

MINUTES OF THE SEVENTH MEETING OF STEERING COMMITTEE ON CONSERVATION & DEVELOPMENT R&D SCHEME TO CONSIDER 08 NEW R&D PROJECTS HELD ON 24th OCTOBER, 2019 AT INDUS CONFERENCE ROOM, INDIRA PARYAVARAN BHAWAN, NEW DELHI

The seventh meeting of the Steering Committee on R&D Scheme for Conservation & Development was held on **24th October, 2019** at Indira Paryavaran Bhawan, Jor Bagh, New Delhi to consider 8 projects received online under the new R&D Scheme for Conservation & Development, Dehradun. The list of participants is at **Annexure-1**.

2. Confirmation of Minutes of 6th Meeting of the Steering Committee

The minutes of the sixth Meeting of Steering Committee held on 16th November, 2018 were circulated to the Committee members and were confirmed subject to the following corrections in:

Agenda Item No. 3.2: No. 265/2018/RE: **“Assessment of Disease Prevalence in Ungulates in Protected Areas in Mizoram”**. Dr. S. Sathyakumar, Scientist G, Co-PIs Prof. Qamar Qureshi, Dr. Vishnupriya Kolipakkam, Dr. T.K. Dutta. Post Box no 18, Wildlife Institute of India, Chandrabani, Dehradun, 248001

In the minutes, the revised cost of project is given as Rs 77,68,463/- instead of Rs 75, 87, 485/-.

Year-wise break-up of the revised budget (in Rs) is given below:

Tenure	1 st Year	2nd Year	3rd Year (6 months)	Total Budget
2 years 6 Months	38,15,815	32,65,015	5,06,655	75,87,485

The component-wise break-up of revised cost of the project is given below (in Rs.):

COMPONENT	Year 1	Year 2	Year 3 (6 Months)	Total Cost
Salary	10,07,760	10,07,760	3,96,720	24,12,240
Equipment	4,20,000	-	-	4,20,000
Consumables	12,35,000	11,35,000	-	23,70,000
Travel Cost	3,50,000	3,50,000	50,000	7,50,000
Contingency	8,03,055	7,72,255	59,934	16,35,245
Institutional Charges	-	-	-	-
Any Other	-	-	-	-
Total Budget	38,15,815	32,65,015	5,06,654	75,87,485

3. Consideration of Proposals

Dr. T. Chandini, Advisor welcomed Shri Ravi Agrawal, Additional Secretary, MoEFCC and Chairman and the members of the Steering Committee and the invited experts including representatives of Wildlife Division and Research & Training (RT) Division of the MoEFCC for

consideration of the 8 new projects listed at **Annexure-2**. It was informed that these projects have been received on-line on the MIS-Portal under the new revamped Scheme on R&D for Conservation and Development. The projects were first considered in the meetings of Technical and Financial Appraisal Committee (TFAC) under the R&D Scheme on Conservation & Development and have been recommended for funding by the TFAC.

The projects were taken up for consideration.

3.1 No. 24/2018/RE: Project titled “**Assessment of Changes for the Conservation and Management of Sathyamangalam Tiger Reserve**” of PI- Prof S Jayakumar, Department of Ecology and Environmental Sciences, School of Life Sciences, Pondicherry.

Details of the Project:

Duration of Study: 2 years

Location of Study: Sathyamangalam Tiger Reserve, Dist Erode, Tamil Nadu

Objectives:

- i) Identification and mapping of elephant habitat and corridor through direct sighting and indirect signs.
- ii) Mapping the status of elephant habitat and corridor using remote sensing data for 1987, 1997, 2007 and 2017 in 1:50 000 scale and by ground truthing.
- iii) Estimating the forest regeneration status of elephant habitat and corridors in the STR
- iv) Change analysis of elephant habitat and corridor using GIS and by ground truthing.
- v) Mapping and change analysis of human settlements and agriculture areas adjacent to the elephant habitat and corridor using remote sensing data for 1987, 1997, 2007 and 2017 in 1:50 000 scale. Mapping of drainage network, water bodies, reservoirs and watershed in the STR and identifying locations for constructing water recharge structures in each watershed
- vi) Recording the human-elephant conflict locations of present and past and questionnaire survey
- vi) Spatial analysis of human-elephant conflicts and by ground truthing
- vii) Preparation of conservation and management plan

Expected Outputs:

1. A detailed map of intensity of Elephant Habitat and existing corridors use.
2. Regeneration status of Elephant Habitat and existing corridors.
3. A detailed map of locations for constructing water-harvesting structure.
4. Spatial distribution of human elephant conflict locations and hot spots.
5. Forest type and cover density maps and change maps of elephant habitat and corridor.
6. Map of change dynamics of settlements and agriculture areas in the STR
7. Management plan

Expected Outcome:

1. Mitigation strategy for human elephant conflict
2. A detailed conservation and management plan for Elephant habitat and Corridor of STR which includes:
 - i. Mitigation strategy for human elephant conflict

- ii. Implementation of conservation strategies with understanding and Involvement from the State Forest Department
- iii. Awareness among the tribes for the conservation of elephant habitats and corridors
- iv. Trained man power (MSc and PhD scholars), publications, improved interpersonal relationship between researchers and administrators.

The proposal was considered by the Technical & Financial Appraisal Committee in its 4th and 8th meetings held on 29.05.2019 and on 26.09.2019 and recommended with the following conditions:

- i) The Committee had noted that the study must focus on the regeneration of degraded areas including forests of Sathyamangalam Tiger Reserve (STR) and its degraded elephant corridors instead of 5km area proposed by the PI outside the STR.
- ii) The data collected by geospatial studies using remote sensing should be validated by ground truthing studies in the area (STR + corridors) for vegetation and species identification and mapping water resources mapping.
- iii) The Committee noted that water availability in STR and along the corridors is scarce and address the issue of how the water bodies, reservoirs and water holes are recharged and ensure water availability perennially in elephant habitat and corridors. Modelling of water availability should be undertaken.
- iv) The study must come up with specific plan for recharge of water reservoirs and ground water in the STR + corridors.
- v) The PI must engage the State Forest Department to collaborate in the proposed study.
- vi) The PI had agreed to drop the Equipment (Advanced computational facility) costing Rs 1,50,000/- as work station already exists.
- vii) It was suggested that local people/villagers should be engaged in project.
- viii) The Committee was of the view that considering the extent of study area and scope of work, the budget of Rs. 38,95, 000/- appears to be less and needs to be re-examined along with cost break-up of various components. The salary of JRF/SRF should be as per the revised order of DST/MoEFCC. The Committee, after deliberations, recommended the project for funding and requested the PI to modify the proposal as proposed above and resubmit the revised project cost on the MIS-Portal.

