MBAI
Marine Biological Association of India

Book of
# Abstracts & Success Stories

# COMAD 2018

## National Conference on Marine Debris

11th & 12th April 2018, Kochi, Kerala, India

# National Conference **on Marine Debris**

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**Book of Abstracts and Success stories**

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# Foreword

Marine debris has become a global problem with considerable threats to the habitat and to the functions of marine ecosystem. One of the first reports of large areas of plastics in the ocean has been by National Oceanic and Atmospheric Administration (NOAA) in 1988 about the Great Pacific Garbage patch or the Pacific trash vortex, where the density of litter is estimated as four numbers per cubic meter. Globally, this shocking information led to initiation of new research programs on marine litter and in India, the ICAR-CMFRI started an in house research program on this theme in 2007.Understanding the significance of this ecological problem which is purely a direct impact of anthropogenic activity, the Marine Biological Association of India decided to organise a National Conference on Marine Debris (COMAD 2018 ) with an aim to bring together researchers, planners, NGOs, entrepreneurs and local governing bodies working on this theme. Thus, this conference was planned with three main components- understand the research outputs, get first- hand information on the various activities carried out by the public to reduce or recycle non degradable waste generated at various levels and also to have an exhibition of eco-friendly activities and products which would help to reduce marine debris in the long run.

The response to all the three themes has been very encouraging. We have received about 50 research articles on themes ranging from micro-plastics to ghost nets and the same number of success stories which are actually details of the diverse activities carried out in different maritime states of the country to solve the issue of solid waste generated in the country. The section on success stories includes attempts by eco-clubs, individuals, schools, colleges, local governing bodies, district administrations, Institutions and NGOs.

Activities by some Panchayats like banning plastics in public functions and mechanisms to collect sold waste from households are really commendable. Similarly, the efforts put in by various groups to remove marine debris from the coastal waters is something which should be appreciated. The message from these success stories is that, this problem of increasing marine debris can be resolved. We have got success stories from almost all states and these leaders of clean campaign will be presenting their work in the conference.

It is well known that visuals such as photographs and videos are powerful tools of communication. In COMAD 2018, we have provided an opportunity for all across the nation to contribute to this theme through photographs and videos. Am very happy that we have received more than 300 photographs and nearly 25 videos. The MBAI will place these on the web site. It is really shocking to see the quantity of litter in the fishing ground and in the coastal ecosystem.

Though not as destructive and persistent as the non-degradable waste, the solid bio-waste has also emerged as a major problem in the recent years. Assessment on the water quality of coastal waters by Fishery Environment Management Division of ICAR-CMFRI have shown that there are patches of low dissolved oxygen, high ammonia and high Biological Oxygen Demand in several parts of the coastal waters were biodiversity is low. Apart from untreated industrial effluent, direct dumping of slaughter-house waste and fish waste packed in plastic covers in coastal waters adjacent to urban areas are responsible for such hot spots. So, in this compilation of success

stories, we have accepted and included efforts made by individuals and groups to reduce and recycle bio-waste.

It is hoped that the research findings on this theme included in this Book of Abstracts and success stories will be useful to all not only in India, but also in other developing nations.

Since its establishment in 1958, the Marine Biological Association of India has organised International and National seminars on topics of topical interest in marine biology. These were on Scombroid fishes (1962); Crustacea (1965); Mollusca (1968); Corals and Coral Reefs (1969); Indian Ocean and Adjacent Seas (1971); Coastal Aquaculture (1980); Endangered Marin Animals and Marine Parks (1985); Tropical Marine Living Resources (1988); Eco-friendly Mariculture Technologies (2000), Challenges in Marine Mammal Conservation and Research (CIMCAR-2011) and MECOS -Marine Ecosystems: Challenges and Opportunities (2009, 2013).

We are indebted to the sponsors who have supported the smooth conduct of this conference. The committee constituted for fund mobilization has tried their best to get sponsors for this event. A uniqueness of this conference is that we have not taken registration fee from the contributors of success stories and those who have submitted photographs and videos for competition. Hence the MBAI has actually taken up lot of financial commitment to bring together this diverse group of researchers, innovators and planners.

Personally, I thank all the committee chairs and their teams for tirelessly working to make this program a success. Special thanks are due to the editors of this book of abstracts and success stories, since they had to literally develop the story for several contributors who were not well versed in documenting their work. This was a herculean task and they were so committed that I place on record special appreciation.I also thank the Scientist-in-charges of CMFRI Regional and Research centres for trying to identify contributors to success stories.

There are also several new and innovative changes in this conference. We are not promoting any type of plastics in the conference and hence we have a wide range of eco-friendly items ranging from a jute based backdrop for the stage, canvas bags and so on. Actually it was the vision of Dr K Sunil Mohamed, Secretary MBAI, to avoid plastic posters and to put up digital posters and I gratefully acknowledge his relentless support since the program was planned. We hope these changes will act as trend setters for other conferences also thereby reducing the use of non-degradable items.

The support extended by Dr A Gopalakrishnan, Director CMFRI and President MBAI is deeply appreciated. The Executive committee members of MBAI including late Prof (Dr) NR Menon, former Vice –President of MBAI have given timely advices and have motivated the team to organise the event. On behalf of all the co-convenors, I place on record our gratitude for this support.

The present conference is the first of its kind in India and we hope that COMAD 2018 would bring out extensive developmental changes and there would be more active research on this theme as well as networking among different groups sharing their innovations and adopting and replicating the success stories across the country.

V. Kripa
Convenor COMAD 2018

# Contents

# LEAD SPEAKERS

# Adv. Afroz Shah

Adv.Afroz Shah is a practising lawyer / counsel at Bombay High court. He obtained LLM from Mumbai University with Gold Medal. He is an ocean lover, child of the environment and a beach cleaner. He is also a Special counsel for the Government of India at Bombay High court. He has been cleaning the beach, the ocean and the mangrove for the past 120 weeks along with volunteers. More than 12 million kgs of plastic and filth has been removed from the ocean and the beach till date. In Afroz's words "The cleaning will continue till the ocean is made plastic and filth free". He is also running awareness programme in schools, colleges, slums, commercial establishments; on how to handle plastic and to reduce the empathy to plastic. His activities of cleaning the ocean; he dubs it as "date with the ocean" and "connect with the environment". He is the first Indian recipient of the highest International environmental award by the UN Environment – "Champions of the Earth" for 2016; which is equivalent to Noble prize in the field of environment protection. Afroz Shah is also the recipient of "The Indian of the Year 2017" Award instituted by CNN-News 18. Shri Narendra Modi, the Hon'ble Prime Minister on "Mann Ki Baat" said "He is an inspiration for the entire country". Through his activities Afroz Shah gives a simple message to people that we must build our bond with the environment and the ocean and the water bodies.

# Shri. Ajay Venkataraman

Shri. Ajay Venkataraman currently works with the marine programme at the World Wildlife Fund for Nature–India, which is involved in work on quantifying the extent of and mitigating impacts of ghost nets and marine debris. At WWF, Ajay works on projects related to marine debris, elasmobranchs, marine protected areas and coral reef monitoring, among others. His primary interest lies in the removal of ghost gear through participation of fishing communities by giving incentives. During his Masters Programme at James Cook University, Australia, he created a mathematical model for estimating life history stages in snappers (Genus: Lutjanus) from video footage.

# Padma Sree Vasudevan Rajagopalan

Dr.Vasudevan Rajagopalan, a Padma Sree awardee in 2018, is known as the Plastic man of India. His ingenious idea of converting plastic waste into usable form of tar for road construction has caught the world's attention and he has shared this technology with the Government of India for free. Dr Vasudevan's innovation was patented in 2006 and it generated interest among civic bodies in the country and in Japan and China as well. It has since been used to build over 100,000 km of roads in at least 11 states, including Tamil Nadu.

Dr Vasudevan has several innovations to his credit. The corrosion-free rods and "plastone" blocks, a mixture of plastic and stone used for flooring is one among these. He received several awards for his work, including the Dr A.P.J. Abdul Kalam Memorial award for Innovation in Governance. His research was showcased on the television talk show 'Satyameva Jayate' as an innovative solution to the growing problem of plastic.

He obtained his Bachelor of Science degree and Masters degree from the Madras University in 1965 and 1967 respectively. He also earned his Ph.D from the same university in 1974. Later in 1975, he joined Thiagarajar College of Engineering as Lecturer and became Professor in 1998. Currently, he serves as the Dean and head of the Chemistry Department, Thiagarajar College of Engineering, Madurai, Tamil Nadu.

# Dr. E. V. Ramasamy

Dr. E.V Ramasamy is an expert on biodegradation, bioremediation and water quality. He contributes to science in his capacity as Associate Professor, Division of Environmental Biotechnology and Waste Management, School of Environmental Sciences, Mahatma Gandhi University, Kottayam, Kerala.

# Dr. J. R. Bhatt

Dr. J. R. Bhatt is an internationally known expert in marine science and climate issues. At present, he serves in the capacity of Advisor (Climate Change), Ministry of Environment, Forest and Climate Change, Government of India. He also acts as the Chair, Steering Committee, Asia Pacific Network for Global Climate Change Research. As the Director, Ministry of Environment and Forest, Government of India, he has handled many projects in the areas like coastal and marine biodiversity, mangroves, coral reefs, capacity building in taxonomy, traditional knowledge etc. He has represented the country in several International forums and has contributed to the preparation of relevant documents related to Environment especially marine ecosystems.

Dr Bhatt is the recipient of Indian National Science Academy (INSA) Medal and Award for young scientist in the year 1992. He has also received the Professor L.S.S. Kumar Memorial Award in 1992 instituted by Indian National Science Academy, New Delhi.

# Dr. V. Kripa

Dr V. Kripa, Principal Scientist, CMFRI is currently holding the charge of Head of Fishery Environment Management Division of the Institute. She joined Indian Council of Agricultural Research and was posted at the Central Marine Fisheries Research Institute in 1986. She has been awarded T.V.R. Pillai Foundation award (Team Member) for popularizing bivalve mariculture. Apart from this, has also won (as team) National Science Popularization awards, Vigyan Prasar award and the Beevar Bronze award for a short documentary on plastics in the oceans (Ocean or Plocean?). Presently, she is actively engaged in research on marine habitats, quantification and impacts of marine debris and climate change. Represented India for the IPCC meeting on Climate Change and Oceans held at Monaco in 2016. She is also associated with IPCC for review and preparation of IPCC reports.

# Dr. Saly N. Thomas

Dr. Saly. N. Thomas is Principal Scientist in the Central Institute of Fisheries Technology, Kochi, India. She took her M.Sc. in Industrial Fisheries and Ph.D. in Marine Sciences (Gillnets of Kerala) from Cochin University of Science and Technology, India. Joined Central Institute of Fisheries Technology, Cochin in 1986 and has 32 years of research experience in the field of Fisheries Science viz., fishing craft and gear materials, fishing gear technology and resource conservation. Currently working on projects in Fishing Technology with special focus on fishing gear materials, design optimization and selectivity of low energy fishing techniques- gill nets and stake nets (set bag nets), assessment of juvenile catch rates in fishing gears, optimization of fish harvesting systems for reservoirs etc. Recently completed a study on 'Assessment of food and gear loss from selected gillnets and trammel net fisheries of India' (FAO funded project). Undergone 'Advanced Training and Research in Fishing Gear Design & Testing' from Fisheries and Marine Institute of Memorial University of Newfoundland, Canada. She is a recipient of Jawaharlal Nehru Award for Outstanding PG Agricultural Research 2004 in Fisheries instituted by ICAR, New Delhi. Also a recipient of the 4th National Award 2014 (Runner up) in Technology Innovation in Petrochemicals and Downstream Plastic Processing Industry instituted by Ministry of Chemicals & Fertilizers, Govt. of India. Dr. Saly. N. Thomas is the Chairman of BIS Sectional Committee TXD 18, for standardizing and revising Indian Standards for Textile Materials for Marine / Fishing Purposes, Bureau of Indian Standards, Govt. of India and Chief Editor of the journal `Fishery Technology' for 5 years. She has more than 100 publications including 40 research papers in national and international journals to her credit.

# LEAD ARTICLES

# Marine Debris - A threat to sustainable fisheries

**V. Kripa**

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One of the major threats faced by fishermen operating their fishing gears in coastal waters of India is the alarming influx of litter in the fishing area. There are about 4 million fishermen spread across 3288 fishing villages. Of the 1.9 lakh fishing crafts, 36.7% are motorised and 26% are non-motorised. Though the Indian EEZ is spread to an area of 1,629,607 $km^2$, major fishing takes place in the inshore waters (total area-225,029 $km^2$) and in the continental shelf (total area-393,527 $km^2$). There are different types of fishing craft and gear combinations and among these the most affected by marine debris is the bag type of fishing gears and the trawlers. Most coastal villages and urban cities do not have well planned solid waste management programs. With the increasing coastal population and lack of proper solid waste management protocols, the quantity of solid waste entering the coastal waters through rivers, estuaries and canals is enormous.

The interlinking canals of major estuarine systems along the Indian coast carry the domestic waste to the coastal waters which often get collected in the several bag type of fishing gears like the stake net and dol net along the Indian coast. Average discharge from estuaries is estimated as about 1422 $m^3$ sec-1day-1 along the west coast and 43766$m^3$ sec-1day-1 along the east coast and the high silt in these waters reduces the buoyancy of drifting articles, making them sink down quite close to their place of origin. Monsoon waters from the coastal areas aggravate the situation by washing off the land based litter to the open waters. It has been observed that during spring tides, the quantity of litter in the stake nets close to the coast have almost doubled the quantity of litter observed during low tide. The fishers have to spend considerable time and money to remove these from the fish catch. The fishermen throw back the litter collected back to the same waters. Thus the problem is not resolved. These issues can be easily solved by starting a proper waste collection mechanism in the villages and we can even think of giving incentives to fishers to bring back litter from fishing area.

The type of litter entering the ecosystem is also diverse and depending on the size and spread, they either settle at the site of origin or drift away, only to sink down and spread in a distant location. Similarly, smaller the size, easier it is for the particle to enter

the food chain. The marine food web starts with the plankton and observations in the plankton samples collected regularly in some of the major fishing areas have indicated the presence of micro-plastics.

These tiny particles have been found to enter the gut of filter feeding organisms like mussels, clams and oysters and also higher bony fishes like the sardines. Though the percentage occurrence of micro-plastics of size 50 micron to 5 mm is less than 5%, it still is a matter of concern. These particles can go up the food chain. The number of reports on micro and macro-plastics in the gut of fishes has increased over the years. Now CMFRI researchers have observed plastic ingestion in sardine, mackerel, anchovy, ribbon fishes, dolphin-fish, tunas and several other fishes caught from almost all states along the southwest and southeast coasts. Apart from these, plastic pieces were observed in the carcasses of sea bird and stranded whales.

One of the major sources of litter contributing to marine debris is the tourist's areas along the coast. Beaches are used for recreation and also for several religious festivals. Studies done by ICAR-CMFRI have indicated that the quantity of litter increases during festive seasons. Only very few beaches have regular cleaning programs. Littering is rampant in beaches and these have been found to affect the vulnerable ecosystems like the sea grass, coral reef and the mangroves. Though the coral reefs of India are just 0.660 % of world coral reefs, they support the livelihood of several thousand of fishers. The proximity of Indian coral reefs to the mainland makes them more vulnerable to anthropogenic impacts. Based on observations by the researchers of ICAR-CMFRI across the Indian coasts, it can be authentically stated that litter is affecting the biological functioning of critical habitats. Hence it is proposed that in all coastal villages proper facilities should be developed for disposing plastic and other non-degradable waste. Simple facilities like this would help to reduce the litter entering the coastal waters.

Another major issue is the abandoned or lost derelict gear. Researchers from ICAR-CMFRI have recorded several sightings of ghost net entanglement of turtles from the Bay of Bengal and Arabian Sea during research cruises. All these observations are messages from the deep that derelict fishing gears are swaying like ghosts threatening the benthic habitat and the marine biota. Recent reports have shown that unexpected natural disasters like cyclones along the coast lead to loss of fishing nets. These cannot be retrieved easily and the Indian fishing community is not aware about the impacts of these on the fauna. Hence it is strongly recommended that activities by NGOs and fishing communities be encouraged to remove these derelict gear, create awareness among the fishing community on the need to bring back the damaged gear and dispose the same on land. The recycling industry can also try to find ways to effectively utilize these.

If we go specifically on the type of waste, we have the Medical waste which is expected to grow at a compounded annual growth rate (CAGR) of about 7 per cent, which can reach 775.5 tonnes per day by 2022 from the current level of 550.9 tonnes daily. In the studies conducted so far, occurrence of hospital waste in coastal and marine litter is less than 5%. But extensive underwater surveys have not been conducted in coastal waters. So the threat by this waste remains largely unexplored. India along with UK

collaboration is planning to embark on a marine litter program in Indian Ocean and it is expected that this project would come up with more insight on marine debris and also solutions for effective reduction of plastic waste.

Lack of awareness about the impacts of litter on the coastal and marine ecosystem is one of the reasons for the increasing litter in marine habitats. Installation of art form has been used to create awareness among the public in Kerala. Huge installations by CMFRI of an ' Octopus' created by using plastic bottles from Cherai, an important tourist spot in Central Kerala in June 2012; a "Mad Crab" installed using wire and filled with litter collected from Fort Kochi in December 2013 and finally a "Fish cemetery" created in March 2016 with a message that plastics is now entering the food chain have been able to make the public think about the threat caused by plastic in marine ecosystem.

However, we have to go beyond all these research and awareness programs and work towards a permanent solution to this problem. Reduction in use of plastics and proper solid waste management programs are required. Moreover, there should be facilities to deposit non-degradable litter in public places. Along with these programs, we should also plan for extensive village level coastal clean- up programs to remove already accumulated litter. Marine debris is not something which can be neglected; if ignored, it can completely destroy the resources and the livelihoods depending on aquatic ecosystems.

# ALDFG, ghost fishing and mitigation measures

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Marine debris, also called as marine litter, is an aesthetic insult to our beautiful blue planet perpetrated by man. Common constituents of marine debris are plastic, glass, metal, rubber etc of which plastics constitute between 60 and 80%. Global plastic production increased from 1.5 million tonnes in 1950 to 335 million tonnes in 2016, with an annual increase of 8.7%. Annually, our oceans amass 8 billion kg of plastic. It is predicted that by 2050, the weight of plastic in our oceans will be more than the weight of fish, if stringent measures are not taken to reduce plastic production and prevent plastic dumping in oceans. In a study published in Science journal in 2015, India ranks 12th among 192 countries that dump plastic waste into the high seas from their respective coastlines.

Fishing related debris contributes substantially to marine debris. ALDFG is the internationally recognized name for derelict fishing gear (DFG). UNEP defines ALDFG as the "multitude of nets, lines, traps, and other commercial or recreational fishing equipment that has been lost, abandoned or otherwise discarded in the marine environment". Though accurate data is not available, extrapolated figures suggest that DFG contributes about 10% of the marine debris by volume. A study across six beaches in Kerala during 2017 showed that fishing-induced debris contributed to 26% of the total beach litter. According to the UN, 640 000 tonnes of fishing gear are lost or discarded in our oceans annually.

Fishing gear loss is isn't a new phenomenon; rather it is an age-old occurrence. Currently it has turned into a crisis with serious ecological, health and aesthetic implications due to the shift from natural gear materials to synthetic ones. Natural materials such as cotton, hemp, coir, wood etc are biodegradable and disintegrate within a short time if lost in sea. Whereas, non-biodegradable synthetic materials such as polyethylene, nylon, etc if lost, abandoned, or discarded, continue to stay intact in the water body up to 600 years.

`Fishing net' becomes `ghost net' when the operational control of the gear is lost to the fisher. A derelict net is termed as a ghost net only when a fish or an animal, is trapped in the net and mortality occurs. Ghost fishing is most severe in passive fishing gear such as gillnets, trammel nets and traps than in active gears. The time over

which DFG can continue to ghost fish can vary according to the specific gear type and may range from days to years. The fishing ability and catching rate of the ghost net depend on the gear configuration and until the gear configuration is intact, the gear continues to fish. Considering the volume of the gear, gillnets pose a greater threat, but traps retain fishing ability for an extended period which is due to the more stable gear configuration in traps. Gillnets, if lost are more prone to distortion in structure in response to slight disturbance.

The ability of ALDFG to continue to fish (ghost fishing) has detrimental impacts such as destruction of habitats such as coral reefs and benthic fauna and wild life especially marine turtles, seabirds, dolphins, whales, seals etc; introduction of invasive species; hazards to navigation and safety of life at sea, aesthetics and tourism, and human health and safety. Ghost fishing kill target and non-target organisms, including endangered and protected species; and contribute to marine pollution. Unaccounted catch losses of up to 7% of all landed catches has been estimated to occur in certain fisheries where ghost fishing has been studied.

Factors that cause ALDFG are vessel-gear conflicts, rough weather conditions, underwater obstructions (both natural and man-made), interactions with large fish and animals, use of extra large gear, use of very thin or damaged material etc.

Ghost fishing issue was first brought to the world's attention at the 16th session of FAO Committee on fisheries in April 1985. Much of the research in ALDFG and ghost fishing has been carried out in North America and European countries and not much work in this area has been done in India.

Increased fishing pressure the world over and the development and use of durable and long lasting fishing gear materials aggravate the problem. Latest figures show that the global fishing vessels have reached a record 4.06 million. Also the introduction of highly resistant materials like ultra high molecular weight polyethylene (UHMWPE) which is 15 times stronger than steel in the fishing and culture sectors has heightened the crisis .

As per 2010 statistics, India has 154 008 gillnets/ drift nets and 7285 traps in operation (CMFRI, 2012). As per the FAO reports, the average loss of gillnets and traps per year is 10%. Therefore, roughly 15400 gillnets and 728 traps are likely to be lost/abandoned annually. Indian drift gillnet sector witnessed a drastic increase in the quantum of net used during the last five decades. During the last one and a half decades large mesh gillnets targeting tuna and other large pelagics has have switched over from small scale to large scale operation by increasing the length of nets from 2500 m to >15000 m and the depth from 7 to 18 m . With the deployment of such long nets and widespread use of polyamide (nylon) monofilament which lasts for four months to a year, the risks of gear loss and consequent ghost fishing in Indian waters are very high.

So, the unaccounted loss of fish resources due to ghost fishing induced by these gears is expected to be substantial and hence needs careful consideration, in the context of resource sustainability and environmental safety.

The first study on ALDFG relating to gillnets and trammels nets in Indian waters by ICAR-CIFT in 2017 showed that this is a grave problem and needs effective monitoring and control. Though purposeful discarding of gear is almost minimal, the quantity of gear lost and abandoned amounts to 29% of the total gear used in some gillnet sectors. In some locations, it is as high as 600 kg of net per vessel per year which incurs a direct loss of Rs. 3 lakh per year. A minimum of 60 000 km of netting is deployed by gillnet vessels in Indian waters. Considering the average 10% loss proposed by FAO, 6 000 km of netting is likely to be lost to the sea. It has a direct effect on the fishers' income besides the environmental impact due to addition to marine debris and ghost fishing. Apart from the gear loss, it has a socio-economic impact on the fishers' livelihood by way of the extra cost involved in replacement of gear, loss of fishing days and loss of income by way of the opportunistic cost of the income the lost gear could have brought to the fisher had it not been lost.

Research, Awareness, Removal and Recycling are the four possible approaches to curtail ALDFG and ghost fishing. Fishing gear marking, GPS enabled operation of fishing gear, attaching radar reflectors and radio buoys to fishing gear, offshore collection facilities for damaged gear, discouraging use of damaged or old gear, reduction in fishing effort, reduction in soaking time of gear, reducing depth of deployment of gear, use of biodegradable and less durable gear, incorporation of time release mechanism to stop the fishing ability of gears such as gillnets and traps once they are lost etc are the main preventive measures. Recovery and disposal of ALDFG and recycling are curative measures.

Critical analysis of Indian gillnet fisheries showed that the gillnet sector is rapidly moving from small scale to large scale at least in the mechanized sub-sector, targeting tuna and other large pelagics with the nets extending to more than 15 km, weighing up to 3000 kg. Besides, with almost 100% adoption of nylon monofilament in small mesh and large mesh gillnets operated from non-motorized and motorized sub-sectors, ALDFG and ghost fishing is going to be a critical problem in the coming years.

# Ghost gear, marine debris and related impacts on marine ecosystems

**Shri. Ajay Venkataraman**
World Wildlife Fund, India

Marine debris is an important issue affecting the health of global oceans. They are particularly harmful to marine organisms, causing death or debilitation through either ingestion or entanglement. Abandoned, lost or otherwise discarded fishing gear (ALDFG) is an issue that is of increasing concern. Discarded and lost nets continue to trap target and non-target marine organisms for a long time after breaking away, sometimes for up to months, depending on physical conditions. 'Ghost fishing' is the term given to the continued entrapment of marine organisms by ALDFG. The lack of data on the prevalence of ALDFG in marine debris, sources and movements within the ocean system hampers efforts to tackle this issue. The matter is further compounded by its complexity, as it involves multiple stakeholders at different scales, operating across jurisdictional boundaries.

A primary stakeholder in this issue is the network of fishing communities and large scale fishing operations. They tend to be a primary source of ALDFG, but the time spent at sea provides potential for recruiting their services for its removal. Removed nets have the potential for recycling through various means. Industrial applications include the use of removed plastic material as fuel for concrete factories, the production of certain types of nylon fibres, making diesel, etc. On a smaller scale, removed nets can be converted into art and composite plastic products. This provides a source of livelihoods for communities involved in the extraction of such gear from the ocean. There is hence a need to incentivise this in order to promote involvement of all stakeholders on this issue, which threatens all aspects of marine ecosystems. There exist initiatives in other countries that harness the potential of marine debris to provide recycling opportunities and a source of income through products utilising such material. There is enormous scope for finding and utilising applications of such debris.

WWF has a global initiative for addressing plastics in the ocean through a three pronged approach, namely;

1. Plastic pollution free cities: A core focus of the Plastic Pollution Free City approach is to create a scalable action-program, to transform global hotspots for plastic pollution into circular economies starting with top 5 most polluting countries and then top 20 countries

2. Closing the loop: Collaborating with industries and working towards circular material management

3. Global platform for a plastic free ocean: Global and regional coordination, knowledge and expertise sharing to build a strong network globally.

WWF-India is currently starting a project which will aim to establish a baseline of ALDFG incidence along the coast of India, a monitoring programme for ALDFG incidence and eventually start an incentives programme, which will engage fishing communities in the removal and "up-cycling" of ALDFG. There is currently a lack of data on the spread and extent of ALDFG in Indian waters, and using a combination of surveys on fishing communities and spatial mapping will serve to address this gap. Following this, engaging fishermen, who spend a significant amount of time at sea compared to researchers and conservationists, to collect data in real time on the incidence and spread of ALDFG, can serve to create a monitoring programme. This will provide data on not only ALDFG, but also marine debris encountered when in offshore waters. The final stage of this programme will be the establishment of an incentives programme to remove ALDFG. Through collaboration with industry, exploring opportunities to recycle removed plastic marine debris, including ALDFG, can offer incentives, through alternative employment and financial benefits, for fishing communities to remove ghost nets as and when encountered. The ultimate aim is to rid our oceans of such debris and mitigate the vast array of negative impacts they confer on marine ecosystems.

# ABSTRACTS

# Presence of microplastics in benthic fauna: preliminary evidence from the coastal waters of Kochi, southeastern Arabian Sea

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With rising plastic production and per-capita consumption of plastics, it is obvious that plastic litter would be an environmental issue and aquatic organisms would be exposed to microplastics. The benthic invertebrates that include the filter feeders and deposit feeders are likely to ingest the microplastics present in the water column and in sediments because of their selective or non-selective feeding behaviour. Consequently, the predation on these benthic invertebrates by the higher trophic organisms may be a pathway for the transfer of microplastics along the food chain. This study examined microplastics in the benthic invertebrates *Sternaspis scutata*, *Magelona cincta*, *Paraprionospio pinnata* (deposit feeders) and *Tellina* sp. (filter feeder) from the surface sediments of off-Kochi, south west coast of India. The microplastic particles and thread-like fibres detected in the benthic organisms were identified to be polystyrene by using DXR Raman microscope. Examination of the microplastic particles in *Sternaspis scutata* and *Paraprionospio pinnata* by epifluorescent microscopy showed fragmentation marks on the surface suggesting that the microplastic particles were degraded/weathered in nature. The study provides baseline evidence of the presence of microplastics in benthic fauna from the coastal waters of India. However, further studies are required to understand the sources, distribution, fate and toxicity of the different types of microplastics in benthic invertebrates in order to identify any potential threats to higher trophic level organisms.

# Threats of plastics to marine fishes: observations on entanglement and ingestion

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The use of plastics in our daily life has become unavoidable as it is the main packing material for everything. Once the use is over, it is normally thrown into dust bin or any other convenient places. Now the sea has become an ultimate receiver of all the unwanted plastics. There is an increasing knowledge about the deleterious impacts of plastics on marine biota (Goldberg, 1995). The threats to marine life are primarily mechanical due to ingestion of plastic debris and entanglement in packing bands, synthetic ropes, lines or drift nets (Laist, 1987, 1997; Quayle, 1992). The present article showcases instances of entanglement of fish in packing band and also plastic ingestion which were observed during the routine collection of fish samples from Chennai and Tuticorin fish landing centres for biological observations.

A cobia (*Rachycentron canadum)* of 656 mm TL with a girth of 250 mm at the opercular region caught in trawl net and landed at Kasimedu on 3.11.2016 had a plastic ring stuck around the opercular region. As the diameter of the ring was only 70 mm, this would have easily passed through the head when the girth of the fish at the opercular region was smaller than the diameter of the band. When the fish grew, the ring got stuck around the opercular region making the area constricted. The body had lesion beneath the band and the ring rendered it difficult to close the operculum properly (Fig.1a & b).

When the stomachs of 103 numbers of sharpnose sardine, (*Amblygaster clupeoides)*

Fig. 1a & 1b The Cobia *Rachycentron canadum* with the ring (operculum removed).

ranging in size from 185 mm to 245 mm TL were analyzed, one fish contained a piece of plastic having a length of 51 mm, width 27 mm and weight 0.043 g inside the stomach (Fig.2). The percentage of fishes with empty stomachs was 85. These fishes were caught from the inshore waters of Gulf of Mannar on 21.12.2015 by the trawler and landed at Tuticorin. The fish is a zooplankton feeder.

Fig. 2. *Amblygaster clupeoides* with the plastic in view.

On 30.11.15, out of 52 numbers of Pompano dolphnfish (*Coryphaena equiselis)* ranging in fork length from 238 mm to 310 mm were analyzed, the stomach of one fish contained a plastic piece having a length of 10.5 cm, breadth of 6 cm and weight 0.65 g (Fig.3). The fishes with empty stomach dominated with 75 %. These fishes were caught in a multiday gill net targeting belonids, operated in deeper waters in Gulf of Manner and landed at Tharuvaikulam. The fish is a carnivore feeding on smaller fish and squid.

Fig. 3. *Coryphaena equiselis* with the plastic in view.

The plastic pieces in both the stomachs were found to be in multi folded condition giving it the shape and size of a prey. The ring is the part of a lid of some container. These observations fortify the views that threats of plastic to marine life are primarily mechanical and the plastic pieces and bands which are of suitable size to ingestion or entanglement constitute immediate threats to the fishes

# Fish mortality in Adyar and Muthucadu creeks in Chennai, Tamil Nadu

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Increasing urban domestic and industrial effluents along with organic loads and silt from farmlands, river-runoff and rains has led to the increased siltation, reduced catchment areas and lowering of water depth in estuarine areas along the Chennai coast. The monsoon run-off coincides with heavy flushing of domestic and industrial wastes and ETP chains which are forced through narrow streams usually formed during the rains, which eventually leave puddles and pools at low tides when the outflow is reduced. High density polythene and plastic wastes contribute towards blockades in the flow pattern, which in return cause to increased sediment accumulation in patches leading to the formation of small pools and puddles in the approach to the barmouth. During the rainy season, these smaller catchments act as reserve for breeding fishes that aggregate in the barmouth vicinity and for juveniles that migrate upstream.

During the monsoon many coastal and brackishwater fishes and crustaceans (mullets, ladyfish, threadfins, silverbiddies, shrimps and crabs) aggregate in the estuarine creeks for breeding and nursery grounds. But at lowest low tides in November-January periods, these shallow pools and areas get disconnected or get little flow and thus become stagnant with oxygen deficit due to increased sediment exposure, high COD/BOD and crowding of fishes. The riverine discharge into the creeks is heavily loaded with organic as well as inorganic wastes and the water volume is usually insufficient to ensure continuous flushing since the rains along this coast are not continuous and as heavy as along the west coast of the country.

The sediment pH falls very quickly and all the benthic forms get exposed and perish. The plastic filaments and sheets act as barricades and walls forming increased deposits which harden on the long run and render the sediment non-porous and anaerobic. Organic matter and gases get trapped in their folds and layers. The resultant toxicity and sulphide levels are of high magnitude. No benthos (meio or micro benthos) would survive except the anaerobic/bacteria &fungal colonies. Formation of tidal pools in the estuarine areas with increased BOD, COD and organic loads and sediments with high

sulphide content result in low oxygen levels, even anoxic conditions, causing sudden and sporadic fish deaths in large numbers along the entire stretch of the estuarine mouth.

Two recent incidents of fish death in the Adyar estuary in Chennai city and one incident in the Muthucadu backwaters south of Chennai have raised serious concerns regarding the health of the estuarine ecosystems and the nature of effluents and wastes being flushed through the inland waters into the estuaries. Investigations were carried out on the sudden fish death in the Adyar estuary and adjoining coastal waters in December 2015 and November 2017 and in the Muthucadu backwaters in March-May 2014 and 2015.

The fish deaths in the Adyar estuary followed a spate of heavy rains at both times. The coastward turbulence during rainy season normally brings back heavy loads of drained debris to the shore, which includes plastics, rubber wastes, styrofoam articles, ropes, large foliage and tree trunks. The shore line in this area was strewn severely with these debris and inside the creeks, the banks were found with heaps of plastics and discarded domestic articles. The sediment was black in colour and water surface clearly showed floating oil films. The coastal waters were yellowish in colour and the runoff was continuous even at lowest tide time with fresh water flowing out.

In 2015 it was observed that the dead fish were washed ashore and scattered along a 4 km length of the coast from Srinivasapuram north of the Adyar river mouth till Elliots beach in Besant Nagar to the south of the river mouth. In 2017, dead fish were observed along 5km of the coast from the Adyar barmouth towards south till Thiruvanmiyur, with the numbers reducing beyond the Elliots beach. The estimates were close to 1.5-2 lakhs of fishes in both the years. The dead fishes in December 2015 were predominantly breeding mullets. However, in 2017, the dead fishes were found to be mullets, sand whiting, tilapia, silverbiddies, lesser sardines, catfishes and crabs.

The upstream area of the Adyar creek does not support any fish resource other than a patchy distribution of tilapia in it. The Muthucadu creek barmouth has been restored from 2016, but inspite of this, the falling lake depth and increasing effluent discharge has led to repeated fish deaths (shrimps, tilapia, milkfish, silverbiddies, mullets) in the upstream stretch, 5-10 km from the barmouth. Even mud crabs were affected during the rains and heavy losses were reported. However, compared to the Adyar river, the barmouth area and nearby catchments are still productive due to the water catchment expanse and flowing channe.

# Plastic debris in fishing grounds off Calicut: a quantitative analysis

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The present study deals with the quantification of plastic items collected from the fishing grounds off Calicut namely Puthiyappa, Beypore and Chombala areas during July to December 2016 in monthly intervals. Sample collection was carried out with the help of local fishermen operating trawlers. Plastic samples were collected haul by haul and separate bags were allotted for collecting plastic samples per haul. All the sampling details were noted down along with GPS coordinates and depth of operation. The plastic items mostly recovered from the trawl nets were plastic covers, bottles and plastic bits. The abundance of plastic litter significantly differs among the sites. The trawlers landed in Beypore area was showing significantly higher plastic debris (Av. value-2068.72 g) than Puthiyappa (732.60 g) and Chombala (625.83 g). The data analysis shows an increasing trend from July to December 2016 with a peak value during November (1464.33 g) in all the sites. This may be due to the complete churning up of sea bottom during the monsoon. From the above study, it was observed that land-based sources were the major contributors causing plastic accumulation in the coastal marine areas.

# Marine and riverine litter monitoring

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Marine litter is a global concern causing a range of problems affecting the marine ecosystems. Mangalore, one of the urban coastal cities situated in Dakshina Kannada District of Karnataka is the present area of study. The city is bound by two small rivers, Netravati and Gurupura which form an estuary draining into the Arabian Sea. Though debris cleanup programmes are being routinely carried out by various government and non-governmental organizations, the presence of debris was noticed often in the fishing gears. Passive nets were mainly considered for ascertaining the litter present in the river and near shore area of the sea. Passive fishing gears like trammel net/*gilibale*, *maranabale*, gillnet *kairampani* which are operated by the local fishermen near-shore bring in the litter along with the fish. Marine litter was collected from Gurupur River and near-shore areas during the period from May 2016 to March 2018. The marine litter was then sorted into different groups as given in Table 1. The number, weight and size of the litter were measured and grouped accordingly.

Table 1. Different groups of marine litter.

| | |
|---|---|
| A | Nylon/HDP ropes/ Fish net piece |
| B | Plastics /Covers, sachets, containers of creams, oil ointments, toothpaste |
| C | Chappals/foot wear (other than leather items) |
| D | Glass bottles, electric bulbs, CFL bulbs |
| E | e-waste (TV/computer hard wares, mobile phone, handsets or parts, chargers etc |
| F | Thermocol, PUF insulators of AC/Fridge, Styrofoam |

The graph (Fig. 1) show the number and weight (g) of the items obtained in all gears combined.

Trammel nets are operated in the estuary and near river mouth and the litter gets entangled in the net during operation along with the fish. The land based litter flows through the drains and canals and gets accumulated in this area. *Maranabale* are operated mostly during monsoon season and a little beyond breakwater/ bar mouth, hence the chances of accumulation of litter due to the seasonal current changes close to the shore are high. The order of abundance of litter groups in the Maranabale was A > B > C > F. In trammel nets the order was B > A > E, while in *Kairampani* and

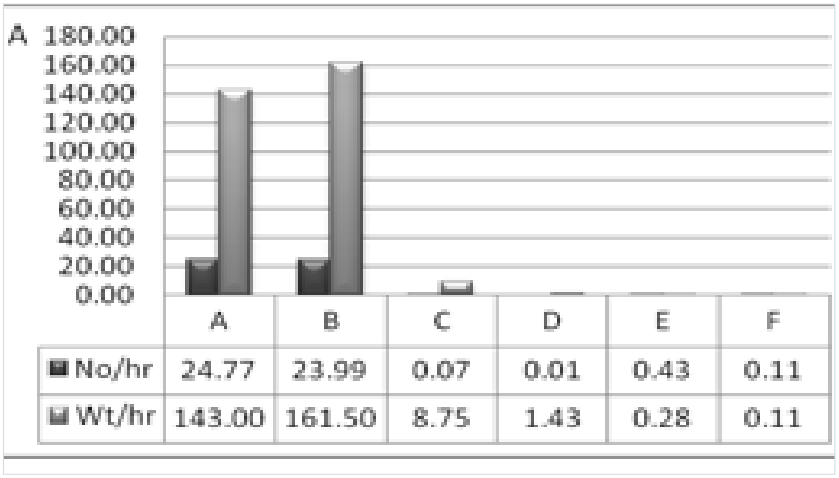


Fig. 1. Quantity of litter trapped in the fishing gear.

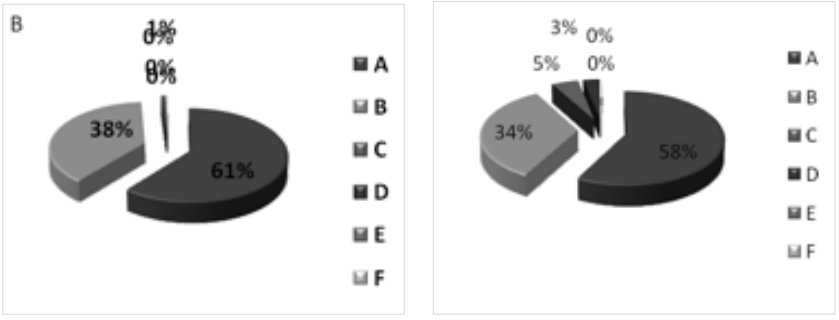


Fig. 2. Variation in number and weight (g) of the litter obtained in all gears combined

gillnet the order was A > B. In trawl nets only plastic litter was observed whereas in purse seine net the order was A > B > C. The most abundant litter items recorded by the 2016-2018 survey were group B followed by group A. The aim of this report is to provide an overview of the prevalence of litter in the riverine and near-shore waters. This is expected to lead to further studies to assess the severity and scale of the harmful effects of marine litter and adopt appropriate measures to manage the litter pollution.

# Plastic debris upsets bag net fishery along hooghly estuary, West Bengal

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Hooghly estuary in West Bengal supports livelihood of several rural people and also is an important nursery ground for marine and freshwater fishes including the most valuable Indian shad, Tenualosa ilisha. A large population along the stretch are involved in capture fisheries and fish seed collection for aquaculture. Gillnets, bag net, drag nets, dip nets, seines, traps, etc. are the major fishing gears in operation. Juveniles and sub adults of fish and shellfish constitute a major share in the catches of most of these gears, especially in the stationary bag nets. Thousands of stationary bag nets are operated mostly in the brackish water zones of Hooghly, where the water current is strong. During winter season intensive fishing by the migrant fishermen was reported from the lower stretch as the catch rate was very good. However, health of this important estuarine system has been seriously affected due to pollution, siltation and other anthropogenic activities.

A study was carried out during 2013-2015 in the Hooghly estuary and monthly sampling was carried out in the bag net catches at Tribeni in the upper stretch, Godhakali and Diamond Harbour in the middle stretch and Fraserganj in the lower stretch. Since the debris issue was very serious at Godhakali, this centre was selected for this work. It was found that along with fish catch the strong currents bring large quantity of debris which clogs mesh openings of the net and the incident was more in the middle stretch. Total catch ranges from 2-4kg in which fish component ranges from 0.2-1.3kg, plastics 0.2-0.45kg (dry weight) and the remaining part was composed of weeds, decaying plants, slaughter waste, etc. Plastics form the major share of this debris and an approximate percentage of different components is shown in Fig.1. Large plastic bags and sheets entered in the net act as a screen, which almost fully prevents the filtration of the gears. During monsoon season huge quantity of aquatic weeds are also washed into the net, which aggravate the situation and force the fishermen to stop bag net operation. Once the catch is sorted all the debris is discarded back resulting in piling up the waste load which ultimately end up in the adjoining Bay of Bengal.

Debris is the number one issue in almost all inland and coastal waters in the country. All kinds of plastic sheets, carry bags, packaging materials, bottles, disposable items from the food caterers, chapels, rubber items, e-waste, old fishing nets and several

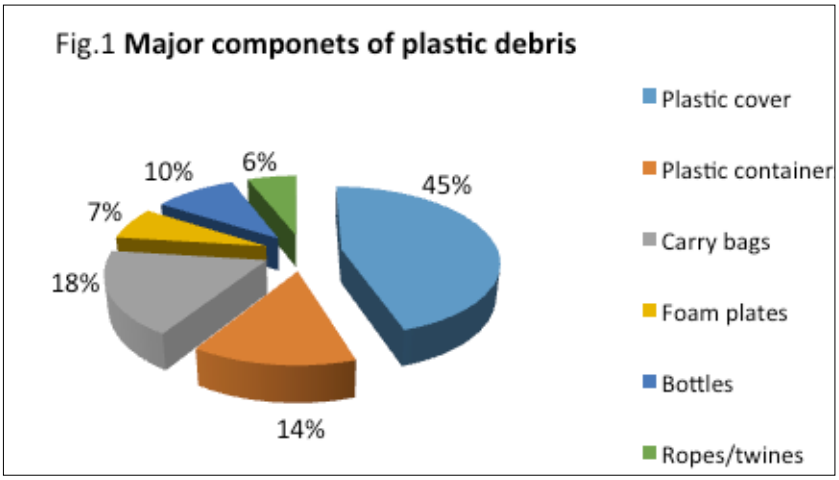

Fig. 1. Major components of plastic debris.

other items, which are mostly non-biodegradable are the components in the debris. Common fishing grounds are declining and navigation of fishermen and fishing craft are blocked due to excess debris accumulation. Debris in the bottom prevents the feeding, settlement, propagation and movement of aquatic flora and fauna. Proper functioning of the fishing gears are affected due to excess chocking. Needless to state that the entire ecosystem is suffocating due this ever increasing threat, which need to be addressed on top priority to protect the most valuable hilsa fish. All government, NGOs, cooperatives including local people should participate failing which the already dwindling fish stocks will disappear and the remaining fishermen also will migrate to other states in search of better occupation.

# Marine debris impedes coral reef endurance- a situational remark from the Rameswaram Island, Palk Bay, Indian Ocean

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Coral reefs, one of the most productive marine ecosystems, is under greater threat from stressors associated with climate change. Last two decades has registered highest coral reef mortality across the globe with large scale ecosystem phase shifts. Introduction of plastic and other debris into the coral reef system has catalysed the reef degradation processes and aggravated the situation. Human created waste that has deliberately or accidently been released in the marine ecosystem is called as marine debris. Benthic surveys conducted along the Palk Bay reef sites have revealed accumulation of marine debris at most of the reef locations. Extensive benthic surveys were conducted at four reef locations (Olakkuda, Villoonditheertham, Thangachimadam and Pamban) of Rameswaram island in Palk Bay during August 2017 and February 2018. Random belt transects of $30 \times 2m^2$ with replicates were established at all selected reef sites. Total number of debris materials collected were counted and recorded as density of marine debris averaged at reef sites. Highest density of marine debris was recorded from Pamban reef site (16.42 nos/$m^2$) and lowest was recorded from Olakkuda reef site (5.42 nos/ $m^2$). The debris collected from the reef sites were broadly classified as rubber, derelict fishing gears (DFG), plastics and glass. Percentage composition of rubber (20.9±2.8%) and DFG (56.9±8.1%) was found highest at Olakkuda reef site. Pamban reef site was recorded with the highest plastic composition of 55.5±3.5%. Mandapam North reef site was observed with highest percentage composition of glass debris (12±1.4%). Marine debris accumulated over coral colonies were removed carefully during August 2017 survey period and coral colonies observed with physical damages were selected for impact assessment. Massive coral forms (*Porites* sp.) and branching coral forms (*Acropora* sp.) illustrated varying response to marine debris interaction. While 43% of *Acropora* sp. coral forms were observed with partial mortality, only 6% of *Porites* sp. corals indicated partial mortality from debris induced physical damages. Branching corals are reportedly vulnerable to climate change stressors and the synergy of stress from marine debris on branching forms as observed from the present study may

augment the coral reef mortality and degradation processes in the region. Stringent management plans to be introduced to prevent the marine debris accumulation in the coral reef system and periodic benthic surveys to be employed to assess and prevent the expansion rate of debris accumulation in Palk Bay region.

# Microplastic pollution in the inshore waters of Tuticorin, Gulf of Mannar

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Ocean plastic pollution, primarily caused by the microplastic is an alarming issue due to its persistence, complexity, steady growth and the pervasive impacts on marine ecosystems. Microplastics are small plastic fragments of <5 mm size, entered directly through effluents of various sources or produced from floating plastic debris due to wave action and exposure to hot sun. Microplastic contamination may spread from organism to organism through the food chain and also due to chemical pollutants bind to it causing internal blockages and disrupted digestion, morbidity, liver toxicity, endocrine disruption and neurotoxic effects.

