भारतीय-गैर-न्यायिक

एक सौ रुपये

Rs. 100

रु. 100

ONE HUNDRED RUPEES

सत्यमेव जयते

भारत INDIA

INDIA NON JUDICIAL

കേരളം केरल KERALA

DV 853786

Memorandum of Understanding

Between

SCMS School of Engineering and Technology, Vidya Nagar, Palissery, Karukutty Ernakulam, Kerala 683576, Represented by Prof.Pramod P.Thevannoor, Vice Chairman, SCMS Group of Educational Institutions

and

Kerala State Remote Sensing and Environment Centre (KSREC), Vikas Bhavan, Thiruvananthapuram, Kerala 695033, Represented by Sri. A. Nizamudeen, Director

This Memorandum of Understanding (MOU) sets for the terms and understanding between the SCMS School of Engineering and Technology, and the Kerala State Remote Sensing and Environment Centre (KSREC), to collaborate on student training, internships, support for student projects, research and technology on Geospatial Technology.

.....2

SCMS SCHOOL OF ENGINEERING AND TECHNOLOGY ERNAKULAM 683 576 KARUKUTTY

634744 09.12.2022

SCMS School of Engineering & Technology Karukutty

M.A. KUNJU BEEVI
HIGH COURT VENDOR

DISTRICT STAMP DEPOT 18 NOV 2022 ERNAKULAM

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केरळം केरल KERALA

DV 853787

1. Background

SCMS School of Engineering and Technology (SSET) was established in 2001 by the SCMS Group of Educational Institutions to provide quality professional education in engineering & technology. It is affiliated to AICTE, Delhi and APJ Abdul Kalam Technological University (initially Kerala Technological University), a Kerala State Government University. SSET offers B.Tech programs in 8 disciplines, M.Tech programs in 6 specializations and is an approved research centre for PhD under APJ Abdul Kalam Technological University.

Kerala State Remote Sensing and Environment Centre (KSREC) was established in 1995 by the Government of Kerala under the aegis of the National Natural Resources Management System (NNRMS). KSREC is an autonomous body under the Department of Planning & Economic Affairs for carrying out research, training, awareness programs, and other related activities in the application of Remote Sensing and GIS in Land and Water Resources management, environmental monitoring, and upkeep.

.....3

SCMS SCHOOL OF ENGINEERING AND TECHNOLOGY * ERNAKULAM 683 576 * KARUKUTTY * KERALA

NO 63475 DT 09.12.2022

VALUE OF R... 100/-

SOLD TO ...SCMS School of Engineering & Technology Karukutty

M.A. KUNJU BEEVI
HIGH COURT VENDOR

DISTRICT STAMP DEPOT
18 NOV 2022
ERNAKULAM

2. Objectives of Industry-Academic Interaction Programme

The major objectives for which the parties associate with each other are:

a. To effectively share the facilities and expertise to improve advanced education, research, and consultancy capabilities.
b. To facilitate academic and research interactions among employees of both Institutes.
c. Increase the relevance of the academic research and consultancy in the research and product development initiatives.
d. Collaborate to share and exchange information between both parties for mutual benefit and knowledge enhancement.
e. To enable the use of laboratories and test facilities in SSET on a preferential basis and concessional rate by KSREC and vice versa.
f. To provide an opportunity for students from undergraduate, graduate, and research scholars of SSET to undertake industrial training and projects in the KSREC for mutual benefit.
g. To encourage the training of employees of the KSREC in Continuing Education activities, Skill development activities, and Subject up gradation workshops using the facilities of SSET.
h. To provide expert faculty from KSREC for academic and training programs of SSET.
i. To provide advice in formulating the curriculum and syllabus of courses of SSET by the experts from KSREC.
j. To conduct joint/collaborative research and consultancy.

3. Reporting

The effectiveness and adherence to the agreement will be monitored by the Vice Chairman of SCMS Group and the Director of KSREC on an annual basis.

4. Funding

This MOU is not a commitment of funds. Any financial implications shall be discussed and decided on a case-by-case basis on mutual agreement.

.....4

SCMS SCHOOL OF ENGINEERING AND TECHNOLOGY * KARUKUTTY * ERNAKULAM 683 576

5. Duration

This MOU is at will and may be modified by mutual consent of authorized officials from the SCMS School of Engineering and Technology (SSET), and the Kerala State Remote Sensing and Environment Centre (KSREC).

This MOU shall become effective upon signature by the authorized officials from the SCMS School of Engineering and Technology (SSET), and the Kerala State Remote Sensing and Environment Centre (KSREC) and will remain in effect until modified or terminated by any one of the partners by mutual consent. In the absence of mutual agreement by the authorized officials from the SCMS School of Engineering and Technology (SSET) and the Kerala State Remote Sensing and Environment Centre (KSREC), this MOU shall end on (end date of partnership).