This had been agreed to by the PI.

Total (revised) cost of Project: Rs 49,63,400

Revised Cost of project (in Rs):

Tenure	1st Year	2nd Year	Total Budget
2 years	25,39,200	24,24,200	49,63,400

The component-wise break-up of revised cost of the project is given below (in Rs.):

COMPONENT	Year 1	Year 2	Year 3	Total Cost
Salary Research Associate – 1 Junior Research Fellow – 2	13,08,000	13,08,000	-	26,16,000
Equipment (Advanced computational facility)	-	-	-	-
Consumables Satellite data	1,00,000	0.00	-	1,00,000
Travel Cost	4,00,000	4,00,000	-	8,00,000
Contingency	400000	400000	-	8,00,000
Institutional Charges	3,31,200	3,16,200	-	6,47,400
Any Other	0.00	0.00	-	0.00
Total Budget	25,39,200	24,24,200	-	49,63,400

Additional Equipment required (not available with Institution):

Sophisticated computational facility¹

Letter of endorsement from Field Director has been provided. Principal Chief Conservator of Forests and Chief Wildlife Warden, Tamil Nadu Forest Division, Chennai vide letter no WL5(A)/36635/2018 dated 31.8.2018 has granted NOC/Permission for the propose study. Chief Conservator of Forests & Field Director, Sathyamanglam Tiger Reserve Vishakhapatnam (P.O), Erodevide letter no C.No. D/7526 /2018 has also granted permission.

The PI made presentation before the Steering committee. The Committee, after deliberations, recommended the project for funding.

3.2 No.90/2018/RE: Project titled “**To quantify the Economic and Ecological Services of Eco-tourism as a Livelihood Option for the Sustainability of the Rhino Population in Manas Tiger Reserve, Assam**” of PI- Dr. Ajay Kumar, Scientist C, Forest Ecology and Climate Change Division, Rain Forest Research Institute Deovan estate, Sotai Ali, A.T. Road (East), Jorhat, Assam

Detail of Project:

Duration of Project: 2 Years

Location of Project: District and Sub-District Baska, Assam

The project proposal was considered in the 4th meeting of TFAC held on 29th May, 2019 and in the 8th meeting held on 26.09.2019.

It was stated that Manas National Park was declared in 1990 by inclusion of nearby RFs and erstwhile Manas Wildlife Sanctuary. The Area is 950 km² {core area of Tiger Reserve (2,837 km²)} and has been declared a UNESCO world heritage site in 1985 and a Biosphere Reserve in 1989. Main types of vegetation are Sub-Himalayan Alluvial Semi-evergreen Forest, East Himalayan Mixed Moist, Dry Deciduous Forests, and Grasslands. The Manas Basin in the west of the Park is frequently flooded during the monsoon but never for very long duration due to the good slope. For assessment of socio economic status of local communities would be done by collection of data of all habitations in and around MNP and sampling of villages

and households. Preparation of comprehensive questionnaires, data analysis will be done. Selection of ecosystem services for the valuation, conducting Stakeholder/experts consultation workshop. Stakeholder/experts consultation workshop and employment generation will be carried out. Carbon storage/sequestration, pollination, flood regulation, Water flow regulation, Sediment regulation, nutrient cycling, listing of all possible ecosystem services of PA. Contribution of ecosystem services in terms of biomass provision, employment, religious/cultural services, etc will be assessed.

The 1st objective “To assess the socioeconomic status of local communities residing in and around Manas National Park (MNP)” had been revised: **“To quantify the provisioning services with special reference to NTFPs from Manas National Park and surrounding areas”**. Selection of representative villages (at least 20-30%) from each group for the intensive study. Selection of 10% households for final survey. Primary data would be on Collection and utilization of various forest products (fuelwood, fodder, medicinal plants and various NTFPs) from MNP and surrounding forests collected. For estimation of economic value of ecosystem services in Manas National Park, the ecosystem services for the valuation selected, Employment Generation; Regulating Services like Carbon storage/sequestration, pollination, flood regulation, Water flow regulation, Sediment regulation, nutrient cycling, Quantification by biophysical assessment, Cultural Services, etc. will be studied. Data analysis will be done.

Assessment of all provisioning services including NTFPs, cultural services (Ecotourism), Regulating services (Carbon Sequestration) will be based on primary data collection. ‘VALUE+’ approach (Verma et al., 2016) to assess the services for which monetary valuation is not possible, will be followed. Electronic Basal Area Factor Scope is not available with the Institution. The Committee noted that the study carried out by Ms. Madhu Verma on Ecosystem services has not included Manas National Park. In addition to study of ecological services at Manas, impact of indirect services such as eco-tourism, carbon sequestration, ecosystem services should also be assessed in MNP.

The TFAC after deliberations had recommended the project for funding, with these revisions.

The PI made presentation before the Steering Committee.

The Committee observed that the Manas area is Maoist affected and is very huge and it will be difficult to make assessment of the entire National Park. Also, permission is not granted to enter the Manas Tiger Reserve. The Committee observed that quantification of NTFPs is very difficult as venturing into the core zone of Manas National Park is not allowed by Forest Department. It is technically not possible to assess the NTFPs and hence PI cannot do the evaluation of eco-system services in MNP. It was suggested that dependency analysis should be done on services such as eco-tourism and socio-economic study etc, to quantify the eco-system valuation for sustainability of Rhinos. PI should examine the prospects of Eco-Tourism to sustain the livelihood of local communities. It was also suggested to examine the livelihood option of local communities around Manas National Park to wean away the dependency of on NTFPs in MTR.