A study was conducted to assess the level microplastic contamination in the inshore waters of Tuticorin during the period 2014-15. Microplastic constituents were collected by a ten-minute surface horizontal haul using a standard zooplankton net of mesh size 250 $\mu$m from depths varying from 5-20 m. The density of microplastic was estimated quantitatively by counting the numbers in 1 ml samples, and measurements concerning the length and breadth were taken using a phase contrast microscope.

In the present study, the microplastic contaminants in Tuticorin inshore waters are observed in the form of lines, which are microscopic fibres probably liberated from discarded fishing nets and lines. The frequency of occurrence was higher at 5 m and 10 m depth, followed by 15 m depth, while microplastic was rare at 20 m depth. There was a proportionate decrease in the density of microplastic fibres with depth. The density was comparatively higher at 5 m depth and ranged from 1.5 to 7 nos. $ml^{-1}$ in 2014 and 0.5 to 5 nos. $ml^{-1}$ in 2015. The mean value was the highest of 3.625 $\pm$ 0.5 nos. $ml^{-1}$ in 2014 and 2.29 $\pm$ 0.34 nos. $ml^{-1}$ in 2015. At 10 m depth, the density varied between 1 to 6 nos. $ml^{-1}$ in 2014 and 0.5 to 5 nos. $ml^{-1}$ in 2015. The mean value was the highest of 3.33 $\pm$ 0.42 nos. $ml^{-1}$ in 2014 and 2.29 $\pm$ 0.39 nos. $ml^{-1}$ in 2015. At 15 m depth, the microplastic fibres were noticed at a density ranging from 1.5-5 nos. $ml^{-1}$ in 2014 and 0-4 nos. $ml^{-1}$ in 2015. The mean value was the highest of 3.09 $\pm$ 0.31 nos. $ml^{-1}$ during 2014, followed by 1.91 $\pm$ 0.36 nos. $ml^{-1}$ during 2015. At 20 m depth, the microplastics density was comparatively lower and ranged from 1-3.5 nos. $ml^{-1}$ in 2014 and 0-2.5 nos. $ml^{-1}$ in 2015. Our study has found a significant difference

($P<0.05$) in the density of microplastic fibres along water column.

Significant difference ($P<0.05$) was not noticed in both length and breadth of microplastic fibres at concerning depth. At five meter depth, the length of the microplastic was ranged from 0.02 mm to 0.083 mm with mean of 0.056 ± 0.0039 mm during 2014. At 10 m depth, the length varied between 0.039 to 0.073 mm with mean of 0.057 ± 0.003 mm during 2014. At 15 m depth, the mean length was 0.057 ± 0.008 mm during 2014. The average length of microplastic fibres was 0.094 ± 0.0076 mm at 20 m during 2014. The breadth of microplastic fibres was ranged from 0.00165 to 0.00125 mm with the mean of 0.0029 ± 0.0009 mm during 2014 at 15 m depth.

The highest density of microplastic particles at 5 and 10 m depth of Tuticorin inshore water indicated the extent of microplastic pollution caused due to the effect of sun and waves on broken nets and lines discarded by the fishers in shallow inshore waters. The study highlighted the need for creating awareness among fishing community regarding the responsible disposal and proper recycling of plastic litters.

# Qualitative and quantitative estimation of litter contamination in the fishing grounds of Tuticorin, Gulf of Mannar, southeast coast of India

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Marine debris, the solid waste materials has become a pervasive pollution problem all over the world. Plastic and synthetic materials are the most common types of marine debris and cause a harmful impact on the marine ecosystem. These pose a considerable threat to marine ecosystem by ingestion and entanglement, distributing non-native and potentially dangerous organisms, absorbing toxic chemicals and degrading to microplastic particles and damaging the habitat.

The marine debris constituted a significant source of pollutant in the coastal marine environment of Tuticorin. Owing to the fast industrialisation, the present study was conducted to estimate both quantitatively and qualitatively litter contamination level in the fishing grounds of Tuticorin during the period 2014-16. Litter contamination in the fishing ground was evaluated on a monthly basis from the fishers collections caught in two types of off bottom operated specific gears i.e. bottom set gill net from two landing centres- Kayalpatinam and Karapad Bay and in a modified country trawler from Mottaigopuram landings centre. The litter constituents were graded and grouped into five major groups according to the UNEP guidelines and estimated using swept area calculation method.

The studies indicated significant results, the total litter contamination was highest in the bottom set gillnet collections at Kayalpatinam coast with a mean of 24.10 $\pm$ 4.70 $Kg.Km^{-2}$, followed by 20.80 $\pm$ 6.90 $Kg.Km^{-2}$ in the modified country trawler collections at Mottaigopuram coast and the bottom set gillnet collections at Karapad Bay recorded the least value of 11.40 $\pm$ 4.40 $Kg.Km^{-2}$. The mean value of group-A litter constituting broken nets and nylon ropes were highest of 0.74 $\pm$ 0.70 $Kg.Km^{-2}$ at Mottaigopuram coast, followed by 0.67 $\pm$ 0.40 $Kg.Km^{-2}$ at Karapad Bay.

Among the group-B litters, plastics were the dominant litter constituent, in all the

gears from three landing centres. It was comparatively higher in the bottom set gill net samples of Kayalpatinam coast with the highest mean value was of 48.20 ± 9.40 $Kg.Km^{-2}$, followed by 39.20 ± 9.2 $Kg.Km^{-2}$ at the Mottaigopuram coast. Karapad Bay recorded the least amount of 20.80 ± 8.30 $Kg.Km^{-2}$. A highly significant difference ($P<0.05$) was noticed in gear wise variation of group-B litter constituents at three landing centres. Group-E and F constituting electronic waste and thermocols were seen only in the Thallumadi collections of Mottaigopuram coast.

The availability of plastics as the dominant litter constituent at all the places indicated the extent of plastic contamination in Tuticorin Sea. The studies also showed that the poor management of waste at land is the primary source of litter accumulation in the sea-beds of Tuticorin coast.

# Status of marine litter along the inshore waters and beaches of Visakhapatnam, Andhra Pradesh, India

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Aquatic ecosystems are facing a huge threat by the means of waste generated from anthropogenic activities. To regulate the disposal of domestic wastes and debris, first of all there is need to quantify the availability of debris present along the coastal and marine ecosystem. To quantify the amount of beach debris, samples were collected three beaches of Visakhapatnam using 10 x 10 m size quadrats. Triplicates samples from each beach were pooled together. The pooled samples were sorted out group wise, dried to remove sand and other debris. Dry weight of the each group was determined and expressed as, g/$m^2$. The amounts of beach debris along Visakhapatnam coast were ranging from 2.13 to 16.25 g/$m^2$. Surveys were also conducted in near shore areas at depths ranging from 30-40 m during the period from April 2016 to March 2018 with a bottom trawl net having 31 m head rope length and cod end mesh size of 30 mm. The debris collected was segregated into biodegradable wastes (BDW) and non - biodegradable wastes (NBW), dried to remove sand and weighed. The swept area for each haul of the trawl net was estimated and debris collected was expressed as kg/$km^2$. The study reports the monthly variation in the plastic marine debris and its relative percentage in the quantity of fish caught from the trawling grounds off Visakhapatnam. The presence of marine debris and its deleterious effect on marine life will pose a serious threat for sustainable fishing. Hence control measures are needed to manage this plastic debris menace.

# An incident of plastic ingestion in the common dolphin fish *Coryphaena hippurus*

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Plastic marine debris is an all-encompassing type of pollution. Domestic sewage canals, river water flows and estuaries are the major sources of plastics pollution for coastal waters. Hence coastal fauna is continuosly exposed to plastic pollution. An incident of plastic ingestion in dolphin fish, *Coryphaena hippurus* was observed from the hook and line, catches off Visakhapatnam Fishing Harbour. Out of the 31 individuals of *C. hippurus* analyzed for gut contents, two individuals (6.45 % of individuals) with fork length of 780 mm and 840 mm were found to contain plastic marine debris in their stomach. Both the individuals were found to contain more than one type of plastic content. Debris were found to be nylon fragments, hard plastic pieces, plastic wrappers and tooth paste covers. Plastics are well known threat to the living resources in marine ecosystem. It might affect the general well-being of fishes by creating internal injury, toxic effect, by blocking the digestive tract and by reducing its feeding intensity; therefore leading to a serious threat for its survival. Hence control measures are needed to manage this plastic debris menace.

# Occurrence of plastic in the gut of moonfish *Mene maculata* from the eastern Arabian Sea

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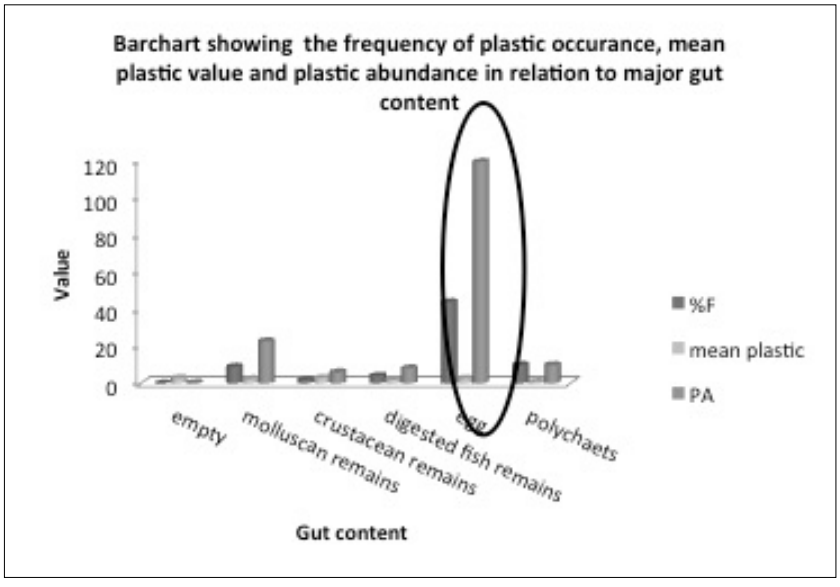
A rising crisis in marine environment is the presence of micro and macro plastics in the water column and the risk of their input and accumulation in the food web. The study reports the presence of micro and macro plastics in the gut of moonfish (*Mene maculate*), commonly known as razor moonfish; has fishery importance as well as play a major role in the marine trophic web as prey of large pelagic fishes. Moonfish samples were collected from the trawlers and purse seiners landed at Mangalore and Malpe Harbour during 2016-17. Details on the length and weight of fish, number of micro/ macro plastic fibres per gut sample, major food items in the gut along with the plastic, gut condition and life stage of the fishes was recorded for further analysis.



Chi-square test and K proportion test were used to analyse the data using XLStat 2017.5 and PAST 3.1software. Of the total 810 fishes examined, only 13 fishes had the presence of plastic fibre in stomach, which accounts to 1.61% of the total fish examined. During the analysis, 33 plastic fibres were observed in the gut of 13 fishes with an average number of 0.27 $\pm$ 0.19 fibres per fish. The size of these fibres ranged from 0.01 mm to 1.2 cm in length and thickness less than 1 mm. The micro plastic occurrence (F) recorded a higher value of 0.44 for the fishes which fed on eggs in contrast to the other dietary items.

# Study on the beach litter pollution along the beaches of Gulf of Mannar and Palk Bay, Tamil Nadu

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Beach litter are man-made objects discarded directly or indirectly into beaches near to sea. A study was carried out on monitoring the beach litter of non-biodegradable objects/items along the beaches of Gulf of Mannar and Palk bay during April 2017 to March 2018. A quadrate with dimension of 1 m x 1 m was selected at each location of Arichalmunai beach, Kunthukal beach, Thonithurai beach and Ariyaman (Kushi) beach were selected. Different type of non-biodegradable objects/items were sorted and quantified in triplicates quadrate. Sampling was done randomly in selected beaches for every month to cover a distance of 20 m beach area from high tide line. From all the beaches, nylon/HDPE ropes/ fish net pieces were the major beach litter, followed by plastic covers, bottles, sachets, etc. Kunthukal beach was recorded maximum beach litter of 54 g/m$^2$ during March 2018. The maximum beach litter were recorded at Arichalmunai, Thonithurai and Ariyaman beaches with the value of 27 g/m$^2$, 22 g/m$^2$ and 25 g/m$^2$, respectively during Jan 2018. At Arichalmunai beach, the maximum beach litter was comprised by plastic items with the mean value of 5.83 g/m$^2$, followed by of Fish net pieces/HDPE ropes 5.25g/m$^2$. The Kunthukal, Ariyaman and Thonithurai beaches were recorded the maximum quantity of fish net pieces/HDPE with the value of 14.58 g/m$^2$, 7.85 g/m$^2$ and 7.16 g/m$^2$, respectively. This study gives overall picture of non-biodegradable litter status along the beaches of Gulf of Mannar and Palk bay region.

# A preliminary assessment of marine debris in a mangrove ecosystem along the Versova creek of Mumbai, India

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Marine debris accumulation in the ecologically sensitive areas such as mangrove ecosystems, disturbs the ecosystem processes and the biodiversity. Mangrove ecosystems are structurally complex, which facilitates the accumulation of debris within it over other coastal ecosystems. In spite of this, very few studies have been undertaken to assess the debris concentration in the mangrove ecosystem in global and Indian context. This preliminary study involves, collection and quantification of marine debris standing stock by conducting surveys in the mangrove ecosystem along the Versova creek, Mumbai in March 2018. A total of 3 transects of varying length were laid perpendicularly from the low-tide line of the creek to the point of convergence of mangrove and terrestrial vegetation at the mangrove sites: open shoreline, creek mouth, and creek interior. All, the items (objects ≥ 5 cm) present in the randomly fixed quadrat (1 x 2 m) replicates along the transect line were collected and quantified following the standard methods of the NOAA marine debris program. A total of 319 objects (13.56 kg) were collected through this survey along the mangrove ecosystems of the Versova creek with the mean value of 13 objects $m^{-2}$ corresponding to 0.56 kg of debris $m^{-2}$. Debris concentration for the three transects were 34, 15 and 2 objects $m^{-2}$ corresponding to 1.59, 5.65 and 0.04 kg of debris $m^{-2}$. A decreasing trend in debris count and mass was observed from the open shore mangroves to the creek interior. Plastics and clothes were the dominant categories of debris by count and mass. The present study gives a snapshot of the extent of marine debris accumulated in an ecologically sensitive ecosystem i.e. mangrove ecosystems through an analysis of their abundance and composition. This study provides baseline data about the emergent problem of marine debris accumulation along the coast. Further, long-term studies can be taken up to understand the debris source, dynamics, accumulation pattern and its impact on the ecology of the mangrove ecosystem.

# Impact of ghost nets in the continental slope of Arabian Sea: a focus on sea turtles

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Sea turtles are distributed throughout Indian subcontinent. All the species of sea turtles in the Indian waters are included in the Schedule I of the Indian wildlife (Protection) Act, 1972 since the year 1977. Ghost nets pose the serious threat to global level, there is no comprehensive study on the impact of ghost net fishery in the Arabian sea.

Report on the occurrence of ghost net entanglement and fishery related mortality of turtles along the continental slope and high seas of southwest coast of India are very less. Ghost net entangled on Olive ridley turtle (Lepidochelys olivacea) was observed between 73° 28´ E; 75° 69´ E and between 13° 26´ N; 08° 59´ N. But none of turtle species were observed beyond 71° 23´ E; 11°13´ N during the study period. Partially decayed carcass of turtles were found in 73° 86´ E and 13° 61´ N. The sighting of ghost net entangled turtles in the Arabian Seas indicates severe threats faced by turtles in the oceanic ecosystem. The details of turtles entangled in fishing nets are given in Table 1. There is an urgent need in creating awareness among fishermen regarding careless discarding of nets in the fishing areas.

Table. 1. Details of sea turtle entangled in ghost nets observed in continental slope of Arabian Sea

| Date | Location | | Depth (m) | Species recorded | Type of Threat | Remarks |
|---|---|---|---|---|---|---|
| | Lat (N) | Long (E) | | | | |
| 2.03.2011 | 08° 63´ 56 | 75° 71´35 | 1642 | Olive ridley | Ghost net | Slashed front limbs |
| 24.01.2012 | 10° 61´ 06 | 72° 39´19 | 1516 | Hawksbill | Trammel net | Trammel net operated during cruise |
| 19.04.2012 | 11° 09´ 34 | 74° 91´24 | 1551 | Olive ridley | Ghost net | Two turtles |
| 07.03.2012 | 09° 41´ 12 | 75° 22´10 | 390 | Olive ridley | Ghost net | Nil |

| | | | | | | |
|---|---|---|---|---|---|---|
| 08.02.2013 | 13° 17´ 31 | 73° 42´41 | 1070 | Olive ridley | Ghost net | Wounds observed on right front limb |
| 06.02.2013 | 13° 67´ 13 | 73° 86´23 | 800 | Olive ridley | Propeller strike | Carapace broken vertically |

Investigation on the effect of anthropogenic activities on sea turtles in Indian Ocean is very less, principally because of lack of targeted cruises. Considering these limitations, we strongly recommend that targeted cruises for evaluation of derelict fishing nets are required and a comprehensive recovery programme is necessary to remove these threats from our oceans. Awareness programme should be conducted to educate fishermen that carelessly disposed or lost nets could trap and kill marine animals.

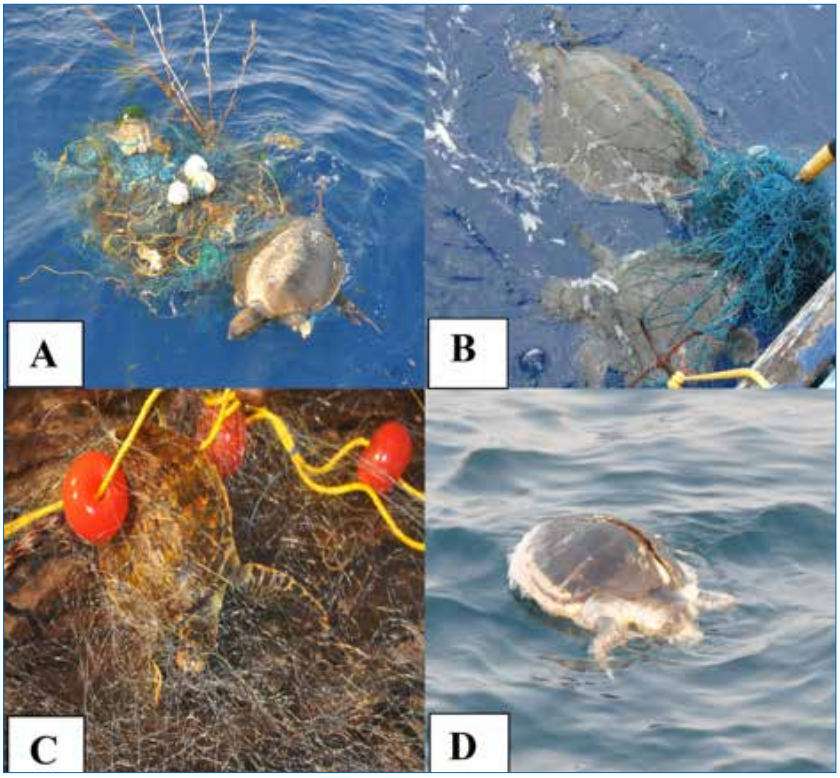


Fig. 1 Athropogenetic impact of sea turtles; A = Ghost net entangled front limbs slashed by nets; B = Two turtles trapped in an entanglement of fishing nets; C = Turtle entangled in Trammel net; D = Decayed carapace of turtle

# Entanglement of marine ichthyofauna in plastic debris in the south-eastern Arabian sea

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Entanglement of marine organisms in marine debris is a global problem affecting several marine species, from fishes to mammals. This study highlights the records of marine fishes (Barracuda, Needlefish, Cobia, Rainbow runner, and Carcharhinid shark) trapped with plastic debris in the south-eastern Arabian Sea. The reported specimens were collected at Cochin and Munambam fishing harbours, Kerala in the southwest coast of India during 2014-2017. Morphological examination revealed the presence of deep wounds where the plastic debris encircled the organism or resulted in entanglement. The causes of these wounds were due to severe abrasion on the tissues by the plastic debris as the animal grew in size. The encircled debris hampered normal growth, feeding and/or ventilation. Most such debris entangled species were deformed and in emaciated condition. The entangled plastic debris were identified as detachable lid of plastic bottles and discarded fishing net material. The exact sources of these plastic debris was unknown, but could most likely be from a land based origin or discarded from fishing vessels/cargo ships/boats used for recreation. The harmful impacts of plastic debris on marine fauna of Indian waters are yet to be understood. The actual number of marine species that suffer and finally die due to entanglement/encirclement by plastic debris in the Oceans is several folds greater than actually reported. The present report just gives a glimpse into the immense dangers to marine life due to careless and thoughtless disposal of non-degradable debris into the marine system.

# Abundance of microplastic fibers in guts of edible crustaceans from north-west coast of India

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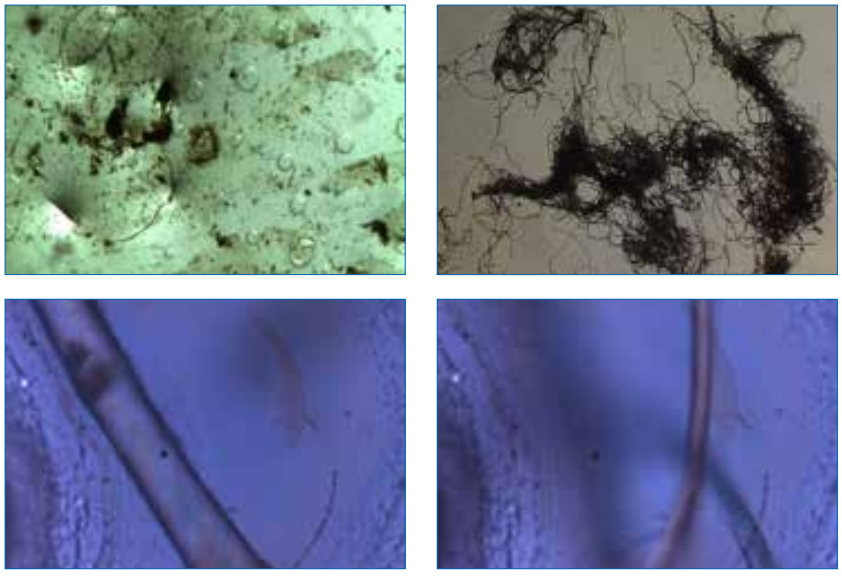
Plastic owing to its low production cost and features like flexibility and durability has emerged as the wonder product. The huge range of possible application of plastic has led to an ever growing demand and use of plastic in every facet of human life. Plastic has become an essential part of our modern lifestyles and finding its way either accidental or intentional in marine environment in alarming levels. Studies reveal that around 70% of marine litter consists of plastic items. Microplastics i.e. plastics of 5mm or smaller size are even more critical as they can find their way in human diet unnoticed via food chain. Crustaceans are considered delicacy among humans preferred food commodity. Being a scavenger in nature and inhabiting sandy and muddy regions of coastal waters, they could possibly have higher chances of plastic ingestion especially microplastics. Though several marine organisms have been reported to engulf microplastics but only a handful of reports are dedicated towards crustaceans. The coastal waters of North West coast of India is probably the most vulnerable coast to plastic contamination owing to the vicinity of two most developed Indian states *viz.* Gujarat and Maharashtra. The current study is based on examination of guts of major edible crustaceans captured all along the continental shelf of NW coast of India. A total of 1267 guts across 12 species were examined and 372 of them were found to be empty. Remaining 895 guts were microscopically examined for the presence of microplastic fibers at different magnifications. A total of 402 guts were found positive for the presence of microplastic fibers. The degree of abundance varies from 25.41 % in Solenocera crassicornis to 62.22 % in Parapenaeopsis hardwickii. The frequency of occurrence is found to be higher in the species found in close vicinity of the coast which can be attributed to the fact that plastic load in marine benthic environment is indirectly proportional to the distance from the coast. There do exist a relationship between frequency of occurrence and length of the species. The larger specimens especially the species of genus Penaeus and Metapenaeus have lower incidence of plastic ingestion as larger individuals are caught from farther locations. The abundance of microplastic fibers in guts vary from single strands to more than 100 strands in one gut with width and length ranging from 9.8 um to 35.40 um and 1.23 mm to 5.96 mm respectively. Though the cepahalothorax

having guts of prawns are not eaten, the incidence of plastics ingestion should not be taken lightly as translocation of microplastics between the gastro-intestinal system and adjoining tissues cannot be completely ruled out. The scavengers like crustaceans can be indicative of the health of benthic marine ecosystem.



Microplastic fibers in guts of commonly occurring edible crustaceans along NW coast of India

Table 1. Frequency of occurrences of microplastic fibers in guts of commonly landed crustaceans along NW coast of India

| Species | Total no. of examined guts | No. of Empty gut | Frequency of occurrences | % of guts (excluding empty guts) |
|---|---|---|---|---|
| *Panilurus polyphagus* | 80 | 24 | 23 | 41.07 |
| *Portunus sanguinolentus* | 90 | 30 | 37 | 61.67 |
| *Penaeus monodon* | 115 | 33 | 30 | 36.59 |
| *Pernaeus semisulcatus* | 85 | 28 | 28 | 49.12 |
| *Fenneropenaeus merguiensis* | 75 | 30 | 19 | 42.22 |
| *Metapenaeus affinis* | 150 | 41 | 49 | 44.95 |
| *Metapenaeus monoceros* | 150 | 52 | 51 | 52.04 |
| *Parapenaeopsis hardwickii* | 66 | 21 | 28 | 62.22 |
| *Parapenaeopsis stylifera* | 150 | 46 | 62 | 59.62 |
| *Parapenaeopsis sculptilis* | 70 | 24 | 22 | 47.83 |
| *Solenocera crassicornis* | 150 | 28 | 31 | 25.41 |
| *Solenocera choprai* | 86 | 15 | 22 | 30.99 |
| | 1267 | 372 | 402 | 44.91 |

# Assessment of marine litter on recreational beaches along Mumbai coast

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Marine habitats worldwide are contaminated with man-made debris and has become a growing concern to our global oceans. Mumbai is one of the most industrialized areas in India and its beaches are under threat of debris load. Hence an attempt was made to quantify the marine litter abundance in Aksa and Juhu beaches, two important recreational beaches along Mumbai coast during October 2016 to April 2017. Three transects having 50m length and varying width were used for sampling the beaches for litter. All visible pieces of litter having size >2.5 cm found on each transect were collected and recorded in terms of count and weight. A total of 52,770 items with 527267.97g weight falling in 41 debris categories and nine major groups were collected with a mean abundance of 837.62±286.15 items/50m and 8369.30±1561.64 g/50m. Mean abundance of marine litter recorded in Juhu beach during the study period on count and weight basis were 1698 ± 838.29 items/ 50m and 11800± 4470.03 g/50m. Whereas, it was 407.43±28.19 items/50m and 6653.75±665.50 g/50m respectively in Aksa beach. The highest abundance of marine litter by count and weight with low diversity and evenness was in Juhu beach in October (Fig. 1, 2). There was no significant spatiotemporal variation in abundance of litter (count and weight wise) between the beaches (Fig. 3a, b). The categorization of litter proved that plastic was predominant with an average abundance of 618±271.82 items/50m and 2616.77± 989.19 g/50m which emphasizes the high risk to marine organisms due to possible ingestion and entanglement. The highest quantity of plastic was in Juhu beach compared to Aksa. The Clean Coast Index (CCI) classified Juhu as a ''Dirty" beach with CCI 12.85 and Aksa as a "Clean" beach with CCI 3.88. General based sources contribute more to the marine litter in Juhu (71.98%) and Aksa (56.24%) beach. The major contributing factors for the litter abundance were beach usage for activities such as recreational, religious and deposition from the sea. The data gathered through this study can be used in removal efforts of litter from the marine environment and in identification of hotspots for particular type of litter within the areas studied.

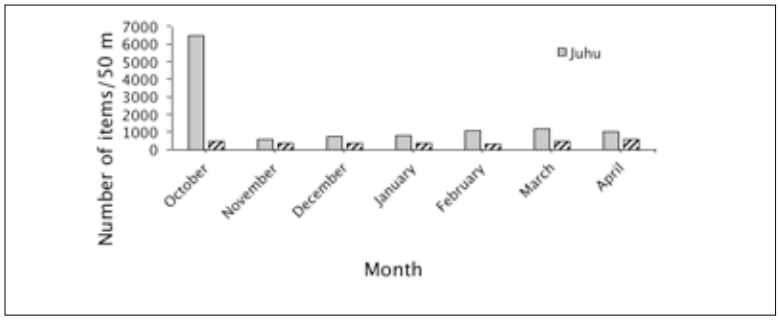


Fig. 1. Marine litter abundance by number of items in Juhu and Aksa beach during the study period

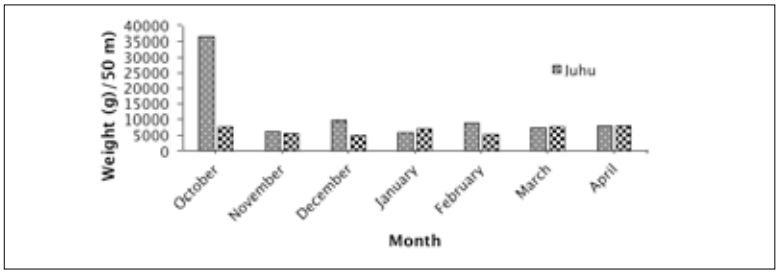


Fig. 2. Marine litter abundance by weight in Juhu and Aksa beach during the study period

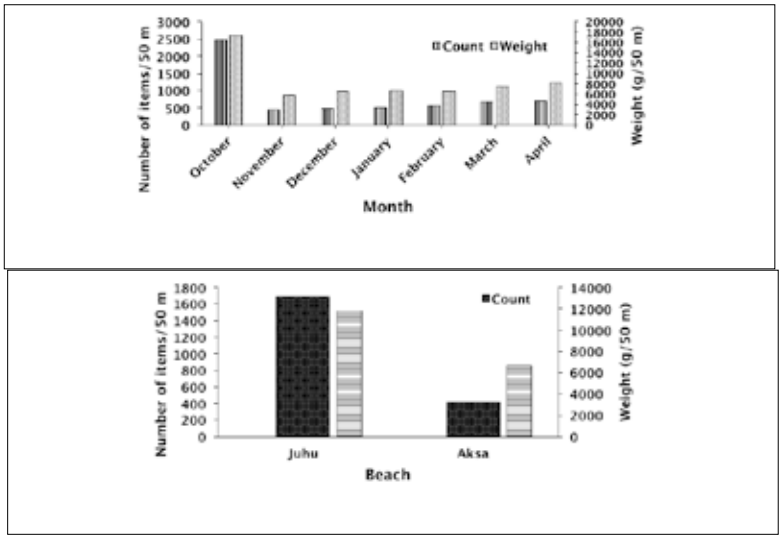


Fig. 3. Abundance of marine litter: (a) Monthly variation by number and weight; (b) Beach-wise variation by number and weight

# GIS mapping of marine litter along Mumbai coast, Maharashtra

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Marine litter is a global environmental issue that degrades the quality of the marine environment and has adverse effects on marine organisms and human health. Beach surveys of accumulated marine litter are the most common means of estimating litter loads. Combining adequate documentation and monitoring activities to assess the abundance of marine litter can lead to the abatement of the marine litter problem. In this context, GIS mapping of the marine litter abundance in Aksa and Juhu beaches, two important recreational beaches along Mumbai coast was carried out during October 2016 to April 2017. Three transects having 50m length and varying width were used for sampling the beaches for litter. All visible pieces of litter having size >2.5 cm found on each transect were collected and recorded in terms of count and weight. The litter abundance maps of the entire study area have been prepared using ArcGIS software (v.10.3) spatial interpolation technique, namely inverse distance weighted to study the spatial variations in marine litter abundance in Juhu and Aksa beach. Distribution of marine litter (count and weight basis) in Juhu beach follows a more or less similar pattern from October to April with a gradual decrease from south zone to north zone (Fig. 1a, 2a). A wave breaker present in the southern end of the Juhu beach accumulates the litter onshore. However, Aksa beach showed differential distribution of marine litter (Fig. 1b, 2b). In October there was a decrease in litter abundance on count basis from south to north zone and a reverse pattern on weight basis (Fig. 1b). This distribution pattern was almost similar in all other months. The differential distribution of marine litter in Aksa beach may be due to several factors such as recreational activity, litter transport by creek, tides etc. The findings of the study can be utilized for decision-making as well as public awareness for the management of marine litter pollution. This study recommends a combined approach of quantitative assessment, monitoring and mapping marine litter through GIS along with its social, economic and ecological impacts. This will lead to a greater knowledge of the problem and helps in the implementation of more effective solutions. GIS mapping helps in locating the litter hotspots which can contribute to more effective cleanups.

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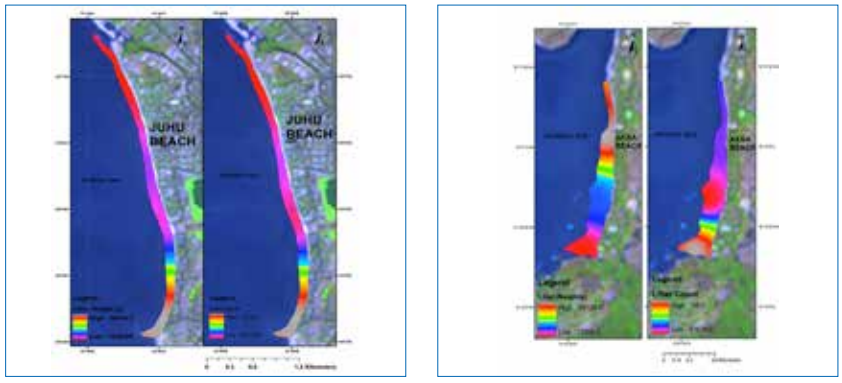


Fig. 1. Thematic maps of marine litter abundance (weight and count basis) in October (a) Juhu beach; (b) Aksa beach

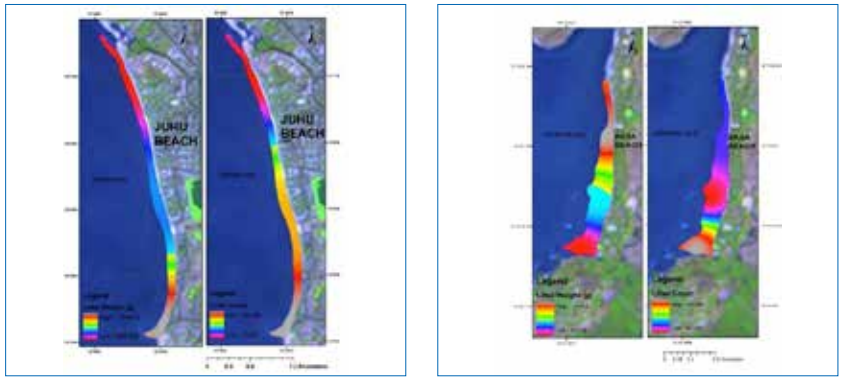


Fig. 2. Thematic maps of marine litter abundance (weight and count basis) in November (a) Juhu beach; (b) Aksa beach

# Comparison of field method and density separation method for extraction of microplastic particles from beach sediment

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Plastic pollution can cause serious threats to the aquatic environment and ultimately to the decline in coastal biodiversity on a global level. In order to highlight the rising threat of plastic pollution in the Kerala coast, an investigation was conducted to detect the presence and distribution of meso and microplastics in a well-known beach. Beach sediments were examined for the presence of meso and microplastics from a busy tourist destination, the Fort Kochi Beach in Cochin. There is heavy dumping of plastic wastes in the intertidal zone of the beach. Three sites were selected on the beach based on the intensity of human activity i.e. a highly frequented area, a moderately frequented area and a less frequented area, with the objective of evaluating the magnitude of plastic pollution in each area and to categorise and quantify the meso and microplastic debris present in each. Samples from selected quadrats of each site were used for extraction and visualis ation of microplasctics following two methods: 1. A field based method in which the samples were sieved through ½ inch mesh followed by 5 mm sieve and 311 $\mu$m sieve for segregating the macro, meso and microplastics and 2. A laboratory based method involving density separation and wet peroxide oxidation to extract the microplastics. Microplastic particles could be recovered from the beach sediment by either method. Potential microplastic particles of size lower than 5mm were recovered from 22 out of 24 samples by sieving and visual sorting method and from 19 out of 24 samples by density separation method. The total weight of microplastics recovered by sieving and visual sorting from site 1, 2 and 3 respectively were 0.036 g, 0.011 g and 0.035 g. The quantity of microplastics was the highest at quadrat 4 in site 1 and quadrat 1 in site 3. Total weights of microplastics recovered by density separation from each site were 0.049 g, 0.004 g and 0.002 g respectively. Maximum quantities of microplastics were recovered by both methods from site 1 which is the busiest portion of the beach where littering was probably the maximum. However, the higher concentration of microplastics at site 3 observed by visual sorting can be assumed to be due to the continuous wave action and deposition. Individual classification of collected microplastic fragments based on colour, by visual sorting method and density separation method

showed that fragments were coloured blue, black, red or were colourless (translucent and muted coloured). Dominance of colourless microplastic particles in almost all the quadrats points at the discolouration of particles due to the degradation over time. One-way analysis of variance (ANOVA) between weights of microplastics from each quadrat sample showed that there was no significant difference in the distribution of microplastics collected from the three sites at Fort Kochi beach.

# Dolnet -an ingenious fishing gear or a debris collector?!

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Marine litter creates environmental, economical, human health and aesthetic problems. It also poses immense threat to variety of marine organisms and interdependent living organisms. In this era of urbanisation, plastic and allied debris has been encountered by fishermen as bycatch in the fishing nets like trawls, dolnets, gillnets etc across the globe. Study on dolnets (Bagnet) of Karanja and Bhayander creeks-two important creek ecosystems located in the Raigad and Thane district of Maharashtra respectively was carried out between September 2016 to May 2017. Dol nets of mesh size 8 mm at cod end were used along this two ecosystems which supported the livelihood of fishers of these villages. Analysis of data revealed that on an average, 10.38 %( maximum 26.23 %) of total catch of waste material got filtered in dolnet within 3-4 hours of setting of the gear in water. Inadequate landing facility and lack of value for their service encourages fishermen to land plastic catch. Usage of a responsible fishing gear with larger mesh along with an incentive for cleaning programme can create a better environment in future.

# Symbiotic microbes in *Perna viridis*- prospecting bioremediation strategy for marine oil pollution

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Oil pollution or spillage is a prevalent problem in many marine ecosystems of developing and industrialized countries. High concentrations of oil and grease decrease oxygen transfer rate in the aerobic process by forming a layer on the ocean surface, making removal of oil and grease as an essential procedure. However, the currently used chemical techniques are inadequate as well as costly, and may result in environmental pollution. Biological methods that use lipases can represent an appropriate, environment-friendly and cost-saving bioremediation system for removing oil and grease. Among different bio-resources, bacterial lipases are gaining utmost attention due to their short generation time and low production cost. However, marine microbes as a source for lipases remain largely under-explored. Marine bivalves are considered to be a rich source for various marine microorganisms because of their filter feeding behavior for obtaining nutrients. Therefore, the present study was carried out to find lipase producing potential marine bacteria from an unexplored marine bivalve, *Perna virdis* (Asian green mussel). For this, seventy bacterial isolates, obtained in pure cultures from *P. virdis* were screened in nutrient agar medium supplemented with 1% tween-20 as substrate. After 48 h of incubation at 28°C, the plates were checked for the formation of clear zone accompanied by small dots around the culture spot. The dia*me*ter of zone was measured for scoring activity in positive cultures. Among the 70 isolates screened, 27 isolates gave positive results (38.6%) and the diameter of clear zones varied from 2 mm to 18 mm. Nevertheless, in order to consider a bacterium as a potential producer for any enzyme, the enzymatic index (EI value) should be > 1. Therefore, calculation of EI value was done for positive isolates. EI values were found to be ranging from 1.0-3.6. Finally, by combined analysis of morphological and molecular characterization (16SrRNA gene sequencing), the potential enzyme producing bacteria were identified and found to be the members of 6 different genera namely, *Shewanella, Providencia, Aerococcus, Acinetobacter, Pseudomonas* and *Rummeliibacillus*. The isolate with highest EI value (3.6) was assigned to the genus *Shewanella*. In conclusion, the present paper indicates the potential of symbiotic microbes from *P. virdis* as an important source of microbial lipase enzyme. However, further research on these isolates has to be conducted especially aiming on optimization of enzyme production so that these bacteria can be commercially utilized for degrading of oil rich waste materials in marine ecosystem worldwide.

# Micro-plastics in the gut of fishes caught from the mudbank off Alappuzha, south-central Kerala coast

**Preetha G Nair*, A. M. Dhanya, Abbas. A. Mohammed, R. Jeyabaskaran, K. S. Abhilash, P. G. Vishnu and V. Kripa**

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Plastic debris have become a threat to sustainability of marine resources and habitats. This non-degradable litter enters the coastal ecosystem due to human activities. Microplastics (size < 5mm) have been reported from most areas of the world ocean and constitute serious threat to organisms even at the cellular level. This study is based on the fish samples analyzed from the Alappuzha mud bank region (9°44. 33' N and 76°17.52' E) in 2013 and 2014, from a depth of 4 to 10 m. Along with the landed fishes adjacent to the mudbank region, fish samples collected from experimental fishing in the mud bank onboard RV Silver Pompano using shrimp trawl were also considered in the present study. The study showed the presence of micro-plastics in the gut of several specimens of Indian oil sardine (*Sardinella longiceps*), anchovy (*Stolephorus* sp.), Indian scad (*Decapterus russelli* ), grey ribbon fish (*Trichiurus lepturus*) and giant tiger prawn (*Penaeus monodon*). It was noticed that the frequency at which micro-plastic beads were observed in the fish increased during the mudbank period (June-September) compared to the rest of the period, this indicate the possibility of the higher quantity of micro-plastics available in the suspended mud during the mud bank period. Presence of high quality of micro-plastic beads in predator such as *Decapterus russelli* may be attributed the possible trophic transfer of micro-plastics through the food chain in the study domain, which needs to be studied further in detail to really comprehend its ecological implications.

# Study of the households on the awareness, usage of plastic products and willingness to participate for 3r's in Vypin island, Kerala.

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Solid waste management (SWM) has a crucial role in maintaining the good health of an ecosystem. But SWM is in criticism because of improper waste management due to negligence by the population and the governing body. In past decade, the changes in the environment have been attributed to rapid urbanization and industrialization which led to an increase in air, soil and water pollution. Solid waste aggregations have increased due to elevation in economical status and activities of the society. The governing body, municipality and the environment itself is not able to cope up with this huge assimilation of waste generated. The main obstacle are the collection, storage, transportation, processing, disposal of solid waste is highly ineffective (due to improper treatment machinery), and consequently damaging to the environment. Though best SWM are practiced in developed countries, developing country like India is lagging behind and the situation is far from satisfaction in dealing with waste management. In India, the urban areas SWM are taken care by the municipality but in rural areas there is a lack of governance in taking care of the situation. The major problem while tackling the SWM is the non-biodegrable waste which mainly composed of plastics. In India, there has been a steady growth in production and consumption of plastic products in past two decades. But there is lack of awareness and absence of effective tools in waste collection, segregation and proper disposal of the waste created by used plastics, which has to be taken care by the state management. This has led to the indiscriminate littering of plastic along the roadsides, canals, waterbodies and degrade slowly in the environment which will have long-term adverse ecological and economic impacts, including the dispersal of persistent organic pollutants.

In this study a location in Ernakulam district, Kerala state was chosen for the assessment of the plastic usage by the population, way of discard and willingness to participate in curbing the menace of plastics. The location for the study is a small rural area surrounded by Vembanad Lake at one side and opening to Arabian sea at other side. For the study purpose 5 villages from Vypin Block (Puthuvype, Njarakkal, Nayarambalam, Edavanakkad

Pallippuram, Kuzhuppilly), one village from Edapilly block (Elamkunnapuzha) and one village from Paravoor block (Chendamangalam) were chosen since all these places are connected to the Vembanad lake. A total of 400 households were randomly surveyed with fifty houses in each panchayat. The results indicated that 100% of respondents are aware of plastics hazards to the environment. The reason for choosing plastics were supported for being cheap (42.5), common (27%), lightweight (19.75% and lack of alternative (13.5%). The results indicated that the larger proportion of the respondent depended on plastic bags for regular purchases regardless of their age, occupation, economic and educational status. The study included way of discard, challenges faced for discarding plastics, awareness on lake degradation and the role of plastics. Also willingness to participate for payment for restoration of canals, recycling, and use of less plastic payment on return of PET bottles are studied. The study also assessed the awareness about the health hazards associated with plastic bag usage among the people and their perception towards the legislation banning the usage of plastic bags. Respondents' demands and suggestion for better management were directed towards the better policies to be implemented at the panchayat level for proper disposal of SWM including plastics.

# Interactive map - a medium for creating awareness about litter status of Indian beaches

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Littering is one of the most grievous environmental menaces faced by the beaches all over the world and its detrimental impacts are being felt by the marine ecosystems. To estimate the gravity of this ubiquitous problem along the Indian coast, a survey was conducted to quantify the amount of litter present in the Indian beaches. The samples were collected randomly from 254 beaches along the eastern and western coasts and further analyses were done. As the maps represents the most efficient medium for visualising the spatial distribution of a parameter under study, the sampling locations and spatial analysis results were generated in the form of maps. The highest sampling density was recorded from Kerala (54), followed by Tamil Nadu (45) and Maharashtra (38). There are about 81 coastal districts in India, out of which 48 were sampled. Form Kerala and Tamil Nadu, 9 districts each were sampled, while from Maharashtra, 7 districts were sampled. Out of about 257 costal talukas, 133 talukas were sampled. There were 23 talukas from Tamil Nadu, 21 Talukas from Kerala and 16 talukas from Maharashtra.

The Mulki beach in Karnataka recorded the highest amount of litter (1240 g $m^{-2}$), followed by Morgim (842 g $m^{-2}$) beach in Goa came and Katpadimattu beach in Karnataka (810 g $m^{-2}$). Taluk-wise average beach litter was highest for Pernem (672.15 g $m^{-2}$) followed by Bardez (386.55 g $m^{-2}$) which are from Goa and Udupi (348.85 g $m^{-2}$) from Karnataka. The district-wise average beach litter data showed that North Goa district had the highest level of beach litter (355.68 g $m^{-2}$), followed by Udupi district in Karnataka (334.25 g $m^{-2}$) and Porbandar (327.75 g $m^{-2}$)district in Gujarat. The state-wise average beach litter data showed that Goa coast (205.75 g $m^{-2}$) reported the highest quantity of beach debris followed by Karnataka coast (178.44 g $m^{-2}$) and Gujarat coast (98.79 g $m^{-2}$).

Apart from generating the static maps depicting these information, an interactive map was also developed and hosted in the CMFRI website, with an aim to make available the information to all concerned parties. The interactive map can be reached using

the URL http://www.cmfri.org.in/Beach_Litter_Map_Final_4/Beach_Litter_Map_Final_4.html#6/15.657/81.607. Open Street Map was used as the base and the interactive layers developed were beach-wise litter, taluk-wise litter and district-wise litter statuses. Checkboxes were provided to manage the interactive layers. In case of beach-wise litter layer, upon clicking each location, the map will open a pop-up window with the following information *viz.* name of the beach, coordinates, state/UT, litter status, category and category-wise photograph. In case of taluk or district-wsie litter status layer, the pop-up window will give the information like name of the taluk/district, state/UT, number of samples used for spatial averaging, litter status and the category in which the taluk/district falls. This interactive map can be of use to the policy makers, researchers and public who are interested in waste management and conservation of marine ecosystems. Moreover, it represents an efficient way to ensure last mile connectivity between the information and its end user.

