged structures such as ship wreck (Malacca, Japan ship wreck, 09'10'88.3 N, 092'50'12.3 E). The ship was submerged 35 years before at Car Nicobar Island. The length, width and height of the ship are 48 m, 12 m and 8 m respectively, offering substrata for fouling organisms compared to natural reef of near by area (Parka, 09'11'08.4 N, 092'49'85.1E). The whole ship wreck is considered as an artificial reef which includes corals, fishes and other fauna. Artificial reefs have been suggested as a tool for reef conservation and rehabilitation. Although successions of artificial reef communities have been thoroughly studied, using Line and Belt transect method to assess the composition of benthic organisms and understand the inter relationship between artificial reef and Natural reef. Live coral cover was recorded 18.75% in artificial reef and 23.8 % in nearby natural reef. Abundances of fish and associated organisms recorded high in artificial reef (28.13%) compared to natural reef (6.9 %) as it provides more shelter area to them.

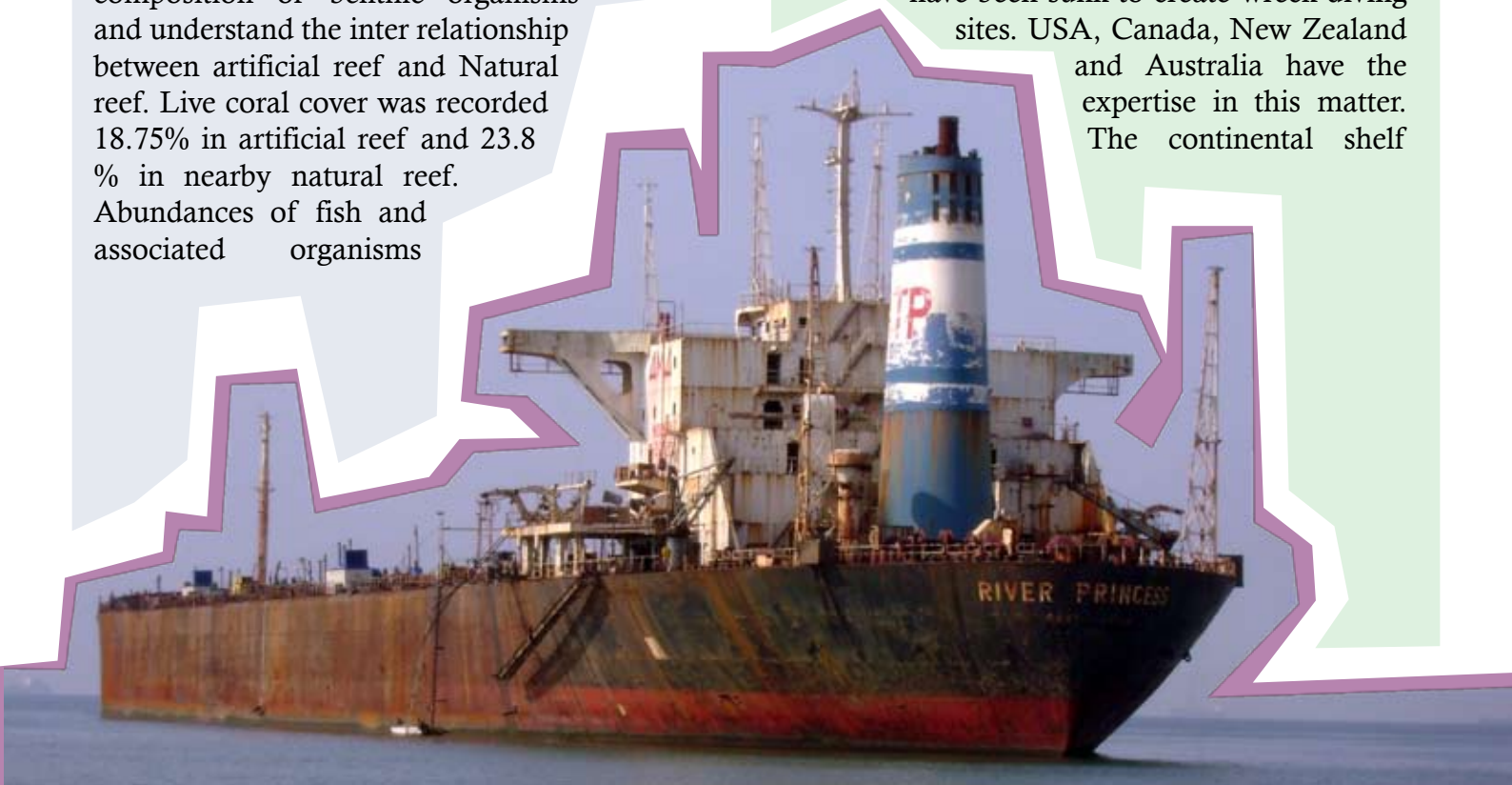
Source:http://tiecon2011.indianscholars.org/2011/02/shipwreck-as-an-artificial-reef-and-its-comparison-with-natural-reef-from-car-nicobar-island-india/