The Committee decided that the PI should change the scope of study and assess other types of services other than ecosystem services that could sustain the local communities. One such service is that of eco-tourism. The contribution of eco-tourism as a main source of livelihood of local communities could be studied under the project. The Committee decided that the title of the project should be revised as **“To quantify the Economic and Ecological Services of Eco-tourism as a Livelihood Option for the Sustainability of the Rhino Population in**

Manas Tiger Reserve”. The Committee also suggested that the objectives of project be revised as given below:

Objective 1: To assess the socio-economic status of local communities residing in and around Manas National Park should be revised as “To assess the socio-economic status of local communities residing outside /periphery of Manas Tiger Reserve”.

Objective 2: To estimate the economic value of ecosystem services in Manas National Park should be revised as “To estimate the economic value of ecosystem for sustainability of Rhino population in Manas Tiger Reserve.

Objective 3: To assess the contribution of ecosystem services in local livelihood in Manas National Park should be revised as “To assess the contribution of local communities living in buffer area of Manas National Park. Dependency analysis (Survey) for wild fruits, Medicinal Plant, fuel wood & fodders, number of Tourist etc.

(Revised) Objectives of Project:

- i) To assess the socio-economic status of local communities residing outside /periphery of Manas Tiger Reserve.
- ii) To estimate the economic value of ecosystem for sustainability of Rhino population in Manas Tiger Reserve
- iii) To assess the contribution of local communities living in the buffer area of Manas Tiger Reserve. Dependency analysis (Survey) for wild fruits, Medicinal Plant, fuel wood & fodders, number of Tourist etc.

(Revised) Expected Outputs:

- i. Report on sustainability of the local communities by eco-tourism as a livelihood option.
- ii. Recommend specific measures that could be implemented/taken up for the livelihood and sustainability of the local population outside/around MTR.
- iii. Recommend other livelihood option of local communities around Manas National Park to wean away the dependency on NFTP's in MTR.

(Revised) Expected Outcome:

- i. Other options of economic services that can provide livelihood for the local communities around MTR.

(Revised) Cost of Project (in Rs):

Tenure	1st Year	2nd Year	Total Budget (in Rs.)
2 years	10,44,800	9,16,760	19,61,560

(Revised) Cost of Project –Component-wise break-up of project (in Rs):

COMPONENT	Year 1	Year 2	Year 3	Total Cost
Salary	4,84,800	5,81,760	0.00	10,66,560
Equipment	2,20,000	0.00	0.00	2,20,000
Consumables	25,000	25,000	0.00	50,000

Travel Cost	2,50,000	2,80,000	0.00	5,30,000
Contingency	15,000	20000	0.00	35,000
Institutional Charges	0.00	0.00	0.00	0.00
Any Other	50,000	10000	0.00	60,000
Total Budget	10,44,800	9,16,760	0.00	19,61,560

Additional Manpower Requirement:

Research Fellow (1)

Field Assistant (1)

Equipment Details not available with Institution:

Sr.No.	Name	No of Unit
1.	Electronic Basal Area Factor Scope/ Dendrometer	1

The Committee, with these revisions, recommended the project for funding.

3.3 No. 152/2018/RE: Project titled “**Design, Development and Evaluation of Indigenous Sensors Based Air Quality Monitoring System and Data Analysis Using Deep Learning**” by PI - Dr. R. Rani Hema Malini, Professor and Head, Department of Electrical and Electronics Engineering, St. Peters Institute of Higher Education and Research, Avadi, Chennai -600 054

Co -PI **Dr. B. Shanthini**, Professor&Head, Department of Information Technology, St. Peter Institute of Higher Education Technology, Avadi, Chennai 600054

Detail of Project:

The proposal was earlier considered by TFAC in its 2nd meeting held on 29.04.2019, and in the 8th meeting of TFAC held on 26.09.2019 wherein the following had been discussed:

Municipal Solid Waste (MSW) generation in Chennai has increased from 600 to 5000 TPD within 20 years. The per capita generation rate is 0.6 kg/day. Although about 269-acre plot in Kodungaiyur, Chennai is used for the garbage dumpsite in Chennai and only about 100 acres of the land is used for haphazard dumping of wastes. Kodungaiyur sewage water treatment plant located adjacent to the dumpsite discharges the sewage water near to the dumpsite. The waste at the site mixes with the sewage water and contaminates it further. It is proposed to Design and Implement a Environment Quality Monitoring device (EQMD) with sensors to monitor environmental quality data.

The project involves the use of an Unmanned Aerial Vehicle (UAV) with low cost and high-resolution monitoring of time and space. Monitoring and tracking of the solid waste disposal sites will be done by using EQMD fitted in UAV. Environmental quality data analysis using deep learning with EQMD data will be done based on which, the trends and variations of pollution would be analysed. Collected data would be represented in time series or hourly time steps. A prediction model will be developed using neural network.

It was also informed that Air quality data from five locations in Chennai from Tamil Nadu Pollution Control Board for the period from 2010 to 2018 and Meteorological data from the Regional Metrological Department for the period from 2010 to 2018 will be collected. It was

clarified that the 5 stations of TNPCB and Met station of IMD are not covering the Dump site area. Among the various monitoring stations of the pollution control board placed in Chennai, the Manali is the nearest monitoring station of study area, hence it is chosen to validate the sensor data. All the data collected by the Pollution Control Board are published daily and freely available on their website. Pollution measurements of AAQ parameters such as PM 2.5, CO, CO₂, NO₂, SO₂, VOC, Methane, and met data such as Wind Direction, Wind Speed, Temperature, humidity, and coordinates of locations will be collected and the same will be imported into the GIS environment using ArcGIS software. Attribute data will be assigned to spatial objects and the system becomes ready for spatio-temporal analysis and management. The collected AAQ data would be transmitted to a server over a wireless internet connection and the server will store, and supply these data to any party who has permission to access it through android phone or website in semi-real time.

It was informed that choosing an appropriate sensor, data reliability and evaluation of sensors is an important step. As suggested by the Committee, a sensor with microchip (a device to monitor the air pollution) for industrial area (which includes dumpsites) will be indigenously developed by the Department in accordance with the type of industries and emissions. In addition, high standard and pre-calibrated sensor with good accuracy available in the market will also be tested in simulation using Pspice software, the simulated data and real time data with in-built sensor will be compared. It is further proposed to validate the data of in-built sensor using linear regression method, and also calibrated from standard calibration centres such as NABL, matching sensor data with data of Pollution Control Board. PI has contacted the TNPCB authorities and discussed about the potential use of the research work in the air pollution monitoring particularly of solid waste management facilities. PI has obtained letter dated 27.05.2019 Chennai.