# Occurrence of plastic debris in the gut of *Johnius belangerii* (Cuvier, 1830) from Vasai creek, Maharashtra, India

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Plastics, despite its versatility and increased use in the recent past, they were dispersed over a long distance in the ocean. Due to its high degree of buoyancy and inertness, it has a huge impact on the ecosystem and human health. Vasai creek is one of the inward estuarine waters along Mumbai coast, through which the Ulhas River of Western-Central Maharashtra joins the Arabian Sea. Non-biodegradable solid wastes create pollution in this creek on account of rapid urbanisation and Industrialization. The occurrence of plastic debris in the gut of Johnius belangerii collected from Vasai creek during December 2017 is reported in this study. The plastic fragment was found to be transparent, irregular in shape and its size was measured around 4.3 cm. Further, it is categorised as macro-plastic and constituted around 50% by volume of the stomach and the rest includes semi-digested paste shrimp (Acetes sp). There were no abnormalities observed in the internal anatomy of the fish. The species was found to be predominantly feeding on macrobenthic invertebrates. Ingestion of plastic probably occurred accidentally during the feeding activity and also the species might have mistakenly identified plastic as prey. Further studies can be undertaken in the future, to understand the trophic transfer and potential negative effects of the ingested plastic debris on the organism.

# Economic valuation of recreational benefit from Vembanad backwater ecosystem at Alappuzha district of Kerala - a travel cost approach.

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Vembanad ecosystem has direct and indirect use value to multiple users and provides livelihood to the people living along the backwater. The economic activities includes fishing, clam picking, shrimp farming, rice cultivation, duck rearing and recreational benefits etc. Recreational activity i.e house boat tourism is the major revenue generation activity. Currently, 1534 boats are operating in the Vembanad backwaters out of which 750 boats are registered under the Alappuzha Port Department the licensing has been stopped as the numbers are already above the optimum levels to be operated in the backwaters. The increase in boats is due to increase in the total arrival of both domestic and foreign tourists over the past decade which rose at 11.5% and 7.6% respectively. In the year 2017, domestic and foreign tourists were approximately 4.33 lakhs and 75,000 numbers respectively.

This study attempt to value the recreation benefits using travel cost approach. In this model, number of visit made by the individual per annum was taken as dependent variable and travel cost, family income, age, family size, time spent, quality of backwater were taken as an independent variables. The analysis was done using trip generating function using count data Poisson model. It was estimated that the total recreational value of Vembanad backwater in Alappuzha was Rs.5629 crores. The potential value of the ecosystem necessitates sustainable management and conservation of the backwater ecosystem, which being effected by increasing pollution as result of increasing tourist activity.

# Comparative assessment of seasonal variation in fishing related debris in selected beaches of Kerala coast

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Fishing related debris is a sizeable component of marine debris and is being widely recognized as a global concern for its adverse impacts on environment and economy. Many studies have been conducted to quantify debris on beaches and few on the Kerala coast, but there is relatively very few studies which focuses on fishing related debris. The aim of the present study is to assess the quantity and composition of fishing related debris on beaches of Kerala coast and also to study the seasonal changes in its quantity on the shore. This preliminary study involved collecting, sorting and quantifying various debris in a high and low fishing intensity beaches in North, Central and South Kerala. The beach litter survey was conducted in six beaches (Malipuram & Kuzhippily in Central Kerala, Thanur & Kappad in North Kerala, Vizhinjam & Cherazhikkal in South Kerala) along the waterline as prescribed by the NOAA Marine Debris Program during 3 seasons-pre monsoon (April-May,2017), monsoon (June-July,2017) and post monsoon (August - September,2017). Of these six beaches in Malipuram, Thanur and Vizhinjam fishing activity is high while in Kuzhippily, Kappad and Cherazhikkal fishing activity is low. The incidence of total marine debris, plastic debris and fishing related debris in both sets of beaches were compared. The seasonal variation in the number and weight of fishing related debris was also analysed. Major fishing related debris encountered were netting, rope, float, bouy, thermocol and fishing line. On an average the weight of fishing related debris in the high fishing intensity beaches during pre monsoon season was 34 ± 16 kg /100 m while that of low fishing intensity beaches came to 5 ± 3 kg/ 100m. During post monsoon season too the variation in their weight was on a similar line, with 20 ± 13 kg /100m in high fishing intensity beaches and 4 ± 1.6 kg/ 100m. But there was significant difference in result during monsoon season, with both group of beaches recording almost similar low level of fishing debris which was 2.6 ± 1.9 kg/ 100m in high fishing intensity beaches and 1.8 ± 1.5 kg/ 100m in low fishing intensity beaches. The number of fishing related debris estimated in these beaches also showed a similar variation between seasons and between high / low fishing intensity beaches. The results indicated that there was considerable abundance of fishing related debris in beaches, where more fishing crafts are operated compared to the beaches where less number of fishing crafts operated. Moreover, there was considerably lesser fishing

related debris during monsoon season when fishing activity is very low, whereas there was not much variation in the quantity of fishing related debris during pre and post monsoon seasons. Both of which highlights the contribution of fishing activities in generating marine debris. Monitoring more areas for considerably longer duration is to be undertaken for accurate quantification of fishing related debris and to design possible ways to reduce contribution of fishing industry in generating marine debris including ALDFG (abandoned, lost and otherwise discarded fishing gears).

# Marine debris in trawl fishing along Mumbai coast, Maharashtra

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Marine debris due to anthropogenic activities significantly impacts marine life all around the world. Mumbai is one of the most densely populated and highly industrialized cities in the world. Plastic pollution in Mumbai region is recognized internationally as a severe problem, and different measures are taken for its mitigation. Mumbai contributed 50.4% to the total marine fish production of Maharashtra during 2015-16 and out of 5,163 trawlers; more than 50% operate from Mumbai region (CMFRI 2015-16). Though different types of approaches are adopted to estimate marine litter in the sea, methods used for assessing the amount of marine debris on the beaches is reasonably reliable. Trawling is considered as an adequate method for estimating seabed litter. In this context, experimental fishing was carried out fortnightly from September 2017 to March 2018 using shrimp trawl in the traditional fishing areas as well as non-fishing zones for the proper understanding of abundance and distribution of marine debris along the Mumbai coast. Total marine debris collected during this study period was 9.744kg (639 numbers) from different geographical locations. Categorization showed that household related debris like polythene carry bags, plastic glasses, plastic bottles, napkins, food wrappers (milk packets, bread packets, biscuit packets, tea packets, etc.) contributed about 60.52% by weight and 82.78% by number. This remaining debris comprised fishing-related materials like torn gill and trawl nets, nylon ropes, baskets and natural debris like stones, leaves, wooden branches, seaweeds, rubber related materials like playing balls, slippers, etc. The high abundance of plastic debris was found in shallow coastal areas and sewage outflow regions. Fishing related debris was common in fishing grounds. The trawl cod-end gets clogged by marine debris thereby resulting in more Juvenile catch.

# Quantitative analysis of marine litter accumulation on high-water strandline beaches of Gujarat, India

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Marine litter has been defined as solid materials of human origin that are discarded at sea or reach the sea through waterways of domestic and industrial outfalls. Marine litter investigation has been an interesting issue for many researchers over the last few decades with its main focus being on its impact on marine life and human activities. The inadequate recycling and poor management of waste has resulted in considerable quantities of litter contaminating beaches of Gujarat. Though Gujarat has long coast line of 1600km along with the mainland with dominant sandy beaches, data on litter accumulation on high water strandline are scanty. The abundance and distribution of marine litter was quantitatively assessed in Somnath, Madhavpur and Porbandar beaches in Gujarat, India bimonthly from October 2016 to November 2017. Triplicates of 2 $\times$ 2 m ($4m^2$) quadrants were sampled in each beach with 78 quadrants. Overall average abundance of 25.8 items $m^2$ and 7.35 g items m2 plastic litter was recorded in three beaches. Marine litter accumulation significantly varied temporally and spatially at $p=0.05$. Significantly higher marine litter was recorded in Porbandar and Somanth beach. Furthermore, the highest abundance by weight was recorded during September and October month numerically. More than 85% of plastic particles were within size range of 5-150 mm both by number and weight. Moreover, coloured particles were dominant with 72% by number of items and 55% be weight. Probably, the intense use of beaches for recreation, tourisms and religious activities has increased the potential for the plastic contamination in beaches of Gujarat.

# An assessment of tourism induced marine litters on coral reef ecosystem of Grande Island, Goa, north-eastern Arabian sea of India - to explore avoidable tourism pollution

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The tourism induced marine litters assessment was attempted in coral reef ecosystem of Grande Island, Goa located 3 NM from the coast of Vasco da Gama during 2017. This island topography is more safe and suitable for recreational water sports activities such as snorkelling, SCUBA diving for beginners, professional divers and tourists. The type of reef building corals coupled with pristine and clear water attracts diverse variety of flora and fauna in wide depth range from 2 to 20m. The availability of dive centres attracts large number of tourist (50 to 80 nos. per day) which ultimately leads to the disposal of more and more plastic's let into the pristine marine environment. In this view, an underwater line transect survey was conducted in three most explored underwater diving sites (i.e., Lobster Avenue, Chow/coral garden point and Jetty point) of Grande Island, Goa. To quantify the marine litter rate, a total of 27 transects (each of 20m length) were surveyed at three depths 3m, 5m and 10m in triplicates. The study revealed that the estimated total marine litter biomass rate (gm per 200 m2) in the three sites were found to be high for ghost fishing net (230.99), followed by cosmetics (69.12), metal tins (39.02), plastic bags (36.45), diving accessories (12.62) and plastic pouches (11.01). Percentage occurrence was found to high for plastic bags (31.25 %) followed by plastic pouches (25 %), metal tins (21.88 %), ghost fishing net (9.38 %), cosmetics (6.25 %) and diving accessories (3.12 %). The highest percentage occurrence of marine litters is found at the depth of 3m (90 %) followed by 5m (65 %) and 10m (22 %). The most striking effects of tourism induced marine debris found arresting the symbiotic zooxanthellae found on live corals leading to coral mortality or coral bleach; in long run this may affects the whole ecosystem biodiversity. In addition, damage caused by anchoring of motorised tourists' boats found to be a potential threat to the reef building corals especially the plate corals. Hence, the present study suggests that an alarming situation prevailing in the pristine coral reef ecosystem of Grande Island calls

for the awareness, enforcement of non-biodegradable amendments and appropriate implementation for the disposal of tourism based marine litters. This study serves as baseline information on the extent of marine litters in the Grand Island and to create awareness on the need for eco-friendly tourism activities.

# An incidence of incorporation of fishing line in the coral reef skeleton from Palk Bay

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During the survey in Palk bay along the Pamban Island in 2015, branching coral of Acropora species have been found to include fishing lines in their reef structure. Fishermen of Palk bay operate various kinds of surface and bottom-set nets which normally entangle the target variety as well as the sessile coral reefs when they are operated in reef rich areas. In most cases when such nets entangled, fishermen cut out the entangled portion and allow it to be in the reef itself. Although entanglement of marine debris on marine organisms such as seals, whales, turtles, seabirds are routinely reported, however, the present observation clearly indicate that the corals have deposited calcium carbonate on the nylon fishing line during the reef growth, which is indicated by the nylon fishing line passing through its reef skeleton.

# Ammonia oxidizing bacteria for the restoration of deteriorated water quality in aquaculture farms

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Aquaculture is a rapidly growing sector in global food production; and maintenance of water quality is a key factor for a successful aquaculture industry. Studies have reported that use of efficient water-probiotic formulations can enhance the survival and growth of animals in aquaculture systems. Therefore, the present study was planned with an ultimate aim to develop an indigenous water-probiotic formulation for use in aquaculture systems. As the competent ammonia oxidizing bacteria (AOB) which can remove ammonia forms the critical component in any efficient aquaculture water-probiotic, the search for such competent microbe is the first step in the formulation; the same forms the basis of this abstract. As per the feedback obtained from aquaculture, farmers on a commercial amino acid plant supplement namely Amino plus (AP) regarding the minor improvement of water quality after its application, the same was screened for the possible presence of an efficient AOB. For this, selective isolation and enumeration of heterotrophic AOB from AP was attempted in specific media. Total viable heterotrophic AOB count was found to be $9X10^3$ CFU/ml AP. Morphologically unique colonies were then screened for their ammonia oxidization potential via. diazotization method. The nitrite production potential of these isolates was found to be varying from 0 to 0.1401 mg/ml of medium. The potential isolate having 62.26% efficacy was then identified as *Bacillus oleronius* by 16SrRNA gene sequencing followed by NCBI blast analysis. Further, the tolerance of these isolate to different environmental conditions was found out to check its suitability in environmental application. The isolate could grow at a temperature of 25ºC- 40ºC, pH of 6-10 and 0-5% salinity. Additionally, other metabolic versatility of this potential strain were also found out in which isolate was found to produce amylase with an enzymatic index value of 2.5; indicating the potential production of extracellular amylase enzyme. Now, further studies after enriching AP with this potential strain are needed to develop a good quality indigenous water-probiotic formulation for use in aquaculture systems.

# A comprehensive assessment of marine debris in the Seeniappa Dargha beach, Gulf of Mannar, Ramanathapuram district

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Marine debris has been defined by UNEP as "any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment". The marine debris poses a big threat to the marine life and habitat as well as livelihood of the fishermen. The objective of the present study is to determine the types and amount of marine debris accumulated in the Seeniappa Dargha Beach, Gulf of Mannar, Ramanathapuram District. The survey was conducted annually on the event of International Coastal Cleanup day observed on third Saturday of September every year. The cleanup site is one of the most prominent beaches of the Gulf of Mannar region, Seeniappa Dhargha Beach. It is a custom among Muslims to visit this Dharga often in near or distant places and pay homage to the holy man who affectionately called Seeniappa. It is also noteworthy that not only Muslims but also Hindus visit this Dharga for making their devotee offerings and for cure from evil spirits. Because of the sanctity attached to this Dharga there is a steady flow of devotees to pay their homage to holy man on the eve of Sundays and Thursdays.

For marine debris assessment volunteers comprising local people, fishermen community, school and college students participated in our beach cleanup programme every year. The survey was conducted as per the UNEP/IOC Guidelines on Survey and Monitoring of Marine Litter Regional Seas IOC Technical Series No. 83. The assessment was carried out for the past five consecutive years from 2013 to 2017. Broadly the litter observation was classified as i) Most Likely to Find Items ii) Fishing Gear iii) Packaging Materials iv) Personal Hygiene and v) other items. The quantification and characterization of the marine debris data revealed the following items in top ten composition *viz*., Plastic Bottles (33%), Plastic Grocery Bags (29%), Glass Bottles (12%), Cigarette Butts (11%), Metal bottle caps (4%) Plastic bottle caps (3%), Food wrappers (2%), Fishing nets (2%), Straw (2%), Construction Material (1%) and other items (1%).

Results indicate that the major source of litter input to the beach was higher by the local people those who frequent to beach for work or recreation. In the initial period of study, we identified that the local people lack awareness on coastal hygienic. An awareness campaign conducted to the local people and to the children studying in the Panjayat School close to the beach had created a positive impact and over the years there was a gradual reduction of debris accumulation in the Seeniappa Dargha Beach. The outcome of the study formed a base-line data of local composition of marine debris accumulation towards developing and evaluating the effective management control, enforcement rules and mitigation strategies to avoid/reduce marine debris in the Gulf of Mannar region.

# Plastic waste component in the bag net fishery along the Maharashtra coast, India

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The present scenario of development produces garbage as one of the component which adversely affects our ecosystem service and goods resulting in huge economic loss to human being. In the same way, plastic waste as a component of fish catch in fishing gears is a regular feature along the coastal waters of Maharashtra. The study on bag net fishery of Vasai fish landing centre of the Thane district was carried out during September, 2013 to May, 2014. The selected landing centre has the largest number of bag-netters compared to other fish landing centres in Maharashtra besides its geographical proximity that has helped to minimize research cost for collecting the unsegregated catch to analyse the plastic waste component in the bag net fishery. The quantity of plastic waste in the unsegregated fish samples was estimated monthly from single-day bag-netters. It emerged from the study that on an average, plastic waste comprised 3.81% of the total fish catch in bag nets during the study period (Fig. 1).

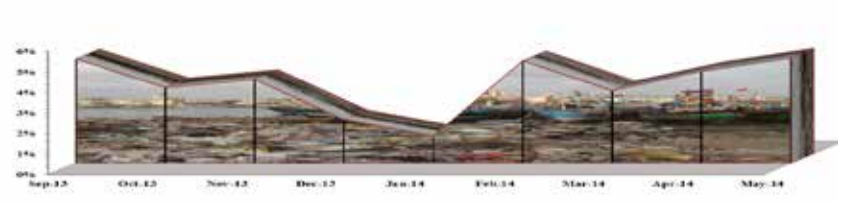

Fig: 1. Plastic waste (% of total weight) in the month-wise catch of single-day bag-net fishery

Most of waste materials were made of plastic that included bags, disposable water and cold-drink bottles, disposable cups, milk pouch, soap covers, strapping bands, sheeting, synthetic ropes, synthetic fishing nets, floats, fiberglass, piping, insulation, paints, adhesives, etc. All such marine debris is an indicator of intensity of pollution leading to long-term adverse impact on the ecosystem. These findings could be used as a diagnostic tool to project the intensity of marine pollution affecting the bag net fishery along the Maharashtra coast.

# Occurrence and distribution of micro plastic litters in the selected beaches of Palk Bay and Gulf of Mannar coast, India during January and March 2018.

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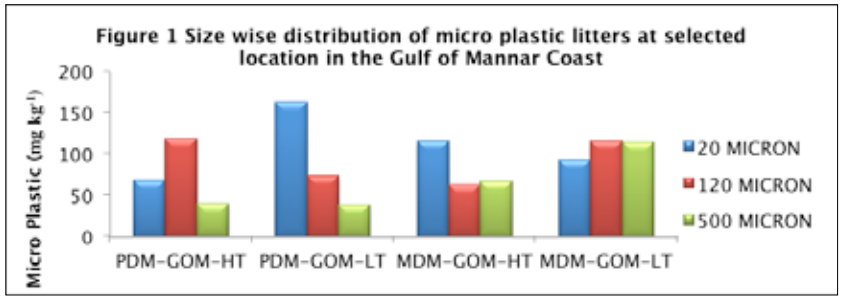
The production of plastics in the world wide was reached to 1.5 million tonnes per year in 1950. Currently it is estimated by 250 million tonnes per year and increasing by 10% each year. Stable increase in plastic and other litter usage leads to serious litter pollution along the coastal areas that increase global interest on study of sources, distribution and risk assessment. In addition, anthropogenic, non-degradable materials are well-known for fragmentation in the coastal and marine environments which leads to formation of micro litter particles. Due to their buoyant and persistent properties, these micro litters have a potential to become widely dispersed in the coastal marine environment through the hydrodynamic processes and ocean currents. These were not visible to naked eye and it is said to be the micro plastics and the size 5.0mm and below. These were ingested in a variety of organisms including zooplanktons, corals, mussels, oysters, fishes etc and indirectly consumed by the Human beings. Very few studies were carried out the sources and distribution of marine micro plastics in the Palk Bay and Gulf of Mannar Coasts. Therefore, it was aimed to study the occurrence and distribution of marine micro plastic litters in the selected beaches of Palk Bay and Gulf of Mannar coasts, India during January and March 2018.

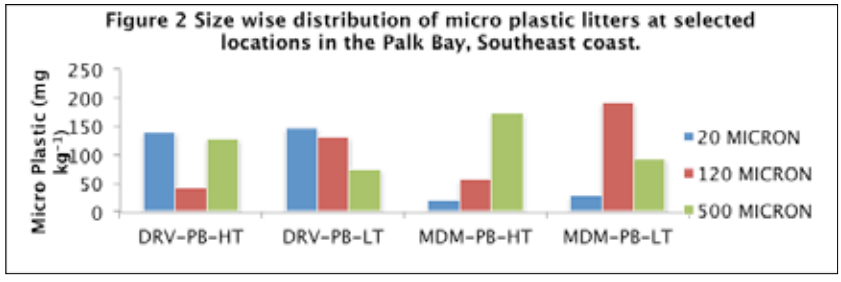
In the present study, the quantification of micro plastic litter was done based on the standard protocols developed by Besley et al., (2016) for beach sand. The beach sands from both high tide as well as low ride marks in the selected beaches such as Pudumadam and Mandapam Boat Jetty in the Gulf of Mannar and Dhargavalasai and Mandapam in the Palk Bay coasts were collected during January to March 2018. For sample collection, the quadrat at a size of 50 sq. cm was made using a wooden frame. It was placed on the high and low tide marks of selected locations and removed top layer of the beach sand upto 2-5 cm depth within this quadrate frame. The collected samples were individually mixed with 3 litres of concentrated saline and allowed to settle for 60 minutes. The samples were filtered using 20, 120 and 500 micron mesh

sieves. The filtrate was allowed to dry and weighed using upto 0.01 mg accuracy and observed under Labomed Trinocular microscope.

The total micro plastic litters collected in high tide mark at Pudumadam and Mandapam beaches in the Gulf of Mannar was 226.9 and 246.2 mg kg-1 respectively and the samples collected in low tide mark were 276.0 and 322.0 mg kg-1 respectively. In the meanwhile, the micro plastic collected in the high tide mark at Dhargavalasai and Mandapam in the Palk Bay Coast were 309.6 and 248.2 mg kg-1 respectively and in the low tide mark, the quantities were 353.1 at Dharagavalasai beach and 311.5 mg kg-1 at Mandapam beach (Figure1).

The size wise distribution of micro plastics was not dependent with tide. In Pudumadam beach, Gulf of Mannar, the low tide mark showed highest quantities i.e., 163.4mmg kg-1 of 20 $\mu$m size. Though the quantities of micro plastics segregated in both low and high tide marks at Mandapam beach showed that the highest amount was noticed in 20 micro size in low tide mark and 120 micron size at high tide mark. In Palk Bay coast of Dhargavalasai beach, the 20 micro sizes was maximum in both low and high tide marks while, in the Palk Bay region of Mandapam coast, 500 micro size plastic litter was highest at high tide mark and 200 micro size was highest in low tide mark (Figure 2).




PDM: Pudumadam ; MDM: Mandapam; DRV: Dhargavalasai ; GOM: Gulf of Mannar; PB: Palk Bay; LT: Low Tide; HT: High Tide

There was no direct relationship between tide and different size of micro plastics in the beach sands collected at all four study sites while the low tide mark noticed

higher quantities of total micro plastics in all four sampled locations and the beach of Dhargavalasai noticed maximum quantity i.e., 353.1 mg kg-1. This concludes that the higher accumulation of micro plastic litters in the low tide mark increases the chance of ingestion of micro litter particles by benthic marine organisms. Of the three different sized micro plastic litter collected, both high tide and low tide marks of Mandapam beach, Palk Bay coast reported highest quantity of 120 and 500 micro sized particles i.e., 171.8 and 196.6 mg kg-1 respectively.

# Incidence of microplastics in *Villorita cyprinoides* from Vemabanad Lake

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Derived from the polymerization of monomers, plastics are nothing but synthetic organic polymers whose production has inevitably increased in the past few decades. With this increasing production and wider use of plastics, the plastic pollution has become a looming spectre to the marine ecosystem. The presence of plastic wastes in the marine environment can be due to the industrial activities, consumption habits, fishing activities, wide usage of cosmetic products, and also due to improper management of wastes in the system. Among the different forms of plastic pollutants, microplastics are considered as an emerging contaminant of concern due to their possible ecological and biological consequences. Microplastics are referred as the small pieces of plastic which are less than 5 mm in size. Microplastics in the marine environment have become a contemporary issue and is receiving an increased attention in the recent years.

This study analysed the incidence of microplastics in the clams of Vembanad lake of Kerala. In this study, 68 samples of *Villorita cyprinoides* were collected from three locations *viz*. Kumbalangi, Kadamakkudy (Mulavukadu) and Thycattussery (Alappuzha district) of Vembanad lake. Microplastics were isolated by incubating the clam tissues in 10% KOH solution at 57$^{o}$C for 48 hours followed by filtration. The solution obtained after filtration was observed under microscope. Qualitative attributes like colour and the shape of microplastic (whether fibre, fragment or a film) were also observed and recorded. They were further confirmed by hot needle test.

In this study, microplastics were found at concentrations ranging from 0.14 ±0.20/individual at Thycattussery to 0.18 ± 0.19/individual at Mulavukadu. Across all three sites, fiber particles were the most dominate shape of microplastics (72.72%), followed by films (27.27%). Sizes microplastics ranged from 0.004 mm to 2.815 mm. The present study provides useful background information for further investigations and subsequent development of management policies to monitor and control microplastics in a fragile ecosystem like the Vembanad lake.

# Effect of marine litter on Palk bay corals in India

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The coral reefs are the primitive and highly productive ecosystem. They are more vulnerable to natural and anthropogenic threats. Coral reefs are in a great threat from man-made activities. Littering the coastal and marine environment is recently an increasing threat that makes the corals t for survival. The present study observes the impact of marine litters in the nearshore corals, series of line intercept transects made on selected sites (from Mandapam to the northern part of Rameswaram Island). Coral reefs available in the surveyed sites are classified as live, dead, macroalgae, and other features. The marine litters such as nylon sacks, ropes, monofilaments and other garbages clogged in the reefs were calculated separately. The results show 14.53% live, 21.07% live with algae, 24.10% coral rubbles, 33.26% dead coral with algae and 7.04% macroalgae. Among that, it has been recorded that nearly 18% of the corals were affected by litters. Mostly nylon sacks, ropes, and monofilament fishing lines were the major components covered the corals.

Interestingly, the types of litters observed in the field were coral form based, such as the nylon sacks in branched corals, ropes in massive corals and the monofilament fishing lines in the tabloid corals. The nylon sacks were found entangled in branched corals, the sacks covered regions were found to be dead due to blockage of light penetration and food supplements to the polyps. Algal spore settlements were found in some dead portions of the branched colonies. It was clear that sack covering can completely kill the coral colony. Secondly, the ropes were found in the nearshore tied on massive corals were used for boat moorings. The ropes are tightly knotted like parcel wrapping on massive corals and being a parasite nature to the colony. Due to wave actions and water movement, ropes were found rubbing along the sides of a healthy colony smoothening it and killing them. Thirdly, the monofilament fishing lines entangled in the tabloid corals were found as a common scenario. It made abnormal growth or deteriorated the colonial growth in tabloid forms with monofilament fishing line accumulation.

Increased coastal aquaculture industries, destructive fishing habits and lack of knowledge among the coastal community made the corals more vulnerable to this. The present study witnessed that the impact of this kind of litters poses an immense threat to the corals. The live coral cover was already low in this region and the present situation

makes it much worse. These kind of litters occupying benthic substrates are unfavourable for the coral recruits to settle down. Marine debris causes suffocation, shading, tissue abrasion and mortality of corals. The corals are already facing degradation worldwide, now the present observation on Palk Bay corals evidence that marine litter can halt the coral growth subsequently leading to mortality. There is a need for framing regulations on waste disposal in shore regions especially with fragile ecosystems and proper awareness among the coastal stakeholders about the waste management on the marine environment is significant.

# Waste mangement- issues and solutions for a coastal village along Kerala, southwest coast of India

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In the present world, plastics play an integral role in human life. Its production crosses 150 million tonnes per year globally and India contributes to more than 8 million tonnes, in terms of consumption. Plastic is cost effective, durable and holds a broad range of application, which turned it to a basic need for the human society. On the other side, 70 % of the consumption is converted as waste and when the infrastructure of the waste management system do not match with the generation rate, it becomes a menace to the society. One of the major concerns of fishermen has been the depleting fishery resources and degrading environment. With an aim to understand the magnitude of marine litter in coastal waters and the way it affects traditional small scale fishers the present study was undertaken. The study area is Mulavukad village Panchayat (latitude 10°02'98.21'' and longitude 76°25'53.26'') which is a long narrow stretch of land located in the Ernakulum district of Kerala state, India with an area of 19.27 sq km. The island is surrounded by Periyar river on the North east and Vembanad Lake on the South west. The major lively hood of the people is fishing and fishery related activities.

The main objectives of the study were to evaluate the practice of waste management in the identified coastal village, to quantify the average degradable and non-degradable waste generated in a coastal village, to estimate the abundance of litter flowing through the coastal waters adjacent to the Arabian Sea. and also to suggest mitigation measures for development as a Green coastal village. House-hold waste survey was conducted with a detailed questionnaire for elucidating information on waste management of bio as well as non-degradable waste generated in the study area by selecting representative households from each Ward. The quantity of residential waste generated from each ward was estimated by distributing two buckets, one each for bio-waste and non- degradable waste to randomly selected individual houses with a request to deposit their day to day waste materials in these. The quantity of bio-waste generated from each house was weighed on day to day basis with the help of ADS members of each ward. The data thus generated was compiled and assessed. The non-degradable waste was neatly packed and transported to the CMFRI laboratory where it was sorted, classified, weighed and

quantified. Twenty numbers of stake net holders were contacted individually on ward wise and garbage bags were distributed to them. The collected litter was sorted as per UNEP guidelines, weighed and counted to estimate the abundance of the same.

The population of this village is 22,232 with population density of 1158 per sq. km. There is no systematic waste collection method for both types of waste. In less than 5% of the households, bio-waste is processed in bio-pots. The Bio waste generated from individual house hold with 3-4 members per family was 0.35 kg and the total for Mulavukad Panchayat was estimated as 7500 kg per day or 2738 tonnes per annum. Similarly the Plastic and other non-degradable waste generation data showed that around 100 gm of litter is produced from each house which leads to a production of 200 kg of waste from the Panchayat per day (73 tonnes per annum). The percentage composition of litter shows that 68-70% of the litter generated is plastic waste namely carry bags, food cover etc. which can be segregated and recycled easily. Stake net litter sampling done on seasonal basis shows that on an average 600-650 gm per day of litter is accumulated on each stake net during their 4-hour operation in post monsoon season and 300-350 gm per net during pre- monsoon.70-90% of the waste thus collected was recyclable. The canals and creeks were surveyed and many places are having a visual spread of plastics. Details of the types of litter and the way forward to make the Panchayat a totally "Green Coastal village" is presented in the paper.

# Issues of pollution in the famous religious tourist destination and the coastal belt of Bay of Bengal, Puri, Odisha and their mitigation measure

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Odisha possess all three vital attributes of coastal tourism - sun, sea, and sand and is an amalgamation of nature and culture. The world famous Sun temple at Konark, a UNESCO heritage sites of 12th century, the temple city of Bhubaneswar (9th century) & Puri (11th century) are widely popular as the golden triangle which draws large number of domestic & international tourists. Puri urban region is an amalgamation of two important places in the cultural map of India which are both religious and recreational in nature. It is an important tourist destinations because of golden sea beach, Lord Jagannath temple, the Sun temple at Konark, the Asia's largest lake Chilika, the famous mosque in a serene environment Pir Jahania in Astaranga and nearly 72 square km Balukhanda wild life sanctuaries having plantation casuarinas and cashew nut in the sandy beach along the coast of Puri and Konark. Besides nature gift like wildlife, flora and fauna, endangered species, Irrawaddy dolphin, migratory birds, mass nesting of olive ridley turtle, animals like black bucks, Hyena, Jackal, deer and varieties of reptiles, huge mangrove vegetation, many sand dunes and sandy beaches are among to attract tourists. Tourism industry contributes around 13% of GDP of Odisha's economy. There has been a steady increase in domestic tourist arrival in the state due to regular and extensive marketing strategy of the tourism sector. There are more than 700 hundreds hotels in the seashore accommodating the burgeoning floating population of Puri. Tourism combined with religious sentiments attract more and more people to this place, exerting tremendous pressure on the environmental and cultural resources of the coastal areas and are adversely affecting the health of the sea. Besides there are many other issues like fishing villages in Penthakatha, Chandrabhaga, Arakuda, Balinolia sahi and Nuasahi harbouring more than 15,000-20,000 households living with very trying condition also cause major health issues, environmental degradation and coastal pollution. Tourism sector in Odisha is slowly declining for the foreign tourists due to lack of basic amenities like proper transport, sanitation, hygiene, financial safety and social security. There is wanton expansion of buildings and hotels in the Puri coast without adhering to any CRZ rules. Recreation in the sea sand, unauthorized vendors, solid wastes from these areas,

waste from the fishing villages, open defecation, beggars near temple and sea shore, rampant use of alcohol and drugs among the coastal communities and other activities like lack of sanitation and social security are creating a fear psychosis for the foreign tourists and the environmentalists. It is already observed that the disposal of sewage water to Puri sea by making ring wells in the seashore and the total sewage disposal of the Puri town through Banki mouth without treatment has damaged the beautiful sea shore and the golden sand. It is high time to address these issues through proper policy guidelines. Thus environmental safety and economic sustainability have to be considered in the context of protecting the fragile environment from tourism pressure and adequate rehabilitation of the fishing community with proper housing, health and sanitation. In this respect increased attention must be given to proper planning and better integration of tourism in coastal development. With this background the present paper will address the issues of pollution and their possible mitigation measures to achieve sustainable development in the religious place of Puri, which not only can bring revenue through tourism industry to the state but also would create a healthy environment and protect the fragile ecosystem.

# Impact of marine debris on subsistence fishers of Million plus city Mumbai, India

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Marine debris is a major global pollution threat having direct and indirect impact on marine and coastal environments, biodiversity, dependent community and their health etc. It has been affecting the fisheries sector in several ways especially in developing countries, which doesn't have much waste management practices or awareness on marine debris or garbage discard issues. Impact on fisheries has been mostly perceived as threat to ecosystem or marine life as entanglement or ingestion. However, the economic impact on subsistence fishers are poorly documented. Several previous studies have shown that marine waters around Mumbai is one of the most polluted in the world. We investigate and document the impact of marine debris on urban subsistence fishers of Cuffe Parade, a small traditional fisher village in the Mumbai metro concentrating on their fishery-based livelihood and socio-economics. Study shows that the economic impact occurs in terms of loss of fishing days, area, longer voyage time, damage to gears and accessories, catch decline etc. We recommend a major national study to understand the economic impact of marine pollution.

# Waste in coastal villages of Kerala - a looming threat to marine ecosystems

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Marine litter is now recognized as a complex environmental challenge which needs to be tackled on a global, regional and local scale. Since around eighty percent of marine litter is estimated to originate from land-based sources such as poor waste management and sewage overflows, the extent of waste generated in a locality and effectiveness of its management can serve as significant indicators of the threats to neighbouring ecosystems. Such threats loom large on Kerala State which is experiencing the paradox of high personal hygiene with low environmental hygiene as a consequence of inadequate infrastructure for disposal of solid and liquid wastes. Specificities of the state such as high per capita income, urban nature, high population density and extensive coastline coupled with inefficient waste management indicate significant sources of marine debris in the region. While a few academic studies have focused on estimation and management of such waste threats in urban areas, they are generally silent on the issue in rural areas. This paper addresses this research gap by estimating the quantum and composition of solid waste generated in Ezhikkara-a coastal village in Kerala- and assessing the prevailing arrangements for its management. The paper also examines the performance of the Panchayat- the entity which is legally entrusted with putting in place appropriate management systems.

Waste audit conducted in Ezhikkara estimated around 36 tonnes of solid waste generated per week most of which is disposed off unscientifically. Eighty percent of this was generated from residential buildings indicating that these should be the primary points of intervention in any management strategy. Analysis of the composition revealed that major proportion was organic kitchen waste which are bio-degradable. However plastic waste constituted a significant 11 percent, the major component of which consisted of plastic carry bags. This is much higher than all official estimates for urban areas in Kerala indicating a rising use of plastics even in rural areas. Significant quantities of sanitary waste was also being generated indicating usage of sanitary pads and diapers even in villages all of which lack proper disposal system. Open burning and dumping were the primary methods of disposal being practiced for all types of solid waste indicating threats to the environment and coastal ecosystems.

Despite 90 percent of the sample households/ institutions owning houses, living in

semi pucca and pucca buildings, nearly everyone having electricity connection and more than 60 percent having LPG for cooking purpose, almost all do not have proper drainage system for disposal of liquid waste from kitchen and bathroom. Disposal of liquid waste into water bodies was prevalent particularly among houses situated close to canals and back waters. Another disturbing practice was makeshift toilets directly over water bodies which was observed in a few households having limited land and located on the banks of canals and back waters. While a large segment discharged their waste into septic tanks, some were also observed to be using ring / pit types of toilet which are potential sources of soil-water contamination particularly during monsoon season when the rings/pits overflow. Such inadequate liquid and septage waste management has resulted in bacteriological contamination of water bodies in the Panchayat. Thus around 45 percent of water bodies tested for water quality revealed presence of E. Coli and Coliform bacteria indicating pollution stress in rural ecosystems. Lack of clearly visible symptoms of environment stress has resulted in underestimation of the magnitude of the problem and the local government, which is legally entrusted with the responsibility of putting in place adequate management systems, has not been successful in implementing effective strategies. Analysis of plan funds by the Panchayat for various schemes reveal low priority for such issues with very low allocation of funds and dismal utilisation.

The paper highlights the need for design of an integrated Environment Management Plan in villages covering solid, liquid and septage management, utilizing both plan as well as MGNREGS funds. Since people think automatically, socially and with a mental mode, pivot of the program should be on social engineering and shaping the mental mode of the local community as a whole. However it also highlights that mere awareness induced action without support systems will be unsustainable and turn counterproductive in the long run. Thus a comprehensive action plan involving relevant support systems and concerted effort by all stakeholders- state, district & local authorities, public, NGOs and civic groups is the need of the hour to face the" Damocles waste sword" which looms large over Kerala.

# Incidence of microplastics in the gut content of Pearlspot (*Etroplus suratensis*) larvae

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Large plastic waste products that fragment in to smaller pieces results in the formation of microplastics. Microplastics in aquatic ecosystems are a growing concern as they are ingested unknowingly by the fauna. *Etroplus suratensis* is the state fish of Kerala and is considered as a delicacy across the state. The species though omnivorous in its feeding habit prefers zooplankton during its early larval stages. The present study documents the presence of microplastics (polypropylene) in the gut content of pearlspot larvae (0.035±0.01g weight and 1.456±0.01cm length) for the first time. The larvae were collected from breeding grounds in Vellayani Lake (8° 24′ 09′- 8° 26′ 30′ N and 76° 59′ 08′-76° 59′ 47′ E), a freshwater lake in Trivandrum district, and were subjected to gut content analysis to ascertain the feeding habits. Microplastic fragments (1.8 $\mu$m length and 0.5 $\mu$m width) were found in the gut of larvae (8 out of 60) observed and the number of pieces per gut ranged from one to two. The microplastic fragments present were characterised using scanning electron microscopy plus energy-dispersive X-ray spectroscopy (SEM/EDS) and Fourier transform infrared spectroscopy (FT-IR). The report points to the presence of microplastics in inland water bodies and its impact on the most sort after fish in Kerala.

# Shore seine based litter assessment along the selected tourist beaches in Mumbai metropolis region

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Rapid litter survey was conducted to assess the quantum of litter and coastal debris along the selected tourist beaches of Mumbai *viz*. Girgaon Chawpatty, Juhu Chawpatty, Dadar Chawpatty and Aksa beach in the metropolis during 2016. Type of gear used for litter sampling was shore seine, locally called as Maag having length of 25 feet and width of 12 feet with mesh size 20 mm. The gear was operated in the intertidal zone with depth less than 1.5 meter. Duration of haul was kept constant i.e., 10 minutes/ haul. Each beach was sampled 9 times during the survey. Collected litter was subjected to further processing and weighted upto gram level in laboratory. Among the surveyed beaches maximum average quantity of beach litter was recorded at Juhu Chawpatty (3207.78 gm/10 minutes haul) followed by Dadar Chawpatty (2520.78 gm/10 minutes haul) and Girgaon Chawpatty (1334.22 gm/10 minutes haul). However, minimum average quantity of beach litter was recorded at Aksa beach (272.11 gm/10 minutes haul). Popular tourist beaches Juhu Chawpatty, further recorded for the widest range of litter types. Different aspects of required disposal and awareness mechanism are presented in the study.

# Observations of marine litters in various fish landing centres and occurrence of plastic debris in gut contents of climate vulnerable fishes along Ramanathapuram coast, Tamil Nadu

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The primary information of marine litter in the oceans during 1970s drew minimal attention of the scientific community. In recent years, with actual data on biological consequences of marine and associated debris on coastal ecosystem, the theme recognized an attention on research. Hence, the study was conducted to investigate about the status of marine litters and ingestion of plastics in various fish gut in six Fish Landing Centres (FLC's) of Ramanathapuram coast of Tamil Nadu. The present study reveals that the Rameswaram Verkode FLC was found to have maximum (9.464±1.488; $R^2$=0.521) and Pamban Therkuvadi FLC was found to have minimum (1.161±0.238; $R^2$=0.641) marine litters in terms of cumulative weight (kg/$m^2$). The gut of dorsal fin deformed black pomfret, *Parastromateus niger* (Bloch, 1795) was found to contain strands of fish net pieces (Length 5mm & Width 0.5mm) and non-biodegradable materials (Length 6.3mm & Width 2mm). Similarly, fish net pieces were recorded in Pink ear emperor, *Lethrinus lentjan* (Lacepède, 1802) and Indian mackerel, *Rastrelliger kanagurta* (Cuvier, 1816). The study depicts the significant entry of micro plastics and fragments from coastal areas to fishing grounds. Yet, the baseline data on the negative impacts of plastic ingested fish and its fishery; effects on food chain and food web and human health needs to be studied and strengthened.

# Temporal variation of plastic litter in traditional bag net off Mahul hemmed in by densely populated city, Mumbai

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Dol net is one of the major fishing gears operated along Maharashtra coast. It is a traditional labour-intensive fixed bag net, working entirely by the forces of tide. Study was conducted during 2016 to assess the seasonal variation of litter in the small *dol* net locally called as *Bokshi* net; operated between 8-10 m depth near Mahul creek in the Mumbai City. Net immersion period was 3 hours. Monthly catch of *bokshi* net was analysed for a year, and categorized into pelagic, demersal, crustacean, molluscan and plastic-litter. Study revealed that; during monsoon period (June-September) total quarterly plastic-litter recorded was 2166 gm followed by pre-monsoon period (February- May) 11278 gm and post-monsoon (October- January) 31412 gm respectively. The recorded plastic litter was 3%, 42 % and 45% compared with total fish catch that was analyzed during monsoon, pre-monsoon and post-monsoon. Compared with pre-monsoon and post-monsoon quantity of plastic litter recorded during monsoon is significantly low. At same station earlier during 2015, 11% of plastic-litter was observed in annual catch composition of the *bokshi* net ; however, in some locations along the coast of Maharashtra plastic in the *dol* nets constituted 40-50 % that leads to huge economic loss to the fishers. As *dol* net fishing supports the livelihood of the major population of fishers in Maharashtra; there is an urgent need of its critical and in-depth study to assess the temporal and spatial behavior of plastic-litter in various bag nets (like *dol* net, *karli dol*, *bokshi* net) at different depths ranging from 5 to 40m. The study throws a new perspective to an existing situation.

# Ghost nets in Trivandrum coast- a community understanding and initiative

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Ghost fishing is a term that describes what happens when derelict fishing gear continues to fish. Ghost nets that have been lost, dumped or abandoned - have emerged as the greatest threat of the underwater ecosystem in the sea of Kerala especially after cyclone Ockhi. Ghost nets stay for a long time- sometimes even 600 years- polluting the sea. The net fishing in rocky reef areas with modern technology like Eco-sounder and ornamental fishing in near inshore reefs using nets are emerging tendencies lead to ghost nets in the seabed. A UN 's report released in 2009 estimates that abandoned, lost or discarded fishing gear in the ocean make up around 10 percent (6,40,000 tons) of all marine litter.

Friends of Marine Life (FML) found ghost nets in many places off Trivandrum coast during our underwater studies and it entangles fish and many other marine creatures. On 18th March 2018, the SCUBA diving team of FML along with the volunteers made an attempt to remove the ghost nets from the coast off Vizhinjam and removed 400 Kg of ghost nets in just 90 minutes.

To minimize this issue it needs regular monitoring of seabed ecosystems with the involvement of coastal communities and collaborative effort of civil society organizations and scientific community.

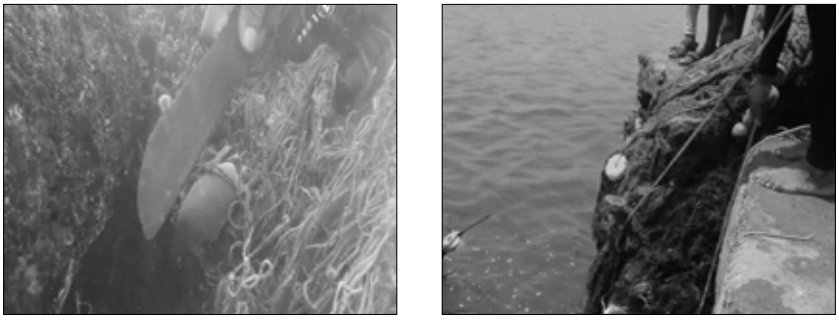

Fig. 1. A. Removing ghost nets from Vizhinjam, B. FML volunteers getting the removed huge mass of ghost to the shore.

# Marine debris clean - up program at Kovalam, Kerala

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Any persistent solid material manufactured or processed and directly or indirectly, intentionally or unintentionally disposed or abandoned into the marine system is known as marine debris. Such marine debris can injure and kill marine organisms, hamper navigation courses and create health issues to human and other living beings. The world produces 300 million tons of plastic each year. Plastic and synthetic materials are the most common types of marine debris and cause the most problems for marine animals and birds. Globally at least 267 different species are known to have suffered from entanglement or ingestion of marine debris. Friends of Marine Life (FML) and Department of Aquatic Biology and Fisheries (University of Kerala) jointly organized 'Our Ocean Our Future' a Marine Debris Clean-up Program, an initiative to raise marine literacy among the community at Kovalam beach on 11th of January 2018 and brought to the shore 71 Kg of debris and sorted out and handed over Trivandrum Corporation to process. The clean-up drive was also conducted at Enayam, Tamilnadu. It need documenting the seabed ecosystems in regular intervals with the co-operation of fisher folk and join hand together for conserving our ocean for our future.

Fig. 1. A. Marine debris settled in Kovalam seabed B. FML's SCUBA divers bringing collected debris to the shore

# Plastics in our green lungs: a case study of the microplastic abundance in the Mangalavanam bird life Sanctuary, Kochi, Kerala

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Plastics and their end disposal have been a growing concern lately due to the increase in micro-plastics distribution. As micro-plastics are mostly visible under microscope observation, it was overlooked by scientists and the public until recently. As compared to larger-sized plastic products, microplastics potentially pose a more serious threat as organisms occupying the lower trophic levels, frequently ingested these particles leading to a bioaccumulation through the food web until higher trophic levels including humans. Also, they are hydrophobic in nature which can lead to the absorption of persistent organic pollutants such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane (DDTs) which may cause health hazard when ingested. The aim of this study was to investigate the abundance and distribution of microplastics in Mangalavanam's mangrove sediments. Despite the long-term threat of microplastics on the marine ecosystem, monitoring of the abundance of microplastics has been seldom carried out due to sampling challenges. In this study, we have adopted core sampling using PVC pipes to collect the sediment samples during low tides. Microplastics were extracted from sediment samples using a modified flotation method. The results have indicated considerable accumulation of microplastic mostly in sediments of the swampy areas of the mangrove. Interpolated GIS maps were produced using Inverse distance weightage (IDW) method to indicate the spatial distribution within the sanctuary. Record of a higher abundance of microplastics in the mangroves points to more in-depth studies on the impact of such plastics on the physiology of mangrove species and innumerous associated species which are supported by this ecosystem.