Creating Artificial Reef by Sinking 'River Princess'

By Dr. Nandkumar M Kamat

When there is a problem, there also comes an opportunity. The government is soon going to waste massive public funds - almost Rs 100 crore - in removal of the drifted vessel M/V River Princess. The amount is several times the total budget of the tourism department and at least hundred times the income of the Candolim panchayat. For a smaller amount Candolim could have got Goa's best underground sewerage system.

The grounded merchant shipping vessel, River Princess presents an opportunity for the fisheries and tourism departments of the Government of Goa, scuba divers and Indian Navy. It is a win-win situation. Since 1970 at least 30 ships have been sunk to create wreck diving sites. USA, Canada, New Zealand and Australia have the expertise in this matter. The continental shelf



near Goa is like a smooth plateau. The grounded River Princess is at sea level. These are very shallow waters. The real sea begins only one km away from the ship. If we draw an east-west straight line from the site of the River Princess then it is only at a distance of 20 to 30 kms that we see the depth of the sea slowly increasing. That's where River Princess should be entombed, on a smooth, gentle continental shelf - at a depth of 60-100 metres at least. It would turn into a paradise for divers and for underwater ecotourism.

Many years ago a ship had sunk in the middle of the Siridao bay. It has created an artificial reef where fish are found in plentiful according to fishermen of Nauxe, Cancra and Odxel. USS Spiegel Grove - an 11000 MT ship - was deliberately sunk in Florida to create an artificial reef for divers. Fishermen and NGOs in Kerala have shown the way to creating artificial reefs - where fishes are attracted - by sinking all types of objects. These small reefs near Thumba are artificial underwater habitats for fish. It would cost much less to drag the 'River Princess', emptied of all potential hazardous materials, and sink it at a depth of 60 to 100 metres, at a distance of 15 to 25 kms from the Candolim coast.

That would create a new artificial underwater ecosystem. Instead of the proposal to dump the pieces cut from the ship on land, it is better to dump these in a computer aided pre designed underwater formation to create a novel habitat for marine life. That's the solution.

The only problem is getting rid of all toxic elements like PVC, oil, grease, etc. This is not difficult. Compared to the meagre scrap value of these pieces - the ecosystem value would be several fold and sustainable over the years. Actually this condition should have been factored in by the government before framing the objectives for the contractor. Even now it is not very late. As per the present proposal, dragging large pieces of the ship on to beach and then piling these on the ground after transportation on narrow village roads would be a public and environmental nuisance. Therefore lifting and towing these pieces with heavy ship lifts, systematically, one-by-one, to a predetermined, well researched, benign spot on the continental shelf for submergence would be the most practical and beneficial idea. Computers and satellites with GPS today help in doing such tasks and the governments of the above mentioned countries would always give a helping hand.

I have put forward this proposal to the Governor at a recent meeting of the Goa State Environmental Protection Council where the issue of the 'River Princess' came up.

Why does the 'River Princess' need to be removed from the Candolim waters?

The first reason is that it is an artefact; it does not belong to the beachscape and seascape and therefore needs to be removed. The second reason is that it is an eyesore that is aesthetically polluting. It looks odd - like a linear mega version of Dr Subodh Kerkar's beach installations. Third reason is that it is allegedly causing beach erosion. However, satellite images show expansion of the beach between 2003 and 2010. In April 2010 satellite images show a mini triangular shoal formation. It corresponds with the angle of the ship to the beach. The fourth reason is that the River Princess, if not towed away, may break and all the junk could pollute the beach. This is possible, but it would be a slow process if the ship gets stabilised with heavy sand deposition. After its removal, if the erosion of the Candolim Beach continues then what would happen? How would that be explained? Wasn't the ship acting like a buffer - a giant linear metallic tetrapod? The bitter truth is that the Baga-Candolim-Sinquerim beach stretch is not being nourished anymore from natural, normal sediment transport from the Baga and Nerul rivers. Both these rivers show clogging of the channel and interference in their smooth flow. Slightly higher tidal amplitude at Baga some days back submerged a large part of the beach because the natural drainage has been compromised. By pointing fingers only towards the River Princess as the cause of beach erosion the hydrology of Baga and Nerul rivers would not be automatically restored.