The TFAC had observed that the data generated should be verified for its validity. CPCB/SPCB website has a well-defined Protocol for on-line monitoring system. The MoEFCC has given the Council of Scientific & Industrial Research (CSIR)-National Physical Laboratory (NPL) with certifying air quality monitoring instruments. This is in anticipation of a rising demand by States - against the backdrop of the National Clean Air Campaign - for low cost air quality monitoring instruments that can monitor levels of nitrous oxides, ozone and particulate matter recently. The Central Government has designated CSIR-NPL as national verification agency for certifying instruments and equipments for monitoring emissions and ambient air. CSIR-NPL shall develop necessary infrastructure, management system, testing and certification facilities conforming to international standards, according to a notification dated 22 August, 2019.

The Committee decided that the project could be taken up subject to the following conditions:

- i) that the PI should develop an innovative sensor in-house that would meet the requirement of measuring AAQ not just for dumpsites alone but as a reliable alternate to existing method of using CAAQMS, in industrial areas, air pollution control areas, etc, which was agreed to by the PI. Indigenous sensors developed by the Institute would be useful for CPCB and SPCBs. CPCB has a monitoring system wherein the data is verified/validated by NPL and thereafter the validated data is accepted by CPCB.
- ii) Validation of data should be done by NPL and India Meteorological Department (IMD), Ministry of Earth Science.
- iii) In addition to the dumpsite, the sensor should also be used to verify its reliability by checking its data on AAQ at a nearby CAAQM Station installed by TNPCB at Manali. The Title of project should also be

revised accordingly. The Outcome should also be revised specific to the project and not for preparation of Guidelines but as a reliable alternate tool for monitoring AAQ.

The Committee had agreed to PI's request that duration of the project duration should be 3 years for the development of indigenous sensor and the project cost to be revised accordingly. The Committee after deliberations decided that the proposal is recommended for funding subject to the above mentioned conditions.

The PI made presentation before the Steering committee. It was informed that as recommended by TFAC, the title of project has been changed as "**Design, Development and Evaluation of Indigenous Sensors Based Air Quality Monitoring System and Data Analysis Using Deep Learning**". As recommended by the TFAC, it was proposed to extend the project duration from 2 years to 3 years with a revised Budget for development of an indigenous sensor.

(Revised) Project Duration: 3 years.

Geographical location of the project is Chennai, Tamil Nadu.

(Revised) Objectives of the Project:

1. To design a microchip made out of sensors capable of measuring environmental quality parameters
2. To develop an efficient algorithm to determine the optimal observation period for accurate air quality prediction.
3. Compare the techno-economic cost of use of this method vis-à-vis established one of CAAQMS for monitoring air pollution.

Revised Outputs

1. Development of Indigenous Sensors
2. Comparison of and analysis of AAQ data of indigenously developed sensor with sensors available in market and with data from CAAQMS at Manali.
3. Integrated Air Quality Monitoring Device
4. Continuous monitoring of Air Quality status
5. Validation of Predicted Ambient air quality data through NABL.

(Revised) Expected Outcome

1. Environmental quality data for the air pollution control area, industrial area, in and around solid waste dump yards
2. Pollution variation maps based on the location and time with respect to time.
3. Extents up to which the pollution levels have effects on human settlements.
4. Pollution contour maps for the study area.
5. A report of the concentration of the air pollutants in the study area and comparison of data vis-a-vis data of CAAQMS.
6. Standard output operating procedure of UAV and a Guideline Manual should be prepared for use of this technology.

Revised Methodology:

1. Design, development, calibration and evaluation of indigenously developed ambient air quality sensor.
2. Design and Implementation an UAV platform to monitor ambient air quality data
3. Monitoring ambient air quality using integrated device and UAV
4. Analysing the trends and variations of pollution
5. Data analysis and prediction using Deep learning

Details of additional equipment required under the project are given below:

S.No.	Equipment	No of Units
1.	Environmental Quality Monitoring Device(EQMD)	2
2.	UAV (Quadricopter)	2
3.	Portable Power Supply Unit	2
4.	UPS	1
5.	Smart Phone	2
6.	Server	1
7.	Laptop	1
8.	Computer (Desktop)	1
9.	Flight Controller	2
10.	Data Storage (Hard disk External)	2
11.	Camera	2
12.	Printer	1
13.	Plotter	1
14.	Power Bank	2

Manpower : JRF-1Specialist/Consultant -1

(Revised) Cost of project (in Rs): Rs 48,53,240/-

Tenure	1 st Year	2nd Year	3rd Year	Total Budget
3years	27,48,520	10,49,520	10,55,200	48,53,240

Component-wise break-up of revised cost of project (in Rs):

COMPONENT	Year 1	Year 2	Year 3	Total Cost
Salary	6,71,520	7,19,520	7,75,200	21,66,240
Equipment	12,20,000	-	-	12,20,000
Consumables	6,12,000	25,000	25,000	6,62,000
Travel Cost	90,000	1,00,000	1,00,000	2,90,000
Contingency	25,000	25,000	25,000	75,000
Institutional Charges	1,30,000	1,30,000	1,30,000	3,90,000
Any Other	-	50,000	-	50,000
Total Budget	27,48,520	10,49,520	10,55,200	48,53,240

The PI made presentation before Steering Committee. It was informed that as recommended by TFAC, the title of project change as “**Design, Development and Evaluation of Indigenous Sensors Based Air Quality Monitoring System and Data Analysis Using Deep Learning**”. As recommended by the TFAC, It is proposed to extend the project duration from 2 years to 3 years with the revised Budget.

The Committee desired that permission of the Director General of Civil Aviation (DGCA) is required for operation of the UAV under the project and should be included as a condition in the Approval letter of Ministry. The Committee also recommended that there should be consistency in the measurements taken such as height /altitude for data collection. Committee observed that there is difference in revised objective and outcome. The PI should

collect data from available sources/studies already done during the first 3 months of study. It was suggested that a Standard Operating Procedure (SOP) and a Guideline Manual for use of UAV should be prepared. The in-built sensor must be got tested from Council of Scientific & Industrial Research (CSIR)-National Physical Laboratory (NPL) and permission in this regard may be obtained and included as condition in sanction letter. The Steering Committee after deliberations, recommended the project for funding with revised cost. The Committee stated that travel cost incurred by PI for presentations already made to MoEFCC and for future presentations before the Ministry must also be included/reflected in the Travel component of the project cost, if this has already not been done.