6. Contact Information

Partner name	: SCMS School of Engineering and Technology
Partner representative	: Prof. Pramod P. Thevannoor
Position	: Vice Chairman – SCMS Group
Address	: Vidya Nagar, Palissery, Karukutty, Ernakulam – 683 576.
Telephone	: 0484-2882900
Fax	: 0484-2623885
E-mail	: pramod@scmsgroup.org

Partner name	: KSREC
Partner representative	: Sri. A. Nizamudeen
Position	: Director
Address	: Vikas Bhavan, Near Legislative Assembly, University of Kerala Senate House Campus, PMG, Thiruvananthapuram – 695 033.
Telephone	: 0471 2301167
Fax	: 0471 2300624
E-mail	: directorksrec@yahoo.in

Date: 12/12/22
Prof. Pramod P. Thevannoor
SCMS School of Engineering and Technology

PRAMOD P THEVANNOOR
VICE CHAIRMAN
SCMS GROUP OF EDUCATIONAL INSTITUTIONS

Date: 12.12.2022.
Sri. A. Nizamudeen
KSREC
Director

SCMS SCHOOL OF ENGINEERING AND TECHNOLOGY * KARUKUTTY * ERNAKULAM 683 576

Government of Kerala

Department of Environment & Climate Change

4th Floor, KSRTC Bus Terminal, Thampanoor, Thiruvananthapuram- 695 001
Ph: 0471-2326264 (Off)
E-mail: envt.dir@kerala.gov.in web: www.envt.kerala.gov.in

PROCEEDINGS OF THE DIRECTOR

Present: Mir Mohammed Ali IAS

Sub: Research and Development - Project Proposal entitled "Micro Plastic Pollution: Source characterization, transport modeling and assessment of impact on fish population in Kadambrayar river and Vembanad backwater region"– Grant – in – aid- Sanctioned-1st Installment released- Order issued.

DIRECTORATE OF ENVIRONMENT & CLIMATE CHANGE

No. DoECC/AEO1/R&D/2879/2019 dated 10.03.2020

Read:

(1) G.O. (Rt) No. 105/2019/ Envt. Dated 30.10.2019.
(2) Proposal received from Dr.Nisha L, Associate Professor, Department of Civil Engineering, SCMS School of Engineering and Technology
(3) Minutes of the R&D Committee meeting held on 5-6th August 2019.
(4) Triparty agreement executed on 03.02.2020.

ORDER

As an implementation mechanism for the state plan scheme ''Environmental Research and Development'', Government vide G.O cited (1) have authorized Director, Directorate of Environment and Climate Change to release the funds to the agencies undertaking the projects. Vide paper (2) cited a proposal entitled "Micro Plastic Pollution: Source characterization, transport modeling and assessment of impact on fish population in Kadambrayar river and Vembanad backwater region" received under R&D scheme and the same was selected by the R&D committee meeting held on 05.08.2019 & 6.08.2019.

Vide paper read (1) Govt. have accorded Administrative Sanction for a total amount of Rs.13,09,000/- for 2 year with first installment of Rs.5,23,600/-. Vide paper read (4) above, Directorate of Environment and Climate Change, the Principal, SCMS School of Engineering and Technology, the Principal Investigator of the project; have executed a Triparty agreement in the prescribed format.

Approval is hereby accorded for the research project entitled "Micro Plastic Pollution: Source characterization, transport modeling and assessment of impact on fish population in

Kadambrayar river and Vembanad backwater region" for a period of 2 years with Dr. Nisha L, Associate Professor, Department of Civil Engineering, SCMS School of Engineering and Technology. The terms and conditions and directions contained in the agreement executed vide paper read (4) and the guidelines of scheme should be complied with scrupulously by the Institution and Principal Investigator and timely submission of prescribed documents shall be ensured.

In accordance with the approved modalities, terms and conditions and as per the agreement read (3) above, the grant shall be released in 3 installments, at the rate of 60:20:20 respectively. Therefore sanction is accorded for the release of **Rs. 5,23,600/- (Rupees Five Lakh Twenty three Thousand and Six Hundred only)** to the Principal, SCMS School of Engineering and Technology as the First Installment of grant for the project in the subject matter with Dr. Nisha L, Associate Professor, Department of Civil Engineering, SCMS School of Engineering and Technology. The Principal Investigator and to credit the amount to the bank account - **A/C No. 345801010030000 IFSC Code: UBIN0558885**. The expenditure shall be met from the Head of account **"3435-03-103-99 -Research and Development- (Plan- Voted)"** in the current year's budget.

The Principal Investigator has to furnish the progress report, Expenditure Statement and Utilization Certificate (in KFC Form 44) to the Directorate within 30 days from end of first year.

Sd/-
Director

To

Dr. Nisha L, Associate Professor, Department of Civil Engineering,
SCMS School of Engineering and Technology.

Copy to:

1. The Accountant General (A&E/Audit), Thiruvananthapuram
2. The District Treasury Officer, Thiruvananthapuram
3. Principal, SCMS School of Engineering and Technology.
4. Accounts section
5. Bill Copy
6. Stock file.

Forwarded By Order

Administrative Officer

Micro Plastic Pollution: Source characterization, transport modelling and assessment of impact on fish population in Kadambrayar river and Vembanad backwater region

Submitted to

The Department of Environment and Climate Change

DEPARTMENT OF CIVIL ENGINEERING

SCMS SCHOOL OF ENGINEERING & TECHNOLOGY, KARUKUTTY

ENDORSEMENT FROM HEAD OF THE INSTITUTION

(To be given on letter head)

Title of the Project: **"**Micro Plastic Pollution: Source characterization, transport modelling and assessment of impact on fish population in Kadambrayar river and Vembanad backwater region"

The Institute certifies the participation of Dr. Nisha.L as the Principal Investigator and Dr. Ratish Menon as the Principal Co-investigator for the project and that in the unforeseen event of discontinuance by the Principal Investigator, the Principal Co-investigator or any other equally qualified Investigator will assume the responsibility of the fruitful completion of the project (with due information to the DoECC).

Certified that the equipments and other basic facilities mentioned in the Part IV of Application Form and such other administrative facilities as per terms and conditions of the grant, will be extended to the investigator(s) throughout the duration of the project.

The Institute assumes to undertake the financial and other management responsibilities of the project.