There is another problem with the removal exercise of the large ship - the unpredictable weather conditions. It would be difficult to get normal weather for 150-180 days to tow or cut and tow away the ship. Heavy ship lifts, pumping the ballast tanks for re floatation may work depending on the weather conditions. Even if work orders are

issued this month, the contractors are likely to excuse themselves later on account of sudden development of extreme weather phenomena. The optimal period is between January and mid-April. None of the government departments have any experience for such kind of operations. The contractors may drop the operations if they sense public resistance to transport and storage of the pieces of the ship on land. Since these operations may take place during the peak tourist months there would be problems of logistics, and law and order.

So why not cut the costs, save time, save ecological and social impact on land and just dump the River Princess whole or in parts on the continental shelf of Goa in acceptably deep waters? Expertise of the abovementioned countries as well as ONGC engineers may help.

Former Gray's Reef Sanctuary Research Vessel Has Second Life as Home to Sea Creatures

A former Gray's Reef National Marine Sanctuary research ship sunk in 2007 off the Georgia coast as an artificial reef is now home to a diverse array of marine fish and invertebrates after only four months on the bottom, according to NOAA scientists. Researchers diving on the R/V Jane Yarn spotted large numbers of fish such as snappers, tomtates, sheepheads, scad, and sardines visiting the submerged vessel. The team also found soft corals and other invertebrates anchored to the ship.

"It is gratifying to see that fish in great numbers are already using the wreck for shelter," said Greg McFall, the sanctuary's research coordinator. "Gray's Reef scientists will continue to monitor the wreck to track numbers and types of fish that use the habitat."

The Jane Yarn was sunk in September 2007 at a site off the Georgia coast, outside of the Gray's Reef sanctuary, by the Georgia Department of Natural Resources (DNR). Since then, researchers have made periodic visits to the site to document the ship's colonization by fish and other marine creatures. The vessel, named for Georgia conservationist Jane Yarn, was donated to the DNR for use in its artificial reef program.

Located off the Georgia coast, Gray's Reef National Marine Sanctuary is one of the largest nearshore live-bottom reefs off the southeastern United States, covering approximately 23 square miles. Loggerhead sea turtles, a threatened species, use Gray's Reef for foraging and resting. The reef also is near the only known winter

calving ground for the highly endangered North Atlantic Right Whale. The sanctuary is managed by the NOAA National Marine Sanctuary Program.

The National Oceanic and Atmospheric Administration, an agency of the U.S. Commerce Department, is dedicated to enhancing economic security and national safety through the prediction and research of weather and climate-related events and information service delivery for transportation, and by providing environmental stewardship of our nation's coastal and marine resources. Through the emerging Global Earth Observation System of Systems (GEOSS), NOAA is working with its federal partners, more than 70 countries and the European Commission to develop a global monitoring network that is as integrated as the planet it observes, predicts, and protects.

Memorial reefs

What is an Eternal Reef?

An Eternal Reef combines a cremation urn, ash scattering and burial at sea into one meaningful permanent environmental tribute to life.

An Eternal Reefs "Memorial Reef" is a designed reef made of environmentally safe cast concrete that is used to create new marine habitats for fish and other forms of sea life. Eternal Reefs takes the cremated remains or "cremains" of an individual and incorporates them into an environmentally safe cement mixture designed to create artificial reef formations. The memorial reefs are taken to a curing area and then placed in the permitted ocean location selected by the individual, friend or family member.

For families and individuals that choose cremation rather than burial, Eternal Reefs offers a new memorial option that replaces cremation urns and ash scattering with a permanent environmental living legacy. Expected to last 500 years, over 300 Memorial Reefs have been placed off the coasts of Florida, South Carolina, North Carolina, Maryland, New Jersey, Texas and Virginia.
Source: http://www.eternalreefs.com/reefs/reefs.html