3.4 No.151/2018/RE: Project titled “**Assessment of Landfill Gas Recovery and Utilization and Reduction of GHG Emission at the Madurai landfill, Tamil Nadu, India**” by PI- Dr.D.Brindha, Assistant Professor, Department of Civil Engineering, Thiagarajara College of Engineering, Madurai 625105

Project duration: 3 years

Location of the project: Vellakkal Sold Waste Dump at Avaniyapuram, Thirupparankundram, Madurai, Tamil Nadu.

The proposal was considered by TFAC in its 2nd meeting held on 29.04.2019 and in the 8th TFAC meeting held on 26.09.2019.

PI had stated that every million tonne of municipal solid waste (MSW) in a landfill is estimated to be able to produce approximately 300 cubic feet per minute of landfill gas (LFG). This amount of LFG could generate approximately 0.78 megawatts of power, or provide 9 million Btu per hour of thermal energy. LFG is a natural by-product of the decomposition of organic material in anaerobic (without oxygen) conditions. LFG contains roughly 50 to 55 percent methane and 45 to 50 percent carbon dioxide. It was informed that the over a period of 15 years, solid wastes collected from the city is disposed off by open dumping at Vellakkal site, located in Avaniyapuram Municipality over an extent of approximately 110 acres. Total area: 110 acres (approximately); boundary distance: 2.85 km (1.77 miles). Vellakkal is an operating landfill. Field measurement techniques for landfills range from square meter to square kilometre scales, including chambers, tracer techniques, micrometeorological approaches, vertical radial plume mapping (VRPM), and aircraft mass balance approaches. Generally different models are used to calculate landfill methane emissions such as First order model, Multi-phase model, LandGEM (US-EPA) etc. Testing wells are installed either in a cluster of three or at five dispersed locations in the landfill. A blower is used to extract LFG from the landfill. LFG composition, landfill pressures, and orifice pressure differentials from the wells are measured and the landfill gas production flow rate is calculated.

The Committee had observed that the piping of methane gas to the nearby residential area would make the project sustainable and serve as a model to use it at other similar dumpsites in other towns and cities in the country. This will also help in reducing GHG emissions from the site. The Committee had desired that the Madurai Municipality be also involved and made a stakeholder in the project. The Project may come out with specific assessment of reduction in gaseous pollutants including GHG emissions from solid waste dumps. The Committee had suggested that the PI should suitably revise the project and resubmit for funding.

In the 8th TFAC held on 26.09.2019 the PI has included the feasibility of use of LFG to serve as a pipe line gas connection scheme to nearby houses in the study. As desired by TFAC that the PI should associate a microbiologist who could suggest suitable microbial bacteria which could hasten the process of decomposition in the dump site, the PI informed that the guidance from the Department of Microbiology of Thiagarajar College, (Arts & Science), Madurai would be obtained for fastening the decomposition process. A letter obtained in this regard was placed before the TFAC. A letter from Madurai Municipality was also submitted by PI.

The TFAC had observed that the study the Madurai Municipality can use this study outcome as a template and replicate in other similar sites in other areas also. The PI must identify potential users of the gas supplied by pipeline in vicinity of project area within 1-2 km. The PI should do preliminary survey of the area and potential users of LFG. Desired that the expertise of Dr. J. Daniel Chellappa, Scientist, Bhabha Atomic Research Centre (BARC) who has launched a similar project on natural gas generation project using biodegradable garbage in Melur and Tirumangalam may be obtained which can be included as part of the Project cost. The Committee desired that a condition that the PI must obtain a No-Objection from the Madurai Municipality for the feasibility of supply and use of LFG by pipeline in the vicinity of the landfill after project commencement and after identification of potential users for the LFG. The TFAC after deliberations recommended the project for funding subject to the above conditions.

The PI made presentation before the Steering Committee. It was informed that as per suggestions made by TFAC committee, survey in the residential area surrounding the dumpsite for about 1 to 2 km made by PI, it was found that there are 40 to 50 low income group families and around 100 families of high income group who can use the LFG from the dump sites. The following preliminary survey has already been done in the dumpsite: (i) Ground Water quality analysis; (ii) Level of Particulate matter in air, (iii) Human health issues caused due to smoke, bad odor and other water borne diseases. As suggested, Dr. Daniel Chellappa, Scientist (BARC) has also been contacted. The project cost has also been revised. Letter from Dr.C.Ravi ,Assistant Professor, from Department of Microbiology of Thiagarajar College, (Arts & Science),Madurai Dated 11.10.2019 and letter no. Ma.Po.4/28124/2019 dated 26.04.2019 from Shri S. Aassu, City Engineer, Municipal Corporation, Maligal, Madurai have been uploaded.

(Revised) Objectives of the Project:

1. To quantify the potential greenhouse gas (GHG) emission reduction from implementing a project.
2. To perform a field investigation (pump test) of LFG extraction rates at the landfill by installing extraction wells.
3. To assess the technical and economic feasibility of the development of an LFG control and utilization project at the landfill.
4. To evaluate the project economics by quantifying capital and operational costs and sources of revenues, and calculating the net present value and internal rate of return.
5. Feasibility of use of LFG to serve as a pipe line gas connection scheme to nearby houses in the study.