Date:

Place:

Name and Signature of

Head of the Institution

Annexure-II

APPLICATION PRO FORMA FOR GRANT FOR RESEARCH PROJECT

(To be filled in by the Principal Investigator)

1.	Title of the Project	: Micro Plastic Pollution: Source characterization, transport modelling and assessment of impact on fish population in Kadambrayar river and Vembanad backwater region.
2.	Name and Designation of the Principal Investigator	: Dr. Nisha.L, Associate Professor, Department of Civil Engineering, SCMS School of Engineering and Technology, Karukutty- 683 576.
3.	Name and Designation of the Co-Investigator	: Dr. Ratish Menon Associate Professor, Department of Civil Engineering, SCMS School of Engineering and Technology, Karukutty- 683 576.
4.	Postal Address of the Principal Investigator and the Co-Investigator	:Associate Professor, Department of Civil Engineering, SCMS School of Engineering and Technology, Karukutty- 683 576.
5.	Name of the institution(s)/organization(s) in which the project will be carried out (Specify whether College (Government / Aided/ Autonomous/ Private), University Department, Government Institution, Non-governmental organization, etc.)	: SCMS School of Engineering and Technology, Karukutty- 683 576 (Private Engineering College affiliated to KTU)
6.	Name of other institution(s)/Organisation(s) involved in the project (Specify whether College (Government / Aided/ Autonomous/ Private), University Department, Government Institution, Non-governmental organization, etc.):	: N.A

7.	Geographic location of research project site (latitude and longitude), wherever applicable	: Brahmapuram(10.0010° N, 76.3788° E), Kochi, River Kadambrayar at Brahmapuram and Lake Vembanad
8.	Participation of public and private sector and/or other government ventures: (Please give details regarding sharing of work components, cost and outputs, including implementation arrangements, and modalities of achievement of the envisaged objectives against the stated milestones of work)	: NA
9.	Duration of the Project	: 24 Months
10.	Total amount of assistance required	: Rs. 13,09,000

Micro Plastic Pollution: Source characterization, transport modelling and assessment of impact on fish population in Kadambrayar river and Vembanad backwater region.

Abstract

The project envisages assessing the presence and abundance of Microplastics in river Kadambrayar flowing near the open solid waste dumping site at Brahmapuram. Two sets of sampling with three sediment samples from nearby Kadambrayar river and five top soil samples from various parts of Brahmapuram waste dumping yard were carried out during the months of January – February 2019. The study confirmed the presence of an average of 100 microplastic pieces per 100 gram of river sediments of Kadambrayar in Brahmapuram and a similar quantity of 178 particles in the top soil of Brahmapuram. The results of the preliminary study carried out indicates that the open dumping site at Brahmapuram acts as a primary as well as secondary source of microplastics, which gets accumulated at the top soil in the area. This gets transported via erosion and run off into the river Kadambrayar. The unprecedented amount of microplastics detected in the sediment samples motivated the planning of this proposal assessing the environmental implications of this observation. Projects aims at detecting and quantifying the microplastics in the top soil at Brahmapuram. It also attempts to model the transport of microplastics from top soil into the river using an erosion model. Once the microplastics reach the aquatic environment, it is highly likely that these will be ingested by the aquatic organisms including fishes. There is a growing body of evidence for microplastic ingestion by freshwater as well as marine fish species. The microplastic ingestion by the fishes and its subsequent incorporation into the food chain is likely to have far reaching economic and environmental consequences for a state like Kerala. The preliminary study conducted in the institute also suggested river Kadambrayar as a major pathway for transport of microplastics into Lake Vembanad. This project would attempt to determine the possibility of incorporation of microplastics into the food chain by assessing and quantifying the presence of microplastics in fish species of both a freshwater ecosystem (River Kadambrayar) and a saline water environment (Lake Vembanad). Finally, the project also proposes to assess the implications of presence of microplastics in the aquatic environment by carrying out laboratory studies for assessing the life cycle changes brought out by microplastics in the identified commercially important species in the river and Lake. This project can be a pioneering work which evaluates the ramifications of microplastics incorporation into food chain due to improper handling and disposal of plastic wastes.

Keywords: Microplastics, Solidwaste management, Emerging pollutants, ATR-FTIR spectroscopy, Single-use plastics, Kochi

State of Art of the subject

(including work done in India and elsewhere)

Plastics are a versatile material and have been used for making a variety of products that make human life easier. Many materials were introduced later to substitute plastics, but most of these materials couldn't challenge the overall versatility of plastics. However due to their longevity and non-biodegradability, plastics are becoming a major pollutant. The accumulation of plastics in oceans, water bodies, soil and air is becoming a challenging issue [Sruti et.,al 2016; Naidu et.,al 2017]. The longevity of plastics causes long distance conveyance and accumulation in soil, water and air [Sruti et.,al 2016].

As per US NOAA definition, microplastics are small plastic pieces of less than 5mm in size. They can be either primary or secondary in origin. The primary sources include plastic microbeads in personal care products and synthetic fibres from textile industry. The secondary sources includes the degradation of synthetic polymers like high density polyethylene, low density polyethylene, polystyrene, poly propylene, PET etc by physical, chemical or biological ways. Several studies shows the presence of microplastics in marine habitats, fresh water systems, aquatic organisms, sea foods and even in human tissues [Sruti et.,al 2016; Naidu et.,al 2017; Seth et.,al 2018; Barettet.,al 2019].As per the UN Environment agency, one million plastic drinking bottles are produced every minute and about 5 trillion single use plastic bags are purchased every year worldwide. India produces around 5.6 million tonnes of plastic annually [Toxics link 2014].