Reef Balls as Submerged Breakwaters or for Erosion Control

Red Mangroves are often planted along shorelines because they make excellent fishery habitats and can help stabilize a shoreline from erosion. However, it is difficult to impossible to plant red mangrove seedlings in areas with a firm bottom. Even with softer bottoms, smaller plants my be difficult to hold in place against wave forces before they establish themselves enough to survive. Therefore, Reef Balls can be used as the "pot" into which red mangroves are planted. They can be arranged much like a submerged breakwater to immediately begin protecting the shoreline while waiting for even better stabilization after the red mangroves start sending out protective prop roots. Over time, the burlap bag will bio-degrade and the Reef Ball will be left as additional fish habitat inside the "walking" roots of the mangroves. One can certainly use common methods to plant red mangroves if conditions are right but Reef Balls offer a wider range of possible planting sites

and also avoids leaving plastic PVC pipes in the environment.
Source: http://www.reefbeach.com

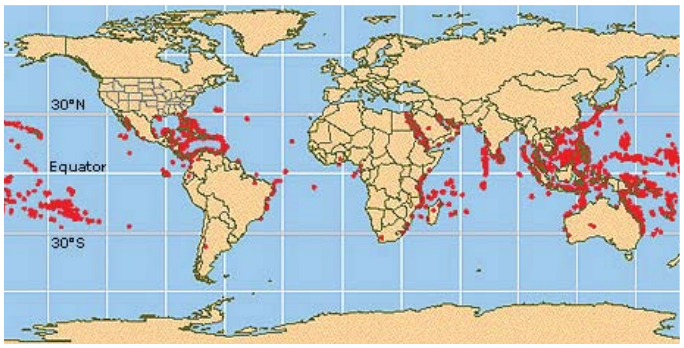
75 Percent of Coral Reefs Under Threat

New Analysis Released by the World Resources Institute

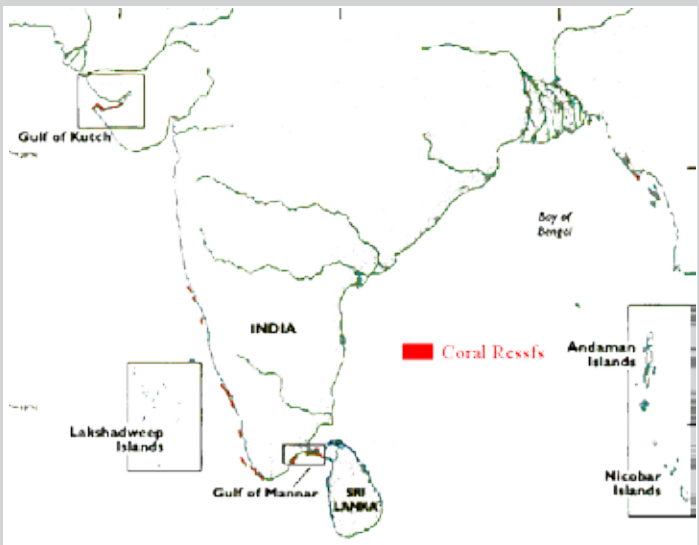
Seventy-five percent of the world's coral reefs are currently threatened by local and global pressures, according to a comprehensive analysis released by the World Resources Institute, along with the Nature Conservancy, the WorldFish Center, the International Coral Reef Action Network, Global Coral Reef Monitoring Network, the UNEP-World Conservation Monitoring Center, and a network of more than 25 partner organizations, including NOAA.

For the first time, the analysis includes threats from climate change, including warming seas and rising ocean acidification.

The most immediate and direct threats arise from local sources, which currently threaten more than 60% of coral reefs. Local threats include impacts from fishing, coastal development, and pollution. Left unchecked, the percent of threatened reefs will increase to more than 90% by 2030 and to nearly all reefs by 2050.
Source: http://oceanservice.noaa.gov/news/weeklynews/feb11/reefs-at-risk.html



Map showing world's coral reef distribution



Map showing India's coral reef distribution

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Ministry of Environment and Forests
Government of India,New Delhi

Facts & Figures

280,000
square kilometres (174,000 miles) - the total cover of the coral reefs

500
million people rely on coral reefs for their food and livelihoods

344,400
square kilometres (132,974 sq mi) - the area of world's largest coral reef system - The Great Barrier Reef, Australia

375
billion US$ is generated by coral reef products and services

25
percent of coral reefs provide home to all marine life and are among the world's most fragile and endangered ecosystems

100
number of countries where coral reefs are found

70
percent of world's coral reefs will be destroyed by 2050 if the present rate of destruction continues.

3000
individual reefs are found in The Great Barrier Reef - the world's largest coral reef system

44
percent of world's reef are already severely degraded

5 percent of world's coral reef is in India

7 rank held by India in world's fish production

15000
species contribute to the Marine biodiversity of India