# Plastic menace to the monsoon bokshi net fishers of Satpati, Maharashtra

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Bokshi nets are small conical stationary bag nets operated by artisanal fishers in coastal areas of Maharashtra. These nets are operated mostly in creeks with strong tidal currents by setting the net in wooden pole (Khunt) driven at creek bottom against the flood or ebb tide. At Satpati creek, there is monsoon specific Bokshi nets fishery for about 16 days in a month at a rate of 2 hauls per day. Opinion survey from the fishermen of Satpati revealed that, the increase in the amount of plastic in bokshi net are highly affecting the fishing operations as well as their livelihood. Three experimental Bokshi net operations were done in Satpati creek (19°43'46.67"N, 72°41'45.55"E) in the month of July 2017. Length of the nets operated was 30 m with 4 panels (Munde, Dhishe, Patala and Khola) of different mesh size varying from 70 mm to 10 mm from the mouth to the cod end. Net was set in the morning during high tide time in the khunt from surface to about 5m depth and hauling was done after 2 hours. During fishing operation, the nets accumulated huge quantities of macro-plastic. More than 85% of the catch in the net was contributed by plastic debris. On each operation 25 to 30 kg plastic litter was trapped in the net and the average catch rate of fish was only 2 to 3 kg/hr. Major plastic debris deposited in the net during fishing were plastic bags, plastic bottles/containers, chappals, boots, straps, fishing gear and ropes. Fish collected during the trials were analysed in the laboratory. 39 fish species were recorded from the catch. Commercially important fishes from the catch were ribbon fish (Lepturacanthus savala), cat fishes (Arius maculatus), bombay duck, mullets, mud crabs, sciaenids and non penaeid prawns. The results from the study revealed that, there is good diversity of economically important fish and shellfish species in Satpati area which can support livelihood of subsistence traditional fishermen. But at the present scenario, Bokshi net fishers are not getting enough remunerative price because of low catch, high sorting time, low soaking time and gear damage due to plastic menace. The impact of plastic debris on the life and well being of coastal bokshi net fishers of Maharashtra is a matter of concern which need to be addressed by different management plans emphasizing on Marine plastic pollution.

# Status of marine litter in the beaches of Karnataka and Goa

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Marine litter reduces the aesthetic value of beaches and hinders navigation in rivers and seas. Besides, the degraded and fragmented plastic materials are ingested by the marine organisms residing in the area. The source of marine litter is mostly through various direct and indirect anthropogenic activities. The coastline of Karnataka extends over a length of 320 km and has numerous river mouths, lagoons, bays, creeks, cliffs, sand dunes and beaches. Goa has a coastline of 151 km and the beaches attract many local and foreign tourists. Monitoring marine litter is crucial to assess the efficacy of measures implemented to reduce the abundance of plastic debris. Hence, a study was taken up to assess the status of litter along the beaches of Karnataka and Goa during September-October 2013 and August 2014 respectively.

The Western Ghats (Sahyadri) forms a major water divide, with short swift flowing rivers in the west draining into the Arabian Sea. Erosion along river mouths and along the coastline occurs especially during monsoon. Based on the importance of the beaches for fishing activities and places of tourist attraction 33 beaches along Karnataka and 20 beaches of Goa were selected. The litter was sorted (Table 1) to assess the pathway and origin of litter. Line transects method (triplicate of 1m2 quadrats) was used for collection of litter from the selected beaches perpendicular to the shoreline from shore to the waterline. The population density of the place adjacent to the beaches was estimated from SEDAC 2011 and based on the presence of river outfall near to the selected beaches and away from it, the beaches were separated. ANOVA showed difference ($P<0.001$) in the number of litter in group B in the beaches near and away from river. The maximum litter number and weight was observed in beaches near to the river (Table 2). ANOVA showed difference ($P<0.0001$) in the population density district wise adjacent to the beaches. Karnataka coastal beaches had the highest density (805.9 nos/km2) and total marine litter number and weight (Fig.1&2). In Goa 75% of beaches were in the category of Pristine ($<1 g/m^2$) to moderately littered (20.01to 50 $g/m^2$) while 39.3% of the beaches were below the category of moderately littered in Karnataka. In Goa the Vagator, Calangute and Mobor were well maintained and devoid of litter while the beaches Anjuna and Baga were highly eroded with no beach during the observation period.

Table 1 List of litter components in the different groups

| Group | Component |
|---|---|
| A | Nylon/HDP ropes/fish net pieces |
| B | Plastics (covers, sachets, containers of creams, oil, ointments, toothpaste etc) |
| C | Chappals (footwares, other than leather items) |
| D | Glass bottles, electronic bulbs, CFL bulbs |
| E | e-waste (TV/ computer hardwares, mobile phone handsets or parts, chargers) |
| F | Thermocole, PVC insulators of A/C refrigerators, styroform |
| G | Others (cloth, metal etc) |

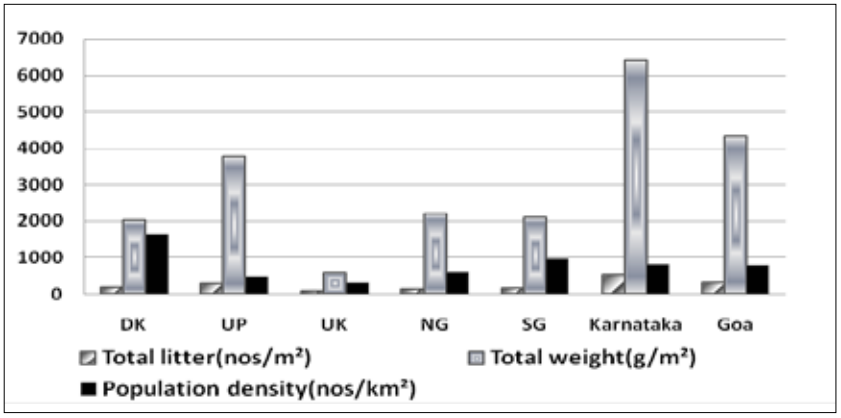


Fig.1 Total litter number, weight and density of population in the different districts of Karnataka and Goa (DK-Dakshina Kannada, UP-Udupi UK-Uttara Kannada, NG-North Goa. SG-South Goa)

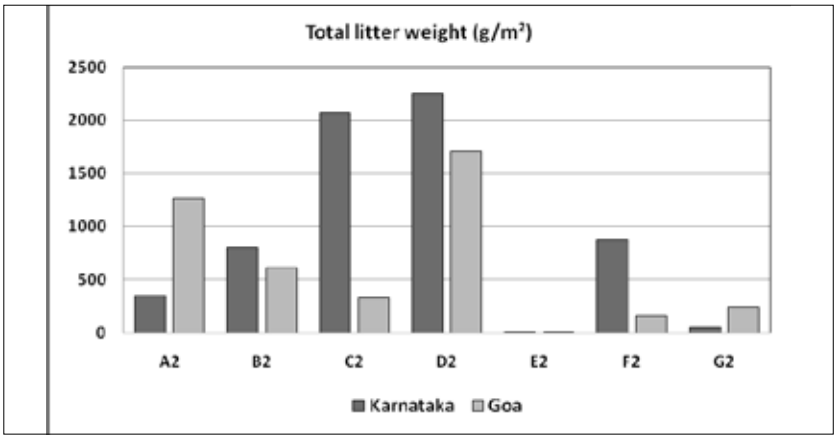


Fig.2 Fig.2 Total weight of litter in different groups in both Karnataka and Goa

Table 2 The litter number and weight observed in beaches near and away from the river in Karnataka and Goa

| Beach | | Total no (nos/$m^2$) | Total wt |
|---|---|---|---|
| Near River | Mean | 24.6 | 366.9 |
| N | 18 | 18 | |
| Sum | 443.1 | 6604.2 | |
| Maximum | 93.7 | 1817.2 | |
| Away from River | Mean | 13.4 | 137.8 |
| N | 30 | 30 | |
| Sum | 402.3 | 4132.8 | |
| Maximum | 47 | 810 | |

# SUCCESS STORIES

# The removal of ghost fishing nets from Sindhudurg, west coast of India

## An experience, learnt lessons and way forward

**Sarang Kulkarni**

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## Introduction

Government of Maharashtra's Tourism Development Corporation established India's first integrated and largest scuba diving institute "Indian Institute of Scuba Diving and Aquatic Sports (IISDA)" in Tarkarli, Sindhudurg district, Maharashtra in the year 2014. IISDA is the only government institution in India with all modern infrastructures in scuba diving, capacity building in marine programs and in-situ marine conservation initiatives.

The genesis of IISDA played an important role in creating alternate livelihood for the local youths in scuba diving by establishing Sindhudurg coast as scuba diving destination. Today over 500 youths are directly employed in scuba diving industry. It has diverted the focus from fishing to non consumptive usage of marine resources in the form of ecotourism which has resulted in higher degree of awareness among coastal communities of Sindhudurg on the importance of marine conservation.

The fishing nets constitute over 45% of the marine debris. And these fishing nets are termed as ghost fishing nets. The issue of 'ghost fishing' first gained global recognition at the 16th Session of the FAO Committee on Fisheries in April 1985, and can be defined as the mortality of fish and other species that takes place after all control of fishing gear is lost by a fisherman. Ghost fishing occurs when passive gears such as gillnets, trammel nets, wreck nets, and traps, are lost or discarded and continue to trap commercially important species of fishes and crustaceans as well as non-commercial species of fishes and crustaceans, birds, marine mammals and turtles. The ghost fishing nets generally occurs where the local fishermen regularly carry out fishing activities. The ghost fishing issue is greatly and directly affecting the livelihood of traditional fishermen.

## Description of the Waste

Non degradable ghost fishing nets have become a serious issue along this coast.

Majority of the population of Sindhudurg, are traditional fishermen whose livelihood is dependent on the coastal waters. Due to the presence of rocky habitat, several types of nets get entangled in rocky bottom and due to the failure in retrieval of these nets; fishermen having no other option, than cutting the nets which remains underwater forever. Sindhudurg coast having been identified as a biodiversity hotspot, even reported to have a population of 600 Humpback dolphins, has become a death ground for the marine resources along this coast due to these ghost nets. They also entangle with active fishing gears and vessel propulsion systems, raising potential safety issues. All this was revealed through underwater studies by scuba diving initiated along the coast of Sindhudurg.

## How was it done?

Removal of the nets from underwater areas physically was the only solution for this problem. And for this we required personnel of higher degree skill and experience in scuba diving, equipments, boats and sound recognition of surrounding water's bathymetric profile and the habitat. And this is where IISDA had to play its role. All over the world several initiatives have been taken to eradicate the ghost fishing nets from sea bottom. However, in India ghost fishing net issues was never dealt directly underwater.

IISDA was conducted capacity building program for 20 local youths in professional scuba diving under the GOI-UNDP-GEF initiative. As a part of the course, each student was to carry out 40 dives to qualify the dive master program. These dives were used to carry out the removal of ghost fishing nets .

Rescuing sea turtles trapped in the ghost nets

Removing floating ghost nets

Rescuing sea turtles trapped in the ghost nets

Rescuing crabs trapped in the ghost nets

Over 800 hours were spent underwater to trace and remove ghost fishing net. Fishing nets covering an area of over 2 lakh square meters was removed from the bottom and surface of the sea. Several turtles, fish, invertebrates were rescued and released back to the sea. Further loss of marine resources and marine endanger animals such as turtles, dolphins and porpoises were prevented. This was first of its kind initiative in India.

## The Impact

The ghost fishing net removal initiative by IISDA has created greater degree of awareness among local fishermen communities, youths as well as many NGOs.

## The adaption by others

Our efforts had resulted in underlining the damages due to the ghost fishing nets as a great threat to marine life in Sindhudurg. As a result, Department of Fisheries, Department of Forests and Department of Environment (Government of Maharashtra) have included the removal of ghost fishing nets along the coast of Maharashtra coast in their programs. It created effective awareness among local fishermen communities which now actively are involved in removal of ghost fishing nets. Several youths now actively are involved in removal of ghost fishing nets. Youth from fishermen communities have formed NGO and regularly remove the marine debris from the ocean and rescuing marine life such as turtles.

## Economic Aspects

There is not scientific data on the rate of loss of fish, invertebrates by ghost fishing nets. However, the removal of 2 lakh square meter of net may have saved loss of over 200 tonnes fishes annually thus saved loss of Rs. 4 Crore fishery resource and it saved loss to thousands of local fishermen. However, this is just tip of ice berg as this initiative was taken in very small part of the coast. If these figures are extrapolated to the entire coast and depth upto 20 meter, then loss could go to several thousands of tones of fishery resource and hundreds of crores rupees revenue.

## Conclusion

The ghost fishing net is a major threat to precious marine resource and marine endangered animals in India. The decline in fish catch by traditional fishermen is attributed to ghost fishing net which is resulting in negative impact on livelihood of traditional fishermen and marine ecosystem. It is necessary that Government of India and that of the coastal states develop a sustainable plan in the form of policies for removal of ghost fishing nets from bottom of seas with the help of local communities. For the same it is important to build highly skilled capacity and infrastructure at local and regional level which will have effective impact on awareness and sustained program on removal of marine debris and ghost fishing nets. There is also a need to form rescue and rehabilitation centers of sea turtles which are rescued from ghost fishing nets before release back to the ocean.

# Bio medical waste treatment facility

By IMA

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## Introduction

Indian Medical Association, Kerala State Branch, established IMAGE, a state-of-the art Common Biomedical Waste Treatment and Disposal Facility at Kanjikode (Palakkad) for the scientific handling and management of biomedical waste generated from health care facilities in Kerala. IMAGE was launched on 21st October 2001and it was commissioned on the 14th December 2003. IMAGE was conceived and launched to support healthcare providers to overcome the challenges posed by the responsibilities laid down in the Biomedical Waste (Management and Handling) Rules 1998.

IMAGE (Indian Medical Association Goes Eco-friendly), the biomedical waste treatment and disposal project of the Indian Medical Association has been wrought with challenges. IMAGE is unique in conception and execution. The project is a testimony of the grit, determination and social commitment of the Indian Medical Association. IMA by its persistence has achieved resounding success by overcoming the difficulties in dealing with a ravaging issue as waste. The story of IMAGE is a reflection of public trust and the unshakable faith in IMA's credentials. IMAGE is an institution of excellence and is now renowned as "THE KERALA MODEL" having catapulted God's Own Country ahead of other states in the field of Biomedical Waste Management. IMAGE is now the largest Biomedical Waste Management Plant in the country.

IMAGE, at the time of its inception in year 2003, had commenced operations with one incinerator, one autoclave, one shredder with a single sharp pit. IMAGE evolved over the last 13 years through a sustained expansion program adhering to the needs of its clients by embracing modern technology and equipment. All the districts in the state was brought under the preview of the service rendered by IMAGE in phases. During the initial years of its inception it was the major private hospitals in the state who had benefited from the service of IMAGE. In the year 2005 the Government of Kerala approached IMAGE for extending the coverage to the Government Healthcare Institutions as well. A Memorandum of Understanding was inked between the Government of Kerala and IMAGE bringing all the Government


Healthcare Institutions in the preview of the service of IMAGE. The vast expands of the project now renders IMAGE as the largest Common Biomedical Waste Treatment and Disposal facility in INDIA.

The plant is situated in the midst of 25 acres of land. There are 5 main buildings & few small buildings for the plant with a total plinth area more than 50,000 sq.ft.

## Common Bio medical Waste treatment Facility

CBWTF, as an option has also been legally introduced in India. The Bio-medical Waste (Management & Handling) Rules, 1998, gives an option to the Bio-medical Waste generator that such waste can be treated at the common bio-medical waste treatment facility. The Second Amendment of the Rules in June, 2000, further eased the bottleneck in upbringing the CBWTF by making Local Authority responsible for providing suitable site within its jurisdiction.

The concept of CBWTF is also being widely accepted in India among the healthcare units, medical associations and entrepreneurs. In order to set up a CBWTF to its maximum perfection, care shall be taken in choosing the right technology, development of CBWTF area, proper designing of transportation system etc. to achieve optimum results. These key features of CBWTF have been addressed in the IMAGE plant with utmost care & perfection.

The wastes produced in the course of health-care activities carry a higher potential for infection than any other type of waste. Inadequate and inappropriate handling of health care waste can have serious public health consequences and a significant impact on the environment. Safe and reliable methods for their handling and management are therefore essential, wherever they are generated. Thus the management of health care waste should be put into a systematically multifaceted framework. It should become

an integral feature of health care services.

The Ministry of environment, of the Government of India promulgated the Bio Medical Waste (Management and Handling) Rules, 1998. These rules apply to all hospitals, clinics and veterinary institutions animal house, pathological laboratory, blood bank etc. who generate, collect, receive, store, transport, treat, dispose or handle biomedical waste in any form.

As per these rules it shall be the duty of every occupier of an institution generating biomedical waste to take all steps to ensure that such waste is handled without any adverse effect to human health and environment. This includes hospital, nursing home, clinic, dispensary and veterinary institutions.

## Segregation of BMW at source

Colour coded bags and containers are provided in sufficient numbers to HCOs for seggregation and collection of waste at source. Special training is imparted to hospital staff regarding seggregation and collection.

## Biomedical waste treatment details

On an average, about 25 Tonnes of Biomedical waste reaches the IMAGE plant daily, of which 15 Tonnes are Incinerable waste (collected in Yellow bags) & 10 Tonnes Autoclavable waste (collected in Red bags). This waste is collected from all 8000+ healthcare centres across the state of Kerala within 24 hours of its generation.

The affiliated institutions are ensured the following services by the IMAGE.

1. Imparting training to appropriate staff of the institution for scientific segregation

of biomedical waste.

2. Provision of appropriate colour coded bags and containers for reasonable price through PEPS wing of IMA.
3. Daily collection of appropriate segregated biomedical waste from the institutions.
4. Transportation to common treatment plant at Palakkad.
5. Safe disposal of the Bio medical waste in the plant as per biomedical waste handling rules.
6. Annual statement regarding the quantity of biomedical waste collected and disposed on behalf of the institution.
7. Facilitate to obtain the authorization from the Pollution Control Board for functioning of HCEs.

The quantity of biomedical waste handled by IMAGE

| DAILY | MONTHLY | YEARLY | |
|---|---|---|---|
| AUTOCLAVABLE WASTE | 12 Tonnes | 360 Tonnes | 4300 Tonnes |
| INCINERABLE WASTE | 20 Tonnes | 600 Tonnes | 7000 tonnes |
| TOTAL | 32 Tonnes | 960 Tonnes | 11300 Tonnes |

## Other Services offered by IMAGE

### Koumarasree Project

"Koumarasree" is an extension of Biomedical Waste Management activity of the Indian Medical Association Kerala State Branch attempting to ensure a clean and safe environment. IMAGE attempts to spread its activity beyond safe disposal of biomedical waste from healthcare institutions across the state by joining hands with the local branches of Indian Medical Association to scientifically dispose used sanitary napkins from school across the state. The services of IMAGE will be rendered to schools sponsored by the local branches of the Indian Medical Association.

## Service offered to Pharmaceutical Companies

Scientific disposal of Discarded Medicines and provision of statutory Destruction Certificates are the services offered by IMAGE to all registered Pharmaceutical Firms in the state.

## BMW Collection from Apartments

Bio Medical Waste emanating from the apartment complexes in the cities in Kerala is assuming humongous proportions. As pioneers in the field of Bio Medical Waste Management, IMAGE envisages the first and only project in INDIA to scientifically collect treat and dispose these wastes by entering into an agreement with CREDAI CLEAN CITY Movement, which is a project of CREDAI, Kerala.

# FUTURE CONCEPT

## Research Centre

IMAGE is planning to set up one research centre with consent from Kerala University of Health Sciences (KUHAS) to facilitate training on Biomedical waste management solutions & also for training health care workers across the Kerala on safe handling & proper segregation of biomedical waste. We have also initiated discussion with KUHAS on starting Paramedical Courses related to Biomedical Waste Management.

## Need for additional Facility

The IMAGE Plant at Palakkad was established as a health industry wide response to a crisis situation in the handling of biomedical waste management and has taken the burden

of handling a large capacity of average 30 tonnes of biomedical waste per day using a fleet of 40 vehicles covering 7500 kms per day. However, due to the immense pressure felt on the facility at Palakkad, owing to the humungous volume of bio medical waste being brought into the facility on a daily basis, the current situation is not ideal for the state especially with its unique geographical layout, road congestions and high density of health care beds. The current model has inherent risks of potential accidents with resultant spills of toxic biomedical waste and also higher transportation and handling costs to transport waste from southern and northern parts of the state.

It is well understood from experience and published studies that there is increased efficiency and safety in handling biomedical waste with in specific geographical clusters itself. Also a risk mitigation strategy for a scenario of shutting down of the current plant in Palakkad due to unforeseen circumstances like a natural calamity which would lead to pile up on biomedical waste across the state due to lack of an alternate facility.

Thus IMAGE itself has advocated the concept of creating a more decentralized approach with division of the state into zones for logistical purposes and more efficiency in handling of biomedical waste. This would have enabled us to make sure that the biomedical waste is not transported beyond the stipulated distance of 150 kms as per Biomedical Waste Handling Rules.

## Kochi Project

There is an increased growth in bed capacities in Kochi hospitals adding over 700-800 tertiary care beds per year in average. Ernakulam District is the largest district which generates the highest quantity of biomedical waste in the state. Also there is an additional scenario of increasing quantity of biomedical waste being generated at domestic level. A recent study by Confederation of Real Estate Developers' Association of India (CREDAI) has identified increasing issues of disposal of this waste especially in large apartment complexes.

# ‘Thelima’ Kolayad Grama Panchayath

**K. P. Suresh Kumar[1], Munna P Sadanand[2], E K Uma[3]**

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## Introduction

A cleaning project named ‘Thelima’ was introduced in the panchayath for solving waste products in the society.

## Description of Solid waste

As the Panchayath is near to the forest wastes were dumped near its area. The forest area is considered as the easy area for dumping food waste after marriage. Plastic carry bags, used plates and glasses were creating pollution to the society. People used to throw plastics in public places. Burning of waste plastics were common in the area.

## How was it done?

Kolayad Panchayath introduce “Green Protocol” campaign in the area. Panchayath authorities conducted meeting with all stake holders including Kudumbasree, Youth clubs, political parties, catering agents, owners of auditoriums etc. at different levels. In this meeting process, guidelines and benefits regarding waste management were discussed and necessary action was taken.

Saree bags were used instead of plastic bags. Panchayath provided saree bags at free of cost which are manufactured by the Kudumbasree members with the help of old sarees collected from houses of panchayat. Plastics and other materials were collected and recycled with the help of recycle units and degradable wastes were converted to compost by the households.

A programme named “Malinyamillatha Mangallyam” (Waste less marriage function) was implemented. This programme directs the citizen to conduct functions of marriage by observing green protocol. Food was served in steel plates and glasses. Panchayath is providing steel plates and glass through anganawadis with no rent. No flex and decorations were used made with plastics.

"Sujalamsulabham" (Clean water everywhere) was implemented for water conservation. Constructed bunds at each and every streams after the monsoon. Rain harvesting pits were constructed Permission will be given to those who plant at least five seedlings of plants (except teak wood and mahagony) within the plot intended for the construction of new house. They should submit the photographs for ensuring the sustainability of the programme. If all these planted seedlings are properly maintained then only the application for registering and numbering the house will be undertaken. The registered houses only get water connection and electricity connection.

Steel bottles were used instead of plastic bottles in all schools of the panchayath. Steel bowls were used instead of plastic bags for buying fish. "Harith Award" was given to best institutions for following green protocol. Various awareness programmes were conducted for implementing waste management in panchayath.

## The Impact

Earlier people used to dump wastes near forest and burn plastic. But after implementing the project these problems were solved.

## Adoption of this method by others

This project create awareness among the people. Green army by a group of voluntary youngsters were constituted in each wards monitored all activities and submit report to the Panchayath.




## Economic aspects

Panchayath decided to collect Rs.10,000/- from those persons who violate green protocol which was implemented in panchayath.

## Conclusion

Various awareness programmes in each and every ward educate the people regarding the need for observing green protocol and creating clean and green panchayth.

# "Garbage doesn't have to be a dirty thing"

**Gayitri Handanahal[1], Bindu Sulochanan[2]**

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## Introduction

Waste Impact Trust is a NGO founded by Ms. Gayitri Handanahal who has served for 13 years in the social sector under diverse areas such as skill development among BPL Self Help Groups, Safe drinking water with the Naandi Foundation. For the last four years she has been working in Solid Waste Management. She conceptualized and coordinated a programme namely, "Reimagine Waste" as a series of Waste Hackathons in collaboration with the Centre for Product Design and Manufacturing (CPDM) at the Indian Institute of Science (IISc). These hackathons have specific themes on waste and are supported by corporates and institutions through 4-day events and the post hackathon activities. Hackathons provide a platform for creativity to find low cost, high impact solutions for day to day problems of waste management using technology. The unique aspect of these hackathons is that the vulnerable communities are part of the hacking teams and contribute to solutions from conception to prototyping to creating business plans.

## Description of solid waste

Both biodegradable and non-biodegradable wastes are targeted. In the pilot project conducted with 'Trixie' at Nayandahalli- plastic waste wires of various diameters having aluminum or copper inner wires are targeted. 'Waste Samaritan' the other pilot targets all types of house hold waste.

## Mode of collection/transportation/processing

"Reimagine Waste"-a series of Waste Hackathons conducted in Bangalore in collaboration with CPDM at the IISc campus facilitated the process of co-creation of, innovative solutions in solid waste management.

**REIMAGINE Waste 1-** The Waste Picker- was conducted in April 2016 for four days. Activities included, immersion, problem pitching, hack-team formation, solution

Crystallisation, prototype making, business plan making and solution pitching. Among the 36 solutions emanating from the hackathon "Waste Samaritan" has developed a system to enforce source segregation at house hold levels and a machine by 'Trixie' group to separate the plastic covering on the waste wires and extract metal in a safe and productive manner.

**REIMAGINE Waste 2-** The Street Food Vendor- was conducted in collaboration with CPDM, IISc in August 2017. 175 participants had taken part including 26 Pourakarmikas, 15 waste collectors and 7 street vendors. 3 teams are on the verge of piloting their solutions.

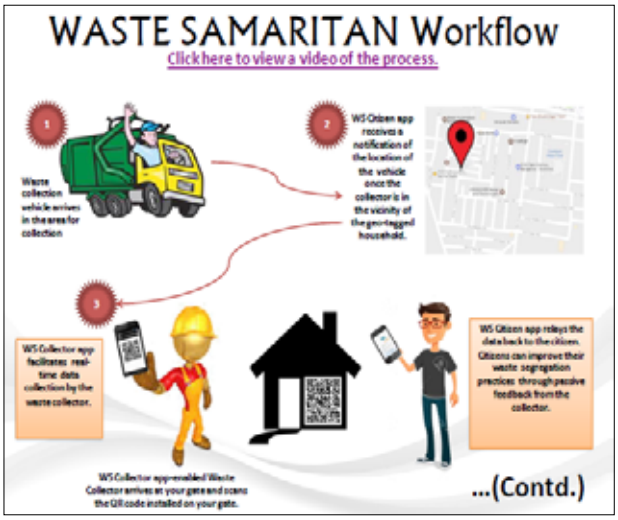
Out of some 32 teams hacking during the Reimagine Waste-1, on issues faced by waste pickers on a day to day basis were discussed - 2 teams are on the verge of becoming startups as social enterprises. One of them - 'Waste Samaritan' created an app with 3 interfaces- 1. The collector 2. The citizen and 3. The back end analytics. A QR code ensures each house is geo-tagged on a central database. Pourakarmikas will record their attendance at every house by scanning the code and rate its level of waste segregation. This also ensures that no house is missed. At the citizen's end, the app helps track the local waste collector. The second team Trixie developed a simple tool for peeling plastic and extracting metal from waste wires. The first bench prototype developed during the Reimagine waste hackathon was ready by the 45 day challenge. The next 3 prototypes were delivered by the fabricator 'Surya Industries' on the 20th of January 2017. There were some glitches which were taken care of. All four prototypes are now in use. After a few days of house trials, they were taken up for field trials from the 28th January 2017 onwards. The prototypes are undergoing much iteration based on the feedback from end users.

45 day challenge

As raw material comes in different size ranges

## Impact

Team "Waste Samaritan" consists of Wisvesh B S who works for Infosys and Krishna a DWCC manager conducted a pilot at Domlur with 152 households and the results worth to emulate in other areas. Initially the citizens were not willing to segregate the waste, as per the statement of waste collectors in the piloting team. Only 1 to 4 houses in a line were segregating the waste. The mobile app, rates the segregation of each house hold on a 5-point scale. The fact that this data can be monitored on a dash board at





Trixie prototype

the BBMP or RWA control room increases the motivation to segregate better. There is a visible improvement in the quality of egregation and awareness among the citizens.

A pilot was conducted with 'Trixie' at Nayandahalli to evaluate the tool and the difference it could make to the lives of wire strippers. In total observation time of 23 days - five family members (all women and some of them were part of the hacking team) contributed wire stripping work.

## Adoption of this method

There was a visible improvement in the quality of segregation and awareness among the citizenry through "Waste Samaritan" venture. Proposals have been given to 4 wards and we hope they will be adopting this system. Self Help Groups are being formed to take up 'Trixie' as an enterprise.

## Economic aspects

For the Trixie project, the raw material - waste wires-are bought at anything between Rs.35 and Rs.80/kg from various sheds/dealers/homes in the locality. The price paid depends on the quality of the material and the need of work at home. Once the wires are stripped, the metal is sold between Rs.200 and Rs.300/kg depending on the kind of metal and quality of metal. The stripped plastic fetches about Rs.14 to Rs.18 depending on the quality. In the total observation time of 16 days it was found that the average productivity per person with 'Trixie' will be 3 times greater than that when the same is done manually. The productivity is likely to increase with iterations on the machine design and refining of the process. The earnings can increase to about 4 times what they are making now.

## Conclusion

The success of Reimagine Waste may signify the coming of age of social hackathons in the city. We are now planning Reimagine Waste - 3 in the month of August 2018 in collaboration with CPDM-IISc under theme 'Water and Waste'. Our ultimate goals are to reduce non-recyclable waste to $< 20\%$, transform 80% of waste we produced into value, create opportunities for up-valuing waste, create more scalable and equitable businesses and finally to create a smarter and cleaner future for Indian cities.

# Plan@Earth- NGO for turning waste as a resource

**Mujeeb Mohammed[1], Sooraj Abraham[1], T. G. Sumithra[2], Reshma[3]**

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## Introduction

Plan@Earth is a Voluntary organisation registered as a charitable trust under the Travancore-Cochin Literary, Scientific and Charitable Societies Act (Reg No ER-313/09). It works in the area of environment conservation by offering solutions for waste management. Plan@Earth believes that "waste is not a trash but a resource" and proper waste management is the vital part for sustainable development of society. The activities of Plan@Earth are directed towards the 6 Rs namely, Reduce, Reuse, Refuse, Restructure, Remove and Recycle. The first 3 Rs are achieved through awareness classes, campaigns, street-plays. The other 3 Rs are achieved by training the community to segregate waste at source followed by door to door collection of waste from over 20000 households using push carts and directing clean and dry waste collected for recycling. The dry waste that cannot be recycled are washed and made into bags, file-folders, items of home décor using the method of up-cycling. With the help of the mechanical engineering dept of SNGCE College, Kolenchery, Plan@Earth has also developed a machine to make "Eco-Bricks" using discarded plastic packaging and sand. Every year Plan@Earth carries out nearly 200 awareness classes and uses mimes, skits, street plays and dramas performed by student volunteers to get the message across to the public. Each project in this NGO can support 20-25 women from poorer backgrounds as means for poverty alleviation.

## Description of solid waste

Non-degradable wastes are handled. Monthly 50, 000 kilos of dry waste mostly plastic gets collected, sorted, graded, and recycled through door to door collection of over 20000 households and shops. The waste is then manually sorted into 62 grades. 38 grades are sent for recycling to respective recyclers located in different parts of south India. The dry waste that cannot be recycled are washed and made into bags, file-folders, items of home décor using the method of up-cycling. Plan@Earth has operations in 4 municipalities and 4 panchayaths (Aluva, N. Paravoor, Angamaly, Chalakudy, Kodakara,

Karumalloor, Kadungaloor and Edathala). Last year 600000 kilos of plastic and other dry waste was sent for recycling through the efforts of Plan@Earth.

## Mode of collection/transportation/processing

Door to door collection of waste from > 20000 households (Suchitwa Sevanam) of 4 municipalities and 4 Panchayaths (Aluva, North Paravoor, Angamaly, Chalakudy, Kodakara, Karumalloor, Kadungaloor and Edathala) are done using push carts.

The waste collected mostly belonged to plastic in nature. After collection, the waste are weighed and documented, and then brought to decentralised hubs. The waste is then manually sorted into 62 grades, of which 38 grades are sent for recycling to respective recyclers located in different parts of south India. The dry waste that cannot be recycled are washed and made into bags, file-folders, items of home décor using the method of up-cycling. A workforce has been trained and retained to carry out the skilled work of sewing and weaving to convert waste plastic into bags. Over 120 workers are employed at various levels of waste collection and processing. With the help of the mechanical engineering dept of SNGCE College, Kolenchery, Plan@Earth has also developed a machine to make "Eco-Bricks" using discarded plastic packaging and sand.

## Impact

There was no system for plastic waste disposal in the working areas before they have started. Plan@Earth initiated a waste management culture which made the people in these premises to carry out the waste management in much more systematic way.

In terms of carbon saved, 50000 kilos of plastic that is collected and recycled can be accounted as 50000 kilos of carbon dioxide saved from burning, landfills or ending up in the ocean. In order to convey the message of reducing the use of plastics, nearly 5000 cotton bags and paper bags are distributed among a chosen community. Members of the community are also trained to make their own carry bags from old rags.

## Adoption of this method by others

There was no system for plastic waste disposal in the working areas (4 municipalities and 4 panchayaths of Ernakulam District) before they have started. Plan@Earth initiated a waste management culture which made the people in these premises to carry out the waste management in much more systematic way.

## Economic aspects

The waste removal projects are made sustainable by collecting a monthly service fee of Rs. 30-50 per household, as well as using the CSR funds of companies (like Apollo Tyre's Founadtion). The cash received from the sale of recyclables also contributes to make this project run in a sustainable manner. Each project can support 20-25 women from

poorer backgrounds and is a means for poverty alleviation. In terms of carbon saved, 50000 kilos of plastic that is collected and recycled can be accounted as 50000 kilos of carbon dioxide saved from burning, landfills or ending up in the ocean.

## Conclusion

Every year thousands of tons of solid wastes are getting dumped in landfills or burnt up in black smoke. Plan@Earth tries to save the waste from getting charred or buried. Our aim is to work towards a waste-free future where reutilization becomes the norm. Considering the success of this small start up in local bodies in Ernakulam district, we plan to extend our projects to all over Kerala for a better and cleaner environment in future.

# No waste in Universe- Nature recycle all the waste

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## Introduction

Since my father was a book binder, from my early days I got a chance to assist in the work around fifty years back. He has fabricated own equipments for the industry. Having completed my graduation in Botany from Maharaja`s college in 1969, I got a chance to study Pulp and Paper Technology, Saharanpur, U. P. donated by the Swedish Government for transfer of technology.

On completion of course having a duration for 3 years, by the help of family I have started own handmade paper industry at Thammanam for production of handmade paper and boards from the waste paper collected from own industry and nearby industries.

When M/s Hindustan Paper Corporation started the Newsprint Paper Production unit at Vellor, Kottayam District, joined as a senior operator in production paper machine in 1979. In Asia, this was the first paper mill having a capacity of 350 M Ton from wood, bamboo and Era. In the year 1993, 100 ton plant was started for production of pulp from used newspaper and paper wastes.

While I was in service, worked in various sections of production and in 2003, I was transferred to R and D for conducting research for converting around 15 M Ton waste generated to useful production for own use for packing the reels.

Here I got a chance to study how to handle the problems due to accumulation of solid waste like paper, plastic etc.



On retirement by 2005, again started my own micro unit, fabricating own designed equipment, almost all varieties of waste paper to value added products. While processing the plastic laminated waste, the disposal of plastic was a problem. By conducting experiments, made products from almost all plastic waste to various products. Till date, I am engaged in the conversion of almost all types waste to useful products.

## Description of waste (solid)

1. In 2008, designed equipments for conversion of elephant dung to paper and paper boards at Konni Eco Tourism project, Konni, Pathanamthitta District under Forest Department.

2. The accident death of a deer at Athirappalli Waterfalls area by consuming the plastic waste in 2010. They implemented my recommendations for tackling the problem. Tried to make awareness of the problem from the bottom most labourer to topmost authorities, designed equipments, provided training, made the area clean from 2008 onwards till date and they are getting income from waste around 1-2 lakh per year.

3. Waste management at YNP Trust located at Mattanchery- conducted the study of waste generated while conducting the functions like marriages, seminars etc, trained the labourers for collection of various disposable items like biowaste. All required bins, trollies, bundling press were designed, fabricated and introduced there which yielded good results for waste handling very economically.

4. Last year at Mar Augun School, Kodanad, various programmes were conducted to collect plastic waste and last month they have employed a bundling unit which made them successful in waste handling.

## How was it done

All the above problems were solved by the financial help from concerned authorities. At Athirappalli waste management was done with the cooperation of local people.

View of Athirappalli location after cleaning compaign

## The Impact

Before introduction, they were all worried about waste disposal. Now, they have even some financial gains.

## Adoption by others

Though approached modifications due to various problems beyond my control, has not gained good results.

Other Organizations such as Chavara Cultural Unit organized Workshop on 23.10.2004 in which talk was given by me on the subject "Plastic less Kochi".

## Economic Aspects

Al the projects were funded by the concerned heads of Institutes.

## Conclusion

From my all previous experiences, now I am fully confident that having proper awareness from bottom to top authorities employing local technologies can be tackled to very great extent.

# "Suchithwa Sagaram" - an initiative towards a garbage free sea bed by Government of Kerala

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## Introduction

The project concept "Shuchitwa Sagaram", was evolved in a discussion held by the Hon. Minister for Fisheries Smt. J. Mercykutty Amma with the Kerala Fishing Boat Owners Association. The proposal was to collect the plastic and other garbage from the sea bed with the cooperation of the fishing boat operators take it to harbours, sort, wash and crush it in the shredding units installed in harbours and make it ready for recycling. Fishing boat operators at Neendakara harbor came forward to take the responsibility of collecting the garbage from sea take it to the land without any cost.

The Hon. Minister for Fisheries Smt. J, Mercykutty Amma was the sole inspiration of the project. Under her patronage a team of dedicated Govt. officials from Harbour engineering Department, Fisheries Department, NETFISH (MPEDA), State Shuchitwa Mission, Society for Assistance to Fishermen (SAF), etc were mobilized and the project Shuchitwa Sagaram was launched as a multi-disciplinary project.

First formal meeting to discuss about the project implementation was held on 27-07-2017 chaired by the Hon. Minister. It was decided to establish a plastic shredding unit in Neendakara Fishing Harbour, with the funding of Shuchitwa Mission, Initiate collection from boats etc. Net Fish MPEDA had assured to supply 2000 bags for collecting plastic from the sea. As scheduled in the first meeting, the collection of plastic from boats started on 05-08-2017. The women workers of SAF started processing of collected plastic from 07-08-2017 onwards. The shredding unit was installed within a record time of Four months as scheduled, and the project was inaugurated on 20-11-2017

## Description of solid waste

The garbage collected from sea contains non-degradable wastes such as plastic carry bags, pet bottles, cement bags, pieces of wire ropes, tyres, fiber glass products, clothes, pieces of fishing nets etc. The land based waste collected from coastal areas also comprised of non-degradable plastics like plastic carry bags, pet bottles, fishing accessories like nets,

നീണ്ടകരയിൽ ശുചിത്വസാഗരം പദ്ധതിയുടെ ഭാഗമായി സ്ഥാപിച്ച പ്ലാസ്റ്റിക് ഷ്രെഡ്ഡിംഗ് യൂണിറ്റിന്റെ പ്രവർത്തനം വീക്ഷിക്കുന്ന മന്ത്രിമാരായ ഡോ. ടി.എം. തോമസ് ഐസക്കും ജെ. മേഴ്സിക്കുട്ടിയമ്മയും

നീണ്ടകരയിൽ ശുചിത്വസാഗരം പദ്ധതിയുടെ ഭാഗമായി സ്ഥാപിച്ച പ്ലാസ്റ്റിക് ഷ്രെഡ്ഡിംഗ് യൂണിറ്റിൽ സാഫ് വനിതകളോടൊപ്പം മന്ത്രിമാരായ ഡോ. ടി.എം. തോമസ് ഐസക്കും ജെ. മേഴ്സിക്കുട്ടിയമ്മയും

ബോട്ടുകൾ കടലിൽ നിന്ന് ശേഖരിച്ച് കൊടുവന്ന അജൈവ മാലിന്യങ്ങളടങ്ങിയ കാർബാഗുകൾ തൊഴിലാളികളിൽ നിന്നും മന്ത്രി ജെ മേഴ്സിക്കുട്ടിയമ്മ ഏറ്റുവാങ്ങുന്നു

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പ്ലാസ്റ്റിക് മാലിന്യങ്ങൾ 'ശുചിത്വ സാഗരം പദ്ധതി'ക്ക് കൈമാറി

floats, buckets etc., pieces of wire ropes, tyres, waste cloths, foot wears cement bags, etc. sometimes parts of artificial reefs deployed by some local fishermen containing nets, bottles, twigs coconut husk etc were also trapped in the trawl nets and brought to harbour.

## How was it done?

Collection: A major role is played by the Boat Owners Association by voluntarily participating in the process of collection of plastics from the sea bed. The collection of plastics is done by trawlers, along with their fishing operations. The plastic wastes trapped in the trawl nets are collected in the bags supplied by NETFISH.

Sorting, washing and drying: These bags are collected at the fishing harbor wharf at

Shakthikulangara, the southern bank of Neendakara Estuary, by the Shuchitwa Sagaram workers and taken for sorting washing and drying. The Washed and dried plastics are then stored in an old building available in the harbor. 15 women workers are regularly working in the project for sorting cleaning and drying. To ease their efforts HED has designed a washing and drying unit and the fabrication of the same is under way. Once the washing and drying machine is installed the number of workers will be reduced to nine.

Shredding: The shredding unit is located at the Neendakara side, the northern bank of the estuary. There are two machines one shredding machine and one bailing press. These are also operated by the women workers. Six women are working in the unit in two shifts. The daily out turn is around 200 kg at present. This can be raised to 300 to 350 kg per day if there is an un interrupted supply of raw material.

Transportation: The material is transported within the harbor by using local means whereas collecting and conveying plastic wastes from land side to shredding unit is the responsibility of local bodies.

The shredded plastics are proposed to be used for the road works undertaken by the Harbour Engineering Department. For other wastes like fishing nets pet bottles etc., tender has been invited from dealers of scrap materials to take away the wastes at competitive prices.

## The Impact

The project was commissioned on 20-11-2017 only. It could collect only a Nano fraction of the garbage from the sea bed. But we believe that whatever little quantity we could collect, the message that is conveyed by this project to the rest of the world is more important and, in that aspect, this is one of the most successful project.

## Adoption of this method by others

From the experience of the Shuchitwa Sagaram project, we realize that the initiatives for waste management will be successful only if there is a coordinated effort of various disciplines. There are many success stories and failures in waste management projects. Before stepping in to any such venture we should do a critical analysis of success and failure of similar projects. We are receiving a number of enquiries from various corners to know more about this project. It is not known whether this has been adopted anywhere else.

## Economic aspects

The land and building for the project were provided by Harbour Engineering Department. An old canteen building left unused was altered suitably to accommodate the shredding unit, raw material store, product store etc. A total amount of nearly 5.00 Lakhs was spent towards this from HED funds. The Shuchitwa Mission has sanctioned an amount

of Rs. 14.70 Lakhs for the supply and installation of the shredding unit. They have also allotted Rs. 5.00 Lakhs towards the operational expenses of the project. Wages for the women workers were met from the Harbour Engineering Department's allocation for operation and management of Fishing Harbours.

Now the project operations are streamlined and we are trying to make the operation and maintenance sustainable. The wages are proposed to be productivity linked in order to have a maximum out turn from the workers. It is expected that about 350Kg plastics can be shredded every day. The average selling price expected is Rs. 20/- per kg. Hence an income of Rs. 7000.00 per day is expected from the project. If there are 15 workers Rs.400 each can be shared among them and Rs. 1000/- can be kept aside every day towards the power charges, maintenance etc. Additional fund requirement is planned to be met by sponsor ship as well as by space marketing for advertisement purpose. However, a viability gap funding will be required to meet the wages during the monsoon when it will be difficult to collect, wash and dry the plastics.

## Conclusion - Future plan of work or any other aspect

Based on the success of the Neendakara project, the activities of Shuchitwa Sagaram will be extended to other harbours in the state also. In the inaugural address of the Shuchitwa Sagaram project, the Hon. Minister for Finance Sri. Thomas Isaac has extended his full support for the project and suggested to extend the project to the back waters of the state also. It is quite sure that this project will be adopted as a model for the whole state for the management of plastic wastes protection of water bodies and conservation of the aquatic environment. This project was successfully implemented with the participation of the fishermen of Neendakara and surroundings. It is worthwhile to note that this success story has come out from a society who are educationally backward, economically weak and living in primitive environment. The Shuchitwa Sagaram team extremely grateful to the fishermen of Neendakara for the success of the project. It is not the technology alone but the deep involvement and sincere efforts of all the concerned agencies and departments has led to the success of this project. Such a coordinated effort for waste management is implemented for the first time in Kerala.

# 'Our Ocean, Our future'

## A Success Story of Marine Debris Clean-up and Ghost Nets Removal

**Robert Panipilla**

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## Introduction

FML is a registered and an indigenous coastal community voluntary organization registered under the Travancore Cochin Literary, Scientific and Charitable Societies Registration Act XII (1955) and started since 2010 based at Trivandrum. Also FML is an UN accredited organization for FML's voluntary commitments towards UN's agenda for 2030 for achieving its Sustainable Development Goal-14: *"Conserve and sustainable use of oceans, seas and marine resources"*. www.fmlindia.org

The main purpose of the organization is to safeguard the marine biodiversity and coastal ecosystems services in South India. FML is also engaged in documenting and sustaining the traditional and local knowledge of the coastal communities in India especially in Kerala and Tamil Nadu. So far we conducted Underwater Biodiversity documentation in the Gulf of Mannar, Kanayakumari district in Tamil Nadu, Trivandrum and Quilon districts in Kerala. These studies led by citizen marine researchers with the support of most knowledgeable traditional fishermen or ILK holders and academic experts. We disseminate our study findings through social media and other research publications and by conducting photo and video exhibitions, seminars in schools, colleges and other institutions.

## Description of Marine solid waste

So far FML has gathered information about marine debris and ghost nets throughout the coast off Trivandrum and Kanyakumari through our underwater visual documentation. The marine debris include Plastic wastes such as carry bags, disposable water bottles, hard plastics (PVC), plastic ropes and nets, plastic shoes and remains of sanitary napkins. The presence of ghost nets have already found in Anjengo, Vettucadu, Shankhumughom, Kovalam and Vizhinjam coasts off Trivandrum. Apart from this we found the presence of marine debris accumulated in near inshore rocky reefs especially in Kovalam, Vizhinjam and Enayam coasts.

In the occasion of National Convention on SDG-14 conducted by Niti Ayog which held at Cochin CMFRI on July 2017, FML raised this issue at the convention and concluded that the institutions and organizations involved in the marine conservation activities lack the capacity to involve in such issues. In this context, the FML initiated the, marine debris clean up venture as a role model which has two stages of implementation.

## The Process of Debris clean up and Ghost net removal

We realize, in the first stage it was necessary to build up a team of skilled SCUBA divers those who are capable to trace and remove the marine debris and ghost nets settled in the seabed. For this we chose ten youngsters from the coastal community and provided SCUBA diving training between November 2017 and till the end of December.

The marine debris accumulated in the seabed as a result of Ockhi cyclone was noticed by the mussel collectors in Kovalam and informed FML. Afterwards two members from FML diving team conducted a pilot underwater survey in the Kovalam sea and determined the exact locations and the following preparations was carried out throughout a week.