Expected outputs of the project:

1. Extent of GHG emission reduction as a result of this project
2. Extent of LFG recovery
3. Feasibility /SOP for implementing LFG to energy recovery project for similar dumpsites/landfills

Expected outcome of the project:

1. Reduction in GHG emissions
2. Outcome will help field/communities for improving quality of life and for sustainable livelihoods.
3. Study will help in significant reduction of pollutant generation and energy efficiency

Total (Revised) Project cost: Rs. 21,16,200

Project Duration: 2 years

Revised cost of the project and year-wise break-up of the cost (in Rs):

Tenure	1 st Year	2nd Year	3rd Year	Total Budget
2 years	11,06,100	10,10,100	0.00	21,16,200

The component-wise break-up of revised cost of the project is given below (in Rs.):

COMPONENT	Year 1	Year 2	Year 3	Total Cost (In Rs.)
Salary	5,10,600	5,10,600	0	10,21,200
Equipment	2,87,000	1,75,000	0	4,62,000
Consumables	15000	15000	0	30,000
Travel Cost	50,000	50,000	0	1,00,000
Contingency	25,000	34,500	0	59,500
Institutional Charges	0.00	0.00	0	0.00
Any Other	2,18,500	2,25,000	0	4,43,500
Total Budget	11,06,100	10,10,100	-	21,16,200

The details of manpower and equipment required for the project is given below:

Research Fellows (JRF/SRF)-1, Field worker -1

Details of equipment required under the project are given below:

S.N.	Name	No. of units
1.	Micro GC Biogas analyser	1
2.	Gas Chromatograph electron capture detector	1

The Committee desired that this project should be covered under Smart City Programme for utilising LFG from dump sites lying for years. PI should develop a Standard Operating Procedure and a Guidance Manuals for recovery of LFG from small dump sites for the use of Ministry of Urban Development for Class II cities. All unattended dump should be taken up. Gas is getting leaked which helps local/nearby people. PI should measure pre and post

emission of Methane gas. PI should select new bacteria for fast decomposition of garbage/organic matter etc. Microbiologist has already been selected. The Committee desired the project should be extended for three years.

The Committee, after deliberations, recommended the project for funding with revised budget of Rs 21,16, 200/- The Committee also stated that travel cost incurred by PI for presentations already made to MoEFCC and for future presentations before the Ministry must also be included/reflected in the Travel component of the project cost, if this has already not been done.

3.5 No.271/2018/RE: Project titled “**Sustainable utilisation of Industrial waste materials for the development of cementless ferrocement precast panels for Impact load**” by PI - Dr. R. Mohana, Asst. Prof., Dept. of Civil Engineering, MepcoSchlenl Engineering College, Sivakasi, Tamil Nadu

Co-PI: Dr.S.Prabhavathy, Dept. of Civil Engineering, MepcoSchlenl Engineering College, Sivakasi, Tamil Nadu

Project Duration: 3 years

Location of Project: Dept. of Civil Engineering, MepcoSchlenl Engineering College, Tamil Nadu.

Objectives of the Project:

Overall Objective:

A need is felt to develop a new impact resisting panels by utilizing the industrial waste materials such as flyash, slag and crumb rubber that will overcome the limitation of the existing systems, which will meet the requirements of simple design, ease in fabrication, construction, less maintenance and economy while achieving desired impact resistance of structures. The proposed research includes both analytical and experimental investigations

Specific objectives:

- i) To review the literature for the waste materials such as fly ash, slag and crumb rubber used as a ingredients in concrete with their merits and demerits.
- ii) To Study the structural properties such as density, youngs modulus, compressive strength, split tensile strength, fire safety, etc. for the following Ordinary Portland cement mortar (OPC) and Potassium based cementless mortar(PCM) with treated crumb rubber and plastic pellets as a partial replacement of sand. Use of ASTM as a standard method of testing.
- iii) To study the Impact strength of potassium based nano geopolymer ferrocement precast panels with treated crumb rubber and plastic pellets in terms of First crack load, Ultimate impact load, Residual impact strength ratio.
- iv) To study the effect of treated crumb rubber as a partial replacement of sand in PCM.
- v) To ascertain the durability behaviour of crumb rubber and plastic pellets of potassium based nano geopolymer ferrocement precast panels to that of control ferrocement panel by accelerated durability and fire endurance test.

- vi) To validate the experimental results by conducting Impact dropping test with analytical simulation by ansys software.
- vii) Conduct accelerated and fire endurance test for both crumb rubber and plastic pellets as partial replacement of sand in geopolymer mortar.

Expected Outputs of the Project:

1. Techno-economic evaluation and characteristics of the final product in terms of strength, durability, impact load, fire-safety (flammability), etc and parameter-wise, should be done vis-à-vis conventional technology and products at the end (final) of project
2. Commercial viability of replacement of sand vis-a-vis alternate material(s) for mass production/replacement of use of cement in building.
3. Feasibility of various uses of the input materials and the final product(s) vis-a-vis for construction (as a replacement of cement).
4. Extent of minimisation of CO₂ emission (and carbon footprint) and reduction in hazardous wastes from this method.

Expected Outcome:

1. Assessment of extent of reduction in waste dumping and land filling and thus reducing environmental pollution.
2. Extent of reduction in carbon footprint.
3. Since it is Zero cement concrete, the extent of reduction in cost of production of cement cement in the final product.
4. Feasibility of extent of use of Industrial waste products such fly ash, slag, crumb rubber used as alternate material to cement and recycled to manufacture structural elements can help in construction of low cost housing, Hot water storage tanks, silos, etc.
5. Indian construction industry may get a new innovative cheap product for rapid construction.

Cost of Project: Rs 22,88,160/-

Cost Break-up of project (in Rs):

Tenure	1 st Year	2 nd Year	3 rd Year	Total Budget (in Rs)
3 years	7,79,000	8,45,160	6,64,000	22,88,160

Component-wise break-up of cost of the project is given below (in Rs.):

COMPONENT	Year 1	Year 2	Year 3	Total Cost
Salary	5,64,000	5,64,00	5,64,000	16,92,000
Equipment	90,000	1,56,160	0	2,46,160
Consumables	50,000	50,000	25,000	1,25,000
Travel Cost	50,000	50,000	50,000	1,50,000
Contingency	25,000	25,000	25,000	75,000
Institutional Charges	0	0	0	0
Any Other	0	0	0	0
Total Budget	7,79,000	8,45,160	6,64,000	22,88,160

Additional Manpower Requirement:

1. Research Associate (1)

Additional Equipment (Not Available with Institution)