Studies of microplastics in Kerala, is limited. Kochi city was selected as the broad study area as it is the second most urbanized city on the west coast of India [Naidu et., al 2017] and also due to its high density of population, large riverine discharge and industrial and marine discharges. With its high density of population, solid waste management is one of the challenges faced by the State. The intensity of plastic pollution in Kochi can be assessed by the analysis of soil samples from Brahmapuram, the small village which has became the waste dumping yard of Kochi since 2017.The city does not have proper solid waste disposal methods and the drinking water pollution in the city is around 50%. As per reports, Kochi city generates around 380 tonnes of solid waste per day, of which 150 tonnes are biodegradable and 100 tonnes comprise of plastic waste. The major portion of this waste is dumped at Brahmapuram, a suburban village [Kerala Suchitua Mission 2018; Kerala SPCB Directory 2010]. This subsequently pollutes the rivers of Kadambrayar and Chitrapuzha, which borders the open

dumping yard of Brahmapuram [Kerala SPCB Directory 2010].According to the 'Water and Air Quality Directory 2010' published by the SPCB Kerala, the mean value of DO in Brahmapuram was only 2 mg/litre against the minimum limit of 4 mg/litre prescribed by the Central Pollution Control Board(CPCB).As per Kerala Suchitwa Mission statistics of 2018, Kerala produces 480 tonnes of plastic waste per day as the administration fails to enforce a ban on plastic material below 50 microns [Kerala Suchitwa Mission reports 2018]. On an average, a family in the state produces 60 grams of plastic waste per day and of these Kochi municipal corporation alone generates 16 tonnes of plastic wastes a day [Kerala Suchitwa Mission reports 2018]. The main portion of this plastic waste is dumped into Brahmapuram.

The recent study conducted by Anupama (2019) confirmed the presence of an average of 100 microplastic pieces per 100 gram of river sediments of Kadambrayar in Brahmapuram and a similar quantity of 178 particles in the top soil of Brahmapuram. The size distribution of particles showed that comparatively larger particles of size range between 2.36mm-4.75mm were present in the top soil than that in river sediments which had more number of particles in size range below 2.36 mm. The study found that the major part of microplastics was contributed by polyethylene which is the main constituent of single use plastics. It was followed by polypropylene, which are used as packaging materials. Also there was slight amount of polyethylene terephthalate (PET).

The preliminary study carried out by Anupama (2019) indicated the magnitude of microplastics contamination at Brahmapuram. This unprecedented amount of microplastics detected in both the top soil and the sediments motivated this proposal. The microplastics in the top soil would eventually find its way into the river and from there into Lake Vembanad. The River Kadambrayar is the source of water for nearby panchayats and supports a number of freshwater fish species. Several farmers and families of fishermen had depended on Kadambrayar for their livelihood till a few years ago, but the depleted quality of water in the river has made fishing unsustainable. The presence of microplastics would further accentuate the problem and would have far reaching environmental consequences. Seasonal analysis of microplastics in the river could also identify the contribution of Kadambrayar to the microplastics found in the back water regions of Vembanad lake, a popular Ramsar wetlands in India.

There is a scarcity of information about the occurrence of microplastics (MPs) in edible fish tissues in India, especially in Kerala. Kerala with a network of rivers, lagoons and backwaters flowing into a nutrient enriched coastal sea has an abundance of aquatic resources. This factor,

added to the diversity of the fishing technology, provided the socio-ecological basis for fish becoming an integral part of the cuisine of this region of the Indian sub-continent (http://www.fao.org/3/Y1290E/y1290e0g.htm). The reports of microplastics in tuna in Arabian Sea anchovies in Alapuzha, Indian Mackerel and Honeycomb Grouper in Tuticorin and mackerel caught from the coastal waters off Mangalore indicate that pieces/ strands of plastic enter the food chain [Kumar et al.,2018].

With this background, the objective of this study was to provide a critical assessment of the presence of microplastics in the top soil and in the sediment of river Kadambrayar which is flowing round the dumping yard of Brahmapuram and to investigate the presence of microplastics in the fish species in river Kadambrayar and Lake Vembanad. Effort would also be made to model the transport of microplastics from land to the river and also to assess the effects of microplastics on the life cycle of the identified fish species.

Literature Survey

Several studies have been conducted worldwide to estimate the severity of plastic pollution that we face today. These studies primarily focus on microplastic pollution because of their persistent nature and the adverse effects on our environment. Some of the relevant studies carried out are briefly described here:

The first report of microplastics in lake and estuarine sediments in India were carried out by in Vembanad lake, Kerala [Sruti et.,al 2016]. Vembanad lake is one of the Ramsar sites in India. Samples were collected from 10 different locations during pre-monsoon period from March-April 2016. Out of the 10 sampling location, 8 were in the fresh water zone that is south of Thaneermukkam bund and the remaining 2 were in the salt water zone from north of Thaneermukkam bund. The results obtained shows the mean abundance of 252.8 microplastic particles and consists mainly of polyethylene, polystyrene and polypropylene. Higher concentration of microplastics were found in high salinity areas.

Microplastics enters the living organisms through the food web. The evidence for this have been obtained by the study of benthic invertebrates from the coastal waters of Kochi, south-eastern Arabian sea [Naidu et al.,2018] Studies were conducted on the species of Sternaspis scutata and Magelona cinta. Samples were collected, sieved through 0.5mm mesh and preserved in Formalin-Rose Bengal mixture. The observations were carried out using DXR-microscope. The results disclosed the presence of microplastics in the form of polystyrene fibres. This was postulated to be due to non-selective feeding of polychaetes.