- Developed an appropriate tool (Kachaal) to collect the marine debris from underwater.
- Invited interested volunteers through social media network and other means of communication for the clean-up drive.
- Made necessary arrangements for proper waste disposal with Trivandrum Corporation
- Came to an understanding with the Dept. of Aquatic Biology and Fisheries, Kerala University to carry out study on Micro-plastics.

## Process & findings

Based on the pilot survey, on 11.01.2018 three teams of two divers each conducted clean up dives in different depths in Kovalam and after an hour long clean up drive they brought 71 Kg of debris in to the shore. Among the non-biodegradable substances, plastic wastes alone weighed 19 kilograms which was 27.02% of the total waste collected. Plastic wastes included carry bags, disposable water bottles, hard plastics (PVC), plastic ropes and nets, plastic shoes and remains of sanitary napkins. Micro-plastics were found in the sediment samples and 68 micro-plastics were seen in 1 kilogram of sediment samples. Fibre type is the predominant type of micro-plastic found.

Similarly, we organized two days clean-up program at Enayam on Feb 1-2, 2018. Spending an hour in each day the divers could bring to surface a total of 75.4 Kg of marine debris. Among the collected debris plastic waste alone weighed 42.2 Kg which was 53.3 % of the total waste collected. Even though 29 Kg of clothes collected are categorized under biodegradable waste, but most of the cloths are made of polyester and nylon which indicates that more than 75% of the waste collected can be considered

as non- biodegradable. The analysis of sediment samples shows the presence of different type of micro-plastic. 500 gm of dried sediment sample showed a total number of 19 different types of micro-plastic are bit alarming and indicating the plastic crisis in the Enayam marine system.

The ghost net removal was conducted in two locations at Vizhinjam on 18th February this year. The FML diving team and volunteers were able to remove 400 Kg of nylon ghost nets.

## The impact

The Kerala Legislative Assembly Environmental Sub Committee conducted a sitting on 11th Jan 2018, to discuss about the marine ecological impacts of Ockhi cyclone. In this meeting they invited FML to share about our experience. We have submitted our findings with underwater photographs. As a result of that meeting the committee suggested to the concerned authority to stop the project of constructing break water in Veli estuary which could have used as a channel to dump all the city water based waste along with the debris into the sea.

The marine debris clean -up held at Kovalam resulted in high attention of media after which the local people started responding by providing us with the information about similar issues. Afterwards, we were able to organize the marine debris clean-up activities in Enayam and ghost net removal at Vizhinjam.

Recently, an internationally known media called 'Future Planet' came forward to prepare a digital story about FML's Marine debris clean-up drive which indicates that our effort made wider impact on public by creating awareness.

## Adoption of method by others

We need active support and co-operation of SCUBA divers to remove the marine debris from seabed. After our clean -up drive in Kovalam some diving institution who were working related with tourism came forward to join with us for future conservation activities. Similarly a week before, a Pondicherry based organization named 'Temple Adventures' also conducted ghost net removal from the artificial reefs.

## Economic Aspects

Now FML has a team of ten member SCUBA diving team including two marine biologists. This training was done considering its future activities which costs around 3.5 lakhs. We have mobilized contributions from Latin Arch Diocese of Trivandrum, South Indian Federation of Fishermen Societies (SIFFS), Sakhi Women resource Center and other philanthropic persons and well-wishers of FML for this training.

The two marine debris clean-up drive in Kovalam and Enayam and the ghost net removal


Kovalam

in Vizhinjam was completely a voluntary activity. SCUBA Cochin, Kerala University Dept. of Aquatic Biology and Fisheries, Trivandrum Corporation, SIFFS and other volunteers have supported in this process.

## Conclusion

'Swatch Bharat' is a dream project and big achievement which is being highlighted by our respected prime minister. But, in the case of ocean, this project has not started any significant steps yet. In this context, the small initiative by FML in the name of 'Our Ocean,


Ghost Net removal in Vizhinjam

Our Future' hopefully would create awareness among the public and policy makers.

We are aiming to organize a network all over the coastal states of India those who are working with similar vision and mission.

We are also open to join hand with CMFRI like organizations who are working with the goal of Conserve and sustainable use of oceans, seas and marine resources. Through such shared studies and involvement FML hope to utilize our efficiency of Under-water diving, documentation skills and traditional knowledge.


Diving into an ocean of opportunities

Training-Scuba diving

# Kerala Dheevara Mahasabha - a success story

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## Introduction

Kerala Dheevara Mahasabha is a non-governmental organisation under the leadership of the youth movement which aims in cleaning of the coastal waters of Kerala.

## Description of solid waste

We have been dealing with solid waste management mainly plastic waste disposal mainly the buried marine debris and plastic bottles, ghost nets, tyres etc. and distribution of old clothes.

## How was it done?

To an extent we could accomplish solid waste management by removal of plastic wastes from coastal waters. In 2nd October 2017, our organization members had actively involved in the Kayal cleaning programme of Vembanad Lake, Marine drive, Kochi, removing the buried and floating marine debris form the lake.

We have also provided the women of employment guarantee programme, involved in solid waste management activities with hats and jerseys and also actively involved with them in the cleaning programmes in Nayarambalam.

Another issue was the excess weeds in the estuary, which was disturbing fishermen in their fishing activities therby their livelihood of Kerala. Even after frequent reporting of this issue to the government, there has never been a positive action taken to solve this issue. Hence, we have filed a complaint to the Human Rights Commission in the absence of any action against the government and they have passed Rs 10 crore annually.

We have also actively participated in the protest against sand mining issue of Thottappally village which has caused severe damage to the environment in the High court of Kerala, Our organization has also provided clothing and beds to the Okhi effected families who

have lost their homes in Azhikkodu, Edavanakkad and Nayarambalam.

## Conclusion

Our organization has always stood forward in activities to eradicate environment pollution and waste disposal management and in future will always stand for this purpose.





# Shuchithwatheeram initiative of Kumbalangi grama panchayat

## - A MODEL VILLAGE IN KERALA

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## Introduction

Kumbalangi, an island village on the outskrits of Cochin city, was selected as one of the model villages by the Kerala Government in 2003. The Kumbalangi integrated tourism village project is intended to transform the hamlet into a model fishing village and tourism spot. The project aims to create job opportunities for the villagers, while also ensuring that the tourists experience real village life. Recognising the challenges and responsibilities normally faced by tourist destinations especially with respect to waste generation, the Panchayath has taken serious efforts in waste management. During the last financial year, the Panchayath initiated a cleanliness drive "Shuchithwa theeram 2017-18" as part of the Haritha Keralam Mission of the State Government, which has helped the village to look clean and attract tourists.

## Mode of collection/ transportation/processing of wastes

As part of the "Shuchithwa theeram" programme, cleaning up of littered road sides, streets, canals and public wells as well as mosquito control prgrammes were undertaken, Steps were taken to process the biodegradable wastes from households at source as well as to collect non-biodegradable solid wastes in separate gunny bags for sending to recycling plants outside the state. The villagers were given instructions to collect/ treat wastes accordingly from their own households and also to clean their premises and adjacent streets/roads. Initiatives were also taken to get participation of school students in this drive. The Panchayath has installed 600 biogas plants in different parts of the village to manage degradable wastes. Kumbalangi is the first Panchayath in the state to set up such an efficient waste management system. Workshops on "Waste Management" were conducted in all wards in the village to create awareness regarding treatment of biodegradable and non-biodegradable wastes and about reuse/recycling of plastic wastes.

## Economical aspects

The project is being implemented by the Panchayath with financial assistance from the state government.

## Impact

The most remarkable achievement is that this drive has helped to create awareness among the local people on proper waste disposal/management and has immensely benefited the local population and also to attract tourists.

# Plastic waste management initiative of "go green farmers' club"

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## Introduction

The "Go Green Farmers' Club" formed by a group of people engaged in agriculture in Poothrikka Grama Panchayath, Kakkattupaara, Ernakulam District aims at encouraging organic farming and solid waste management in the village. The farmers are resorting to organic farming and each farmer member of the club has vast experience in various agricultural fields and is capable of improving their respective agricultural sectors as well as to earn enough revenue. Recognising the adverse impacts of plastic pollution, the club has initiated a plastic waste management system in the village.

## Description of solidwaste

The farmers face a major issue of plastic wastes such as plastic bottles, plastic covers and other wastes that reach the paddy fields through the irrigation channels. Recognising this grave issue, the club has taken an initiative with the aim to eliminate such type of plastic wastes.

## How was it done?

A plastic waste shredding unit was established near Meenpara junction, on February 20th 2017, with the assistance of the Panchayath committee and in accordance with the norms approved by the Kerala State Pollution Control Board.

## Mode of collection/ transportation/ processing/ any other important point

Buckets were set up to collect wastes from all hotels, bakeries, shops and other public places as per instruction from the local Panchayath, on a daily basis. The workers for collection and transportation were appointed by the Go Green Club committee members. Sorting was done in the unit by a group of 4 members appointed by the

committee members of the club. The processed solid waste is handed over to various construction establishments under the Panchayath authority and the organic waste is converted into compost and used for agriculture purposes.

## Economic aspects

The revenue was generated by charging a fee from the various shops and hotels @ Rs.30/- per month from shops and hotels and Rs.50/- per month from public places. Salary of those engaged in waste management is fixed based on the amount received from the shops and Panchayaths.

## Future plan of work

The Club plans to bring more public awareness and participation in waste management.

# Abating coastal pollution for protecting environment in ecologically sensitive area of Astaranga, Puri district, Odisha

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## Introduction

Pir Jahania, the famous shrine situated in the shore of Bay of Bengal and its scenic beach attract many tourists for their religious sentiment and as a beautiful picnic spot. The green cover of casuarinas, good mangrove vegetation and the mass nesting site of Olive ridley (*Lepidochelys olivacea*) turtles are the specialty of this place. In spite of constant efforts by the forest department of Puri, continuous human interference deteriorates the environment with plastic pollution and other non-biodegradable materials like stray foam, thermocol, glass bottles turning the protection of the same as a major concern for the environmentalists. Puri Field Centre of ICAR-CMFRI along with forest department of Puri thus decided to make an awareness programme on plastic pollution in this tourist place.

## Description of solid waste

Both biodegradable (Paper plates, leaf plates and Katori plant and leaf wastes) and non-biodegradable materials (Plastic and tin bottles, plastic packets, ghutaka cover, stray foam, thermocol plates, glass bottles) were handled.

## Mode of collection/ transportation/ processing

Dr. Reeta Jayasankar, Scientist-in-charge Puri Field center along with the staffs visited Astaranga, Puri on 24/03/2017. A meeting was organized with the Chairman of Astaranga Block (Mr. Swadhin Kumar Nayak), range officer with his team from the forest department, deputy Sarpanch of Churiana Panchayat, Secretary of one NGO, Green Life Rural Association and the mullah of the Mosque Pir Jahania. There are more than 100 women belonging to different SHG. The group was joined by Mr. Toby Whitefield,

a French national associated with NGO group. Besides beach cleaning an awareness campaign was organized by forest department of Puri district, Odisha and the school children from Astaranga by making cycle rally for nearly 60 km from Astaranga to Arakuda of Puri district to send a message on green India and clean India to protect the ecologically sensitive areas from plastic pollution.

All the wastes (Paper plates, leaf plates and Katori plant and leaf wastes, Plastic and tin bottles, plastic packets, ghutaka cover, stray foam, thermocol plates, glass bottles etc.) dumped in the site were removed. Presently, regular cleaning is being done by the women SHG.

## Impact

The main agenda of the meeting was to make the holy shrine free from plastics, Styrofoam products and polythene and declare the place for eco-tourism. Suggestions were made to a new entrepreneurship for the coastal women by making jute bags, paper plates, paper bags, supplying banana leaves, khali plate to the tourists during their picnic party. It was suggested to implement a check post before entering to this area. Awareness was created for the routine cleaning of the environment.

## Adoption of this method by others

The already established method of making leaf plates and katori has been popularized as an entrepreneurship drive in the coastal area.

Children of the village schools were also sensitized to avoid the use of plastics. The Chairman Astaranga block has given whole hearted support to the people of Jahania to keep this destination as tourist hub for ecotourism. High decibel sound system is banned by the forest department to protect the turtle from noise pollution during nesting period.

## Economic aspects

Astaranga Block is now taking care of the expenses for cleaning the area. Additionally, the Women SHG do this as a volunteer service to protect the environment. The programme suggested them to generate income generated from the same source, by following pay and use method for toilets, entry fee for the tourists etc.

## Conclusion

Puri Field Centre of ICAR-CMFRI along with forest department of Puri made an awareness programme on the pollution in Pir Jahania, an ecotourism place in the shore of Bay of Bengal. Both biodegradable and non-biodegradable wastes dumped in the site were successfully removed. Presently, regular cleaning is assured by the women SHG of the location. Several suggestions were made to sustain the cleanliness of the premises to use this place as a picnic spot.

# Namakkal municipality

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## Introduction

Namakkal has been a Town Panchayath from 1943 to 1970. Namakkal Town Panchayath has been upgraded as a III Grade Municipality with effect from 17-01-1970 in G.O.Ms.No.54 Rural Development and local Administration dated 12.01.1970. In addition to the area of Namakkal revenue village some portions from revenue village of Periyapatti is also included in this Municipality. The Municipality has been upgraded as a II Grade Municipality from 01.04.1975 in G.O.Ms.No.200 RDLA dated 07.02.1975. Again the Municipality has been upgraded as a I Grade Municipality from 09.05.1983 in G.O.Ms.No. 631 RDLA Dated 09.05.1983 and then upgraded as selection Grade Municipality in G.O.Ms.No.1074 RDLA Dated 14.12.1988. Namakkal Town is extended by adding nearby Panchayaths with urbanized nature to an extent of 55.24 sq.km in G.O.Ms.No.22 MA&WS(ele) dated21.01.2011. Namakkal Municipality divided in to 39 wards.

## First municipality which became zero garbage town. No garbage town is equal to a holy temple

Primary segregation of organic & inorganic waste for 100% removal of garbage and all uncovered areas are being covered, effective delivery of public health activities.

A stage has come that people should not throw wastes on streets and roads and competition between private and municipality to show their efficiency. To deliver good services and garbage free streets and roads.

### Solid Waste Management

| Land Fill | Area (Acres) | Distance From Town (Km) | Further Usable Period (Years) |
|---|---|---|---|
| Kosavampatti | 8.53 | 3 | Exhausted |
| Lathuvadi | 13.41 | 10 | Acquired |

## First eco-friendly municipality

Various environmental improvement measures have been adopted here which are all very very eco friendly. The following environmental improvement measures are being implemented at Namakkal which are all in thought in mind of by other local bodies.

- Door to door collection with segregation at source in entire town.
- Segregation of wastes into wet compostable and dry recyclable and household hazardous waste.
- Manufacturing of VermiCompost from organic waste.
- Manufacturing of Aerobic method from organic waste.
- Door to door collection and sweeping on all holidays and Sundays.
- 100% removal of garbage daily.
- Scientific Landfilling.

## Description of solid waste

Solid waste is described as the bio degradable / non-bio degradable, recyclable and non recyclable wastes which are collected from households, commercial complex, parks, shops, of the municipality includes:

- Organic Waste
- Plastics
- Paper
- Rubber
- Glass
- Silt
- Metals
- Clothes

## How was it done?

### Mode of collection

- Extend door to door collection in entire town and make the streets and roads without garbage.
- Introduced night sweeping in important places and maintain clean in all 24 hours.
- Door to door collection and sweeping on all holidays and Sundays by continous sweeping to maintain it clean in all days.

### Transportation

- Optimisation of Transportation Routes
- Collection points
- Disposal site

## Benefits

- Fuel and cost savings
- Ensured 100% removal of garbage
- Integration of MIS & GIS based tracking system

## Processing

The technology to process daily fresh mixed municipal solid waste simultaneously process the existing old legacy waste / dumping yard waste and to convert into useful end product includes following categories;

- Recycling and Recovery
- Biomethanation- Anaerobic Digestion
- Composting - Aerobic Windrows

## Recycling and Recovery

Recycling plays a vital role in reducing the quantity of waste, increasing resource recovery and minimizing the financial and environmental burden of MSWM.

### Advantages for the economy

- Reduction of imports of raw materials, fertilisers etc.
- Livelihood opportunities for recyclers in the recycling industry.

### Advantages for the environment

- Sustainable use of resources
- Reduced amount of waste going to storage sites and reduced requirement of land.
- Reduced environmental impacts including impacts of climate change.

### Material Recovery

Material recovery unit, depending on the level of complexity, will consist of a combination of units in varying degrees of mechanization.The unit involves the following;

- Pre-sorting
- Mechanical sorting
- Screening
- Size reduction
- Baling

### Composting

Composting is a process of controlled decomposition of the organic waste, typically

in aerobic conditions, resulting in the production ofstable humus-like product, i.e., compost.

### Biomethanation

Biomethanation is the anaerobic (in the absence of free oxygen) fermentation of biodegradable matter in an enclosed space under controlled conditions of temperature, moisture, pH, etc.

Generally the overall process can be divided into four stages:

- Pre-treatment
- Anaerobic fermentation
- Collection of biogas and its usage
- Residue treatment

## The Impact

## Situation Before

- All the waste has been taken to dump site and minimum quantity of wastes has been Composted.
- Area of dump site is drastically reducing due to day to day dumping.

### Situation Now

- More than 50% of fresh waste is being processed and taken and out from the compost yard on daily basis.
- Land is recovering gradually and more than 40,000 square feet of land is recovered.
- More than 70% of the day to day plastics is recycled inside the plant.

## Adoption of this method by others

- Presently the method is running successfully in the municipality and the quantity is 150MT per day.
- This method can be replicated and also can be sealed in to any level in terms of quantity.

## Economic aspects

- Presently Municipality has provided the machinery to process fresh mixed waste and the contractor has installed their own machinery for processing legacy and recycling techniques.
- Processing sheds, composting pads and biomethantion plants has been setup up municipality.
- Processing operation and maintenance and additional investments is under contractor scope.






- All Products, by products can be sold by contractor.
- Contractor takes care of operation and man power expenses to process the waste.

## Conclusion

- We believe that a successful project is the one which is financially viable. Hence these kind of project shall be funded by the government to encourage the contractor for sustainable processing for a long term period.

# Waste management activities in Mar Augen school, Kodanad

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## Introduction

Mar Augen school at Kodanad Panchayath is giving equal importance to academics and environmental protection activities. From 2012 onwards various activities were done under environmental club of the school. Medicinal value plants were planted in the school. But 2015 onwards club is giving importance to the environmental problems created by plastic. For this we were awarded with cash award from plastic manufactures association, Best School award for collecting maximum plastics under Mathrubhumi 'Love Plastic' Campaign and "A" grade for "Kuppayile Manikyam" project in State School Science festival describing recycling of plastics.

## Description of Solid waste

Plastic is big threat which is creating environmental pollution to the society.

## How was it done?

Unusable plastics were sorted with the help of PTA members, children, teachers and people of the Panchayath. These plastics were supplied to recycling units. For giving awareness to the people science drama was presented.

## The Impact: How was the situation (before) and how it is now

Earlier people used to burn plastics. But now they are collecting plastics and providing to school. With the help of compression machine they are provided to recycling units.

Vegetable garden and medicinal plant garden are maintained in school by students and teachers. Tiles are used as boarder of these gardens instead of plastic or other materials.

## Adoption of this method by others

' Love Plastic' campaign is getting more attention from people.

## Economic aspects

No fund is received from government or any other organizations.

| Estimate : | | |
|---|---|---|
| Compressing machine | - | 30,000.00 |
| Documentary cost | - | 25,000.00 |
| Science Drama | - | 35,000.00 |
| Making of paper pen | - | 5,000.00 |
| Plastic collection & Bundling (Trasportation)- | | 5,000.00 |

## Conclusion

We plan to establish waste bin in all places. We wish to prepare drama, awareness classes, informative pamphlets for the people.

# PRIA (Plastic Recycling Industrial Association)

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## Introduction

PRIA (Plastic Recycling Industrial Association) is the togetherness of approximately 50 companies in kerala, which collects the plastic wastes, gradated it and refined as reused material. We collected plastic wastes and electronic wastes from 14 districts, recycled it as useful raw-materials.

## Decription of solid wastes

We collected plastic carry bags, non-woven bags, all types of plastic papers, film grades, molded plastics, plastic scrap, flex boards, pet bottles etc. In land based.

## Mode of collection

Mode of collection is from scrap yards, kudumbasree, residence association etc.

## Transportation and processing

The plastic wastes from above mentioned parties are collected through our own vehicle to our factories.

Then we gradated it with its grade and color and used it for recycling.

## Situation

In earlier times, there was a great objection from the people towards factories. But now a days the public realized its advantages and they co-operated with us. But government shows great contempt towards us.

## Expense

The total expense is approximately 60 lakhs to 3 crores for individual company

## Conclution

We are planning a company which collects plastic wastes and to recycle it as a useful material with the support of government.








# Microbial inoculum for composting household waste management

**Jyothi Rachel Varghese**

## Introduction

### Mitraniketan KVK

Mitraniketan Krishi Vigyan Kendra is one of the Technology Transfer projects of the Indian Council of Agricultural Research (ICAR) with a mandate of technology transfer, refinement and training in agriculture and other allied fields. This institute is the pioneer to establish a KVK in 1979 under a Non Government Organization just immediately after five years of the establishment of the first KVK in the country.

### Awards or recognition

The efforts done to fulfill the mandate of KVK through an integrated approach have made a distinct positive impact on socio-economic life of rural people. The Indian Council of Agricultural Research acclaimed this fact by presenting the "Best KVK Award" for the biennium 1998-99 to Mitraniketan KVK for the outstanding contributions in the field of Technology Transfer, refinement and Training.

## Description of solid waste: Bio-degradable

Waste is an unavoidable by-product of most human activity. Rising living standards and urbanization have led to increase in the quantity and complexity of generated waste management .Waste is a major challenge in the present scenario. Limited land space in urban areas is a major constraint for proper waste disposal. Government of India and state government have taken much effort in this regard. Trivandrum Corporation was promoting various home-based waste management solutions for bio-degradable waste. These included vermi composting, biogas plants, pipe composting, E.M composting etc. Various methods for proper waste management was popularised in urban areas of Trivandrum district by Mitraniketan KVK. For last 3 years we have taken initiative in demonstrating use of composting inoculums (Microbial Consortium) for decomposition of house hold waste in to organic fertilizer. Biodegradable wastes can be easily converted into compost within 40-45 days. The compost can be used effectively as oganic fertilizer in vegetable or floral gardens .It can also be done even with common pots used for planting vegetables.

## How was it done?

KVK conducted group meeting and focus group discussions to find out the major problems faced by the farmers. Unavailability of organic manures for safe to eat vegetable production was one among them. In order to solve the problem in urban household where land holding is a major constraint, KVK intervened by providing composting inoculum and a dump-pot (three Tier pot) made at Mitraniketan for Kitchen waste disposal. Method of making compost using composting inoculums is as follows. Put one inch thickness coir pith on the base of the bin/pot. House hold kitchen waste can be put inside the bin .Add 5 to 10 gm composting inoculum for 1 kg kitchen waste. Rake the mixture well and put powder put wetting agent (control moisture). Continue this process till the pot is full.

Urban farmers could utilize the home made compost that they manufacture effectively for vegetable gardening. Proper waste management was popularized in urban areas of Trivandrum district by Mitraniketan KVK. For last 3years we have taken initiative in demonstrating use of composting inoculums for decomposition of house hold waste in to organic fertilizer the compost thus generated, is high in nutrients and gives good yield when used for farming. Various technologies are available to reduce the kitchen waste at source itself by converting it to organic fertilizers which in turn can easily be used for family farming/terrace farming.

As part of KVK front line demonstration, seven dumpot and composting inoculum were provided to the beneficiaries during the year 2015 -16. Twenty demonstrations were conducted in urban area for the year 2016-17.

## Impact

The result for the demonstrations

| Parameters | Result |
|---|---|
| Compost yield / 2 years | 56 kg |
| Waste disposal / month | Rs.150/- |
| C:N Ratio | <20 |
| pH | 6.27 |
| N:P:K Content | 1.7% : 0.3% : 2% |

### Farmer's Feed back

- Eco - friendly waste management of bio waste
- Suitable for urban area.
- Easy to handle.
- Good quality organic manure 7 kg/ month

## Adoption

Kerala Irrigation Infrastructure Development Corporation has taken up a project for urban farmers and they have distributed around 1200 dumpot to urban household.

## Economic aspects

Mitraniketan KVK initiated the technology transfer with the support from ICAR.

Unit cost for dumpot - Rs. 500/-

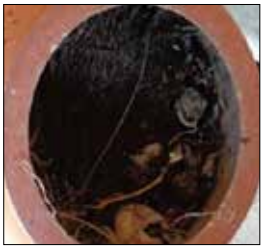
Unit cost for composting inoculums (1 packet) - Rs.80/-

Total Expense for one unit including dumpot -Rs.580/-

Other details/sustainability composting Inoculum can be kept for 6 month and it is very effective technology. Farmers can reuse the compost as inoculum for composting the next time.

## Conclusion: Future plan of work

Conclusion: Proper disposal of waste is very essential to provide clean environment and health for generations to come. If managed properly Kitchen waste can be converted to high quality organic manure. Composting Inoculum from KAU is a very good technology which should be given much importance for effective utilization of waste to compost for production of vegetables for the use at their own home. KVK is planning to ensure easily availability by selling through the sales outlet.



# Solid waste management: the YSSO way of improving the socioeconomy

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## Introduction

Youth Social Service Organization (YSSO) is Registered Non Govermental, Voluntary Organization. Working for the Integrated Development of Socially & Economically weaker sections of rural population with special emphasis on Women, Children, SC/ST and Small and Marginal farmers.

They take up solid waste management as social service to improve the status of the above mentioned weaker sections of the society, in participation with local governing bodies supported by funding from government schemes. Their activity is wide spread in Kerala, covering selected panchayaths of different districts. In 2016-17, they got accreditation with ECOSOC (United Nations Economic and Social Council) and also achieved UN DPI Status.

## Description of solid waste

To avoid pollution of the environment and to ensure healthy living of the society, the YSSO concentrate their efforts to remove / reduce solid wastes in land and rivers which include both biodegradable and non biodegradable wastes.

## How was it done?

They have conducted Waste Removal Camps as awareness programmes in the selected panchayaths. The plastic waste collection, segregation, processing, recycling were done through participatory approach in collaboration with Suchitwa Mission, keeping in line with the Green Protocol. Efforts are made to reduce the use of plastics. The bio waste management included biogas production and organic farming in an organized way through Haritha Keralam project.

## The Impact

The impact of their programs in improving the socioeconomic status is assessed through

social impact assessment units and the results made them receive accreditation with ECOSOC and achieve UN DPI Status.

## Adoption

Many government associations like Suchitwa Mission, Green Highway Mission, Kudumbasree, NABARD etc take the help of YSSO for implementing their programmes.

## Economic aspects

The YSSO works in collaboration and gets funding from different government organizations for the execution of their programmes.

## Conclusion

They look forward to extend their works towards marine region for conservation of sea turtles.

# Solid waste management in Rameswaram island

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## About the Organization

Hand in Hand Inclusive Development and Services (HHIDS), is a Not for Profit company incorporated under the Section 25 of the Indian Companies Act, 1956 with its registered office at Kancheepuram, Tamil Nadu, India.

HHIDS works in the field of Solid Waste Management. This involves educating the people in waste management principles, conducting awareness programs and on field implementation of waste management. In the process, all bio-degradable waste is either sent for composting or converted to energy through bio-methanation, gasification and other similar technologies. The non-biodegradable waste is sent for recycling thus diverting waste from landfills, reducing air, water and soil pollution and thus ensuring environmental sustainability.

## Solid Waste Management

The solid waste management initiative of Hand in Hand India offers a simple message: "With a little bit of awareness and the participation of local people our environment can become much cleaner."

## Present Scenario and issues

Environmental degradation such as polluted marine, contaminated water, sinking groundwater levels, unhealthy soil, and polluted air has become a harsh reality in most parts of the developing countries. Noteworthy, a damaged local environment hits the most vulnerable groups of society; the poor and marginalized people as they lack the resources needed to reduce the negative effects of a degraded environment. At the same time, they are usually directly dependent on their close natural environment for their daily survival.

## What we do

The solid waste management projects of Hand in Hand strives for maximum waste recovery through composting, recycling, and reuse, and aims at minimizing the waste being sent

to the dump yards. The project also ensures that the practices are implemented in a sustainable manner through community participation. The long-term objective is thus to reduce the environmental degradation caused by the unscientific handling of solid waste.

At present, Hand in Hand's solid waste management project is being implemented with community participation at 22 locations, in 8 districts, in the State of Tamil Nadu, Andhra Pradesh, Gujarat, and Union Territory of Puducherry; covering 156,878 families with a total population of 627,512. The locations include local government bodies, educational institutions, slum settlements, housing complexes of government officials including the army, etc.

### Strategy

Hand in Hand's Solid Waste Management project works in partnership with local government and communities to initiate an environmentally and economically sustainable system. Local government bodies provide land and buildings; households pay a small fee, while we provide training and implementation.

Awareness campaigns for the community are conducted through street plays, informational pamphlets, hoardings, board advertisements and other means of Information Education Communication (IEC) activities. Such programmes are conducted at regular intervals at the project locations to bring in behavioral changes amongst various stakeholders.

The Field Coordinators and Green Friends (people engaged in door to door collection and processing of waste) are recruited and trained to facilitate the project activities. Procurement of the required equipment to carry out the primary and secondary collection of the garbage will follow. Door to door collection of garbage with segregation at source and processing of various categories of waste with appropriate techniques will happen.

The project aims at ensuring environmental, social and financial sustainability in a period of three years and advocating the 3 R concepts - Reduce, Reuse and Recycle, to achieve that the people are educated on the importance of segregating garbage at source and avoiding usage of disposable plastics. User fee payment is collected on a monthly basis to ensure the financial sustainability of the project.

## Awards and Recognitions

- Environment Award for the year 2010 by the Govt. of Tamil Nadu
- Hand in Hand India selected as 'Runner up' in the BBC's World Challenge contest 2011
- UNEP World Environment Day challenge - 2012
- The fourth State Finance Commission of Tamil Nadu had asked our recommendations for a better implementation of solid waste management in the state.
- First prize for excellent performance amongst CSR Partners under 'Watershed Development Programme in Tamil Nadu' for Nammiyampattu Watershed from NABARD in 2018.

## SWM in Rameswaram Island

Hand in Hand India (HIH) works in association with Vivekananda Kendra to implement Solid Waste Management initiatives as part of "Green Rameswaram project" at Rameswaram Island since 2014. The main objective is to create a clean, environment friendly and Green Rameswaram Island, which includes preserving the ecology and marine biodiversity. The issues of plastic littering are quite common in the Rameswaram Island as the tourist inflow is high throughout the year. Though the usage of plastic is banned, it has not been effectively enforced.

Green Ramesawaram project, strives for maximum waste recovery through composting, recycling, and reuse. It objectives is achieved by converting biodegradable organic waste to fertilizer via composting and channelizing the non-biodegradable dry waste to recycling agents thus minimizing the waste reaching the dump yard. Regular mass cleaning drives are conducted in the coastal areas including Agni theertham, Dhanushkodi and other beach areas.

Mass cleaning drives are done by green friends along with the help of the general public, NSS volunteers and Pilgrim Volunteers. Huge volumes of plastic items, discarded clothes by pilgrims after religious rituals and marine debris are collected during the mass cleaning drives. During the observation of special days like coastal day celebration, The District Collector along with the other key officials joined the SWM team on cleaning drive and motivated the volunteers.

Plastics production has increased twenty fold since 1964, reaching 311m tones in 2014, (Ellan Mac Arthur Foundation Report). It is expected to double again in the next 20 years and almost quadruple by 2050. Despite the growing demand, just 5% of plastics are recycled effectively, while 40% end up in landfill and a third in fragile ecosystems such as the world's oceans.

To create awareness on this predominant environmental issue and to promulgate source segregation, Hand In Hand organized various Behaviour Change Communication activities like one on one campaign, One to Group ( Self Help Group Women ), Awareness programme for School and College Students, Picking litter campaign and sensitization programme for various stakeholders like women, Resident Welfare association (RWA), General public, tourist etc., Special IEC Programme using folk media were conducted from time to time to impart knowledge on solid waste management concepts to the fisher folk community.

## How was it done? (Mode of collection/ transportation/ processing)

The municipal solid waste collection was done through door to door waste collection using the goods auto. Every morning 6 am to 2 pm our green friends go to each and every household to collect the waste. Orientation was given to all the residents about segregation at source and two coloured dust bins were provided to collect organic and

domestic hazardous waste respectively. A specially designed non-oven bag was given to every household for collection of recycle waste.

Special Awareness program using folk media: To create awareness among the general public and tourist special awareness programme using tamil folk art like Thappattam, street play and traditional puppet show was conducted.

## Conclusion

As an outcome of the proper implementation of solid waste management programme, District administration supported Hand in Hand through various initiatives under Swachh

Door to Door Collection of waste

Awareness rally involving school and college students on progress

Beach Cleaning by Hand In Hand India's Green Friends

Bharat Mission and entrusted the responsibility to create a clean and green Rameswaram Island. Impressed by the success of the Solid Waste Management Project, ONGC came forward to fund Tangachimadam Village Panchaychat, the gateway of Rameswaram Municipality, Ramanathapuram District.

Mass cleaning at Agni theertham by school NSS volunteers

Volunteers, Coastal guard officials with the collected waste during International Coastal Clean-up Programme

# Clean visakha green visakha

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## Introduction

Visakhapatnam is a port city on the southeast coast of India and is often called as "The Jewel of the East Coast". With a population of 20,91,811 and occupying 681.96 sq.km(proposed), it is the second largest city in the state of Andhra Pradesh and the third largest city on the east coast of India after Chennai and Kolkata. The Vizag(Visakhapatnam) Municipality was set up as early as in 1858. The Vizag Municipality was formed in order to full fill the basic infrastructural needs of the people of the city and was converted into Municipal Corporation in 1979. With the inclusion of nearby municipalities and villages, the Greater Visakhapatnam Municipal Corporation was formed in the year 2005. The Public Health and Sanitation Department of GVMC is responsible for collection, transportation and disposal of solid waste generated in Visakhapatnam City. Visakhapatnam was adjudged as the 3rd Cleanest City in the Swachh Survekshan Survey 2017.

## Description of solid waste

The waste collected from the GVMC area were segregated into dry waste, wet waste, bio-medical waste and e-waste.

## How was it done?

### Dry and wet waste management

**a. Source segregation and door to door collection**

Primary collection of waste from the houses (door to door waste collection) is practiced in 100% households with the help of pushcarts that are deployed across all the micro pockets (350 households). There are nearly 2000 pushcarts in operation across the city for collecting the waste. The segregated garbage collected is transported to the transfer stations and then to the processing plants with the help of a fleet of 346 vehicles.

There are almost 950 dumper bins and 1500 compactor bins placed all around the city to collect the waste.

### b. Sanitation - Road Sweeping and Drain Cleaning

There are around 5239 sanitary workers involved in regular sweeping and drain cleaning and their time of operation is from 6.00 A.M to 11.00 A.M and from 2.00 P.M to 5.00 P.M. For the night sweeping of main roads, about 802 workers are appointed and their timings are from 10.00 P.M to 5.00 A.M.

### c. Transportation and Storage of Waste

Using tricycles/push carts, wastes from the households are collected and tip the waste in metal dumper bins and compactors. Transportation of waste is done partly by mechanized Dumper placers and partly through open trucks. Dumper placer vehicles lift the metal dumper bins, transport the waste to the transfer station. At the transfer station, 14 ton capacity Taurus Tipper vehicles collect the waste from dumper vehicles and transfer it to the processing plants. Wet waste collected are processed at Windrows composting and Vermi composting plants at locations namely MSF-1, MSF-5, MSF-6, KRM Colony, Bheemili. The dry waste collected are processed at the Recycling centers at KRM Colony, MSF-3, Nadupuru, Anakapalli and Bheemili. The Inert waste and unsegregated waste is dumped into the dumping yard at Kapuluppada. The following table lists the assets owned by GVMC for the purpose of collection and transportation of wastes.

Table 1. Assets owned by GVMC for the collection and transportation of wastes

| **Material** | | | **Machinery** | | |
|---|---|---|---|---|---|
| Pushcarts | : | 2000 Nos. | Mini Tippers (3.5 CMT) | : | 44 Nos. |
| 1 Tub Wheel Barrows | : | 323 Nos. | Big Tippers (10 MTS) | : | 33 Nos. |
| 2 Tub Wheel Barrows | : | 158 Nos. | JCB's | : | 19 Nos. |
| Compactor bins | : | 1500 Nos. | Tractors | : | 16 Nos. |
| Dumper Bins | : | 950 Nos. | Sweeping Machine | : | 01 Nos. |
| Tata Aces | : | 144 Nos. | Small Compactors | : | 50 Nos. |
| Bob-Cat machine | : | 14Nos. | Big Compactors | : | 20 Nos. |

The wastes from fish/meat/poultry/vegetable markets and that from the commercial areas are collected separately by corporation vehicles. The waste generated from the cleaning of the roads, footpaths, and open places, collection of sweeping and other solid wastes, transport of the solid wastes and disposal at the landfill sites are organized by the Public Health Section of GVMC.

### d. Beach Cleaning

All the beaches coming under GVMC (Greater Visakhapatnam Municipal Corporation) has contractual arrangement for regular collection of litter either by employing people

to collect litter manually during (10 - 12pm) and early mornings or by employing Beach sand cleaning machine in the morning hours. Dust bins are also made available on the beach road.

### Bio-Medical Waste Management

- Bio Medical Waste from Hospitals are being collected by private agency by name M/s.Maridi Eco and treated as per the norms of Pollution Control Board.
- GVMC has given 5 acres of land at Kapuluppada Dumping Yard to install incineration unit. Land leased for installing incineration unit for 33 years @ Rs.25000/- per annum.
- In GVMC limits nearly 320 Health Care Institutions covered nearly 5,200 beds.

| | |
|---|---|
| Total Biomedical waste generation | 850kg / per day |
| Incinerator | 250kg/per day |
| Autoclave | 10kg / per hour |
| Shredder | 50kg / per hour |
| E.T.P | 10 tons |

## The Impact

After the huge devastation caused by Cyclone Hudhud in October 2014 GVMC worked hard to bring back the city to its present glory. Due to the sincere efforts of dedicated staff, Visakhapatnam had a 360° transformation from the 205th rank in 2014-15 to 3rd rank in the 2017 SwachhSurvekshan Survey, which also enabled it to enter the premium league of 20 Smart Cities

| Year | Rank |
|---|---|
| 2009 - 10 | 91 |
| 2014 - 15 | 205 |
| 2015 - 16 | 5 |
| 2016-17 | 3 |

Visakhapatnam district has achieved the distinction of being Number One in the state in terms of efficient garbage disposal. In April 2016, the municipal staff aggregated about 33,727 metric tonnes (99.96 per cent) of garbage in Visakhapatnam district against the target of 33,741 metric tonnes.

## Adoption of this method by others

Many other cities have approached GVMC seeking guidance as to how to implement such a waste management system, as Vishakapatnam has been considered as the model city. In this regard several workshops were also conducted by GVMC. About 27 urban local bodies and 50 NGOs from various places attended the workshop concentrating on the best practices performed by the Municipal Corporation to make the city one of the leading model cities in the country.

## Economic aspects

This project was funded by, Directorate of Municipal Administration, Government of Andhra Pradesh, The Ministry for Urban Development AMRUT Scheme 'Atal Mission for Rejuvenation and Urban Transformation, Smart City challenge and CSR funds of the Private firms.

### A small user charge was also collected from the public

**Corporation resolution on user charges collection**

- Rs.15/- Minimum per Month
- Rs.20/- Shared Independent Residence
- Rs.30/- Posh Residence & Small Shops

**Bulk garbage collection**

- Rs.100/- per ton

## Conclusion

- GVMC is planning to install a recycling plant for the processing and demolition (C&D) of waste. It is a move which is expected to reduce the load at landfills and massive dumping of construction debris in and around the city.
- As per the projections, the quantum of household garbage is likely to double in the next 10 years and alternatives, such as waste-to-energy plants, have to be found. A GVMC official said, "We have already entered into a MoU with the Jindal Group to establish a 15 MW waste-to-energy plant, which will further improve the city's cleanliness and sound solid waste management which is currently under construction."

- Taking Swacch Bharat a step forward, Vizag city is soon going to get Andhra Pradesh's first authorized e-waste collection and handling unit for safe disposal of electronic junk or waste. The eco bins will be provided free of cost by private company and installed in colonies, institutes and industries.
- All the apartments, gated communities, and industries (that generate waste on a large scale) separate dustbins will be kept which are catered to the respective categories. Those who fail to follow the same will be charged with a fine ranging from Rs. 100 to Rs. 500. Also, gated communities and large-scale organizations must mandatorily make arrangements to prepare compost.


# Successful management of beach litter at Puri sea beach, Odisha, India

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## Introduction

Puri is the greatest iconic sacred pilgrimage destination in India and one of the four abodes of divines and blessed with a scenic Sea beach on Bay of Bengal. Puri beach is also known for its tourist attraction and Hindu sacred place. Every year around onecrore tourists visit the state because of its magnificent beaches, the twelth century Lord Jagannath Temple, nearby black pagoda (The Konark Sun Temple), a UNESCO World Heritage site and the Chilka lake.

Cleanliness of Puri beach has been maintained by Puri Municipality. But due to man power shortage and administrative issue of Puri Municipality, the State Tourism Departmenthas signed a contract in 2nd February 2014 for 10 years with Jagruti Welfare Organisation (NGO), a city based organisation specialising in solid waste management and to carry out the drive on beach cleaning from Hotel Pink House (Pentakota) to Sterling resort (Baliapanda), Puri.

Since then Jagruti Welfare Organisation has been actively involved in beach cleaning and successfully managing the beach litter along with the lifting of garbage on the road running parallel to the beach from Digabareni Square to Swargadwar, Puri. Jagruti Welfare Organisation was felicitated as the "Best Organisation" for Cleaning and Sanitation Work in Odisha on the eve of Independence Day in 2005.

## Description of wastes

Solid wastes are the unwanted and discarded wastes coming to Puri beach by three ways: land based, sea based and river based origin. Land based solid wastes are mostly coming to the beach by tourist, local people and drainage from the city. Sea based solid wastes are coming from the fishing vessels, tourist boats and river based solid wastes from a small river known as River Mangalapasses near the Hotel Sterling Resort, Puri and finally join in the Bay of Bengal. Solid wastes are categorised into two types, bio-degradable and non-biodegradable.

Biodegradable wastes are identified as plant leaves, flowers, banana leaf, betel nut and leaf, dead Tulsi plant, fruits, teeth cleaning stick, food packaging material, bamboo basket, sweet corn, ice-cream spoon, newspaper, cotton cloth, earthen pot, brick, palm leaf basket, baby diaper, biscuits, match stick and box, cigarette butt and box, coconut and tender coconut, lemon, wooden stick, paper cup, crab shell, clay diya, egg shell, packaging carton, leaf plate, incense sticks and tissue paper.

Similarly, non-degradable solid wastes are identified as plastic packaging materials, drinking water pouch, plastic bottle, umbrella handle, plastic toy, globes, synthetic cloth, balloon, liquor bottle, hair oil bottle, glass bottle, ice-cream, plastic glass, liquor can, ice-cream cup, tea cup, plastic spoon, polyethylene, thermo coal plate, monofilament twine, thermo coal floats, discarded fishing net, eye glass handle, plastic rope, plastic bag, Dettol bottle, chapal, chocolate cover, and tooth brush.

## How was it done?

According to the agreement, manual sweeping and picking of solid wastes is practicing twice in a day (morning and evening). In summer season, from 5.30am to 11.30am in morning & 3.00pm to 9.00pm in evening and in winter season 6.00am to12.00pm in morning & 2.30pm to 8.30pm in evening is following for cleaning. All together 100 waste pickers (70 female and 30 male) are regularly cleaning the Puri beach. The solid wastes are collected both manually and mechanically and collected in dustbins of 120 litre and 1,100 litre capacity placed along the beach and are transferred to the bigger dustbins as transit bins for transportation through tractors and finally to the refuse compactors which are also introduced (capacity 9 cubic meter) in the recent past for better management of the solid wastes having features for loading, compacting and transportation makes the collection process easy and efficient. Solid wastes are also removed mechanically with the help of Barber surf rake beach cleaner which was imported from Australia. The machine is a hydraulic drive for smooth operation and capable of capturing even the smallest objects from the sand such as glass, cigarette butts and depositing them in the hopper, leaving the sand cleaner and safer. All the solid wastes are transported by both Refuse compactor and Tractor, and disposed at the final dumping point situated at Achia, Baliapanda (Puri) which is the only treatment plant in Odisha where the solid wastes are segregated into bio-degradable and non-biodegradable solid waste. The bio-degradable solid wastes are treated by the biological treatment method and the end product of these bio-degradable solid wastes are utilized as manure for plantation and kitchen gardening. Non-biodegradable solid wastes are segregated into different categories and used for recycling.

## The Impact

Before the intervention of Jagruti welfare organisation, the beach was maintained by Puri Municipality, Puri. During that period, proper cleaning mechanism was not there due to several reasons such as manual cleaning by less manpower, non-availability of sufficient dustbin, lack of awareness among the tourist and local people, no mechanical

way of waste collection from the beach, and no proper transportation of the waste to the duping point. The beach was with full of solid wastes and in few places with big stones. But after the contract signed by the State Tourism Department with Jagruti Welfare Organisation, the scenario has been changed completely. Even though, the quantity of solid wastes has increased to 50 % in comparisons with the previous 4 years due to increase tourist, venders, and population, but Jagruti Welfare Organisation is maintaining the beach properly with proper cleaning mechanism by both mechanically and manually year-round.

## Economic aspects

The Tourism department of Odisha has funded this project and investing Rs. 97 lakh annually to keep the beach clean.

## Conclusion

There is no proper segregation mechanism for organic, inorganic and recyclable waste at beach site. Lack of implementation of legal framework exists in our country to address such solid wastes. There should be proper institutional arrangement with appropriate technology, operational management, human resource development, public participation and legal frameworks for an integrated solid waste management along the beach. Municipality, political authority and most importantly the common people should be more conscious about beach cleanliness and solid wastes problem which is now a global concern. However awareness among the general public through mass media, meetings, posters and activities of different NGOs can act as a preventive measure for such an environmental degradation due to solid waste. A regular drive to remove the encroachment occurring along the beach area and carry out an eviction drives in a regular interval is highly essential. Utilization of plastic bottles and other non-biodegradable wastes in road making is a future breakthrough. In spite of many future prospect and potentialities of this particular pilgrimage tourist destination did not grow to a great extent. The scenic beauty of Puri beach is yet to be explored properly both by domestic and international tourists.

## Acknowledgement

We are highly grateful to Mr.Santosh Kumar Mahanty, Project Head, Jagruti Welfare Organisation for providing all the necessary information and support during the entire survey period.



# Conversion of a cement bag washing yard to a recreational beach and its maintenance: A success story

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## Introduction

Tuticorin is known as pearl city of India has credited to have a beach in its name "the Pearl City Beach "(8°48'27.7"N 78°09'44.1"E) which has been dedicated to Public in July 2012 in a function organised to celebrate the silver jubilee programme to mark the bifurcation of Tuticorin from Tirunelveli organised by the Tuticorin police. Earlier this beach was exclusively used for dumping and washing of cement and poultry bags and was looking filthy, unhygienic and not fit for recreational purpose. With the combined efforts of Tuticorin Police department,State Ministry of Housing and Urban Affairs and the City Corporation Authority, the beach is well maintained.

## Description of solid waste

Earlier non-biodegradable wastes like cement bags, poultry bags were dumped in the beach. After the beach has been opened for tourism, the solid waste consists of plastic and food wastes.