1. Direct fall impact testing machine (1)
2. Laptop with Printer (1)

In the presentation made by PI before the TFAC, it was informed that production of cement leads to depletion of natural resources (limestone) and is energy intensive, causing environmental pollution (1 tonne cement = 1tonne CO₂), and contributing to 7% global CO₂ Emissions. Due to increasing road and building construction projects, the demand for sand mining continues to grow and recycling of the scrap tyre to produce useful products or materials would be a viable solution. Waste utilizations of flyash, GGBS and Crumb Rubber from scrap tyres reduces pollution level mainly in air, land and water. Turning the waste into a valuable resource and the products provides low carbon footprint. The aim of project is to reduce the use of cement and replace the same with fly ash and other materials. Categories of wastes utilized in green concrete are agricultural waste (rice husk, corncob ash, saw dust ash); Industrial waste are fly ash, granulated blast furnace slag, silica fumes; Municipal waste are rubber, plastic, paper. FERROCEMENT consists of Ferro (steel or iron) and cement (a binder or cementitious substance). Fibrocement-made up of rich cement mortar and wire mesh reinforcement. Advantages of Ferro cements are A high ratio of strength to weight in comparison to R.C.C; Cost - effectiveness compared to R.C.C; Lower intensity of material use; Speedy process of construction; Flexibility with regards to cutting, drilling & joining; High acceptability in terms of shape and form.

GEOPOLYMERS is inorganic aluminosilicate polymer is synthesized from silicon and aluminium material of geological origin. The ingredients are source material (rich in Silicon and Aluminium) + Alkaline solution. Curing would be heat curing or steam curing. Mechanical properties of geopolymer mortar and short term and long term durability of geopolymer mortar will be assessed. Experimental studies of the impact strength of Potassium based cement less ferro cement panels by dropping impact test will be done.

The TFAC had noted that PI would be using nanoflyash, flyash and Crumb rubber instead of sand. The Committee desired to know the techno-economically feasibility and commercial viability of replacement of sand vis-vis alternate materials. The slag proposed to be used in manufacture of panel is similar to cement. If the temperature increases the crumb rubber may melt and to avoid this, surface treatment to Crumb Rubber (using chemicals) may be required, which may lead to fire and safety issues. The Committee also noted that Crumb Rubber is an additive fuel material technology and if this is to be used on a large scale for construction purpose, the study must ascertain the availability of Crumb Rubber for construction vis-a-vis competing users of Crumb Rubber. It was suggested that the PI may include the component of using plastic pellets instead of crumb rubber. However, the study must include safety aspects of use of Crumb Rubber and plastic pellets as a composite material in construction in view of their high flammability levels, especially if they are used in Panels for walls. Material strength must also be ascertained by Impact Tests and durability by Accelerated Durability Tests. The Committee had noted that the budget of the project requires upward revised based on revision in emoluments to Research staff.

The TFAC had recommended the project with revised budget as given above for grant-in-aid under the Scheme.

The PI made presentation before Steering committee. It was informed that due to increasing road and building construction projects, the demand for sand mining continues to grow; recycling of the scrap tire ingredients to produce or modify useful products or materials would be a viable solution; waste utilizations of flyash, Ground Granulated Blast Furnace Slag (GGBS), Crumb Rubber and plastic pellets reduces the pollution level mainly in air, land and water; turning the waste into a valuable resource and the products have a low carbon footprint. Categories of wastes utilized in green concrete are (i) agriculture waste eg Rice huskash, corn cub ash, saw dust ash; (ii) Industrial waste are flyash, granulated blast furnace slag and silica fumes; (iii) Municipal waste eg Rubber Plastic, paper etc. Ferrocement-made up of rich cement mortar and wire mesh reinforcement. Advantage of this technology would be high ratio of strength to weight in comparison to R.C.C Cost - effectiveness compared to R.C.C; lower intensity of material use; speedy process of construction; flexibility with regards to cutting, drilling & joining; High acceptability in terms of shape and form. This study is aimed at developing potassium based geopolymer ferrocement panels with GGBS and flyash as source materials and crumb rubber and plastic pellets as a partial replacement of sand for impact load and durability test. will be done. The ingredients source materials (rich in Silicon and Aluminium) + Alkaline solution; curing will be heat curing or steam curing. Characteristics of Geopolymers are less shrinkage; less permeability; less flammable and emit no toxic fumes in fire and more freeze-thaw resistant, more resistant to acid attack, better fire safety, strength, durability & service life. The durability can be ascertained by accelerated and fire endurance test for both crumb rubber and plastic pellets as partial replacement of sand in geopolymer mortar. Finally, the test report would be compared to the conventional specimen.

To study the ingress of chloride, Rapid Chloride Permeability Tester (RCPT), which is the fastest and accurate test and is conducted as per ASTM C 1202, would be done. The mechanical properties of ferrocement before and after fire exposure, namely the flexural strength and toughness, would be obtained by the flexural strength test. In order to determine the degree of deterioration of the panels, post-fire flexural strength and toughness would be calculated as a percentage of the reference properties. It is found that the cost of 1 cubic metre of mortar compared with Conventional mortar is Rs 83; cost of conventional mortar with crumb rubber is Rs 93; cost of conventional mortar with plastic pellets is Rs 89; cost of Cementless mortar with sand is Rs 77; cost of cementless mortar with sand and crumb rubber is Rs 82; and cost of cementless mortar with sand and Plastic pellets is Rs 80.

The Committee noted that there is flammability issue and a NOC for the same is required. The Committee suggested that American Society for Testing and Materials (ASTM) International Fire Standards and Flammability Standards should be followed for fire safety of panels. A certificate from fire regulating agency for the final product (panel) should be obtained. It was observed that PI intends to replace cement with 80% flyash. The Committee desired that techno-economic evaluation and characteristics of the final product in terms of strength, durability, impact load, and parameter-wise, etc, should be carried out vis-a-vis conventional technology at the end (final) of project. The sample of product should be sent to the Central Building Research Institute (CBRI) and get their certification. Disposal of Cement and other waste as per CBRI norms. The extent of reduction in requirements of dump sites, landfills, hazardous material generated, should be studied.

The Committee recommended the project for funding under the Scheme for Rs 22, 88, 160/- subject to the aforesaid conditions. The Committee also stated that the travel cost incurred by

PI for presentations already made to MoEFCC and for future presentations before the Ministry must also be included/reflected in the Travel component of the project cost. If this has already not been done, PI may upload the details in the Correspondence section of the Portal, which may be included in the total cost of the project.