To assess the occurance of microplastics in fishes, a study was conducted in two harbours of Tuticorin, south-east coast of India [Kumar et al.,2018]. Fish species used in the study were Rastrillegar kanagurta (Indian Mackeral) and Epinephalus merra. The intestinal contents of these fishes were removed and digested for 5 days at 60℃. It was then filtered through a millipore filtration unit. Hot needle test was used to confirm the presence of microfibres. Results showed the presence of poly ethylene and polypropylene.

The presence of microplastics were also detected in the inland fresh waters of China [Wang and Li, 2016] Samples were collected at a depth of 0-20cm. After wet peroxide oxidation, the samples were filtered and observed under stereo microscopic and scanning electron microscopy (SEM). It was observed that degradation of large particles of plastic occurred either on land or in water. Biofouling was reported to change the density of particles which in turn leads to its suspension in water.

Microplastic pollution and its reduction strategies were explained in the review paper [Wu et al,2017] The paper estimated that the production of petroleum based plastics is exceeding 300 million tonnes in 2015. The study suggests that, microbeads in the cosmetics can be replaced with natural exfoliating materials. Also the use of biodegradable materials like polyacetide and polyhydroxy alkanoates was reported to limit the pollution caused by non-biodegradable plastics. Reuse, recycle and recovery of plastics need to be improved.

Microplastics acts not only as a source of toxic chemicals but also as a sink for toxic materials [De Sa and Oliveira, 2018]. Microplastics are difficult to clean up because of their small size and widespread distribution

Objectives

The specific objectives of the proposed project are as follows

1. To detect and categorize the microplastics in sediments and topsoil using ATR FT-IR spectroscopy.
2. To quantify the microplastics in each sample.
3. Model the export of microplastics into the river from land
4. The analyse common commerically used fish species of Kadambrayar andLake Vembanad to assess the presence of microplastics and the possibility of transfer of microplastics through food web.
5. To conduct laboratory studies to assess the effects of microplastics on the life cycle of the identified species.

Methodology

Top soil and sediment samples would be collected from various locations of Kadambrayar near Brahmapuram (Fig 1).Sediment samples would be taken from Kadambrayar at different locations and samples of topsoil would be collected from various locations of the open dump at Brahmapuram. The samples would be collected once in every month during the specified tenure of the project. The samples would then be sealed air tight in order to avoid contamination.

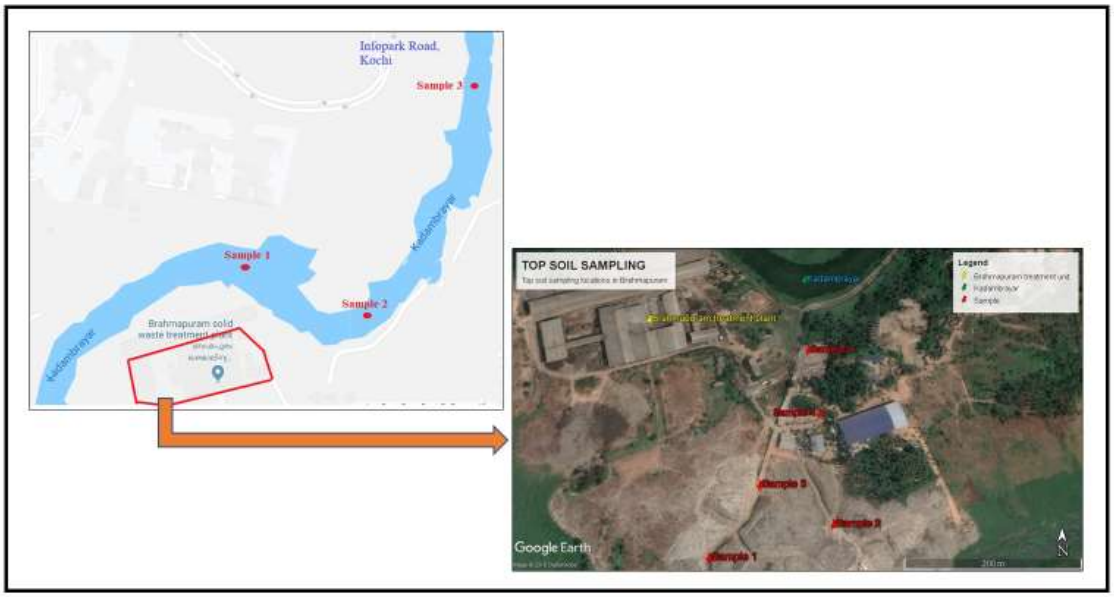

Fig.1. Study area

The water quality analysis would be conducted in the laboratory to evaluate pH, electrical conductivity, biological oxygen demand (BOD), hardness, chlorides, iron, nitrite and alkalinity of the water samples. The water quality analysis will serve as a tool to evaluate the magnitude of pollution at River Kadambrayar due to the open dump at Brahmapuram and assess the seasonal variation.

The sediment samples would be analysed as per US National Oceanic and Atmospheric Administration (US NOAA) protocol. Soil and sediment samples would be first oven dried at 90℃ for 24 hours and are then disaggregated manually. The disaggregated samples are then sieved through a series of sieve sets of 25mm, 10mm,

4.75mm, 2.63mm and 1.70mm respectively. Then the sieved samples below 4.75mm are subjected to wet peroxide oxidation using 30% concentrated $H_2O_2$and left overnight for 24 hours to digest the organic matter. Then density separation is carried out using sodium chloride of density 1.3g/ml to separate the microplastics using floatation technique. The supernatant would be then filtered using filter paper and microplastics are extracted. The water quality analysis of river Kadambrayar carried out previously has indicated high organic pollution (Average BOD of 125 mg/L). Due to the high organic contamination on plastic pieces, the organic oxidation is repeated for a minimum of 3 times and packed in air tight bags to avoid air borne contamination and for getting accurate results in spectroscopic analysis. Otherwise the organic contamination may lead to erroneous results.