## Mode of collection and processing

At present, regular cleaning is being done at this beach with the help of labourers engaged by the City Corporation Authority to maintain better hygiene and provide a platform to the public for entertainment and relaxation. The regular beach cleaning is recognized by the State Ministry of Housing and Urban Affairs. The land-based non-biodegradable solid wastes that constitute the significant portion of the beach litter are regularly being collected from this beach on a daily basis by the workers (5-6 workers) engaged by the civil authority. The litters collected in garbage bags are deposited in dustbins kept in different places of the beach and once these are filled

up, taken by trucks to the compost yard at Tharuvaikulam and incinerated regularly.

## The impact and adoption of this method by others

After the implementation of the structured cleaning activities, the Pearl City beach has turned to an attractive recreational beach to visit in Tuticorin city, primarily by the tourists.

## Economic aspects

Since the beach cleaning process in Tuticorin is not supposed to be of cost concerning or a complicated process, there has been no attention to adopting it. Although there is nosupport from external sponsorship there is funding support by the Sterlite Copper Smelting Unit & Port Trust of Tuticorin under their Corporate Social Responsibility (CSR) initiatives. The monthly expenses incurred for the maintenance work is Rs.24000/-.

## Conclusion

The transformation of an old cement washing yard to a spectacular beach with sustained aesthetic appeal has attracted the authorities to conduct frequent food festivals in this beach, which proved the success of the ongoing beach cleaning activities. There is an upcoming plan to set up a new recreational beach in Tuticorin, and the City Corporation Authority is planning to improve the existing cleaning procedure of litter contaminants from beaches and coastal waters with the help of Fishers Self Help Group.

# Solid waste management in Rameswaram Island - "Green Ramesawaram project"

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## Introduction

Hand in Hand Inclusive Development and Services (HHIDS), is a non-profit company registered under Section-25 of the Indian Companies Act, 1956 with its office at Kancheepuram, Tamil Nadu, India. HHIDS works in the field of Solid Waste Management. This involves educating the people in waste management principles, conducting awareness programs and on field implementation of waste management. The project also ensures that the practices are implemented in a sustainable manner through community participation. The long-term objective is thus to reduce the environmental degradation caused by the unscientific handling of solid waste. The project aims at ensuring environmental, social and financial sustainability in a period of three years and advocating the 3 R concepts (Reduce, Reuse and Recycle), to achieve that the people are educated on the importance of segregating garbage at source and avoiding usage of disposable plastics. At present, Hand in Hand's solid waste management project is implemented with community participation at 22 locations, in 8 districts, in the State of Tamil Nadu, Andhra Pradesh, Gujarat, and Union Territory of Puducherry; covering 156,878 families with a total population of 6, 27,512.

Hand in Hand India (HIH) works in association with Vivekananda Kendra to implement solid waste management initiatives as part of "Green Rameswaram project" at Rameswaram Island since 2014. The main objective is to create a clean, environment friendly and Green Rameswaram island, which includes preserving the ecology and marine biodiversity.

## Awards and Recognitions

- Environment Award for the year 2010, by Govt. of Tamil Nadu
- Selected as 'Runner up' in the BBC's World Challenge contest, 2011

- UNEP World Environment Day challenge, 2012
- The fourth State Finance Commission of Tamil Nadu had asked for the recommendations for a better implementation of solid waste management in the state.
- First prize for excellent performance amongst CSR Partners under 'Watershed Development Programme in Tamil Nadu' for Nammiyampattu Watershed from NABARD in 2018.

## Description of solid waste

Both bio-degradable and non-biodegradable wastes (including plastics) are handled. Bio-degradable waste is either sent for composting or converted to energy through bio-methanation, gasification and other similar technologies. The non-biodegradable waste is sent for recycling thus diverting waste from landfills, reducing air, water and soil pollution and thus ensuring environmental sustainability.

## Mode of collection/transportation/processing

Hand in Hand India's solid waste management team operates in 10 wards in Rameshwaram. The municipal solid waste collection is done through door to door waste collection using the goods auto. Every morning 6 am to 2 pm, green friends (people engaged in door to door collection and processing of waste) go to each and every household to collect the waste. Orientation was given to all the residents about segregation at source and two coloured dust bins were provided to collect organic and domestic hazardous waste respectively.

A specially designed non-oven bag was given to every household for collection of recycle waste. Regular mass cleaning drives are conducted in the coastal areas including Agnitheertham, Dhanushkodi and other beach areas. Mass cleaning drives are done by green friends along with the help of the general public, NSS volunteers and Pilgrim volunteers. Huge volumes of plastic items, discarded clothes by pilgrims after religious rituals and marine debris are collected during the mass cleaning drives. During the observation of special days like coastal day celebration, The District Collector along with the other key officials joined the SWM team on cleaning drive and motivated the volunteers. To create awareness and to promulgate source segregation, Hand In Hand organized various behavior change communication activities like one on one campaign, one to group (Self Help Group Women), awareness programme for school and college students, picking litter campaign and sensitization programme for various stakeholders like women, Resident Welfare association (RWA), General public, tourist etc. Special IEC Programme using folk media are conducted from time to time to impart knowledge on solid waste management concepts to the fisher folk community. To create awareness among the general public and tourist special awareness programme using tamil folk art like Thappattam, street play and traditional puppet show was conducted.

## Impact

The issues of plastic littering are quite common in the Rameswaram Island as the tourist inflow is high throughout the year. Though the usage of plastic is banned, it has not been effectively enforced. Through this project a solid waste management culture was established in Rameswaram, which made the people in these premises to carry out the waste management in much more systematic way. Under the project, a decentralised composting facility was constructed and vehicles were procured for collecting waste, and dustbins and bags were provided to the residents to segregate waste at source. This project is benefitting 3,000 households in four wards and provide employment to 24 'Green friends' and seven managerial staff, who would be engaged in collecting waste from door to door for processing.

## Adoption of this method by others

The general public, NSS volunteers and pilgrim volunteers are also actively involving in this project. The District Collector along with the other key officials also joined the team on cleaning beach areas and motivated the volunteers. As an outcome of the proper implementation of solid waste management programme, District administration supported Hand in Hand through various initiatives under Swachh Bharat Mission and entrusted the responsibility to create a clean and green Rameswaram Island. Impressed by the success of the Solid Waste Management Project, ONGC came forward to fund Tangachimadam Village Panchaychat, the gateway of Rameswaram Municipality, Ramanathapuram District.

## Economical Aspects

A user fee payment is collected on a monthly basis to ensure the financial sustainability of the project. Impressed by the success of the Solid Waste Management Project, ONGC came forward to fund Tangachimadam Village Panchaychat, the gateway of Rameswaram Municipality, Ramanathapuram District.

In 2016, the public sector Oil and Natural Gas Corporation (ONGC) has launched a mega solid waste management project in this island on an outlay of Rs. 68 lakh. The project is jointly implemented by ONGC, Hand in Hand India and Rameswaram Municipality, will benefit nearly 3,000 households. The total outlay of the project is Rs. 68 lakhs. The ONGC bear the recurring expenses for six months and later hand over the project to the local municipality.

| S.No. | Verticals | Budget (in Rs) |
|---|---|---|
| 1 | Water Management | 6,06,30,000 |
| 2 | Waste Management | 7,16,82,600 |
| 3 | Renewable Energy | 1,33,40,000 |
| 4 | New merchandise and Livelihoods | 1,67,80,000 |

| | | |
|---|---|---|
| 5 | Building Heritage | 2,09,96,000 |
| 6 | Green Health | 84,55,000 |
| 7 | Marine Biodiversity | 1,04,55,000 |
| 8 | Landscaping and Beautification | 1,42,75,000 |
| 9 | Eco Tourism and Green Transport | 2,36,10,000 |
| Grand Total | | 24,02,23,600 |

## Conclusion

Hand in Hand's Solid Waste Management project works in partnership with local government and communities to initiate an environmentally and economically sustainable system. The project helped to improve local environment, protect the pilgrim island from air, soil and water pollution and boost tour.

# "Building from bottom" a success story

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## Introduction

Rajkot Municipal Corporation (RMC) is a local government committed to provide basic infrastructure facilities including entertainment facilities to the people of the city. RMC is very well known for managing the city by using private sector participation as well as introduction of innovative mechanisms in management to serve people efficiently. City has prepared different plans for improving services and to nullify the gap between services and demands. The sole responsibility of Solid Waste Management (SWM) in the city lies with the Soild Wate Management department of Rajkot Muncipal Corporation (RMC).

## Description of Solid waste management

RMC deals with the city waste comprising of both biodegradable as well as the non degradable waste. There was no proper management of the solid waste system in Rajkot due to which the all the wastes including the recyclable were dumped in open land again leading to foul odor. Also, the area of landfills was more prone to fire disasters as there was continuous generation of methane due to anaerobic digestion of organic waste. The waste materials and garbage dumps led to an increase in number of stray animals and flies. Birds also got attracted towards the dumping sites, which increased the risk of air disaster. Further, the lifespan of landfill decreased as waste got accumulated. There was also the risk of increased contamination of groundwater.

## How we do?

The Rajkot Muncipal Corporation (RMC) has successfully ventured a waste processing plant project through public private partnership (PPP) model. It has adopted ways and means to process and dispose off the waste that are generated on a daily basis. Reuse and recycling of the waste is followed to process the waste such that least is sent to be disposed off. As part of decentralization, the entire city has been divided into four zones. There are various activities that have been assoiciated with the management of municipal solid waste from the point of generation to final disposal.

These activities are, waste generation, storage, collection, transportation, segregation and waste processing and finally disposal.

Hanzer Biotech Energies Private Ltd. (HBEPL) was considered as the private partner who could handle the waste processing plant. RMC and Hanzer Biotech established the waste processing plant on the Built Own Operate and Transfer (BOOT) basis. RMC acquired a 200 acre barren land for developmental purposes from the collector 's office. Out of these 200 acres, 30 acres were sanctioned to HBEPL for the establishment of a waste processing plant on lease at the rate of Re. 1 per square metre per year.

**Collection:** Waste both dry and wet were collected door to door collection from households.

**Waste segregation:** involved six stages. No segregation of waste is done at source; hence the entire waste was taken to the processing plant where end stage segregation is done to segregate water into wet organic, dry organic waste, recyclable and inert materials.

**Waste processing:** After the waste is successfully segregated, wet organic waste is kept aside and sprayed in the composting yard and left for aerobic digestion. After 40 days, wet waste is transformed into organic compost. The dry organic waste is utilized for making green coal or fluff. The recyclable wastes like rubber, metal, plastic, which bear economic importance in junk market, are separated. Magnetic separators take out the metals whereas rubber is handpicked at the platform sort conveyor. This waste is then sold by HBEPL.

The last stage of the process decided the one major constituent of waste which used to go the landfill site until now. HBEPL came out with the technology and innovation which made it possible to use the most of this waste. HBEPL utilized 20-35 per cent of waste for making bricks by mixing it with fly ash. Finally, the residue from this process, which was as less as 10-15 per cent, was sent for landfill in sanitary landfill site.

## The Impact

The results for the waste management plant have been very encouraging. This has made the waste management plant at Rajkot the first-of-its-kind in the country. It is the first fully-integrated waste processing plant. The entire waste of 300 MT of municipal solid waste (MSW) is processed into biofertiliser which is of 40 MT, fluff (green coal having calorific value of: @ 3500 to 4000 kCal/kg) which comprises of 70 MT, eco-bricks, which is 15,000 MT, and finally, recyclable materials, which is plastic, metals and others.

The processed plastic is being successfully used by small scale industries around Rajkot city in manufacturing ropes of different types and sizes. The entire compost, or the bio fertilizer, is being sold to corporate clients including Reliance Industries at Jamnagar

(Gujarat) and Reliance Energy at Dahanu (Maharashtra). Compost is also being used in appropriate mix with chemical fertilizers and has been approved by Gujarat State Fertilizer Corporation Ltd. (GSFC). The fluff has high demand in the nearby paper plants and the cement industries due to its high calorific value at reasonable price. The fluff could be used in combination of other sources of fuel like coal, wood, natural gas, etc. Presently, fluff is being sold to cement factories at Kodinar, paper mills at Vapi and Kuwadwa. Gujarat Ambuja Cements Ltd. also has placed order for fluff.

## Adoption of methods by others

The integrated waste processing plant is first of its kind which has been utilizing nearly 85-90 per cent of waste and only leaves behind 10-15 per cent as reject. The integrated waste processing plant has created a ripple in the region. It is reported by HBPEL that Bhavnagar Municipal Corporation (BMC) and Jamnagar Municipal Corporation (JMC) have set up a similar integrated waste processing plant in a fashion similar to the RMC.

## Economic Aspects

The production cost of compost is Rs. 1.50 per kg. The production cost of the fluff is also very economical-just Rs. 1.40 per kg. The eco-bricks are utilized by HBEPL for construction work in their plant. The production cost of eco-bricks is Rs. 1.10 per unit, while the cost of normal burnt brick is Rs. 1.40 per unit.

## Conclusion

The success of Rajkot Municipal Corporation (RMC) with public private partnership (PPP) model success story belongs to citizens of Rajkot.

# Eraviperoor grama panchayath

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## Introduction

From 2012-13 onwards, many project related biodegradable and non biodegradable waste management are being carried out in this panchayath. Among this, plastic road is recognised as the most scientifically proven and ideal project. The mile stones in this project during this time line are detailed below.

Eraviperoor Grama Panchayath governing council decided to organize the Ecofriendly Grama Panchayath. They felt that along with the development projects, there should be awareness among the public regarding environment related issues, so as to conserve our inherited environmental values. Accordingly an Eco Gramasabha was organized by the Panchayath, in all 17 wards during 3rd -24th August 2013, where it was discussed on how to process the waste at their origin, analyse the functioning of Arogyasabha, dealing with health related projects and assessing the activities of 'Harithagrama' involving the agriculture related projects.

## Recognitions and dignitary visits

A team of 20 delegates from International centre for local democracy, comprising of 11 foreign countries like Cambodia, Vietnam, Malasia etc who are studying on local governing bodies which has its head quarters at Sweden and representatives from four North Eastern states of India had visited the Grama Panchayth on 25thJune 2014. The visit aimed to study on the plastic waste management and working of plastic recycling units in the panchayath. They had visited all the recycling units and their feedbacks were highly commendable and we consider it as a token of appreciation.

## Description of the waste

The Panchayath focused mainly to manage the non degradable plastic wastes (bottles, covers etc.) within each ward of the panchayath. Issues on biowaste management was also taken care.

## How was it done?

### Awareness programme

In various Gramasabhas, experts in ecology and health related fields took classes (2012-2013) and based on these discussions different project proposal were formulated. Accordingly, as part of the yearly programmes of the Panchayath (2013-14), various projects like complete waste management, construction of biogas plants, vermicompost units, plastic recycling units, plastic roads, modern slaughter units cum fish markets were implemented.

### Participatory waste management

With the increased concern in plastic waste management, participation of the people is ensured and with the guidance and support of the eco gramasabha, decisions were made for a proper plastic waste management practices and establishment of plastic recycling units.

### Plastic waste collection

As a part of project, it was decided to keep dustbins at anganwadis, schools and public places and training given for plastic collection. For regular collection of the wastes. Haritha plastic unit was created which involved 5 Kudumbasree (self-help group) workers. A total of 51 dust bins (3 each/ward) were also kept in different centres for the collection of plastic wastes. Even when waste disposal bins were supplied, the question of proper disposal of plastic wastes remained as an issue. Strict decision was made to keep the plastic items which had become inevitable in modern day to day today life, in a clean and orderly way without throwing away aimlessly, and in coorporation with the plastic recycling unit of Panchayth.

### Construction of Plastic roads

The initial thought was to produce products like plastic plates, garden pots, tarpaulin etc. from the collected plastic which was ground into fine grains. Since enough plastic won't be available from a small Panchayath like Eraviperoor to run a plant like this, on further brain storming discussion, it was decided to use plastic waste scientifically for road tarring availing the technical assistance of public works department (PWD). Information was also collected from the plastic road website.

For tarring the road in 100m length and 3m depth, there was a requirement of 675kg of bitumen. Since plastic was added to tar, a reduction of 8% in total bitumen requirement could be achieved. 54kg of plastic (8% of total required bitumen) and 621kg of bitumen could be used instead for the normal tar. Here, the plastic used for tarring is heated upto 165°C along with gravel and made into a mixture with tar and laid on road.

The Local Self Government Department (LSGD) certified that the experimental tarring with this mixture has higher quality compared to the normal tarring mixture. It may also be noted that the quality of the road constructed incorporating plastic is better especially in areas where chance of water logging is high.

## Biowaste management

Successfully, 183 biogas plants, 52 vermicompost units, 3700 compost pits, construction of modern slaughter unit cum fish market were established.

## The Impact

Eraviperoor is the first Grama Panchayath that has received the Prime Minister's Public administration award. Among the the projects discussed for this, plastic road was the most appreciated. Eraviperoor plastic road project was selected as the model project in the screening of model projects in Kerala state planning board in 2015. The government of Kerala has issued order to include the same model in each panchayath of Kerala state. Afterwards when PWD has constructed plastic road, the requirement of shredded plastics got increased which has become an additional source of income to Eravipeoor Panchayath.

## Economic Aspects

Tender was invited from agencies having approval of 'Suchithwa mission 'and purchase of equipment for the recycling unit worth Rs 2.1 lakh was made. The income generated from this unit was Rs 60,650/-.

## Adoption by others

The plastic road project of Eraviperoor Panchayath is being installed in nearly 14 sates of India. The panchayath raj employees from these 14 states have visited 'Haritha plastic unit and the constructed plastic road. Also the 'Sansad Adarsh Grameena Yojana' of nation Rural development Ministry, the selected Eaviperoor model plastic road project as ideal.

## Conclusion and future plan of work

The fututе plans of the panchayath on waste management vision a Green Working Force (haritha Karma Sena) by 2018-19 to vigil the sustainability of the environment and establishing a cloth bag unit by 2018-19 to refuse the useof plastic bags inorder to reduce the plastic waste accumulation.

RMC is still aiming for an even better rank in near future. Rajkot has thus become a model city and the working of its municipality an example for other municipal corporations to follow and implement in

# Clean city - Green city - zero waste Vatakara

**Sreedharan. K[1], E K Uma[2]**

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## Introduction

'Clean City - Green City- Zero waste Vadakara' project was implemented during 2016-17 at Vadakara municipality. This project emphasizes on the scientific aspect of waste management and public involvement programmes. Under this project bio- degradable and non- degradable waste management, awareness classes, waste processing units, material recovery facility centre, household waste management, production and marketing of eco- friendly products were implemented.

## Description of Solid waste

Everyday 7470t degradable and 8966.7t non-degradable wastes were accumulated in the Muncipality. Small canals like Karimpanathodu, Palolithodu, Aavithodu flow through this area.

## How was it done?

During June 2017 a meeting was conducted for explaining the project 'CleanCity - Green City- Zero waste Vadakara' to all members of Socio - Political and Voluntary Organizations. A monitory committee was formed. Waste management processing group was formed under Kudumbasree. A green task force was formed for 47 wards. For the smooth functioning of the force a Project manager and Project coordinator were appointed. Several awareness classes were conducted for waste management. A pamphlet containing 12 pages explaining the Zero waste project method were distributed to 18,000 houses and 7000 shops in the municipality. Rs. 50/- and Rs. 100/- were collected (according to the source) respectively from each houses and sale centers. Biogas plant, ring compost, kitchen bin, bio-bin were provided to each houses. Non- degradable things were separated. Plastic bags on January, Plastic bottles on February, glass items on March, electronic wastes in the month of April, clothes in May and rubber in June were collected and the same cycle repeated during next six months. For helping the task force cluster leaders from 40 wards were appointed. A calendar

was prepared regarding the visit of task force in each ward. Waste materials from each cluster were collected in vehicles. Due to the unavailability of shredding machine plastics were exported to Karnataka recycling unit. The sorting of non degradable wastes provide earnings to 60 peoples. Compost pit was made in different schools. Disposable glass, plates, plastics below 50 micron were prohibited in the area.

**The Impact:** How was the situation (before) and how it is now?

Earlier people used to dump wastes on road side and burn plastic. But after implementing the project these problems were solved. Animation video named " Janu Jokes" regarding waste management was released for giving message to the people.

## Adoption of this method by others

This project created awareness among the people. They are ready to take responsibility of sorting non degradable wastes.

## Economic aspects

Rs. 50/- and Rs. 100/- were collected (according to the source) respectively from each houses and sale centres. Rs. 8000/- was provided to task force member as monthly income.

## Conclusion

'Clean City - Green City - Zerowaste Vadakara' project under central government " Swacch Bharat" and Kerala government " Haritakeralam" programmes got wide appreciation from audio - visual medias.





# RAMKY GROUP- Experts in domestic waste management

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## Introduction

Ramky Group since inception in 1994 in Hyderabad has been focusing on developing projects that positively impact both the environment and the economy. As part of the blueprint to be an active participant in global economic progress, Ramky Group has augmented potential in key growth sectors including Water and waste water management, Transportation, Industrial Infrastructure, Commercial, Residential, Social, Institutional and Irrigation Infrastructure, Environment Management, Energy Generation, transmission and distribution. Major operations of the group are conducted through companies sucha as Ramky Infrastructure Limited (RIL), Ramky Environ Engineers Limited (REEL), Ramky Estates and Farms Limited (REFL), Ramky Life Sciences Limited (RLSL) and Ramky Life Sciences Limited(RLSL) .

Out of which Ramky Environ Engineers Limited (REEL), is a pioneer in all kinds of waste management.

Water Awards 2009, 2010 &2011-Ramky Infrastructure Ltd bagged the Water Digest 'Water Awards 2010-2011' under the Best Water Conserver-Waste Water Management Category for 80 MLD Airoli Project in Mumbai.

The Water Digest "Water Awards 2010-11" as the "Distinguished Water Company" for outstanding contribution in the field of water in India.

D&B Axis Infra Awards 2011-The 80 MLD Sewage Treatment Plant at Airoli earned the D&B Axis Infra Awards 2011 under the categories of Urban Infrastructure Development and Pharmacity under Public Private Partnership.

## Description of solid waste

Ramky Environ Engineers Limited (REEL) provides a comprehensive range of services, including solid municipal waste, bio-medical waste and hazardous waste management

services to commercial, industrial and municipal customers including recycling, collection and disposal services. Cost-effective solutions, customized projects and comprehensive resources combined with safety and regulatory compliances make them one of the most efficient players in this sector.

Ramky Environ Engineers Limited (REEL) has to its credit many firsts in:

- Establishing India's first and largest Industrial Waste Management Facility
- Operates India's largest hazardous waste incinerator complex at Taloja, Maharashtra
- Established India's first and largest Biomedical Waste facility on BOO basis
- Established India's first Integrated Municipal Solid Waste Management Company on BOOT basis
- Established India's first Integrated recycling facility
- Only company in the country to serve industry, healthcare and household recycling needs
- Rated as one of the best for Environment Impact Assessment (EIA) studies, Environment Audits and Research & Development initiatives

We cover the Karnataka Region for biomedical management of waste and the plant is located in Karnad Industrial Area, KIADB (Karnataka Industrial Areas Development Board), Kolnadu, Mulky, Dakshina Kannada.

Ramky Group has a pan-India presence with more than 500 project locations across 23 states (including Union Territores).

## How do we do?

### Methods adopted for processing of waste

REEL delivers recycling services including industrial and domestic recycling to its customers across the sectors. It collects, sorts and processes the waste materials like of Paper, Plastic, E-Waste, Used Oil, ULABs, Solvents, Metals etc. from its customers. Its clients include individual households to commercial establishments to corporate and industrial establishments.

### Fully intergrated E- Waste Management

Process involves collection, separation including picture tubes, shredding and recovery of metal through chemical process and recovery of precious metal through thermal process and Base metal recycling, PGM (Platinum Group Metals) recovery and refining processes. Waste management at source is also carried out at source. Total support in scrap handling, collection, transport, documentation, shipping export and other related areas.

## Impact

- 100% recycling of E-Waste collected i.e. Zero landfill
- Currently has E-Waste Management Facilities in Hyderabad and Bangalore

### Biomedical waste management

Ramky is the first private company to establish a Biomedical Waste Management Plant in Hyderabad, first Biomedical Waste Management Facility in India in 2000. The company own & operate 15 fully compliant medical waste facilities, 125 waste collection vehicles and provide medical waste disposal services to over 20,000 Health Care Establishments in 14 cities in India and has obtained the ISO 9000, ISO 14001, OSHA 18000 certified facilities.

## The process includes

Door-to-door Collection & Transportation of Bio-medical waste. The main modes of biomedical waste destruction includes sterilization using autoclaves and chemical treatment.

### Hazardous waste management

Ramky Enviro Engineers Limited (REEL) has set up India's first integrated industrial hazardous waste management facility at Hyderabad in 1998. The Company handles more than a million tonnes of hazardous waste annually which counts to be approx 65% of total waste treated in India. The IWM facilities of Ramky are guided by international standards - they support double composite liner landfills with Leachate collection arrangement following USEPA's RCRA Subtitle C requirements for landfills. Waste received at these facilities is disposed off by three modes.

- Direct Land filling
- Stabilization of Waste
- Incineration of Waste

The facilities and specific equipments used are fully dedicated to handle hazardous waste and are complied with rules defined by Central Pollution Control Board and the Ministry of Environment and Forests, New Delhi.

## Impact

Ramky operates hazardous waste incinerators at Chennai (Tamil Nadu), Haldia (West Bengal), Hyderabad (Telangana), Kanpur Dehat (Uttar Pradesh), Indore (Madhya Pradesh), Taloja (Mumbai) and Vizag (Andhra Pradesh).

## Conclusion

The dedicated remediation team at REEL has the expertise to cater to the varied

remediation needs of the customers. However, apart from utilizing the services of the in-house experts, REEL also collaborates with respective industry experts in order to meet any specific technological requirements of the clients.

Our site remediation services include excavation, treatment and disposal of contaminated soil, bioremediation, lake remediation, on-site treatment of contaminated water, safe treatment and disposal of hazardous materials etc.

Presently IWM has 9,600 customers all over India. Our ISO 9001, ISO 14001, ISO 17025, OHSAS 18001 certifications and state-of-the-art R&D with NABL accredited labs, have set the platform for excellence in environmental and industrial Waste Management Sector. Constant up gradation fuels our future plan of action in exploring neoteric options in environmental sustainability.

## Future

Solvent recycling for industries, used automobile oil recycling, paper recycling are some of the technologies that are currently under review.


Shredder


Shredded material


Incinerator


Ash storage facility

# Hi-tech bio fertilizers

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## Introduction

Hitech Biofertilizers India was started in the year 2001 with the aim of creating role models for ecofriendly economical solid waste management at source. Our intention was to develop a culture of hygiene management to enable people to own up the responsibility of self reliant waste management at source. We documented all dumping grounds in Kerala from Kasargod to Trivandrum, Villappilasala. Our study proved that pollution in the urban areas is increasing day by day.

Vennala division of Cochin Corporation was selected to create a role model SWM. A peoples movement in the name of "Janakeeya Paristhiti Samrakshana Samithi (JPSS) was formed with the office bearers President, Adv. Girija, State secretary women's advocate association, Vennala Councilor of Cochin Corporation, Sri. Jose Pettah, President and Mr. Jose Joseph Moonjely, Vice President of Vyapari Vyavasayi Ekopana Samithi, Devankulangara unit, Edappally as Treasurer and Secretary.

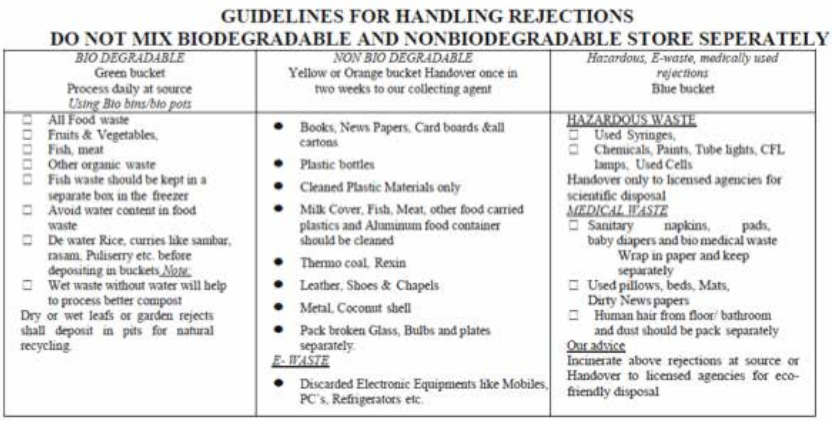
Mr. Jose Joseph took initiative for developing an equipment which is an eco-friendly, economical and self-reliant composting of biodegradable rejections at source.

The biobins developed by us were installed at Palarivattom Byepass signal on the Vennala side of the road. Daily generated biodegradable rejections were collected from door to door from every house of Vennala division and processed the same to compost. The compost was utilized for developing organic garden on the shoulder road in a length of 300 meters. The project got attention of the media. Judges of Kerala High Court and Supreme Court commission member Mrs. Almitra Patel visited the site.

After 18 months, and a successful public demonstration we have shifted our activities to apartment complexes to encourage and enable the residents to handle their rejections at source itself.

Won best technology award from Corporation of Cochin in 2008

## Description of solid waste



**GUIDELINES FOR HANDLING REJECTIONS**
**DO NOT MIX BIODEGRADABLE AND NONBIODEGRADABLE STORE SEPERATELY**

| *BIO DEGRADABLE*<br>Green bucket<br>Process daily at source<br>*Using Bio bins/bio pots* | *NON BIO DEGRADABLE*<br>Yellow or Orange bucket Handover once in two weeks to our collecting agent | *Hazardous, E-waste, medically used rejections*<br>Blue bucket |
|---|---|---|
| ☐ All Food waste<br>☐ Fruits & Vegetables,<br>☐ Fish, meat<br>☐ Other organic waste<br>☐ Fish waste should be kept in a separate box in the freezer<br>☐ Avoid water content in food waste<br>☐ De water Rice, curries like sambar, rasam, Puliserry etc. before depositing in buckets *Note:*<br>☐ Wet waste without water will help to process better compost<br>Dry or wet leafs or garden rejects shall deposit in pits for natural recycling. | • Books, News Papers, Card boards &all cartons<br>• Plastic bottles<br>• Cleaned Plastic Materials only<br>• Milk Cover, Fish, Meat, other food carried plastics and Aluminum food container should be cleaned<br>• Thermo coal, Rexin<br>• Leather, Shoes & Chapels<br>• Metal, Coconut shell<br>• Pack broken Glass, Bulbs and plates separately.<br>*E- WASTE*<br>• Discarded Electronic Equipments like Mobiles, PC's, Refrigerators etc. | HAZARDOUS WASTE<br>☐ Used Syringes,<br>☐ Chemicals, Paints, Tube lights, CFL lamps, Used Cells<br>Handover only to licensed agencies for scientific disposal<br>*MEDICAL WASTE*<br>☐ Sanitary napkins, pads, baby diapers and bio medical waste Wrap in paper and keep separately<br>☐ Used pillows, beds, Mats, Dirty News papers<br>☐ Human hair from floor/ bathroom and dust should be pack separately<br>Our advice<br>Incinerate above rejections at source or Handover to licensed agencies for eco-friendly disposal |

## How was it done?

The principle of "Do not mix" is followed. Three reusable containers with colour code is provided to each residence (Green for biodegradable, yellow for non-biodegradable and red for hazardous) with printed guidelines for handling daily generating rejections. Biodegradable waste is transferred to ecofriendly biobins developed by us to process all to humus compost by treating it with Aerobic Microbial Composting.

## Adoption of this method by others

### Timeline

- **2005** Govt. recognized Hitech Biofertilizers India as a service provider to Clean Kerala Mission.
- **2006** Demonstrations conducted to convince corporation and municipalities, the possibilities and benefits of source level composting. We have conducted demonstrations are Ernakulam Market, Changapuzha Park, Edappally, Changampuzha Nagar, Kalamassery, Aluva Market, etc. Later, we have done composting by installing biobins and applying bioculture developed by us.
- **2007** With the association of builders fraternity the challenges of SWM at Kochi were addressed. Enabled the residence associations and individual residents to handle waste generated by them, ecofriendly and economically at source. The project scaled up and the technology developed by us benefitted to 80,000 apartments in the state and also spreading to the other states.
- **2011** Apartment complexes of Trivandrum and Trichur corporation adopted this technology to address the challenges faced by them due to the closure of Vilappilasala and Laloor dumping grounds. The system is also presently operating under our direct

supervision in 156 building complexes at Trivandrum and 75 in Trichur.

- **2012-13** The SWM system was adopted in Calicut, Kottayam cities in the apartment complexes and at TechnoPark, Trivandrum.
- **2014** SWM manual published by MOUD ministry, Govt. of India recorded our project implemented at Cochin apartment complexes as the best role model.
- **2015** Apartment complexes at Mumbai, Chennai and Indore adopted our system.
- **2016** Swachh Bharat recognition: The book edited by Mrs. Mridula Sinha Hon. Governor of Goa published the article written by Mr. Jose Joseph and declared our project as the best role model SWM.
- Empanelled agency of Suchitwa mission to prepare DPR for local self governments to submit Swachh Bharat mission for funding. Agreements signed with Guruvayoor, Kothamangalam municipalities and 8 panchayaths of Kothamangalam assembly constituency.

## Conclusion - Future plan of work

Create a role model recycling park in the state for non biodegradable rejections such as plastic, waste papers, tube lights, CFL lamps and all new generation electrical and electronic waste. Hitech wishes to empower and encourage manufacturers to discharge extended producers responsibility to dispose the materials manufactured by them ecofriendly.

# Grama swarajya samithi - Visakhapatnam swachh bharath swachh Vidyala (SBSV) project

**B. Ramu[1], Yellam Naidu, D[2] and Loveson L. Edward[3]***

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## Introduction

Grama Swarajya Samithi (GSS) is a non - governmental organization involved in various developmental activities in Visakhapatnam District and the focus groups are children, women, tribal, rural and urban disadvantaged communities for the last 20 years. The 'Urban WASH - Swachh Bharat Swachh Vidyalaya' project, a three-year project that aims to promote sanitation, effective use and ownership of school Water, Sanitation and Hygiene infrastructure in 20 GVMC schools in Vishakhapatnam city is implemented through GSS and the benefactors are Plan India, USAID and Coca Cola India Pvt. Ltd. Through this project, around 6,000 girls and boys from 20 Greater Visakha Municipal Corporation (GVMC) schools are getting access to potable water and safe sanitation. It will enhance the capacity of key stakeholders particularly the school children, teachers, School Management Committees (SMCs), functionaries and communities in performing their responsibilities for ensuring quality WASH in schools. The project interventions contribute to the Swachh Bharat Mission (SBM) through the Swachh Bharat Swachh Vidyalaya component. It will address school sanitation and importance of segregation waste into degradable and non-degradable wastes. The project will create replicable models for municipal corporation school improvement program.

## Description of solid waste

Around 6000 children from 20 schools segregate the waste generated from their day to day activities in the school and put the degradable and non-degradable waste into separate bins.

## Mode of collection/ transportation/ processing

The collection of segregated waste is by the door collection agents of GVMC and it is transported and processed by GCMC.

## How was it done

GSS has provided the separate dustbins to the schools for collecting the segregated waste. These wastes were removed daily from the schools by GVMC. The children are also encouraged to create awareness among their parents and their families also participated in the segregation of wastes and gave it to GVMC door to door waste collection staff. A committee was formed in schools to effectively implement and monitor the activities. The school level committees formed among the children gave information about segregation of the wastes during the morning assembly. A cluster of 5 schools were provided a GSS appointed hygiene promoter. They also closely monitor the schools. Capacity building trainings were organized for the children, teachers, school management committees, parents, midday meal cook and non-teaching staffs of the schools, public health department officials and local leaders. The participants were strongly discouraged from littering the roads, drains and public places. Twenty children's clubs were formed in the schools to motivate, guide and monitor the waste segregation activities. Hygiene promotion of committees were also formed in the slum areas. World Environment Day, World Water Day etc. were celebrated, organized campaign rallies, distributed IEC materials like wall papers, door stickers and cultural activities with the massage were also organized to generate maximum awareness and involvement of the people to make the programme a success.

## The Impact

Waste Management is a challenging issue in the city of Visakhapatnam. Segregation of waste and its proper disposal can alleviate this problem. It is very important to protect our natural resources, water bodies and beautiful beaches. Behavior change communication (BCC) have great impact on children and in turn they act as change agents. The children who got sensitized on waste management in turn sensitized their parents, friends and relatives. Through this kind of effective dissemination of knowledge, people of Visakhapatnam adopted the measures of the waste segregation and the local government implemented the schemes that ensured proper collection and ecofriendly disposal of wastes. This positive change happened due to the community interventions carried out by Grama Swarajya Samithi. We think it is a significant and sustainable change made possible through the efforts of GSS, Plan India, USAID and Coca Cola India Pvt. Ltd.

The programme could ensure 100% participation from the school children and about 85% of their families also participated in the segregation of waste. The GVMC ensured the safe disposal of segregated wastes.

Due to the effective implementation of the scheme, 2 GVMC schools were selected for Andhra Pradesh State Swachh Vidyalaya award.

## Economic aspects

The project is implemented under Swachh Bharat Swachh Vidyalaya (SBSV)

programme funded by Plan India, USAID, Coca Cola India Private Limited.

## Conclusion

The GSS-SBSV project has shown that children could be effectively utilized as game changers to alleviate the problem of garbage heaps in our habitats. Along with the children, the general public, different government and non-governmental agencies have a definite role to play in the efforts to make our habitats garbage free.





# Mangaluru Ramakrishna mission Swacchata Abhiyan

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## Introduction

Ramakrishna Mission, Mangalore is a branch of the worldwide organization, Ramakrishna Math and Ramakrishna Mission started by Swami Vivekananda, a century ago. Since its inception in Mangalore more than six decades back, the Ashram has initiated several welfare activities for the benefit of the needy. Our main focus has been instilling values in youths, students, teachers, professionals and the corporate. All our programmes have been well received thanks to the quality, content and commitment of our institution for the ideal it represents.

"Swacch Mangaluru a plan for Swacch Bharath" programme which was inaugurated on the 1st February 2015 at a grand function attended by about 1500 youths, general public and several eminent men of repute. 75 sweepers and other workers of City Corporation was honoured as a token of respect for their services in keeping the city clean. Government of India had made a special request to the Headquarters of Ramakrishna Mission at Belur, Howrah, to take up the Abhiyan. On the advice of the Headquarters, the Branch of the Mission in Mangaluru took up the Abhiyan in right earnest, and immediately called upon its devotees, well-wishers and the public to join this historic Abhiyan. The response was beyond anybody's guess.

## How was it done?

In the first phase, the Abhiyan involved about 25000 youths and volunteers cleaning the city and improving basic amenities under the aegis of Ramakrishna Mission for 40 consecutive Sundays. 40 successful drives were already completed in the first phase in different localities. In addition, "Swacch Manas for Swacch Bharath" was also conducted - an evening with our young volunteers who join their hands in the cleanliness drive. As they assemble in the Ashram on Saturdays, they were taught meditation, briefed about our activities, the need for this programme, creating awareness among them regarding their social responsibilities and inculcating values

among them through interaction, discourse and bhajans etc. They are also provided food, tea, snacks and accommodation.

## This Initiative included

- Renovation of dilapidated and neglected bus shelters.
- Repair & renewal of Auto rickshaw stands
- Urgent & minor road repairs
- Cleaning roads and public places
- Repair of footpaths & Adopting a few roads
- Awareness programme through distribution of literature (about 1500 persons every week)
- Clearance of drainage and garbage
- Painting and beautification of compound walls
- Clearing unutilized dumping places for public utility
- Developing gardens and planting saplings at road medians.
- Planting saplings on roadsides.

It was held every Saturday evenings and on Sunday for about three hours in the morning by the volunteers.

## How was it done?

### The First and Second Phase

The First Phase was inaugurated on 1st February 2015 at the Ashrama premises. It continued for 20 weeks non-stop up to June 2015. A special highlight of the inaugural function was honouring of 75 street sweepers under the service of Mangaluru City Corporation. While honouring they were offered fruits, flowers, shawls and sarees in the presence of eminent citizens. This is how the Ramakrishna Mission Mangaluru recognized their invaluable services in keeping the city clean for years. About 1500 youths who had assembled also took oath of "Swacch Mangaluru" for "Swacch Bharath". The function was preceded by a spirited rally composed of 1000 youths on the streets of the city.

In the first 2 phases, about 40 drives were conducted in and around Mangaluru involving around 8000 volunteers.

### Third Phase: Concept and Action

Encouraged by the overwhelming response towards the First and Second Phases of the Abhiyan, the Third Phase was launched on 2nd October 2016.

The structure, functions and action plan of the Third Phase had been conceptualized as follows:

- There were 40 teams having 40-50 volunteers each. Teams were given maximum freedom to function as per the local situation.
- Each team was to offer service on just one Sunday in a month.
- The first set of 10 teams would work on first Sunday of each month, and that is all for that month. The second set of 10 teams on 2nd Sunday and the third and fourth sets on third and fourth Sundays. In one word, forty programmes would be covered during each month.
- The Third Phase went on from October 2, 2016 to July 2017. However, during south-west monsoon, for two months Abhiyan was suspended. On the whole 40 Sundays (10 months) were covered during the period October 2016 to July 2017. The 40 teams covered about 400 locations.
- The teams worked under the guidance of the coordinators. Ramakrishna Mission, Mangaluru provided the following items to each team:

Vivekananda T-Shirts,Cleaning equipment (which were kept with the teams), Awareness literature, banners, broachers/flyers, Vehicles to transport garbage to the dumping places,Financial assistance, Refreshments.

In the 3rd phase, 400 cleanliness drives were successfully carried out in different parts of the city through 60 groups guided and supported by the Ashrama. About 50000 volunteers actively participated in the drives that were carried out on Sunday mornings.

In the current 4th phase that was started on 3rd November 2017, Abhiyan has been channelized into 4 different modules. In the first, daily Abhiyan, the Ashrama has formed 30 groups who visit door to door spreading the message of awareness about hygiene and cleanliness and solid waste segregation. Daily more than 100 households & shops are covered in this.

In the second weekly Abhiyan carried out on Sundays for 3-4 hours, an area prone to dumping of solid waste is selected and with the help of 300-400 volunteers the spot is cleaned and basic civic amenities are repaired or beautified like repair and renewal of bus shelters, painting compound walls, converting dumping yards into small gardens etc. directly benefitting the public.

In the third, about 100 villages are earmarked and with the help from District Administration and cleanliness drive is carried out once in a month in each village.

In the fourth titled, "Swacch Manas", the message of awareness is being taken out to students, who are the future citizens of this nation. Students (10750 nos) from 108 schools in and around Mangaluru have been enrolled as "Swacchata Senanis". With the help of 50 resource persons, an activity is conducted in each school once in a month, like swacchata talks, competitions, conducting cleanliness drives in their school premises, garbage segregation, "Swacch Ambassador Workshop" for selected 500 students, bringing out a workbook to create awareness among the students about cleanliness etc.

Special feature of the "Swacchata Abhiyan" being carried out by Mangaluru Ramakrishna Mission is participation by people irrespective of caste, creed, colour, age or religion. The consistency of the abhiyan as well as the genuine concern of the Ashrama to keep our surroundings clean has attracted thousands to become volunteers in this Abhiyan. It has become a mass movement and the main purpose of reaching out to the common mass with the message of awareness about cleanliness is being slowly and consistently achieved.

### 4th Phase 2017-2018

- Total registered Volunteers - 20000
- Number of villages adopted for Cleanliness - 115
- Schools adopted to create awareness - 108 (107500 Students)
- Nitya Jagruthi Teams - 50

## Conclusion

"Swacch Mangaluru Abiyan" has become a "Jan Andolan" receiving tremendous support from the people. Citizens too are turning out in large numbers and pledging for a neat and cleaner Mangaluru. Taking the broom to sweep the streets, cleaning up the garbage, focusing on sanitation and maintaining a hygienic environment has become a habit with many after the launch of "Swacch Mangaluru Abhiyan". People have started to take part and are helping to spread the message of 'cleanliness is next to Godliness'.

# Oorja Nirmala Haritha Gramam - energy efficient, clean and green village

**Suresh T. K**
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## Introduction

'Oorja Nirmala Haritha Gramam' project was flagged off by Kerala Sastra Sahithya Parishad (KSSP), Thuruthikkara unit in association with Energy management centre, Kerala. ANERT, Haritha Kerala Mission Sujitha Mission CUSAT, Model Engineering College, Clean Kerala Mission, IRTC. These organisations are continuously engaged in different measures to save the environment and bio-diversity of Thuruthikkara, Mulanthuruthy Grama Panchayth.

Our objective is to create an example by focusing on primary sectors like waste management, energy efficiency, environmental conservation, water security and scientific farming in 10th Ward located in Mulanthuruthy Panchayath of Ernakulam District.

## Description of waste

The project aimed to handle both bio degradable wastes such as kitchen waste, food waste and non-degradable wastes such has e-waste like bulbs and plastic wastes.

## How we did?

This project was officially inaugurated by Mr. Renji Kurien, President of Mulanthuruthy Grama Panchayath on 15th October 2017. It was implemented during September 30, 2017 to January 21, 2018. To start the project, we had formed a committee in collaboration with various regional organizations.

Group of people from these organizations collected primary sources from the households and made a detailed report using the survey method. It includes energy consumption, waste disposal, water availability, plastic & e-waste disposal etc. Based on the survey the organization planned a subsequent event.

The project officially started with door to door awareness classes and exhibitions. The demonstration in each house had the following things.

- Waste disposal - biogas plant, kitchen bin
- How to make LEDs
- How to handle e-waste
- How to recycle plastic waste?
- How to start subsistence farming?

## Impact

As a result of our well-organized project, the village has made remarkable achievements such as,

- Around 300 kitchen bins and 52 bio gas plants had been installed in this ward and they are producing nearly 1 ton of organic manure.
- More than 1,000 LED bulbs had been made (SELF) sold in Thuruthikkara. The villagers are now self-reliant to repair the bulbs instead of wasting it. All incandescent (filament) bulbs (around 400 Nos) have been replaced. The village has been declared as 'filament free' village on December 7 2017 by Mrs. Jaya Soman, president of Mulanthuruthy Block Panchayath.
- We had collected all kind of plastic waste and send it for recycling. Instead of the plastic bags, this project introduced cloth bags to be given for the shopping purposes. We made an arrangement in each house to collect the plastic wastes once in every four months and warned the people from burning the plastic by giving the proper instructions. As a result of these activities MLA Advt Anoop Jacob declared Thuruthikkara as 'Plastic waste free area' on 31st October 2017.
- On December 3rd 2017, volunteers collected 1.5 ton of e-waste from Thuruthikkara and handed over to Model Engineering College, Thrikkakara and they forwarded to Clean Kerala Company for disposal of the collected waste. As a result, this village is declared as the e-waste free village by Ernakulam Zila Panchyath president Mrs. Asha Sanal.
- We had distributed around 1,000 grow bags, 8,000 vegetable plants, 1ton of organic manure etc. among the villagers. We had conducted classes on high tech farming and the use digital space for efficient utilization of land. A model vegetable garden and hundred elephant foot yam had been planted in Government Technical School, Thuruthikkara. We had initiated the project for making bananas and elephant foot yam in all homes in Thuruthikkara.
- People raised the slogan 'My waste is My responsibility' and made sure that 'I am using at least one waste disposal system'. They have started separating plastic waste and handed over to us for recycling. They stopped dumbing waste in public spaces.
- Haritha Kerala Mission, Kerala Government declared Thuruthikkara as 'Haritha Gramam'
- Malayalam daily, Manorama created special supplement for this project and called Thuruthikkara as 'Pachathuruthikkara' (Green Thuruthikakra)
- Malayalam daily Mathrubhumi made a special article and addressed Thuruthikkara as 'Pachakkara'
- Students from IIM Calicut visited Thuruthikkara and Oorja Nirmala Haritha Gramam

and taken up the project as their research project.

## Haritha Binnale

Upon hitting the culmination, the Organisation also organized a Haritha Binnale (Green Binnale) on 21 January 2018. We had selected 12 houses where exhibits of green and energy efficient houses were put up on display to inspire the villagers. Aroung 1,500 people from other part of the villages visited the binnale homes and had expressed gratitude to the project. There was a small concluding function on that day. Mrs Seema, Director Haritha Mission, Kerala State, Miss Isha Priya, Assistant collector, Ernakulam, Mr Sujith Karun, Haritha Kerala District coordinator Ernakulam were present during the function.

# Economical Aspects

Financial assistance of the entire project has been collected from the profit of selling LEDs, Kitchen bin, Biogas plant etc. and by the help of sponsors and advertisements. The concluded details of expense cost calculation is given below:

| Si No. | Item | Income | Expenditure |
|---|---|---|---|
| 1. | Advertisement( Poster Notice) | 12,000 | 10,000 |
| 2. | Anert | 17,800 | |
| 3. | Energy Management Center | 10,000 | |
| 4. | Kitchen Bin | 14,000 | |
| 5. | Bio Bin | 5,000 | |
| 6. | LED Bulb | 16,000 | 10,000 |
| 7. | LED Materials | 13,000 | |
| 8. | Transportation | 7,000 | |
| 9. | Suchithwa Mission | 3,000 | |
| 10. | Vegetanle Plants | 16,000 | 16,000 |
| 11. | Grow bag | 15,000 | 15,000 |
| 12. | Classes & Functions | 11,000 | |
| 13. | Mike & Projector | 15,000 | |
| 14. | Banner & Board | 10,000 | |
| 15. | Haritha Binnale | 15,000 | |
| 16. | Sponsors | 8,000 | |
| | advance | 5,200 | |
| Total | | 1,22,000 | 1,22,000 |

## Conclusion and Future plan

In continuation to this project we are going to start a rural technology and study centre in Thuruthikkara. Many organisation and associations started up a follow up our project for Oorja Niramla Haritha Gramam. 'Ente Gramam' is a project by Thuruthikakra Agriculture development Society in Thuruthikkara in continuation to the prestigious project to provide high quality food, hindi and english education to the people in Thuruthikara.

Rising temperatures made the planet earth horrible for life and rural India is the most affected. So our ultimate aim is to make all homes as 'Haritha Veedu' (Green Home) and all the roads a 'Haritha Veethi' (Green way).

The effort and willingness by the villagers of Thuruthikkara to make their hometown a better place is indeed inspirational. If villages and towns across the country come together and adopt similar green models, we can be sure that a better and carbon-footprint free future awaits us all.

# A man on a mission for waste to wealth transformation

**Ramdas Tukaram Kokare, Pawar N.A, Singh V. V, Rane U H**

Chief Officer in Municipal Corporation, Karjat
SIC, Central Marine Fisheries Research Institute, Mumbai Research Centre, Mumbai
Central Marine Fisheries Research Institute, Mumbai Research Centre, Mumbai

## Introduction

Shri. Ramdas Tukaram Kokare, presently working as Chief Officer in Municipal Corporation, Karjat which has a total population of 30,000 and generates Class III Municipal Solid Waste (MSW) in the tune of 12 metric tonnes per day. Earlier during 2010 to 2015 he had served as Chief Officer at Municipal Corporation Dapoli, Maharashtra and during 2015-2017 he at Vengurla also in Maharashtra.

In 2010, Shri Ramdas came up with the idea of waste management at the source level and decided to segregate plastic waste into recyclable and non-recyclable categories. Plastic carry bags of less than 50 micron thickness were in the non-recyclable category, while bottles, packaging material of food items and wrappers were to be recycled for further usage. Local self-help groups were roped in to produce paper bags and some awareness campaigns were organized.

Furthur in April 2015, Ramdas Kokare took over as Vengurla's Chief Municipal Officer, driving the town's exemplary sanitation schemes and waste disposal projects. Under his able leadership Vengurla Municipality was declared as an Open Defecation Free (ODF) city in Maharashtra on 2nd October 2015. The solid waste management (SWM) project, initiated by Ramdas Kokare- CEO of VNP-has been highly acclaimed even by international experts. He has implemented several innovative schemes like plastic road, zero garbage, biogas etc, which are now being used in the district. He worked on the concept that there should be no landfill site. He segregated the waste not just into the dry and wet categories, but into as many as 11 categories. The segregation was done at the household level. From wet garbage, wet waste is used to generate biogas, producing 30 units of electricity per tonne, whereas dry waste is used for making briquettes. One of the machines powered by the biogas is a plastic shredding machine, provided by UNDP. It crushes up to 180 kg of light plastic every day. This waste plastic has been used as boon for road building. While plastic bags are banned, the remaining plastic is used for making roads.

## Awards/Recognitions

- 'Vasundhara Mitra' Activist' award, 2016.
- 'Best Chief Officer' Municipal Corporation, 2016
- 'NDTV, Banega Swachh India', Award felicitated by Mr. Amitabh Bachchan. 2016.
- 'Vasundhara Mitra' Activist' award, 2017.
- 'Sindhudurg Bhushan' award, 2017.
- 'Vasundhara Sanman' award, 2017.

## How was it done?

Shri.Ramdas Kokare after taking over charges in various Municipal Corporations like Dapoli, Vengurla and Karjat, he motivated staff of these institutions and guided them with clear cut ideas and proper directions. Several local institutions joined hands with Shri. Kokare, Viz,Tehsildar office, chairman of confederation of voluntary organisation, traders and local peoples, SHGs, NCC, NSS volunteers, green corps and staff of Agriculture Universities like Dr. BSKKV, Dapoli.

## Public Communication Strategy

- Complete ban on plastic bags.
- Educated the local vegetable and fruit vendors by narrating the importance of ban for about 1-1 1/2 hr daily for a week and until and unless their mindset was changed.
- Provided a viable replacement for plastic bags, provided bags made out of old sarees and paper bags.
- Bell vehicles to collect the city waste. The three belled vehicles in the morning responsible for collecting house hold wastes from which plastic/ non degradable waste is separated and crushed in plastic crush machine.
- As a part of this drive all the traders were given away a certificate and a letter of thanks for not using plastic carry bags of 50 microns or less and kitkat bags.
- The management strategy simply involved taking rounds around the city just before coming to the office and while returning home, in order to see if the city is clean. Chief Officer personally motivated his subordinates to do the same. He and his subordinates personally talked with a certain number of people daily to educate them about the importance of waste segregation.
- Panchayath also educated the local vegetable and fruit vendors by narrating the importance of plastic ban until and unless their mindset was changed.

## Segregation, Collection and Transportation

- In Vengurla, 20 municipal workers painstakingly segregate waste into 23 different categories. Wet waste is used to generate biogas, producing 30 units of electricity per tonne, which powers all the different types of machines used here. Municipal collectors pick up waste six days a week and transport it to the municipal dumping ground.
- Adequate vehicles for waste collection.
- Route maps are published on council's web site, social media and on vehicle also.

- GPS tracking for monitoring vehicle route.
- Capacity building of staff.
- Daily supervision by chief officer and official staff.
- Implementation of solid waste management Bye-law.

## Financial Strategy

In Vengurla, Machines powered by the biogas are a plastic shredding machine, provided by the United Nations Development Programme (UNDP). The machine crushes up to 180 kg of light plastic every day. Many Nationalised banks, General Insurance Corporation and Musale trust etc. extended their support for equipment, dustbins and vehicles and other machinery.

## The Impact

Under the able leadership of Shri. Kokare, Vengurla has got 12 km of "plastic" roads that earned INR 15 per kg of plastic sold to contractors for road-building in nearby areas. Different type of waste is also recycled. A briquette machine helps process dry waste such as cloth, paper, and cardboard into briquettes, which are sold to nearby industries as alternate fuels for boilers. Heavy plastic is sold to cement factories where it is melted at 3000 degrees Celsius. In addition to this, Shri. Kokare had built the capacity among the staff at village level and Municipal level. Under Vengurla Municipal Council he had undertaken several environmental programmes including tree plantation, water conservation and harvesting, turtle conservation activities made Vengurla city open defecation free, introduced eco-friendly Ganesh idols, promoted mangrove tourism and solar as well as LED lights. Implemented innovative schemes like briquette formation from garden waste and biomethanation plant, installed garbage screening machine and plastic crusher machines. Successfully converted waste dumping sites into tourist points, play grounds and cultivable lands.

## Success factor

In Vengurla, the municipal council found considerable support in the private sector with banks and insurance companies, NGOs in the area chipping in to replace plastic with cloth carry bags, and providing waste collecting vehicles, mobile toilets, dustbins etc. Constant motivation, campaigns, awareness programmes under municipal council had promoted the activities and educated the polluters.

## Conclusion

The solid waste management programme has been manged entirely from municipal council. Each month, the municipality earns sufficient amount, which is used to improve solid waste management systems in the village. To encourage reuse, unused items are dropped into a box placed under a tree, called the Tree of Humanity.

*"If we don't effectively manage waste generated in our area, it will follow us everywhere - in the soil, in the air, and in the seas that sustain us."*

Shri. Ramdas Tukaram Kokare

# Road to plastics - a future ahead

**Ahmed Khan[1], Rasool Khan,**

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## Introduction

K K Plastic Waste Management Ltd is Bangalore based firm registered under Companies Act 1956 in the year 2002. They are the founder and commercial promoter of the technology - "Reuse of plastic waste in asphalting of roads". We are the only company with an exclusive patented technology of reusing the plastic waste as an additive in construction of roads since 2002. Further, we are undertaking rigorous research on reuse of plastic waste for manufacturing various construction materials like kerb side stones, slabs, etc.

## How We Started

The idea was conceived in the year 1996, as they were into plastic bag making and there was demands for a ban on plastic. Since their entire livelihood depended on plastic and realising that this would be an environmental hazard, they decided to find a solution which would end plastic waste menace, Mr Rasool Khan and his son Amjad Khan, the brother and niece of the CEO thought of researching on alternate uses of plastic. Later they sponsored a research to authenticate their small laboratory findings, at RV Engineering College and a detailed report was brought out by them authenticating the feasibility and the benefits of using plastic waste in roads. However to authenticate it further, they sponsored a research at, Bangalore university, and also at Central Road Research Institute, a Govt of India undertaking. Since the results were encouraging, the Central Road Research Institute, Government of India authenticated their technology "Reuse of plastic waste in asphalting of roads". Finally, the Indian Road Congress, whose approval is must for any material to be used in road building, has issued a code, to use our material in road building, which is the ultimate certification of our concept. Ours is Ltd. Co and we have commercialised to sustain and expand this concept.

## Description of solid waste

"K K polyblend "is a polymer blend made out of littered plastic bags, PET bottles and thin film grade plastics. As of now we have used plastic waste material in 3500 km consuming around 15,000 tons of plastic waste.

## How was it done?

The waste plastic was collected from various sources, like rag pickers, schools, apartments, factories, and traders at the rate of Rs 6 per kg. The collected wastes processed through a designed and fabricated machinery for cleaning and shredding. It was then blended with the aggregates, which is used for relaying. Proper sorting helps in generation of more compost from garbage if plastic waste is eliminated at source of garbage collections.

Impacts: We have received Real Heroes award from CNN IBN, Dhirubai Bhai Ambani Foundation United Nations Best practices award, Green Leaf awards, Manju Shree award. Our story is covered by several international media BBC, National Geography, Business World, New York Times. In India print media as well all electronic media have covered our work including the CBSE 12 th text a case study.

Adoption of this method by others: In recent times we are getting lot of enquiries from different states and we may set up units in Mumbai, Jharkand, Gujarat, and many more states, we are getting good response from out of country also, we are shortly putting up a unit in Sri Lanka as well. Presently our customers are Bangalore MAHANAGARA PALIKE and several road contractors.

Economic aspects: We are the only company to commercialise the concept, it is a viable industry, with less capital investment, as for we are concerned. It is self-funded, we have not availed any kind support from Government or corporates.

## Conclusion

KK Plastics has an established network for collection of waste in Bangalore. This unit can be replicated in other parts of the world too after undertaking feasibility analysis. This technology will not only save huge cost and extend the road life to another 3 years, but will omit plastics from garbage facilitating for easy composting. We all are aware about the impacts of plastics in garbage. Hence this project creates a win circumstance for any city/town.

Today, Plastic is inevitable. Use it without any hesitation, but also dispose it wisely. Our concept to use plastic waste in building roads can be a great solution, while it helps in getting good and long lasting roads.

# Managing E-waste - A Success story

**Kabeer B. Haroon**

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## Introduction

Clean Kerala Company Limited, formed under the Local Self Government Department, Government of Kerala, is being coined with the objective of ensuring hygiene management of the state through the adoption of innovative and scientific methods and proven technology, adhering to the concept of active participation of the public and private sectors. The company aims to ensure comprehensive management of all harmful rejections in the state, thereby ensuring that the hygiene of the state is never compromised. The company has also been successful in implementing Shredded Plastic Units in almost all districts of Kerala and around 2,03,78.4 kg of shredded plastic has been supplied for construction of polymerized roads.

## Description of wastes

The company is focused to handle non degradable wastes mainly E-waste. On the same lines with the rapid development achieved in the field of information technology, the quantum of E-waste, being generated in Kerala, has leap frogged many folds in the last decade and is assuming humongous proportions. The presence of hazardous materials like mercury and cadmium renders the above said rejections extremely harmful to the environment and the society. Inordinate dumping and indiscriminate disposal of the ever growing E-waste has the potential to pollute the God's own country, no end. The absence of a scientific recycling facility in the state has hampered the proper management of E-Waste being generated from the various government and nongovernment institutions/departments in Kerala. The company has also been successful in implementing shredding units for the management of plastic waste.

## How is it done? Mode of collection/ transportation/processing

Considering the quantum of e waste being generated in Kerala, Clean Kerala Company Ltd submitted a project for the scientific recycling of e-waste being generated in the

state. On approving the project, Govt instructed all the organizations functioning in the state to dispose their e-waste through Clean Kerala Company Ltd vide G.O no: 2612/2014LSGD dated 10/10/2014. After receiving an official communication regarding the e waste accumulated in their office, a visual inspection is carried out by the company officials to assess the quantity. Subsequently, a vehicle is arranged for the pickup and the material is initially transported to a collection centre maintained by our recycling agency at Palakkad District, Kerala. The material is then transported to the recycling facility at Hyderabad, owned by our recycling agency for recycling/disposal. Any disposal item generated in the process is disposed off through authorised TSDF facility by our agency. A manifest in form-6 is issued through our agency for the material collected. And finally a destruction certificate is also issued after the material has been scientifically processed completely.

The Clean Kerala Company Limited, is authorized to collect e waste such as non-usable computers, laptops, telephones, mobile phones, printers photocopiers, scanners, cameras, switches, fans, air conditioners, electrical motors, generators, cables etc from all the public sector undertakings, government organizations, educational institutions, industrial enterprises along with private organizations by paying Rs 10 per Kg to the concerned organization.

Along with e waste we have also made arrangements to collect tube lights and CFL bulbs from all govt institutions in Kerala, scientifically recycle the same in association with a leading recycling organization approved by the Central and Kerala pollution control board.

## The Impact

**E-waste collection through students** Another state wide campaign, of collecting ewaste from households and Engineering Colleges was carried out in associating with National Service Scheme.

**E-Waste collection from schools** In association with Kerala Infrastructure and Technology for Education, a Section 8 Company formed by Govt of Kerala to clear e waste accumulated at schools, which include computers and related equipments dated before 31st March 2008 and UPS, CRT monitors, keyboards, mouse dated before 31st March 2010. Approximately 3000 schools covered and collected 627 tonnes of ewaste through this project. Approximately an amount of Rs62,00,000/- (Rupees Sixty Two Lakh)was compensated to the General Education Department.

**E-waste markets** A project envisaged for the public where anyone can bring e-waste for disposal in exchange for money based on the rate as mentioned in the Government Order No. 2612/2014/LSGD dated 10/10/2014. Clean Kerala Company Ltd collected and transported the e-waste collected through e waste market for scientific recycling/ disposal and compensating the same at the counter itself. This project was implemented in Cochin Corporation and Kollam Corporation, and an approx. quantity of 15 tonne was collected.

Company is engaged in conducting awareness classes/sessions in over 500 educational institutions across the state.

Company is also engaged in creating awareness among public about ewaste, by providing resource presons for handling sessions on ewaste management organised by LSGI's, Pollution Control Board (KSPCB), NGOs and other State as well as Central Govt departments.

## Economic aspects

Clean Kerala Company Ltd has returned 3.5 Crores to the exchequer. Funds generated by NSS Units through e waste collection was utilised for charity such as treatment of poor patients, constructing home for the homeless etc. Also the funds were used for the development of the infrastructure of their institutions. LSGIs has also utilized the funds thus generated for helping the poverty-stricken.

Clean Kerala Company Ltd played a vital role in reducing the peril posed by the hazardous materials contained in e-waste, such as mercury and cadmium to the environment by collecting, transporting and recycling 800+ tonnes of e-waste from the state of Kerala.


In a bid to reduce e-w

ELIZABETH THOMAS
DECCAN CHRONICLE

NSS volunteers after collecting e-waste from Hill Gardens


e-waste, plastic scrap filling State coffers

# The ragpicker with a social cause

**Jabir Karat, Ramya Abhijith**

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## Introduction

Green Worms is a social enterprise on a mission to sustainably and scientifically tackle solid waste menace in the world. We envision a world free of solid waste. Jabir Karat, a post graduate in History from Delhi University lives in Thamarassery. He chose his career in waste management even though it was not his subject. On completion of his studies, he was offered the meritorious Gandhi Fellowship. He opted to work at the Andheri Slum in Mumbai and there the concept of garbage processing struck him. He also found an entrepreneur who transforms garbage into compost in TV show ' Satyamev Jayate' produced by Aamir Khan. The show discusses and provides possible solutions to address social issues in India. He realized that waste is a misplaced resource. Later on he underwent training with the Environmental Protection and Service Organization led by Vellore Srinivasan near Coimbatore. Back home, he failed in establishing his new ideas. People of Thamarassery agreed to everything but were reluctant to pay nominal fees for the waste management services offered. It was easier to throw away.

Jabir then focused on events like conferences, marriages etc introducing the "ZERO WASTE EVENTS" concept. His company, Greens Worms is now providing waste management services and advice on making surroundings waste free during such special occasions.

## Description of wastes

Green worms initially dealt with degradable wet wastes like the food wastes from community and household, apartments, events and presently handling and managing non degradable wastes like e waste and plastic waste.

## How we do?

To tackle this problem of solid waste for every task we take up is guided by three objectives: minimise waste, maximum recycle and reuse of waste and dignify the waste workers job.

To achieve this, we first focused on events like conferences and marriages. Our first step involved in plan formulation to reduce the use of paper and plastic. Steel, ceramic plates and cups are made available for rent. Washing service team was also provided when necessary. The food wastes are segregated at source, collected in bins and is transported to resource recovery centre. Food wastes are composted. The first challenge taken up by Jabir was the Markaz Conference at Kunnamangalam. It was a three days conference attended by over one lakh delegates.

After successfully completing the first challenge, they started providing end-to-end services in waste management right from awareness to recycling. Our current activities include: Awareness, Decentralised Wet Waste Management, Dry Waste Collection, Segregation, Recycling, Consultancy, to government bodies, Productslike decomposing units, bio degradable cutlery, Workers' Welfare, Vaccines; Hygeinic working conditions; Complete uniform; Advocating for their rights, E-Waste ProgramEvent Waste Management.

## Our Projects

- **Government Projects**-We currently provide services to 6 Panchayaths and 2 municipalities which include about 100 residential associations and 40 apartments. The nature of services varies from complete collection of dry waste to providing consultancy services to the bodies on how to manage waste sustainably.
- **Bulk Waste Generators**-We have among our clientele various bulk waste generators including 30 hotels, restaurants and bakeries, 10 city hospitals, more than 30 retail shops.
- **3. Segregation Units**-Currently we have 13 segregation units spread over 5 districts. 3 of these units run from hospital premises and exclusively manage their waste. About 50 tons of combined waste is segregated in these 13 units daily.
- **Recycling Units**-Presently, we have 2 plants to recycle 4 grades of plastic. About 22 tons of plastic is recycled each month in these plants. Green Worms specializes in recycling low grade plastics like milk sachets, poly bags etc which otherwise have few takers in the recycling industry because of low rates. In fact ours is the only such facility in northern Kerala. Rest of the segregated recyclable material is sold to third party recycling units.
- **E-Waste Program**-We have partnered with Karo Sambhav, a Delhi based E-waste management organisation for E-waste collection. As their Kerala partner we:
  - Provide training workshops to students of 50 schools on e-waste management
  - Collect e-waste from these schools and colleges
  - Collect e-waste from 30 shops dealing with electronic material
- **Event Waste Management**-Till date Green Worms has managed waste for more than 100 big and small events including weddings, conferences, food festivals, school festivals and private parties. Our expertise lies in not just managing event waste, but planning for zero waste events.
- Decentralised Wet Waste Management
- All the wet waste or food waste is managed in the same premises of it is generated in i.e. in a decentralized manner. Based on the amount waste generated there are two solutions that we currently deploy:
  - Community composting, whereby we provide community bins to bulk waste

producers like hotels, restaurants, hospitals, apartments etc. The housekeeping staffs of these establishments are trained to use these bins. For those who need, we also collect the end product on request.
    - For individual households we provide single household composting units procured from Daily Dump in Bangalore.
- Awareness Programs and Training-To bring mindset change in our future and present generations regarding waste and its management, we conduct regular awareness sessions. These sessions are conducted with school and college students, residents and households, waste workers and government officials.

Catalysts Foundation for Education and Research is the professional consultants of Green Worms, guiding company to execute the projects.

## Impact

From our first challenge, Markaz Conference at Kunnamangalam, there was good response on everyone after the conference seeing the surroundings trash free even after such a huge gathering. Our company furthur provided-Employment to more than 150 workers, 80% of who are women, 450 tons of waste collected and segregated every month, 22 tons of waste recycled in a month internally, More than 100 awareness sessions have been conducted which have been attended by more than 5000 individuals, Waste managed for more than 100 events .

## Economic aspects

For our first challenge at the Markaz conference we charged a fee of Rs 25,000. The Markaz also received Rs 16,000 from the sale of compost.

## Conclusion - Future plan of work or any other aspect

Today Jabir is an arrow which would normally hit the garbage. Green Worms also provided waste management service for The Youth Conference of Markaz. The company has received orders from various events like marriages etc. The truth is while lakhs and crores are spent on events, people are reluctant to spend even a penny for waste management. We are seeking your support to make environment CLEAN & GREEN. Help us TOUCH THE ROOTS OF DIRT. In a tie up with a local shop owners' association Green Worms will be handling waste for 1000 shops in Calicut.

## Our Future

Green Worms aspires to become a premier organisation for solid waste management combining research, innovation, action and advocacy to make world solid waste free.

# A drive to overpower plastics: Star Polymers

**C K Babu[1], Rekha J Nair[2]**

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## Introduction

The venture, "Star Polymers" is actively involved in raising the awareness of rational use and treatment of non-biodegradable waste. The journey to overpower plastics by star polymers begins from an existing plastic moulding facility owned by the owner's (Mr. CK Babu) father; which during the course of time expanded to a socially committed organisation making good profits through plastic recycling. Taking the idea of recycling household plastics from a government workshop, coupling with his social commitment, the entrepreneur started the venture. At present, the polymer company perform moulding of the waste plastic, collected from the six nearby villages into products like electrical fittings and small household accessories. Such recycled material may be used for anything other than for storing food. The metal coated plastic, often found used as sachets for snacks and other food stuffs are unfit for recycling so that it is used for road asphalting, which gives the roads better durability. At present, the organisation is able to process 15 tonnes of waste plastics a month.

## Description of solid waste

Non-biodegradable materials, especially plastics are handled. The firm star polymers were using conventional PP (polypropylene) granules as their primary raw material. When the price of the raw material increased, he started thinking for the conventional raw materials. Thus the polymer company started to use plastic wastes, collected from the six nearby villages. At present, the company collects 15 tonnes of waste plastic every month.

## Mode of collection/transportation/processing

The venture is collecting the plastic waste with the support of female self-help groups known as Kudumbashree employed by the Government of Kerala. They will go to all houses in the village to collect the plastic waste, along with their other committed works. Apart from this, Mr. Babu created awareness among the people in 6 villages about the

hazards of plastic if it is carelessly thrown outside. The society who was already well aware about the facts was ready to cooperate. He motivated the household to keep the plastic instead of throwing them so that the collection agents can pick the waste once in a week. They provided separate bins for houses to keep their plastic waste. This not only helped in ease of picking up of plastic but also keeping the plastic free from other impurities which was the major hurdle in plastic recycling. The collected plastics are discarded from the impurities such as dirt, soil particles and left over products for which the plastic was used for packaging. Then these are used as raw materials for more than 100 varieties of products. The major products are electrical fittings (such as pipes for carrying wires, joints and connecters), Gardening accessories (plastic pots, pipes, fences etc.) and small household items. The products were initially sold in the nearby villages itself, but as the production increased they started selling it to wholesalers who takes it to cities.

## Impact

The venture motivated the households of the six nearby villages to keep the plastic instead of throwing them. Currently the organisation is able to process 15 tonnes of waste plastics a month.

The village was able to win more than 20 different awards on account of cleanliness and waste disposal which provides motivation for similar projects. The products from the recycled plastics are reported as highly competitive on price which helps them to gain market easily.

## Adoption of this method by others

Two similar plants have been setup in Kannur district which will operate in the same model. As a member of Technical advisory committee of Kerala Total Sanitation and Health Mission (KTSHM), Mr. Babu is also helping the Kannur district Panchayath to recycle plastic. The effort, along with KTSHM, has propelled many Panchayaths in the district to undertake similar schemes under the Susthira Shuchitwa project.

The state government has decided to setup similar projects in 15 other locations across the state which will be able to handle larger quantities of plastic. Many local self-governing bodies also have come forward for the project by deputing members form self-help groups to collect and sort plastic waste.

## Economic aspects

The initiative is finding value in the by-products which leads to the conversion of a negative externality to a positive one. The products were initially sold in the nearby villages itself, but as the production increased they started selling it to wholesalers who takes it to cities. The products are highly competitive on price which helps them to gain market easily.

## Conclusion

The project is a perfect example of a profitable social initiative. The initiatives are finding value in the by-products which leads to the conversion of a negative externality to a positive one. The venture of recycling the household plastic was not a start-up project by C K Babu, it was the transformation of an existing plastic moulding firm into a socially committed organisation. Later on, local government and the Panchayath offered help in the setting up a plant as it will also reduce the waste production in the area. As more plants are being set up they are thinking of other uses of recycled plastic.

# "Kuppayilum Ponnu"

## sovereign from waste

**K. R. Prathapan**
Teacher, volunteer of SS Parishad, Thermocol, Mob: 8281322856, 9947855253

## Introduction

It is a new venture started by Shri K. R. Prathapan, a Retired Teacher, volunteer of Shastra Sahitya Parishad. Here, the thermocol is being used to manufacture handmade mini-solar water heater, handmade mini-solar drier and solar water heater cum cool home equipment.

## Description of Solid waste

Non-degradable solid wastes, namely land based or sea based thermocol are handled. Apart from thermocol, aluminium sheets collected as press waste, flex sheets, rexin sheets, PVC pipes and fevicol are also used.

## How was it done?

The raw materials (land based or sea based thermocol, aluminium sheets collected as press waste, flex sheets, rexin sheets, PVC pipes and fevicol) are collected from fish markets and beaches and transported by own vehicle to the work place, own domestic yard.

These materials are used for manufacturing handmade mini-solar water heater, handmade mini-solar drier and solar water heater cum cool home equipment with basic ideas and measurements. No helpers or workers are engaged.

## Impact

Solar water heater, minisolar drier and solar water heater cum cool equipment are energy saving, eco friendly, cost effective and pollution free tools. Since they can be kept in terrace direct sun light can be utilizedwithout any fuel expense for working. The temperature of water will last up to 12 hours. The temperature of the room beneath the solar water tank will always be optimum. No smoke, no sound or any other disturbances are formed during the time of manufacture. "If there is Sun Light hot water is ready".

## Adoption of this method by others

Nobody has come forward to adopt this venture

## Economic aspects

Solar Heater is manufactured at the cost from Rs.5000/- to 100000/-. It is long-lasting equipment and self-repairable. This can be made in any measurement as per the customer's choice.

## Conclusion

"Kuppayilum Ponnu" is a small but remarkable venture by Shri K. R. Prathapan. He tries to save the many non-biodegradable waste such as thermocol, aluminium sheets, flex sheets, rexin sheets, PVC pipes, fevicol etc. from getting charred dumped or buried.

Additionally, these are used to manufacture energy saving, eco-friendly, cost effective and pollution free tools which are manufactured according to the demand from consumers. However, due to lack of enough laborers and funds, it has not been turned into large scale manufacturing.

# Plastic to Petrol

**V. S. Sreejith[1], Vidya R[2]**

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## Introduction

Perinjanam is a coastal village in Thrissur district in the state of Kerala, India. It is one of the smallest villages in Kerala. Perinjanam Panchayath has been recognized as the first Panchayath in India with 'ISO 9001 2015' certification. National Accreditation Board of Certification Body (NABCB) has conducted valuation in two steps and was found that the Panchayath has fulfilled the criteria suggested by Quality Council of India.

The Science Centre was established in 2006 under the Charitable Society Act with an aim to undertake scientific experiments. Several Teachers and students are undertaking science related activities in 5 buildings spread over 70 cents of land of Kodungalloor Municipality.

Mr. V. S. Sreejith, is the Director of Science Centre, has designed a plant and the perinjanam Panchayath has developed the prototype of a pyrolysis plant in which plastic waste is burnt and distilled to make petrol and other by products. This is a part of its endevour to find a low-cost and pollution free technology for processing non biodegradable waste.

## How was it done?

Mr. V. S. Sreejith, who has worked for several years in solid waste management on solid waste processing and recycling, promotes scientific experiments among students.

As a part of developing Technical know-how in completely removing plastic wastes, success has been made in experiments for converting plastics to different forms like grease, diesel petrol etc. Polypropylene is converted to oil similar to diesel and polystyrene to oil similar to petrol. The volunteers are collecting plastic wastes from the land and aquatic systems in each ward of the Kodungalloor municipality and then these wastes are transported to Science centre where it is processed. These activities helped to create awareness among the public about the plastic pollution and its harmful effects on the environment. The activities of the Science centre has been attracting B.Tech, M.Tech

and MSc. students from various colleges and Universities for visiting and successfully completing their projects.

**Process**- Plastic is converted to petroleum by heating it at a particular temperature. In the pyrolysis plant, a reversal of polymerisation takes place. The plant is at present burnt using LPG for display, but the biogas from organic waste will be used for the purpose when the civic body puts the technology to use for processing plastic. It was found that out of 1 kg of plastics; 960 ml of petroleum can be extracted using this technology.

The plastic burnt in the plant generates gas and the long-chain hydrocarbons in it are condensed using water and converted into petroleum in liquid form. The small chain hydrocarbons remain as gas which, in turn can be used as a substitute for LPG or bio-gas.

The demonstration of the plant was held successfully at the community hall of Perinjanam. The sample of petrol which has been distilled will be handed over to well known petrochemical companies for quality test.

## Economic Aspects

The technology is cost effective to produce one litre of petrol for Rs 35/-. Perinjanam panchayath would soon obtain an NOC from Pollution Control Board and start such plants in different areas in the Panchayath, the first of its kind, a petrol revolution in India.

## Adoption by others

There are queries for using this technology in Pondicherry to convert plastic wastes into oil and discussions are in progress.

# Thumburmuzhy model aerobic composting technique for livestock waste management

**Francis Xavier**

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## Introduction

Non-green livestock waste from animal farms, livestock units and fishery enterprises pose a big problem in the agro-climatic conditions of Kerala. The bio-security measures to handle such waste causes an impasse in this ensuing business and becomes an ecological problem of Kerala. Thumburmuzhy model aerobic composting technique (TMACT) is an eco-friendly, economic and efficient method for organic waste management. The TMACT was approved by the United Nations among the four ideal rural technologies for farmers in India. The technology called as "Gandhian Rural Technology" by UNDP Climate Control group (UNDP Climate change community compendium, 2011); was developed by Dr Francis Xavier, Retired Professor at Thumboormuzhi Cattle Breeding Farm, Kerala Veterinary and Animal Sciences University. As the aerobic method is used, degradation of waste occurs instead of decay, so that the animal waste or fish waste or vegetable waste gets converted to valuable compost in 90 days without any foul smell and harmful bacteria. The green house gas emissions from this technology are meager, thus valuing on carbon credits and there is no much leachate in the process. The method uses a consortium of natural microbes verified and purified by state agricultural university. The NPK value of "Thumburmuzhy model compost" using home waste is N.1.57%, P-0.049%, K-0.73%.

## Description of solid waste

Biodegradable organic wastes are targeted in the technology. These include rural organic waste, hotel food waste, farm waste and dead animal (carcass/broiler waste)/ fish parts which are otherwise dumped in rivers, roads, highways and water bodies leading to pollution.

## Mode of collection/transportation/processing

The composting unit includes a box-like structure with ferro-cement floor, layers of

cow dung (as carbon source) and waste materials. Under the ambient temperature ranging from 30-35ºC and 70-75% humidity, six inch layers each of fresh cow dung/ bacterial consortium (for the aerobic composting process), dry leaves/straw (act as the carbon source for the bacterial consortium to grow), and organic waste were layered. In 90 days time the first crop of manure gets ready. The temperature rises rapidly in the waste to almost 70ºC and this peak temperature kills pathogens so is a boon to rural health and community health. Segregation and collection can be done easily and layering of the waste collected needs less than an hour a day in a Unit. Manpower is never a must in TMACT.

## Impact

Waste management is a big problem in most of the farms of the state and hence the waste can be effectively converted into valuable manure by TMACT. Thumburmuzhy Model composting system is proved to be an eco-friendly, economic and efficient method for the management of various organic wastes (rural organic waste, hotel food waste, farm waste and dead animal (carcass/broiler waste)/fish parts); which are otherwise dumped in rivers, roads, highways and water bodies leading to pollution. Moreover, the waste is converted to high quality manure having N.1.57%, P-0.049% and K-0.73%.The system is proved to be a cost effective, rural system for livestock farms and rural Kerala. Thumburmuzhy Model composting system has a creative commons license and a patent application.

## Adoption of this method by others

TMACT has been adopted by a number of farmers, Municipalities, Apartment complexes and rural communities. TMACT is now owned by Waste-2 Wealth Alliance LLP, under Start up India Stand up India movement, access. Alappuzha municipality's 'Nirmalagramam Nirmala Nagarm project' that gained international attention as one among the five cleanest city in Waste management in the world, is a recent example for the successful adoption of the technology. Thiruvananthapuram Corporation, Kerala is implementing TMACT following the successful implementation in Alappuzha district. Presently, Tamil Nadu and Karnataka have the similar units to handle livestock waste. Nepal and other nearby Asian countries implemented TMACT after seeing Alappuzha experiment.

## Economic aspects

Any public space with 200 square feet shed area can hold a unit. A tank/bin for TMACT plant costs Rs. 10,000. The only one-time expense is the bin and recurring expense is cost of consortium (once a month). The completely filled tanks shall be kept for 90 days after which the manure will be ready.

## Conclusion

TMACT is a farmer friendly cost effective and eco friendly livestock waste management system. This rural technology is a recommended model by the UNDP Climate change

community among the four ideal rural technologies for farmers of India. The system emits green house gases (Methane, $CO_2$ and $H_2S$) in very minimum quantities. It is working through the use of a natural bacterial consortium for breaking down organic waste. The only one-time expense is the bin and recurring expense is cost of consortium (once a month). Good quality manure with N.1.57%, P-0.049% and K-0.73%, having no any foul smell and health hazard bacteria will be made from various organic wastes within 90 days.


# "Kalpa Sasya"- a venture for turning aquatic weeds to value

**G. Nagendra Prabhu[1], V. Anoop Kumar[2], P. Bindu[2] and C. Snishamol[2]**

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## Introduction

Based on the concept of "eradication through utilization" or "use to reduce", Dr. G. Nagendra Prabhu, Associate Professor, P. G. Department of Zoology and Principal Investigator, Centre for Research on Aquatic Resources (CRAR), S. D. College, University of Kerala, Alleppey, Kerala has come up with the innovations for utilizing problematic aquatic weeds of India. His group has developed the techniques for turning the weeds to a variety of products like, bedding material for mushroom cultivation, biomass briquette making, water hyacinth pulp based products and modified hydroponics (floating agriculture). The venture started in 1998 as a new lab scale technique for the production of cellulase enzyme from bacteria using common aquatic weeds of Kerala, viz. Water Hyacinth (*Eichhornia crassipes*) and Water Moss (*Salvinia molesta*). On course of time, the project has expanded to more exploitation techniques. Further, the pulp based products made from theses aquatic weeds are advanced touseful platforms like special canvas for paintings, egg and fruit trays, disposable plates, models of toys, animals, ready to plant biodegradable nursery plots, fruit and vegetable models, office files etc. This innovative movement is presently carried forward by Sanatana Dharma College, Alleppey.

## Awards/ Recognitions won

- Special Award from Sarojini-Damodaran Foundation, Bangalore managed by S. D. Shibulal, co-founder of Infosys, March 2018
- BVS Viswa Konkani Seva Puraskar, World Konkani Centre, Mangalore, November 2017
- Prathibha Puraskar, GSB Mahasabha, Kerala, May 2017
- Special Rural Innovator Award of KSCSTE, Govt. of Kerala, March 2016
- FLAIR-Research Excellence Award, Dept. of Higher Education, Govt. of Kerala 2015-16
- Microbiologist 2014 Award of Society for Educational & Scientific Research, September 2014
- P. A. Harris Foundation Award for contribution to Education, August 2014
- Rural Innovator Award of KSCSTE, Govt. of Kerala. March 2014

- Mathrubhumi-SPARK Award for the Best Kerala College Level Project September 2013.
- BOLT Award (Broad Outlook Learner Teacher)-Alleppey District Runner Up 2008-09 by Air India and Malayala Manorama.
- Young Scientist Award-December 2002, Association of Microbiologists of India
- Best Paper Presentation Award for presenting the paper entitled "Relevance of Solid State Fermentation in Kerala during the National Seminar at Trivandrum on 8th January 2001
- International Biotechnology Training Fellowship-2000-01, German Research Centre for Biotechnology, Braunschweig, Germany.
- Young Scientist (BOYSCAST) Fellowship of the Dept. of Science & Technology, Govt. of India, New Delhi-1998-99 (to visit Dept. of Biochem. & Mol. Biol, Univ. of Georgia, Georgia, USA.)
- Visiting Fellowship of the Indian Academy of Sciences, May 1998 (to undertake a visit to Central Food Technological Research Institute, Mysore, India)

## Description of solid waste

Aquatic weeds infesting the water bodies of Kerala, namely Water Hyacinth (*Eichhornia crassipes*) and Water Moss (*Salvinia molesta*) constituted the raw material. They are abundantly found in fresh water ponds, lakes, backwaters, paddy fields and irrigation channels throughout the tropical and sub-tropical countries of the world including Kerala posing a menace to aquaculture, water transportation and irrigation facilities.

## How was it done?

Three major technologies are developed and adopted for the effective utilization of the collected weeds, for which the weeds are collected manually or mechanically. In the first method, the collected weeds are used as a successful bedding material for three different species of mushroom cultivation and the technology is being transferred to the public. The second method is to utilize the dried weeds along with cow dung for making modified biomass briquettes in which the desired molds were made using empty CD packs. The third method involves preparing pulp from water hyacinth stem and leaves which are then utilized for the preparation of a large number of value added products viz. egg and fruit trays, disposable plates, handicrafts, file boards, fridge magnets, special canvas for painting etc. Some of these products now fetches market through exhibitions and online.

## Impact

The project turns the weeds- an aquatic menace- to a range of useful products and the technology was taken up by a number of SHGs and trainings were provided. As a scientific contribution, the work has been published in several international and national journals and books. Further, the technology had been highlighted through newspapers and magazines in order to motivate the public for "eradication through utilization". The founder is now being included as an Expert in the Committee formed to suggest the ways and means of controlling and utilizing water hyacinth in the backwaters of

Vembanad Lake, a Ramsar site by Govt. of Kerala. It has been identified as a method of control by Expert Team from ICAR, Alleppey Municipal Council and Kudumbasree. For the first time in Kerala, Alleppey Municipal Council has made a provision of Rs. 5.0 Lakhs in their Plan-Fund during 2018-19 for making value added products from aquatic weeds through Kudumbasree Units under them.

## Adoption of this method by others

The techniques developed at CRAR were first popularized among the target groups through articles, awareness sessions, hands-on training programmes and other means. The programmes were organized in association with NGOS, Colleges, Universities, Polytechnics, Engineering Colleges, Government Agencies like Kudumbasree, SBI-Rural Self Employment Training Institute, Jail inmates of Alleppey District Jail, School Teachers, General Public, Self Help Groups etc. CRAR has been working on several key elements that will be helpful in implementing as well as encouraging the general public to adopt these technologies. After developing various technologies through R & D, CRAR has made several national andstate level initiatives in solving the problem of aquatic weeds through value addition. The technology has been adopted by range of policy makers, NGOs, students (NSS, Eco-club, Nature Club), Residents' Associations, Self Help Groups, from 2014 onwards. The students and inmates of BUDS Schools and BUDS Rehabilitation Centres at Alleppey have started making products from water hyacinth.

## Economic aspects

R & D was supported by KSCSTE & Kerala Biotechnology Commission of Government of Kerala as well as UGC and Department of Science & Technology of Govt. of India. Popularization and training programmes were supported by KSCSTE & Kerala Biotechnology Commission. The techniques developed at CRAR are economic and targeted at rural population and hence are inexpensive. The approach has been people participatory, decentralized, self-help based and using minimum investment and using existing facilities available with the groups. The products made are Green and Eco-friendly in nature and will fetch a better price. Hence they are 100% sustainable.

## Conclusion

The ultimate aim of CRAR is to develop and commercialize the eco-friendly technologies for the control and value addition of the problematic aquatic weeds of Kerala. These technologies form innovative alternate livelihood programmes in the wake of climate change & biodiversity loss. The Centre for Research on Aquatic Resources is currently undertaking R & D, Consultancy, Extension and human resource development which is relevant nationally. It is prospected that the same model can be adopted internationally in countries where a similar situation exists.

# A small step for a big cause

**Jasna jaffer[2] and Vandana V[2]**

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## Introduction

My name is Jasna Jaffer. I am a second year Degree student studying in KMEA College, Aluva. I belong to Nettoor and is a part of Maradu Muncipality, Ernakulam. Near to our area is the International vegetable market and besides this market is situated the water treatment plants, post Office, agriculture training centres and soil testing centre. I am a student, social activist and a farmer. I have been honored with the School topper award, Best student of the School, Eastern bhoomika iconic women award for social activities, Best agriculture student of Maradu Municipality, Akshayasree award, Inpham award and also treceived the District level agriculture student award by state government.

## Description of Solid waste

The solid waste was mainly the bio degradable vegetable wastes from the market which was the main problem we were facing in our locality. As there were no facilities for the proper waste management in the market all the market wastes were dumped in the open space near to the market. This caused inconvenience to the people from the foul smell of the rotten vegetables and other wastages. Even the waste water from the market and plastic wastes had started to become a big threat to the fish resources of Vembanad lake. Market place was surrounded with dogs and nuisance pest like African snail. All these matters in turn had affected the tourists coming to the Valanthakad Island - upcoming tourist spot filled with mangrove forests. Many requests were given to the authorities to solve these problems. But no action was taken.

## How was it done?

Finally, when I was studying in plus - two, I came to know about Malayala Manorama " Nalla Padam ezhuthupetti". I wrote a letter regarding the problems of market to Ajitha Miss, who is our principal and Maradu Muncipality Chairperson. It was published in the paper. This letter was widely discussed among the members of Muncipality and a detailed report was submitted to the collector, Shri. Rajamanikyam., Ernakulam. Collector visited the place and conducted meeting with Muncipality members and Resident Associations. Emergency fund was provided for establishing streetlights. Next

day our resident association named "Ninavu" organized group run inside the market which attracted public attention.

## The impact

The market wastes were frequently cleared with the help of JCBs. Steps were also taken for establishing waste processing plants. Peoples were appointed for cleaning the market. Roads to the market were reconstructed.

## Adoption of this method by others

Inspired from the waste management techniques I started making compost from waste of my house and my neighboring houses. Plastics were reused and cloth bags were used as carrier bags. Poultry farming was started and waste from the farm was used as manure for the vegetable farming. For this, I got appreciation from government and organizations.

## Economic aspects

No fund is received from government or any other organizations.

## Conclusion

I wish to get a job. Through serving the society I wish to continue farming also. Its our responsibility to protect the soil. We have to be self- sufficient for getting food without poison. For this farming is the only way for establishing a connection between man and soil.


# Biodiesel, carcass meal and glycerol production from broiler chicken waste

**John Abraham**
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## Introduction

Broiler slaughter waste has become a major source of pollution throughout the world. The unscientific disposal of these wastes poses catastrophic threats to human population in the wake of emerging diseases like avian flu and swine flu. Utilization of broiler slaughter waste by dry rendering produced Rendered Chicken Oil (RCO), a cheap raw material for biodiesel production and Carcass Meal a feed ingredient for pets and fishes.

Bio-diesel is an alternate fuel, which can be used in all diesel engines and it improves mechanical efficiency, brake thermal efficiency, and decreases smoke emissions by 47.14%, reducing pollution and mitigating climatic changes. The technology was invented by Dr. John Abraham through his doctoral research work at Tamil Nadu Veterinary and Animal Sciences University (TANUVAS). Inspired by the idea, a school of Bio-energy and Farm Waste Management was initiated at Kerala Veterinary and Animal Sciences University in 2014. Simultaneously, under ICAR, ECF project, a pilot plant was also installed in 2014 to produce bio-diesel from rendered chicken. The output from the project had been tested at 'Kochi refinery, quality control lab, BPCL and confirmed to 'BIS' standards (IS-15607). An Armada jeep of the instructional livestock farm of veterinary college Pookode is running on this fuel.

## Awards and Recognitions

- 1st rank for Ph.D and 4 gold medals from TANUVAS, for invention of technology
- Process patent (Reg. No. 219/CHE/2014 dated 18/01/2014)
- Dr. Vaithilingam Rathnasabhapathy innovation award, 2012
- DST-Lockheed Martin-India Innovation Growth Programme Award-2016 (Joint initiative of Department of Science and Technology, Govt. of India; Lockheed Martin Corporation, USA; Indo-US Science and Technology Forum; Federation of Indian Chamber of Commerce and Industry; Stanford Graduate School of Business; IC Institute at the University of Texas at Austin and TiE Silicon Valley)

## Description of solid waste

Biodegradable broiler slaughter waste is targeted. In Kerala, it is estimated that about 5.4 lakh birds are slaughtered daily resulting in the production of 350 tonnes of broiler waste per day. Presently, broiler slaughter waste and dead birds from commercial poultry farms are unhygienically disposed off in un-inhabited areas and in water bodies leading to ground and surface water pollution, obnoxious odors and health hazards posed by indiscriminate breeding of pathogenic microorganism, parasites, house flies and also indiscriminate breeding of stray dogs which spreads rabies.

## Mode of collection/transportation/processing

The chicken slaughter inclusive of feather, head, feet and viscera is collected and cooked at high temperature and pressure by a process called 'dry batch rendering' during which the oil is extracted. The dry batch rendering process consists of pre-breaking, charging the cooker, cooking, sterilization, drying, centrifuging and milling. The dry rendering machinery comprised of pre-breaker, a travelling electric hoist, horizontal steam jacketed cooker (Dry Melter), equipped with a set of agitators, percolating tank, fat balance tank, centrifugal turbine fat extractor and milling unit.