The extracted microplastics are again washed in millipore water just before placing it in the ATR FT-IR spectroscope. Once the specimen is placed properly, scanning is performed and the infrared spectra of the sample is generated with the help of a software called Spectrum. This generated spectrum is compared with the spectra available in the digital library automatically and the best suited match is displayed as the result. Preliminary work carried out indicates that the organic contamination in the samples, would interfere with the generation of good quality peaks in the spectra. Hence, a minimum percentage of 60% match would be selected as the best suited one.

Modelling transport of microplastics from top soil to river

Microplastics from land reaches river and subsequently to backwaters through the surface runoff and soil erosion. The impact of microplastics on the river as well as backwater ecosystem depends on the quantity and characteristics of the microplastics being transported from land. As part of the proposed project a mathematical model would be developed to quantify the transport of microplastics and understand their fate in river as well as in backwaters. Model simulation results will be validated from field measurements. Such a model will be replicable and could be used at other locations in Kerala to understand land to surface water contribution of microplastics.

Assessment of microplastics in fish species in River Kadambrayar and Lake Vembanad

This study proposes to assess and quantify the presence of microplastics in fish species of both a freshwater ecosystem (River Kadambrayar) and a saline water environment (Lake Vembanad). Commercially available fish samples would be collected from the river Kadambrayar and Lake Vembanad. After rinsing the fish in sterile water to remove visible

debris, the fish species would be identified according to the FAO species identification sheets. The fish would then be dissected using stainless steel kit, and would be placed in pre-sterilized zip-lock bags, sealed and stored (−4 °C) for analysis. The intestinal contents of fish would be scraped and transferred to clean crucibles. Three times the volume of content of 10% KOH would then be added to the samples and allowed to digest for 5 days at 60 °C. Once a clear solution is visible, the digested contents would be filtered through Filtration Unit. The filter papers are then labeled, observed and would be photographed under a Microscope for visual identification. Compounds suspected for microbeads and microfibers would be marked on filter paper. Primary confirmation of microfibers would be determined by Hot Needle Test wherein plastic fibers curl or deflect when a hot needle tip is moved around the fiber. Later, the suspected particulates would be photographed, isolated and analyzed by FTIR for confirmation of polymer functional groups.

Assessment of lifecycle changes due to microplastics in the identified fish species

Although some aquatic organisms have been shown to ingest plastic, few studies have investigated the life cycle changes brought about by the effects of plastic waste on animals. Exposure to environmentally relevant concentrations of microplastics could interfere with hatching, growth rates, feeding preferences and innate behaviours of fishes. This coupled with the increased incidence of microplastics in the aquatic environment makes it mandatory that the effects microplastics in inducing lifecycle changes in the fish species be investigated.

Laboratory experiments on microplastic grazing and accumulation in marine organisms have usually been carried out in controlled conditions in small experimental units, where the organisms have been exposed to a known concentration of plastic particles. Such studies have given insight into the potential of microplastic ingestion by various aquatic organisms, and raised questions regarding the hazards due to microplastic ingestion. One possibility for collecting realistic data is to study the processes in aquariums resembling natural environments. Experiments would be carried out in small scale aquarium in a temperature controlled condition provided with aeration. The water quality characteristics maintained in the aquarium will closely resemble the water quality of the natural environment which is replicated. The experimental aquaria will contain contained a selection of fishes that are common in the lake Vembanad and would be left to acclimatize to the experimental conditions for one to two weeks. A control aquarium would also be maintained in the same condition. The experimental set up would then be exposed to a selected range of microplastics mimicking the concentration

detected in the natural environment. The morphology of the microplastics would also be the same as that found in the natural environment. The parameters which would be monitored include the weight, reproductive habits and life cycle changes and behavior exhibited. This would then be compared to the control aquarium which would not be exposed to microplastics. After the study the bodies of the fishes (the viscera and gills and eviscerated flesh (whole fish excluding the viscera and gills)) exposed to microplastics would be studied for microplastics ingestion as described in the methodology section.

Year-wise work plan

Work plan including time schedule & chart

Sl. No.	Activity	1st Year				2nd Year			
		1st Qtr	2nd Qtr	3rd Qtr	4th Qtr	1st Qtr	2nd Qtr	3rd Qtr	4th Qtr
1	Detailed Literature Survey								
2.	Identification of relevant fish species for assessing the presence of microplastics in fishes								
2	Sampling and Analysis of Top soil, sediment and water samples								
3	Sampling and analysis of fish to determine micoplastics in fish species								
4.	Laboratory studies for assessing the life cycle changes in the selected species of fish								
5	Modelling Export of microplastics from land to river and Validation								
6	Compilation of results, Final report preparation and submission								

Minimum required tenure of the project: 24 months

Practical relevance/utility of the project

A number of studies have been carried out indicating presence of microplastics in both freshwater and marine environments. A few studies have also indicated presence of

microplastics in fishes also [Kumar et al.,2018]. But most of these studies have concluded that, though the presence of microplastics in the fish is a matter of significant environmental pollution due to plastics, the concern about its transfer to edible parts of the fish could not be ascertained, since fish sellers usually remove the gut/intestinal tracts prior to selling and gut/intestinal tracts of the selected fish species is not consumed. However, there is increasing evidence of edible parts of the fish also been contaminated due to microplastics. In this project the focus would be on microplastics and its morphology (fragments, films, filaments, beads, and foams) in the viscera and gills and eviscerated flesh (whole fish excluding the viscera and gills) of the species selected. Gills of the fishes are the first organ exposed to anthropogenic particles during respiration and this increases the probability of particles getting stuck in the gills of fishes. The microplastics thus stuck in the gills are more of concern in small fishes which are used for consumption as dried fish, since dried fish are often processed without any cleaning process and evisceration is difficult in case of small fishes like anchovies. The study of life cycle changes in fishes due to its proximity to microplastics has not been reported in India. Hence a study of this nature is of vital importance for a state like Kerala where majority of people consume both freshwater and seawater fishes including dried fish. Moreover, the order of magnitude of the abundance of microplastics detected in the sediments in river Kadambrayar is quite high when compared to the reported values elsewhere.

Socio-economic and environmental relevance of the project

Studies of microplastics in Kerala, is limited. With its high density of population, solid waste management is one of the challenges faced by the State. The intensity of plastic pollution in Kochi can be assessed by the analysis of soil samples from Brahmapuram, the small village which has became the waste dumping yard of Kochi since 2017. As per reports, Kochi city generates around 380 tonnes of solid waste per day, of which 150 tonnes are biodegradable and 100 tonnes comprise of plastic waste. This subsequently pollutes the rivers of Kadambrayar and Chitrapuzha, which borders the open dumping yard of Brahmapuram. Hence, a long term monitoring and assessment may help in forming an accurate picture of the problems due to the microplastics in the aquatic environment. It may also help in exposing the deficiencies with regard to handling of plastics and formulating/developing an alternate policy.

The river Kadambrayar drains into Lake Vembanad. This results of the preliminary study conducted at the institute by Anupama (2019) coupled with the study conducted by Sruthy et., al 2016 clearly indicates that river Kadambrayar is one of the major pathway of microplastics

into Lake Vembanad. The River Kadambrayar is the source of water for nearby panchayats and supports a number of freshwater fish species. Several farmers and families of fishermen had depended on Kadambrayar for their livelihood till a few years ago, but the depleted quality of water in the river has made fishing unsustainable. The presence of microplastics would further accentuate the problem and would have far reaching environmental and economic consequences. It has been proven by many studies that microplastics are entering our food web, and as top predators, human beings are exposed to its potential harms.

These factors make it imperative that the studies of presence of microplastics in the fish species in the aquatic environment be carried out to detect its presence and to assess the life cycle changes in the fishes. The fishworker population of the State in 2016-17 is estimated to 10.29 lakh. Out of this, 7.92 lakh fishworkers belong to marine sector while 2.37 lakh fishworkers belong to inland sector. Ernakulam, Alappuzha, and Thrissur are the leading districts in the case of inland fish production occupying the first, second and third positions respectively. The study conducted would throw light on the impact of microplastics on the fisheries industry. Although this study limits itself to fish species in river Kadambrayar and Lake Vembanad, the microplastics found there would eventually find its way into the sea affecting marine fish population also.

Expected and other physical outcomes of the project

The proposal envisages the following outcomes from the study

1. An accurate picture of the abundance, morphology and characterization of microplastics in the top soil at Brahmapuram and in the sediment in river Kadambrayar.
2. Develops better understanding of sources and routes of travel of microplastics
3. Highlights the implications due to the presence of microplastics in river
4. A model which simulates the transport of microplastics from top soil at Brahmapuram into the river.
5. Assessment of presence and abundance of microplastics in the commercially used fish species of river Kadambrayar and Lake Vembanad.
6. Laboratory assessment to assess the lifecycle changes in the fish species due to the microplastics.

Agencies which can utilize the results of the project

Kochi Municipal Corporation: The Kochi Municipal corporation can make use of the study conducted to reassess their plastic waste management strategies. Sruthy et al.,2016 identified low density polyethylene as the most abundant polymer found in Lake Vembanad. Anupama (2019) also found Polyethelene as the most abundant polymer in sediment samples in river Kadambrayar and in top soil at Brahmapuram. Most of the samples from brahmapuram were from polyethelene bags of thickness less than 50 microns. It was also found that, the low density polyethelene bags are liable to disintegrate easily hence also subject to long distance transport via water or air. If the findings of this study, conducted for longer monitoring period reiterates the findings, then it can help in adopting policies/strategies directed to curbing/reducing the specific polymer.

The Central Marine Fisheries Research Institute (CMFRI): Confirmation of the presence of microplastics in might interfere with the commercial value of fishes in Kerala. Ingestion of microplastics by commercially important species in both Kadambrayar and Lake Vembanad would be determined from field observations. The results of the study can be used by CMFRI to frame suitable preventive measures to ensure that microplastics do not enter the food chain via the fishes consumed.

Techno-commercial feasibility of the project, if any: Nil

Modalities for replication of the outcomes, if any

The study serves as a pioneering effort to link the open dumping area as a source of microplastics into the aquatic ecosystems. The model for transport can be extended to determine the transport of microplastics from top soil to any river body. The study conducted can be used to evaluate new knowledge regarding sources, pathways, loadings, and processes for microplastic in the context of a comprehensive conceptual model to allow prioritization of data gaps. The model predictions would be compared to monitoring results and potential reasons for differences between predicted and measured values would be assessed. The proposed study can be used to predict the modalities of transport of microplastics into the marine environment. The parameters and protocols used in the laboratory experiments can serve a guideline for further work in the area.

Standardization of the design parameters for technology and preparation of protocols/ prototypes for achieving reliable and replicable processes, if any:

The model for transport can be extended to determine the transport of microplastics from top soil to any river body. It can be used to evaluate new knowledge regarding sources, pathways, loadings, and processes for microplastic in the context of a comprehensive conceptual model to allow prioritization of data gaps. The protocols developed can be used to evaluate available data on the impacts of existing and proposed management actions to reduce microplastics in aquatic and terrestrial environments.