The overall oil yield was 10.84% of the raw material. This is the only method which could immediately hydrolyse the feathers, which contributed 4.55% of RCO. Average yield of sterilised chicken carcass meal was 31.90% of the raw materials. The crude protein content of chicken carcass meal was 62%, which at the present per unit cost of protein worked out to Rs. 20/kg. This could be utilised as fish and pet feed and could be incorporated as main protein source in the feed for ruminants. The feed was observed to be superior in terms of average daily gains for Malabari goats and was economical compared to other formulated feeds.

Biodiesel production from rendered chicken oil is a two-step reaction; First step is the acid catalysed esterification of FFA portion of RCO followed by the base catalysed transesterfication of triglyceride to produce bio-diesel. Heterogeneous catalyst (CaO) was standardised for transesterification, for an optimum yield of 93% crude bio-diesel. The co-product separated out from bio-diesel i. e 'crude glycerol' is purified by vacuum distillation. The output is 97% technical grade glycerine (fit for industrial application) and 99.7% pharmaceutical grade glycerine (for use in cosmetics, pharmaceuticals and food).

## Impact

This technology produces wealth from waste. Engine testing using the bio-diesel produced at the pilot plant revealed that it improved mechanical efficiency, brake thermal efficiency, and decreases smoke emissions by 47.14%, reducing pollution and mitigating climatic changes compared to other commercial diesel. The bio-diesel produced from the pilot plant was used to run a Bolero Jeep without any modification, which became very smooth and efficient, emitting significantly low smoke. At present the major buyers of biodiesel are Indian oil corporation, Bharat Peroleum Corporation

Ltd, Indian Railways, Karnataka State Road Transport Corporation and Kerala State Road Transport Corporation. Govt. of India has modified rules and regulation allowing retail sales of bio-diesel for its promotion. There is a 36.16% yield for co-product glycerine (technical grade and pharmaceutical grade) during bio-diesel production. The present price of refined glycerol comes to Rs. 254/kg. Using this product, Glycerine soap is being produced at the school now.

## Adoption of this method by others

This technology has been adopted by 'Malabar Meats' the multi species abattoir of 'Brahmagiri Development Socitey, Wayanad. Detailed project report had been prepared for 3 firms for implementing this project at Malapuram and Calicut districts.

## Economic aspects

The Ph.D research project at TANUVAS was funded by ICAR-Senior Research Fellowship. The pilot plant at Pookode was established at the cost of Rs. 12 Lakh funded by the ICAR-ECF. Collection of broiler waste adds to the revenue (Rs. 5/- per kg daily). Carcass meal (Yield 30% of the waste), a suitable animal feed ingredient approved for use by the Food and Drug Administration (FDA 2006) has the cost of Rs.25/kg. Bio-diesel (Yield-10% of waste), a green renewable bio-fuel fetches a cost of Rs.32.23/litre and also will reduce the environmental pollution considerably. The cost of production of bio-diesel at the pilot plant was Rs. 30.23/litre. Glycerol (Yield-24.6% of Rendered Chicken Oil) when purified to pharmaceutical grade fetched Rs. 254/ Kg.

## Conclusion

Biodiesel production technology provides opportunity to produce wealth from waste. At the same time, this concept can also solve the major problem of unscientific disposal of slaughter waste and dead birds. This project stimulates rural development as it provides employment opportunities for waste gatherers, transporters etc. It also produced good quality renewable fuel for diesel engines. Ultimately it reduces green house gas emissions and mitigates climatic change, reduces the incidence of cancer and improves the health of common people. It will also add increased renewable energy capacity of the nation reducing the import of fossil fuels. The other by-products such as glycerine and carcass meal adds to the financial outputs.

# Ecorycle - recycling enablers

**Babu Syed, Fathima Anika, Rekha J Nair**

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## Introduction

Ecorycle is a Kochi based enterprise and a Social Entrepreneur partner of ITC group for their Well being Out Of Waste (WOW) programme. Ecorycle offers training sessions to students, teaching and non teaching staff so that they understand the basic concepts of segregation and imbibe the need for recycling in their institutions as well as their homes. The team was conferred "The Best Innovation-Waste in The Smart City 2018" award by Agence Francaise De Development and Alliance Francaise. Ecorycle organise Training sessions to influence a lifestyle change among all levels of oursociety.

The infrastructure of Ecorycle includes committed team members, who organize doorstep collection for customers who are facing issues with hoarded degradable and non-degradable waste, to the graders who sort the waste materials into groups of recyclables, transport partners, stake holders from various recycling industries and our bankers offer solid support to this endeavour.

## Description of solid waste

Doorstep collection is undertaken for customers who are facing issues with hoarded degradable and non-degradable waste including plastic waste, glass bottles, scrap metals.

## How was it done?

After providing proper training, collection of recyclables from their premises is done by fixing a schedule for pick up based on the rate of waste generation. Lifted materials are graded in the hub and packed for transportation to recyclers. Long term MOUs is signed with the clients so that they enjoy a seamless service irrespective of seasonal market fluctuations. By ensuring that confidential documents are picked up under a strict and safe regime for eventual pulping, large volumes of paper which would otherwise be incinerated are salvaged and the customer is paid for the waste he generated through digital transfers.

## The Impact

With Kerala growing at a threatening pace as a consumer state, more waste is being generated than ever before. Ecorycle has been able to spread its footprints chasing this menace and converting it into value- for the individual, society and the planet.

## Conclusion

Ecorycle ensures that along with Reduce, ReUse, Recycle, thefruits of this value addition is enjoyed by all stake holders, including the "waste handlers", the 4th R Respect is duly accorded.

# Journey of india's first anaerobic digestion waste to biogas plant

**Suhas Bhand, V V Singh, Umesh Rane, Pawar N.A**

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## Introduction

Organic Recycling Systems Pvt. Ltd. which was established in 2008 and functions through its SPV-Solapur Bio-Energy Systems Pvt. Ltd (SBESPL), has established India's first demonstration plant for MSW processing facility based on indigenously developed technology at Solapur, Maharashtra. The company is currently processing 200 Tons per day (TPD) of un-segregated MSW, and now is being upgraded to full working capacity of 400 TPD. Besides this, Bangalore 1000 tonnes and Meerut 800 tonnes are also in advanced stage.

## Awards/recognitions

- Global Excellence Award In Renewable Energy 2013
- Energy & Environmemt Foundation 2013
- Global WasteMet Award 2014
- Fastest growing Indian Company Award by National Achievers Conference 2014
- Global WasteMet Award 2015
- Skoch Smart Technology Award 2015
- Global WasteMet Award 2016

## Success factors

- India's first waste to energy plant on Anaerobic Digestion Process.
- Recognized by MoUD, Govt. of India, under Best Practices towards Swachh Bharat Abhiyaan.
- 1st Plant in India to have exhaustive in-house segregation system that has been indigenously developed and the plant is operated on patented technology DRYADTM.

## How was it done?

### Segregation & processing of mixed waste

Since 2008, we have been the forerunner in sustainable treatment of solid waste. The success lies in the development of scientific approach towards treatment of waste. We are a focused company in the domain of Scientific Treatment of Municipal Solid Waste (MSW). In our endeavor to provide an environmental friendly solution for treatment of MSW, we have developed our patented DRYAD™ - Anaerobic Digester Technology based on the principles of Thermophilic biomethanation. The technology has been developed after a thorough research and development after considering the characterization of MSW in India and validation of operational data through a 12 TPD Pilot Plant on mixed MSW.

The flexibility of the DRYAD™ technology allows the treatment of a wide range of different feed materials. The bio-gas generated from the process is used to generate energy & the digested residue is extracted from the digester, dewatered to a Total Solid (TS) content of about 50% and stabilized aerobically during a period of approximately one to two weeks.

Presently, Power-Installed Capacity 3.60 MW b) Compost - 50 Tons/day c) RDF - 50 Tons/day (Under Implementation).

## Economic aspects

Entire Project has been commissioned on DBOOT basis with an investment of Rs 110.00 crores approx.

## Conclusion

### Overall Sustainability

- Reducing burden on landfill by daily processing 300 - 350 Tons of Waste.
- Reducing Greenhouse gas emission by processing of organic waste
- Recycling the combustible waste (plastic, papers, rags, etc) into useful fuel for cement industry
- Provided training & employment opportunity to 60-80 rag-pickers in the plant. Organic Compost produced from the plant is sold to farmers, which is reducing the consumption of synthetic fertilizer like urea, hence increasing the soil condition and nutrition of the area.

## Additional Information

ORS has also developed a Product line called "YASASU Green" a decentralized

Waste to Energy solution of 1, 2, 3 and 5 tons, to cater Urban, Semi Urban & Rural Market for decentralized processing of MSW while reaping the same benefits. He has also guided ORS team to develop rural solution for cattle manure organic waste. The model developed is Yasasu Urja of capacity 1 $nm^3$. He has represented ad presented technical papers in various national and international conferences. He is also a member of FICCI Advisory group on waste management.

# "Kachil ravi" turns waste to organic fertilizer"

**R. Raveendran and P.S. Swathi lekshmi**

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## Introduction

Shri. R. Raveendran, lovingly called as "Kachil Ravi" is a progressive farmer from Ulloor in Thiruvananthapuram district of Kerala. The nick name connotes to his unique achievement of producing the largest giant African white yam (Kachil in Malayalam, Weight-275 Kg) which has been listed as the world heaviest of its kind in Limca Book of Records, 2011. Shri. R. Raveendran, became popular due to his remarkable production of organic fertilizers also. He used discarded portions of fishes such as head, gills, scales and entrails to produce an aminoacid suppliment for plants. "Hridhayamruth" and "Mutta Mishritham" are other low cost organic fertilizers made by him. He also makes fertilizer based on vermicompost utilizing organic wastes (Vermiwash) and cut pieces of human hairs collected from salons and parlours (human hair vermicompost).

## Awards and Recognitions

- Innovative farmer award, Indian Agricultural Research Institute (ICAR), 2014
- Fellow farmer award, ICAR, 2017
- National Award for the best farmer, 97th Indian Science Congress, 2010
- "Uthradam Thirunal Marthandavarma Award" for the best farmer, Kerala state
- Award from National Biodiversity Congress, India
- Award from Kerala State Biodiversity Board

## Description of solid waste

Biodegradable organic waste (discarded portions of fishes such as head, gills, scales and entrails, leaves from plants, pieces of human hairs collected from salons and parlours etc.) are getting utilized here.

## Mode of collection/transportation/processing

The land based wastes are collected and transformed to organic fertilizers like,

"Hridayamruth, fish amin oacid supplement, Vermi-wash, and human hair vermicompost". Fish waste is procured at free of cost from fish markets and from neighboring houses by employing a labourer. "Hridhayamruth" is made by mixing green leaves of fragrant plants to non-fragrant, bitter and sappy varieties in Jaggery solution. 'Muttamishritham' is made by dipping local/country chicken eggs in lemon juice solution followed by addition of jaggery. For "Vermiwash", organic wastes are collected and fed to earthworms of the species *Eudrilus eugeniae*. The excreta of these earthworms are collected from the compost unit and used as fertilizers. The solid portion will (organic fertilizer) and liquid portion (vermiwash) will be separately used. Further, human hair (collected from salons and parlours etc.) is also effectively utilized in vermicompost.

## Impact

There was no system for waste disposal in the working areas before he has started. The public was desperately seeking a place for dumping fish waste either on road sides, canals and vacant plots. Shri. R. Raveendran could successfully convert this simple waste including marine fish waste in to an economically useful by product. Additionally, use of organic fertilizers could avoid the problems and hazards associated with the use of chemical fertilizers. Shri Raveendran is of the opinion that Fish Amino Acid is a super organic fertilizer that increases the yield of crops tremendously and so does it increase the income of the farmer. He attributes the success of producing the 275 Kg African White Yam to the use of his fish aminoacid supplement. He also motivates the famers and housewives through regular farm field schools. More than 400 people have got trained in the Farm school conducted by him under the Agriculture Technology Agency Programme (ATMA), Department of Agriculture, Government of Kerala.

## Adoption of this method by others

The famers and housewives are regularly getting trained through farm field schools. Many people including farmers and end users from many parts of India and abroad started adopting and producing organic fertilizers through the technology developed by Shri. R. Raveendran.

## Economic aspects

The raw material for production of fish waste based aminoacid supplement is procured at free of cost from fish markets and from neighboring houses. He employs a laborer for collection of fish waste at a cost of Rs. 300 per 10 Kg of fish waste. Net profit for 50 l of this amino acid supplement is calculated as R.11700/-.

## Conclusion

Shri. R. Raveendran could successfully convert various organic wastes waste (which otherwise goes discarded in public places) into useful organic fertilizers of immeasurable value in economically feasible ways. He also encourages other farmers, friends and neighbors to follow the technology through regular farm field schools.

# Wealth from waste-utilisation of fish waste for production of biogas

**Prathibha Rohit, Dineshbabu A.P., Sujitha Thomas, Geetha Sasikumar, Rajesh K.M., Bindu Sulochanan, Purushottama G.B., Divya Viswambharan**

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## Introduction

A biogas unit was installed in the premises of Mangalore Research Centre of CMFRI during November, 2016 in order to utilize the fish waste generated from the biological analysis done in the lab. This biogas unit installed is first of its kind in the state to utilize fish waste. A unit was installed gainfully utilizing the fish waste generated after the biological analysis of fish. Disposal of the fish waste generated periodically at the Research Centre during sampling made for biological studies was becoming difficult. However, with the installation of the biogas unit- designed and supplied by private manufacturer in Kerala, solved the disposal problem of fish waste.

## Description of Solid waste and how is it done

At the centre after the biological analyses about 6-7 kg is produced. The fish waste of about 5 kg along with same quantity of vegetable waste produced in the Departmental Tiffin room is fed to the biogas unit. The portable biogas unit has 2 t capacity and when fully functional around 2 kg of gas is produced every day. The quantity of gas produced is utilized in the Department Tiffin Room. In addition the slurry collected from the unit is utilized for the production of manure by mixing it with the coconut fronds, grass leaves etc., is used as manure in the vegetable patch as well as in the terrace garden of the office. A vegetable garden is maintained in the office and the slurry is utilized for the terrace garden and vegetable patch maintained in the office. Total cost of the unit was about Rs.35,000/-.

## The Impact - How the situation is before and now

The biogas unit has helped in decreasing the LPG consumption to about 25-30 %. The vegetables that were grown included ridge gourd, bottle gourd, bitter gourd,

cucumber, brinjal, pumpkin tomatoes, ladyfinger, chillies, coriander leaves, amaranthus etc. About 100-120 kg of vegetables were produced every year. The vegetables were utilized for preparing food in the tiffin room and the vegetable waste was used for the biogas unit.

## Adoption by others

The program was taken up as part of the regular Swatch Bharath activity at the centre. The biogas unit for utilization of fish waste has attracted many people during the foundation day of ICAR-CMFRI, open house. The activity was covered by the Doordarshan Kannada TV, and most of the newspapers in Karnataka. There were queries regarding the biogas unit and fish processing and fish meal plants have come forward for installing the unit. The Scientists of the centre were called for radio talks to create awareness of the waste management.

The disposal of fish waste is a problem and hence installation of similar units in the fish meal and fish processing plants would address the issue of fish waste management to some extent.

## Economic aspects

The program was funded by ICAR-CMFRI as a part Swatch Bharath program. Total expense incurred was about Rs 35,000/- for installation of the unit. The LPG gas consumption reduced to 25-30% and approximately 100-120 kg of vegetables per year is produced in the premises.

## Conclusion

The utilization of fish waste has helped in minimizing the waste disposed from the centre .The biogas is renewal energy resource which helps in reducing the usage of fossil fuel. This method is efficient alternative technology that combines biofuel production with sustainable waste management.

Vegetable garden to utilize the slurry from biogas

# Solid waste management in Mangaluru

**Madhu S. Manohar[1], Bindu Sulochanan[2]**

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## Introduction

Mangaluru, the fourth largest city in Karnataka State is situated in the west coast of Southern India. It is the fast growing city in education, commerce and industry. The city with more than 5.5 lakh population faces the challenges of dealing with its solid waste. The rapid urbanization and changing lifestyles have led to the generation of huge amount of garbage and wastes in the urban areas. The initiative by Mangaluru City Corporation (MCC) could successfully collect the solid waste generated within Mangaluru City and process it at centralized processing plant at Pachanady of the City Corporation. The raw waste received at the site is pre-sorted and further sent to processing shed. The pre-sorted waste materials are being used as a raw material for windrow composting and vermin-composting. Some percentage of hotel waste and market waste is being used for bio-methanation plant. The rejects from windrow, vermin-composting and bio-methanation plant is sent to sanitary landfill site.

## Description of solid waste

The area coming under the jurisdiction of Mangaluru City Corporation produces an average of 310-320 tonnes per day (TPD) of solid wastes, with a daily collection frequency of 310 TPD. The waste collected has a composition of 60% of organic, 25% of inorganic, 5% of combustible and 10% of recyclable wastes.

### Mode of collection/transportation/processing

Door to door collection from entire 60 corporation wards covering 100% using hydraulic vehicles. All the collection and transportation vehicles have completely covered and automatic unload mechanism which reduced the number of manpower deployment and the manual contact with garbage.

### Collection and transportation

GPS technology was adopted to record the real time fuel level and vehicle location

in all the primary and secondary collection vehicles. Mechanized sweeping was done in South zone for a stretch of 25 km/day.

### Processing of Waste

Windrow composting and Vermi-composting was provided under KUDCEMP Program. 200 TPD of waste was aerobically composted through Windrow method and 25 TPD of waste was by vermi-composting method. Rejects from compost plant was transported to sanitary landfill site. Soil top cover of 30 cm is being provided on regular basis. The operation and maintenance of the processing plant is being outsourced to M/s Unique Waste Processing Company Limited, New Delhi.

Simultaneously, a decentralised plant is setup at Urwa market area for converting waste to energy, the wet waste material is being used as a raw material for bio-methanation plant. The plant is having 2 TPD capacity which is constructed by M/s Wipro EcoEnergy. The plant was commissioned in September 2011 and running successfully. Presently, the plant is generating 150-160 m3/day of gas and 100-120 kg/day of manure. The gas generated is being utilized for generating power & illuminate the surrounding area.

## Impact

- Mangaluru City has got 100% efficiency in door to door collection of the solid wastes generated.
- 100% of the vehicles used are hydraulic vehicles, which has reduced the manual contact with garbage.
- Mechanization of the work like street sweeping, weed cutting, drain cleaning is practised.
- Vehicles are being tracked through GPS, so the monitoring of the collection is easy.
- Man power has been reduced with mechanization of some of the activities.
- Mobile application is being used for the Redressal of the complaints, so that the complaints are redressed within 24 hrs.
- Tie up with major companies to purchase the compost generated at the processing site. And also utilize the compost for Mangaluru parks and gardens.

## Adoption of this method by others

The project is completely outsourced to a private agency and being managed by MCC Health Department. For conservancy works, collection and transportation of waste it has been outsourced to a private agency for 7 years and for processing and disposal of waste another agency has been selected through outsource for 6 years time frame.

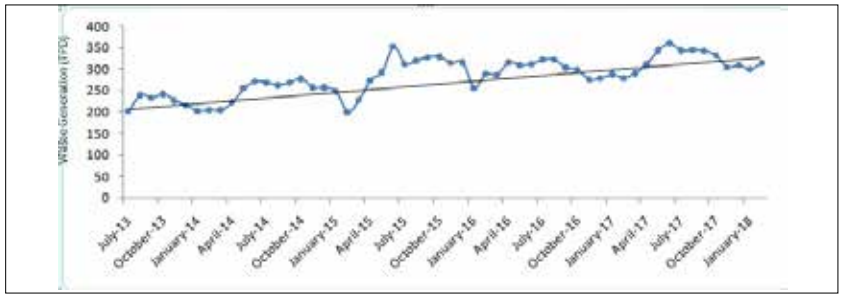
## Economic aspects

For conservancy works, collection, transportation, processing and disposal Mangaluru City Corporation is spending annually Rs. 3500 Lakhs.

City Corporation generates revenue for solid waste management by introducing SWM Cess on Property tax and also by way of tax on trade and business activities. Presently City Corporation is collecting SWM Cess of Rs. 1200 Lakhs from Property tax as well as from different trades. The SWM expenditure is being borne through the SWM Cess and other source of funds from MCC.

## Conclusion

The project could carry out the door to door collection of the solid wastes generated from all the households with the Mangaluru City Corporation limits. Mechanization for most of the procedures could reduce the number of manpower involved, and increase the efficiency of solid waste management. Adoption of GPS could strengthen the communication between the field and office executives. Garbage collected is being completely processed and disposed scientifically through composting process and generation of energy. Overall, the effort minimised the MCC response towards the public grievance.



# No odour and no leachate bio-waste management in Kunnamkulam municipality - (community and household level)

**Musthafa B. M.**
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## Introduction

IRTC is the Research and Development wing of Kerala Sasthra Sahithya Parishad (KSSP), the Pioneer of People's Science Movement in Kerala. It came to existence in 1987 as the natural extension of KSSP's activities for the effective use of science and technology for the upliftment of poor and down trodden.

Our major activities: Research and Development, Technology adaptation and modification, Technology transfer, Product development, technical support and consultancy, Training, Project implementation, Quality testing and analysis.

Accrediations: IRTC is the accredited agency of Government of Kerala in the areas of Solid waste management, preparing master plans for watershed based development Panchayath level resource mapping, rain water harvesting, biogas plant installations. IRTC is the approved centre for providing trainings on waste management to lSGD officials, Kudumbasree groups, Harithakarmasenas, training centre of KILA, IKMetc. IRTC is the Rural Industrial support centre of KVIC and resource support organization of NABARD. The environmental lab is accredited by Pollution Control Board having testing facility for water, soil, oil, soap and compost.

IRTC has been awarded as the 'Centre of excellence in waste Management' by the government of Kerala.

Kunnamkulam Municipality of Thrissur District lies very close to Guruvayoor, the temple city of Kerala. Kunnamkulam is a town with trade, commerce and printing activities. It is 22km from Thrissur. Geographically Kunnamkulam is the exact centre of Kerala .The kunnamkulam municipal council has 36 wards with a total population of 54,071 and the density of population is 2,824 and the no. of house holds 11500.

## Description of waste

The waste handled in Kunnamkulam, Municipality is biodegradable municipal solid waste. In the past few years Kunnamkulam Municipality followed a socially unacceptable way of waste disposal. Around more than 3 ton waste are daily evolve from municipality but all of these were not affordable to dispose within the municipal area. Until 2016 Municipal solid waste were dumped onto land in 22nd ward of Kunnamkulam Municipality, is known as Kurukkanpara. Long year's age Kurukkanpara location was an isolated area and did not have residence, was the main source of the disposal crisis. Due to the lack of unavilablity of space municipality has forced to choosen Kurukkanpara location for dumping waste as a disposal method. Dumping of waste in Kurukanpara location was more than 80 year old. Solid waste management was a challenging issue in Kunnamkulam municipality like other municipalities.

## How was it done?

Centralized approach of waste management is being used here. A plant was built having a capacity of processing 3 Tons of municipal solid waste per day. The collection of wastes from the hotels, bakeries etc. was done by the help of trained Kudumbasree workers. The technology adopted is window composting. EM Enriched Coir Pith is used as microbial supplement for composting. By the technology, they could generate compost within 35-40 days.

Waste Management at household level is carried out by the supply of Inoculum based Bio Digester bins. Municipality has been equipped with a "Haritha Karma Sena" unit consisting of trained women technicians for carrying out maintenance activities of waste management devices supplied at household levels. Till now about 2500 bio bins were supplied at household level and are still continuing. The final compost products from the households were collected by the Haritha karma senas in giving back a small packet of inoculum to the households. The collected composts from the households were packed and are sold out.

## Impact

The final obtained compost is branded and marketed as Samata Compost. It proves to be a success model in managing the municipal solid waste. Samatagreen, Women Self Help group of kudumbasree unit is the local implementing organisation for IRTC. Through the production of bio manure from bio waste they can maintain their income at an acceptable level. It works on the principle of wealth from waste. Now it encompasses micro enterpreneures unit through a sustainable waste management system. In Samata green, they produce one and half ton of bio manure from three tone of bio waste and they send to the agriculture sector at the rate of 15/kg.

## Economical Aspects

- Capital Expenses by municipality

- Recurring Expenses per day for 3 tons ( Practically 350 days taken in an year)
- Cost of Compost media1.00 ton *12000/- 12000-
- Wages 6 prsn*600/- 3600-
- Current,water 1500-
- Repair and maintenance 200-
- Manure value addition and packing 5000-
- Misc. (Depreciation,Insuranceetc) 500-
- Total 22800 ( say 23000/-)
- For 350 days *23000 : 80.00 lakh

## Adoption by others

The waste management plant has been visited by various professionals (Prof. JeenBonhotten, Prof. Mary Swarsa) from Carnel University, New York in order to study about the various aspects of waste management and appreciated us it is a unique process. Municipality has also made an Annual Maintenance Contract (AMC) with IRTC for the overall working and maintenance of the centralized plant.

## Conclusion and future plan

By these projects, IRTC is aiming social welfare through science and technology i.e. by creating job opportunities, women empowerment, making a permanent solution to municipal solid waste, scientific knowledge to people etc.




# Waste management - innovation at home

**John Peter**

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## Introduction

More than 5 years ago, I had created two technologies to solve the problem of waste management. One apparatus made for household waste management and another for the use by interested parties. Many people appreciated and somebody imitated the first one. I am a post graduate and a Rtd. Headmaster. Aged 72. I have invented forty six technologies in different subjects. Govt. and institutions honoured me for my innovative activities (and non- money oriented) services. H.E. Governeor of Kerala sanctioned enhancement of my salary/pension based upon the recommendation of the authorities. The CUSAT, Kochi installed the model of one of my innovations at their compound.

## Description of waste

Bio-degradable & Non-degradable. Also land based & simple machine for (rapid) removal / collection of water based wastes- Bio. & Non - Bio types.

## How we do?

### Land based

Processing: management of house hold food wastes. COLLECTION: bio. & non- bio wastes from rivers, sea.

**STEP: 1.** Fish, Vegetables, Meat… waste pieces are cut into small pieces- using knife / meat cutter with curve upwards at end.

**STEP: 2.** Small pieces are put into bucket and pour water.

**STEP: 3.** The pieces of waste with water sends/ pour to the closet - U - TUBE. Please note that there may be more than onE toilet in many houses and use one of them for leaving the BIO-SOLID/ LIQUID WASTES.

## Important

Those who have large compound or at least a small yard,- shall make a small and open U tube toilet tank using PVC tubes and Ferro- cement and pit of about one square meter area and one and a half meter depth. Attach one U tube and a flower plant pan ["poochatti"] .Construct it near a tree. Connect a PVC PIPE-very small- with a length of 5 meters. This tank / the second toilet inside the house to pour the remains of cooked food which becomes after the use( eating). We should arrange a big dish / bucket near the wash basin with ¾ volume of water. Before using the wash basin, dip the plates, spoons, pots… into the big bucket and almost all the remains on each plate… will be dissolved in the same water. As all of us know very well that "WATER IS A UNIVERAL SOLVENT". We shall save good water -comes from pipe at wash basin. After washing the plates… wait for some - about - 10 minutes to get the solid wastes to go to the bottom of the bucket. Then pour the water in the bucket, at the top part to the wash basin. Then take the bucket with the remains of the solid waste with some water and then pour into U tube.

## Collection of solid waste from water sources

Baby machine for easy collection of solids from waste source: I am introducing an innovative simple, low cost, speedy, energy efficient and environment friendly machine for the collection of solid materials: LIVING and NON-LIVING SUBSTANCES FROM ALL SORTS OF WATER RESOURCES.

**STEP: 1.** Install a simple machine - Ref: Picture: 1 - below. The principles of gravitational force and lever technology are the main aspects of the efficiency of this very simple device. Even an elephant shall be caught and lifted with 1 man power! (at the time of floods wild animals like elephant also come floating through the rivers!) The cost of erecting the machine depends upon the size of it. But please note that the cost of the machine for a catchment area of 500 M2 is below Rs.50,000/- only.

**STEP:2.** Dip the net (made by fiber or metal) into the water source and then use power on the machine; the net comes to the land side with the big load of solids - living or non-living!!! Please note that arrangements are done to bring the load to 3 sides of the pillar.

My point is that easy collection of solid waste from water source. Note that this is a very good machine for fishing also. But be serious while erecting this machine on water vessels like native boat and motor boat, some extra precautions are to be taken.

Waste Collection without touching the water.( 3 steps in 3 pictures with my new machine)

## The Impact

Very easy and non- expensive management of household food wastes. The use of special apparatus or second toilet.

The simple machine designed by me is useful as a multi-purpose one- for easy collection

of waste from river, sea and also for very easy fishing. Nasty situation in public places by thrown away household bio-wastes are gone; very easy and economic collection of wastes and fish from pond, rivers, sea.

## Adoption of this method by others

some people adopted the method for household waste management. The second one: proto type (working model) is exhibited at the yard of my home. I am absolutely willing to give the technology to your institution with free consent for taking the Patent by CMFRI; The application of this machine may be taken as a project work. This machine is named as Baby machine for easy collection of solids from waste source.

## Economic aspects

### Household bio. waste management

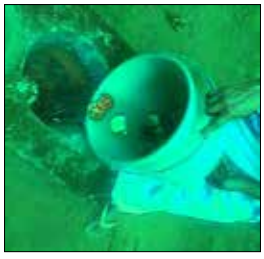
- No expense if we use second toilets at houses.
- If we make a special toilet as said above the expense will be less than Rs. two thousand only.

### The machine

About Rs. 5000 to 50000/- as per the size of the machine. At least Rs. 5000/-

## Conclusion

I shall modify this machine with splendid utility. Free service promised to co-operate with CMFRI in any project works at free of cost. I have already made very simple solutions for very hard problems. I have a fundamental talent for research works. CMFRI May treat me as a primary inventor. My main hobby is innovation and I am well-known as rural scientist in Kochi.


# Step towards reducing plastic/ textile waste in Kerala

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## Introduction

### About us

Bhoomithra Sena Club is the nature club in St. Teresa's College formed in 2010 with support from Directorate of Environment and Climate Change, Government of Kerala. STEP -Society of Teresians for Environment Protection formed in April 2016 is a charitable and literary organization registered under the Travancore Cochin Literary Scientific & Charitable Societies Registration Act; 1955 which strives to promote social entrepreneurship for environment protection.

Based on a solid waste audit done during 2014-16 in four villages in Kerala, including the coastal village of Ezhikkara in Ernakulam District by Dept of Economics St. Teresa's College as a part of KLGSDP project, revealed a worrying increase in plastic waste particularly plastic carry bags in rural areas. Since most of these are voluminous and soiled, recycling strategy is reported to be un-economical. Most of these are burnt, discarded in open grounds or disposed off into canals/ water bodies. In fact news articles report that now fishermen get more plastic than fish as their catch.

## Awards or recognition won already

BhoomithraSena Club in St. Teresa's College- declaredin September 2017 as Best Club among colleges in Central Kerala by Department of Environment and Climate Change, Government of Kerala.

- Recognition by Suchitwa Mission,Govt of Kerala as master faculty on alternatives to plastic carry bags for the HarithaKeralam Mission of Govt of Kerala
- June 2016, Paristhitha Mithra -2016 award instituted by the Centre for Environment Education and Rural Development, St Stephen's College, Uzhavoor
- The Shuchita Haritha Puraskar 2015-16 byMithradam, Rajagiri outreach of Rajagiri college of Social Sciences, Sahridaya Services and Charities and Cochin Shipyard Ltd.

Description of solid waste

## The waste handled in this project is

- Dry waste, mostly Non biodegradable waste - Plastic, rexine, textile, sanitary waste.
- Primarily land based- Indirectly reduced marine debris through reduction of non biodegradable/ non recyclable waste in coastal Kochi, Ezhikkara, Parur, Kadamakkudy.

## How was it done?

Project in Ezhikkara panchayath, aimed at recycling of unavoidable plastic as well as reduction of plastic carry bags. Reduction strategy was carried out in co-operation with Kudumbashree /local Governments/ students. House to house awareness campaign on segregation of solid waste into bio and non-bio degradable components was conducted on a pilot basis in ward 7 in 2015 followed by extension to ward 10 in 2016 and all wards subsequently in 2017.

We also implemented a reduction strategy in 2017 through i) Sanchimela covering all 14 wards for recycling textile waste into cloth bags ii) projects for behavioural change in all five primary schools in the Panchayat.

## Time line of activities

- Design of eco -friendly alternatives to plastic carry bags
- Recycling / up-cycling old textiles, textile waste from tailoring/ upholstery shops
- Design of alternatives to other rexine / non -biodegradable products

| | | | |
|---|---|---|---|
| Dec- 2014 August 2016 | Design of eco- friendly alternatives to plastic carry bags- reducing plastics, up-cycling textile waste | | |
| Zero cost T shirt bag (recycling of old T shirts) | Bhoomithram Ball Bag (outer cover from upcycling of tailoring waste pieces) | Bhoomithram Strawberry Bag (outer cover from tailoring waste pieces) | Bhoomithram Zip Bag outer cover from upholstery waste pieces) |
| August 2016- June 2017 | Design of eco- friendly alternatives to rexine college bags | | |
| Prakrithi college bag | Prakrithi back pack | Prakrith Conference bag | |
| June- 2017- March 2018 | Design of eco- friendly alternatives to plastic / rexine pencil pouches- from upcycling- tailoring/ upholstery waste pieces | | |
| Design of eco- friendly alternatives to other non- biodegradable products | | | |
| Conference tags | Banners | Sanitary napkins | |

When- Where- List of activities - Developed documentary on hazards of plastic waste- Used to sensitise public and popularise alternatives through a number of sessions

| Year | Target audience | No of sensitisation sessions | Place/ district |
|---|---|---|---|
| 2014-15 | Public Students | 2 sessions | Ezhikkara Panchayat |
| 2015-16 | College Panchayath Schools | 17 Sessions-local bodies, civic groups 10 Schools Total =27 | Trichur Paravur Kochi |
| 2016-17 | Coastal Villages, Schools, Colleges, Panchayaths | 13 schools/ colleges 6 coastal villages 3 Other Panchayaths Total = 22 | Coastal…. Nayarambalam, Elamkunnapuzha, Kumbalam, Njarakkal, Pallupuram, Cheranellor |
| 2017-18 | Students, Lions Club, Colleges | Total = 11 sessions | Ernakulam Kasargode Kottayam Palakkad |

When -Where- Sharing of design-Training various SHG / Kudumbashree / civic groups

| Year | Target audience | No of activities | Place/ district |
|---|---|---|---|
| 2015-16 | Kudumbashree | 10 sessions | Paravur block, Pottakkuzhy, Vimalalayam |
| 2016-17 | Kudumbashree/ civic groups/ NGOs | 88 sessions | Trivandrum Paruthiyoor Varkala Shakthi Ekm, Kottayam, Palakkad 82 Panchayaths- Ekm |
| 2017-18 | Kudumbashree Civic groups/ students | 8 sessions | Trivandrum,Kothad,Paravur, Ezhikkara, Ernakulam, Guruvayur |

When - Where- Implementing specific projects for Initiating behavioural change in society

| Year | Type of program | Target audience |
|---|---|---|
| 2014-15 | House to House Campaign | Ward 7 Ezhikkara |
| 2015-16 | House to House Campaign | Ward 10 Ezhikkara |
| | Motivation program | Ezhikkara |
| 2016-17 | Motivation program | All students in St. Teresa's College - Miss Bhoomitram |
| | Institutionalisation of green protocol | -Social entrepreneurship STEP at St. Teresa's College-Drafting of Green protocol |
| 2017-18 | Implementation of Green protocol | 1000 students of First year UG at St. Teresa's college |
| | Ente-Haritha Bhavanam | 1000 students of second year UG at St. Teresa's college- 5000 families |
| | Environment Management Program | 6 schools Ezhikkara I school Cochin Corporation SanchiMela - Ezhikkara |
| | Preventing Ecological Destruction Kadamakkudy | 2 schools |

## The Impact

- Youth who were generally not bothered now function as brand ambassadors of reduction strategy- St. Teresa's College first year students use eco- friendly Prakrithi bags & Bhooomithramsanchis -second year students are participants of EnteHarithaBhavanam
- Best impact -among primary school students who quickly adopted zero cost alternatives and prompted their family members to use.
- Many Self Help Groups have taken up promotion of alternatives
- Ezhikkara - reduction strategy effective with more people using alternatives- recycling- partly successful with many households segregating waste.

## Adoption of this method by others

- Used by Thiruvananthapuram Corporation to support their ban on plastic carry bag
- Used by Shakthi - An NGO to popularize and provide employment to SHG women
- Tutorials on stitching BhoomithramSanchis, made with funding from Suchitwa mission, uploaded for public access on their webpage as part of Haritha Keralam Mission
- Kudumbashree in Ernakulam District trained more than 1000 SHGs in 82 Panchayaths
- Tutorials on stitching used by IGNOU as Environment Sustainability course content.
- Economic aspects
- Ezhikkara- House to house campaign 2015 and 2016- Paristhithikam project of Dept
- of Environment and Climate change, Govt of Kerala Rs 90,000
- Environment Management 2017 -Coastal & Environment Division, KCSTE, Rs2,50,000
- Projects in St. Teresa's College- STEP and BMC- Mostly voluntary or self financing tutorials funded by Suchitwa mission- Rs 8000.

## Conclusion - Future plan of work or any other aspect

- Discussions on with Suchitwa mission and NSS State Co-ordinator to popularise
- Bhoomithramhabit among higher educational institutions, green networks in schools.
- Pencil pouch project to be implemented in Perumbavur Muncipality, Perunthalmanna and Cochin Corporation.
- To conclude-Significant first steps towards reducing non biodegradable litter in Kerala.

# Eco-friendly bags - an alternative to plastic carry bags

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## Inroduction

Fishery Environment and Management Division of CMFRI is always focussing on environment concern issues apart from Research on Marine Environment .One of the major threats the ecosystem faces in the present world is the impact due to non-degradable wastes especially plastics. Enumerable numbers of Plastics in the form of carry bags enter in to our houses and it has become an inevitable item in the daily life. But the improper waste disposal due to poor waste management facilities available in our society causes the accumulation of these non-degradable plastic materials on the road sides and open grounds there by polluting the ecosystem.

To prevent the issues caused by improper waste management, we must take immediate steps to control waste generation, to enhance facilities for better recycling recovery and reuse and to ensure proper collection and sustainable disposal. One of the most efficient management system as far as individuals concerned is, reduce the use of non-degradable materials as far as possible in our day to day life.

## Present Scenario

Studies conducted by CMFRI among house holds in Mulavukad Village of Ernakulam District depicted that on an average, 2-3 numbers of carry bags are disposed of from each family in a day. The village has a statistics of 2000 families and around 15 Lakhs numbers of used carry bags are thrown as waste from the area per year, which is threatening and triggers serious environmental pollution issues.

## How was it Done

Thinking on an alternative to reduce the use of plastic carry bags,Fishery Environment Division has initiated an attempt to popularise the use of a highly user- friendly cloth carrybags. The inspiration behind this was originated from Dr. Nirmala Padmanabhan,

Associate Professor, St.Teresas College, Ernakulam. Borrowing her technology, Mrs. Tasnim, a tailor from, Elamakkara was asked to supply eco friendly cloth bags to the division. Three types of stitched bags namely Ball bags,Shoulder bags and Purse bags which can meet almost all the shopping requirements for the houses, were collected from her and distributed to the needy.

## Trainings Imparted

A training programme was initiated in 2015, during a one-day seminar "Urjakiran" jointly organised by the Energy Management cell, Thiruvananthapuram and CMFRI, Kochi. 25 numbers of ladies from Edavanakkad Panchayath were given hands on training with the help a Mrs.Taslim in bag making. Various training programmes were conducted in different localities in and around Ernakulum namely Panchayath hall, Vayana Sala, Community hall, Schools and Colleges and more than 250 ladies got benefitted out of it. In addition to cloth bags, hands ontrainings were given for making paper bags. Though the cloth bags are washable, using the same for the purchase of fish and other meatproducts are not that much practical. Hence taking the clue from another well-wisher.

A reusable carry bag with synthetic material is designed and stitched which is of high demand now.

| Sl No. | Place | Training /Sale | No. of persons benefitted |
|---|---|---|---|
| 1 | Edavankkad Village Panchayath Hall | Hands on training in bag making | 30 |
| 2 | Chettikkattu church hall, Moothakunnam | Training cum sale | 25 |
| 3 | Friends Festival ,Edapplaly | Exhibition cum sale of cloth bags | 38 |
| 4 | NSS Hall,Cheranalloor | Training on cloth and paper Bag making | 25 |
| 5 | PanditKaruppanVayanasala, Cheranallloor | Training on cloth and paper Bag making | 30 |
| 6 | St.Jameschool,Cheranalloor | Training on cloth and paper Bag making | 40 |
| 7 | St Maris College, Trichur | Training on cloth Bag making cum sale | 40 |

## The impact

Practicing these eco-friendly bags, the use of plastic carry bags is reduced to a great extent. Due to the awesome design and easiness in handling, many house wives are keeping it always in their hands to meet their day today need. Let us hope in the near coming future there will be a drastic reduction in the use of non-degradable bags.

# Shuchithwa theeram surakshitha theeram

**R. Shabu**

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## Introduction

Coastal Police Station, Neendakara launched a project named Shuchithwa theeram surakshitha Theeram in the month of August 2017. The main task of this project is to meet the challenges of inorganic waste deposited along the coastal area and seas. Awareness campaigns are been arranged from Paravoor to Azheekkal extensively.

## How was it done?

By getting closer to the fishermen community and coastal population Coastal Police

expects good feed-back from the society regarding coastal security. In the year 2017-18, co-operating with MPEDA coastal Police, Neendakara already conducted cleaning programmes in Neendakara and Kollam fishing harbours. Nearby Sakthikulangara harbour and by the side of NH 47 a black spot (of waste dumping) been cleaned up and submitted a proposal before Kollam corporation to construct a park. In Alappad panchayath training programme has been conducted for making cloth/ paper bag for fisher women. The trainees are now ready to start a unit with the help of Grama Panchayath and MPEDA.

## Conclusion - Future plan of work

Neendakara coastal Police is now planning to conduct awareness programme for fishermen who are directly engaged in sea fishing about the hazards of in-organic waste deposit in seas. Awareness should make the layman to a volunteer in the fight against in-organic waste. Our Propaganda 'on shore' is always an assistance to off shore activities of Shuchithwa Sagaram Project of fisheries department. The major concern of Kerala Coastal Police is always the Coastal security. With good co-operation and communication with the coastal community, by ensuring healthy environment of their living conditions we aim to keep the coastal security in-tact.

# Succesful composting with our product - "bio clean" in an apartment in Bangalore - omega ecotech

**Joshy V Cherian**

## Introduction

OMEGA ECOTECH PRODUCTS INDIA PRIVATE LIMITED came into existence in the year 1999 at Coimbatore, Tamil Nadu (India). We are engaged in manufacturing, supplying and exporting a comprehensive gamut of bio fertilizers, bio fungicides, bio pesticides, composts, growth promoters and aerobic composting media. This company is promoted by a team of environmental and agricultural scientists who have rich experience in biotechnology, horticulture, waste land development, solid waste management and organic agriculture. Our vision is to promote sustainable agriculture by producing compost by farmers and even in households using our composting media Bioclean.

BIOCLEAN-Bioclean is a highly efficient solid state aerobic fermentation media which can convert biodegradable material into high value compost without any foul odor in 23-30 days time. It is a combination of clean processed coir pith and naturally occurring aerobic composting microbes. It is a patent pending product. Bioclean has to be layered with biodegradable waste. The proportion of bioclean depends on the moisture level in the waste.

Sudhlabh is one of our partners in Bangalore, they are helping various apartments to manage their wet waste in the apartment complex and convert it into compost. The composting set up comprises of a ventilated digester and composting medium, provided by Sudhlabh. This composting medium is a patent pending specially formulated coco peat based product developed and supplied by Dr. Joshy V Cherian.

## Description of waste

We have used this technology successfully in managing domestic waste in thousands of houses in many local bodies in Kerala along with an aerobic container.

We are composting market and commercial waste in various local bodies using this solution. We are also managing the biodegradable waste of various agro industries in India.

## How was it done?

Bangalore city is an important commercial city in South India and known as the silicon valley of India. The city is generating 5000 tons of waste daily. This waste was collected in a mixed format and dumped in nearby villages. Due to the intervention of court, the dumping was banned and therefore the city administrators had to find ways to address the huge waste. The city was forced to regulate the waste management. The Bangalore city corporation classified the large apartments as bulk generators of waste and mandated them to segregate and manage waste by themselves for which "2 BINS AND 1 BAG" model was introduced in 2013.

## Approach

The residents of Purva Fairmont apartment, Bangalore comprising of 324 houses formed a committee to educate the residents about the needs and ways of segregation. Further they explored solutions to manage different categories of waste segregated such as Wet/Organic waste, Dry waste, Reject waste, e-waste etc. Out of these, wet waste management seemed to be the most challenging. After collaborating with vendors and apartment volunteers, the committee studied the pros and cons of existing composting machines and techniques. They concluded with the following requirements for an effective wet waste management method:

- A sustainable composting model well suited for apartment complex.
- Affordability of the composting setup.
- Ease of composting for the workers.
- The compost generated should be of good quality.

Thereafter in 2013, the committee representatives met Mr. Vasuki from SudhLabh. They also visited SudhLabh's first trial run composting digester which was managed by a community of 80 odd apartments mostly of senior citizens. The wet waste and composting medium in dry compacted form should be taken in a ratio of 1:1/8. Further the medium is hydrated, mixed with wet waste and deposited in the ventilated digester (dimensions provided at the end of the document). The final compost generated can be recycled by mixing it with fresh composting medium in 1:1 ratio. The waste was mixed with Bioclean in a room and put into each digester. We fill the digesters one after another. Therefore we get enough time (40 to 45 days) before it is opened for compost harvesting.

## Impact

- By the end of 2016, the apartment had fully functional five digesters which yielded good quality compost.

- Purva Fairmont processed 250kgs of Wet Organic waste and produced approximately 80 to 150 kgs of compost once in 2 days. This compost is used in the apartment complex and the excess is given to the community members for their home garden application.
- After initial struggles, the residents turned to be very cooperative with the process.
- Few residents still complain but they are made comfortable and accommodative by continuous engagement.
- This composting process is great for the environment, this case gives an analysis of the contribution made by an apartment to preserve our mother Earth.
- Many more got inspired with this facility at Purva Fairmont apartment in HSR sector and have adopted the same.

## Adoption of this method by others

Today more than 200 apartments are using this program in Bangalore and also spreading to other cities.





## Economic aspects

| Item | Details | Unit Price (INR) | Qty | Total Investment (INR) |
|---|---|---|---|---|
| Steel Composters with Lid | (300 Homes X 800 grams of kitchen waste Total 240kgs of kitchen waste ) | 60,000 | 1 | 60,000 |
| GST | IGST | 12% | | 7200 |
| Installation, Training | Onsite Installation, Training, Helping till first round of manure is pulled out. 5 Awareness Programs. | 40,000 | | 40,000 |
| Transportation | On Actuals | | | |
| Tools and Equipment | Plastic Tubs, Tarpaulin sheets, Shovels, Rakes, Weighing scale, Manure Sieve | | | 20,000 |
| Initial Bioclean and Grow | | 300 | 7 | 2100 |
| total | | | | 1,29,300 |

Note; The above mentioned apartment holds 5 units of the digester in different places and benefits daily.

The project was entirely funded by the community.

## Conclusion

Our future plan is to expand this beneficial program to various cities of India and abroadFRP Digester with waste and composting media.

# Author Index

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