Component-wise justification of the costing of the project

- The project involves extensive sampling and laboratory work and analysis. This would cost approximately Rs. 2.0 lakhs
- JRF will be employed for 24 months period to assist the investigator during the field work, sample collection and analysis. JRF stipend will be around Rs. 6.0 lakhs
- Supporting staff (during field data collection) & Technical staff salaries (as and when needed) - Rs. 1.4 lakhs
- Field analysis and laboratory of sediment samples (Glassware and chemical) Rs.1.0 lakh
- Travel cost (for field visits) - 1.0 lakhs
- Contingency expenses – 0.5 lakhs
- Institutional overhead – 10% of the above

Budget Modification: No changes have been proposed for the budget in the revised proposal since there is no modification of the objectives and the scope. Only changes made are in the work plan. The sampling schedule remains monthly throughout the tenure of the project. The final results of the sampling will be used to validate the developed model. In the previous proposal the JRF was proposed for a period of 24 months to assist in field work, sample collection and analysis. In view of the hectic revised schedule of sampling and monitoring, the same period of 24 months is retained for the JRF.

References

1. Anupama S. (2019)- "Detection of microplastics at Brahmapuram using ATR-FTIR spectroscopy and modelling its transfer to water sources for risk assessment" .Project Report for the project work in M.Tech submittetd to KTU.
2. Chandan Krishna Seth and Amritanshu Shriwastav (2018), Contamination of Indian sea salts with microplastics and a potential prevention strategy, *Environmental Science and Pollution Research.*
3. Luis Carlos De Sa and Miguel Oliveira (2018), Studies of the effects of microplastics on aquatic organisms: What we know and what should we focus our efforts in future, *Science of the Total Environment*, Vol:645, 1029-1039
4. S. A. Naidu,V. Ranga Rao and K. Ramu (2018), Microplastics in the benthic invertebrates from the coastal waters of Kochi, Southeastern Arabian Sea, *Environ Geochem Health Springer Nature*.
5. S Sruthy and E V Ramaswamy (2016) - Microplastic pollution in Vembanad lake, Kerala India: The first report of microplastics in lakes and estuarine sediments in India – *Environmental Pollution,* 1-8.
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7. Wei-Min Wu, Jun Yang and Craig S. Criddle (2017), Microplastics pollution and reduction strategies, *Front. Environ. Sci. Eng.,* Vol: 11, 1-6.
8. Wenfeng Wang and Zhen Li (2016), Microplastic pollution in inland fresh waters of China: A case study in urban surface waters of Wuhan, China, *Science of the Total Environment.*
9. Economic review SPCB Kerala 2016.
10. Kerala SPCB Directory 2010
11. Kerala Suchitwa Mission reports 2018

Part III - Biographical Sketch of the investigator(s) detailing research credentials and research papers published in the area of the proposed research project

Part IV - Facilities (equipments/instruments) available at institution(s)/organizations for carrying out the project

The Department of Civil Engineering at SCMS School of Engineering and Technology(SSET) has a full-fledged Environmental Engineering laboratory supplemented with modern equipment and research facilities. The Civil Engineering Department also conducts an M.Tech Environmental Engineering programme at SSET since 2013.The Environmental Engineering laboratory is used by both the undergraduate and post graduate students. The laboratory is also utilized by the SCMS Water Institute(SWI) for sponsored research, consultancy and technical services. The preliminary study on detection of microplastics in soil and sediment samples mentioned in the abstract and methodology has been carried out Ms Anupama S, a M.Tech student at SSET as a part of her project work as per KTU norms. The institute also has a Central library with number of online journal subscription. It also has High speed internet facilities and computational facilities to aid research.

Some of the instruments available in the laboratory are as follows.

1. **Water quality analyzer**
2. **UV_VIS digital spectrophotometer**
3. **Compound Laboratory Microscope**

Fourier Transform -Infrared (ATR - FTIR) spectroscopy for the identification and characterization of microplastics will be carried out at either at Department of Civil Engineering, NIT Calicut or Sophisticated Analytical Instruments Facility (SAIF) at Sophisticated Test and Instrumentation Centre.

Part V - Project budget in the prescribed format

	PROJECT BUDGET			
A	**Salaries and Wages**	**I Year**	**II Year**	**Total**
1	JRF/SRF	3,00,000	3,00,000	6,00,000
2	Supporting technical staff or other personnel , if any	70,000	70,000	1,40,000
	Grand Total	3,70,000	3,70,000	7,40,000
B	**Permanent Equipment (Please specify various individual items of equipment)**			
	Not Applicable			
C	**Expendables / Consumables (Chemicals & Glasswares/ Aquariums)**			1,00,000
D	**Analysis of microplastics**			2,00,000
E	**Travel and Field work/sample collection**			1,00,000
F	**Contingencies**			50,000
G	**Institutional Charges (@ 10%)**			1,19,000
	Grand Total (Rs)			13,09,000

Budget Modification: No changes have been proposed for the budget in the revised proposal since there is no modification of the objectives and the scope. Only changes made are in the work plan. The sampling schedule remains monthly throughout the tenure of the project. The final results of the sampling will be used to validate the developed model. In the previous proposal the JRF was proposed for a period of 24 months to assist in field work, sample collection and analysis. In view of the hectic revised schedule of sampling and monitoring, the same period of 24 months is retained for the JRF.

Dr. Nisha.L

Principal Investigator

Name and Signature of

Head of the Institution