3.6 No. 40/2018/RE: Project titled “**Emerging infectious disease in birds across a gradient of alien invasive trees mapped using Remote Sensing on Shola Sky Islands**” by PI - Dr. Robin Vijayan, Assistant Professor, Indian Institute of Science Education and Research Tirupati (MoHRD Institution), Karakambadi Road, Tirupati 517501.

PROJECT DETAILS:

Duration of Study: 3 Years

Location of Study: Kodaikanal, District Dindigul, Tamil Nadu (location details with specific Lat-Longs in a tabular form not provided)

Geographical location of the project:

S.No	State	District	Sub District	Latitude	Longitude
1.	Kerala	IDUKKI	NA	10.710.62N	77.67.29E
2.	Tamil Nadu	DINDIGUL	NA	10.1131.97N	77.2342.63E
3.	Tamil Nadu	THE NILGIRIS	NA	11.1916.21N	76.3246.40E

Revised Objectives:

- 1) Map the extent of Alien Invasive timber plantations (exotic timber trees such as *Acacia*, *Eucalyptus* and Pine) on the spread of disease (Avian Malaria – infects only birds) across in the Sky Island system/Landscape consisting of a network of nine National Parks, twenty Wildlife Sanctuaries and twenty-seven Reserve Forest Divisions of the Shola Sky Islands Protected Areas and Reserve Forests.
- 2) Examine emerging Infectious Disease in an avian system, across multiple Protected Areas that can serve as a baseline database. Sampling birds and malaria across PAs & landscape change.
- 3) Examine interactions of Emerging Infectious Disease with the increasing spread of Alien Invasive species. Identify indicator species.
- 4) Study the impact of alien invasive species (exotic timber trees like *Acacia*, *Eucalyptus* and Pine) on the spread of disease (Avian Malaria – infects only birds) across the Shola Sky Island system.

Revised Expected Outputs:

- i) Inputs for Wildlife Management Plans of three divisions will be provided
- ii) Species management plans can be produced for some specific species
- iii) Maps of invasive species in different protected areas.
- iv) Detailed maps with high resolution Remote Sensing, and establish plots will be generated which will capture birds (for ~10 minutes) and blood samples collected to

understand bird and parasite genetics with advanced Next Generation Sequencing techniques.

Expected Outcome:

- i. Baseline knowledge of disease in the landscape particularly for specific RET species
- ii. An understanding of the spread of exotic invasive species particularly for specific RET species
- iii. Knowledge of the relationship between Emerging Infectious Disease and landscape change particularly for specific RET species

(Revised) Break up of cost of Project (In Rs)

Tenure	1st Year	2nd Year	3rd Year	Total Budget
3 years	30,93,040	23,57,040	23,63,411	78,13,491

COMPONENT	Year 1 (In Rs.)	Year 2 (In Rs.)	3rd Year	Total Cost (In Rs.)
Salary	12,45,600	12,45,600	12,97,440	37,88,640
Equipment	4,95,000	0.00	0.00	4,95,000
Consumables	1,06,000	6,000	6,000	1,18,000
Travel Cost	6,93,000	6,93,000	6,41,700	20,27,700
Contingency	1,00,000	1,00,000	1,00,000	3,00,000
Institutional Charges	4,03,440	3,07,440	308271	1019151
Any Other	50,000	5,000	10,000	65,000
Total Budget	30,93,040	23,57,040	23,63,411	78,13,491

Manpower Requirements:

Research Associate (1)
 Research Fellows (JRF/SRF) (1)
 Field Assistant (1)

EQUIPMENT (Revised)	No of Units
Computer GIS	1
Netbook field data collection	1
High resolution GPS	1

The proposal was considered by TFAC in its 4th meeting held on 29.05.2019 and in the 8th meeting of TFAC held on 26.09.2019.

The PI had informed the TFAC that that PI has been working in Western Ghats area since 2000. The PI has studied the bird species Shortwing found in Western Ghats. Results indicated that the bird is found only on the mountain-tops or Sky Islands. Emerging infectious diseases (EIDs) is one of the greatest challenges to mankind with their recent, human-mediated proliferation through introduced species and climate change. In a community with such diseases, major outstanding questions concern the contrasting roles of evolutionary history and ecology. Of particular significance are vector-borne diseases such as avian malaria (AM), which is caused by *Haemosporidian* parasite genera (e.g. *Plasmodium*, *Haemoproteus* and *Leucocytozoon*). AM has been associated with large-scale mortality when

introduced into naive bird communities on isolated communities like islands. Continental habitat islands, such as montane sky islands, including the Western Ghats (WG) Shola Sky Islands, have different levels of isolation and several similarities with oceanic islands (Gillespie Roderick 2002). Isolated communities like those on islands go through contractions and expansions of ranges, with local extinctions (taxon cycling). Some of these are possibly due to AM or other pathogens, that can severely impact insular communities.

It was informed that Avian Malaria infects only birds of ancient divergence from mammal lineage but birds don't get malaria – hosts immuno compromised. Avian Malaria has caused 7 extinction events and severe decline in population in insular/island populations. Wooded habitats increasing which may spread infections. About 1200 individual birds were screened for avian malaria and 42% overall have infection of avian malaria. Grassland birds don't have this. Avian malaria caused by two parasite *eg. Plasmodium – mosquitoes and Haemoproreus - biting midges*. It is a field-lab-desk research. The Desk work will be - Map landscape, invasive in detail (3m, 5m resolution). Field work is to capture the bird & collect blood samples ~400/year. PI proposed to create 5 sq.km grids covering 3000 sq/km under the study. Lab – generated data Next Gen Seq. data to examine relationships between hosts & parasites. It was informed that map will be provided for preparation of a Management Plan.

The Committee had noted in the 4th TFAC meeting that the scope of the proposed study is very large for the short duration of the project. The Committee had desired that the project period be increased to 3 years. The Committee had suggested that the scope of work should be reduced, The Committee had desired that the study should look into altitudinal gradient of the Invasive Alien species along with land use change gradient in the proposed study area. The Committee had desired that the genetic component be deleted from the proposed objectives or at least not be made part of this study and the costs along with equipment thereon be deleted. The Committee had desired that expected outcome –i)“*Inputs for Wildlife Management Plans of three divisions*” and objectives ii,iii,iv,v,vi, and viii should be continued. Outcomes iii,iv,v should be only for selective species as per RET.

The Committee had also observed that the budget appears to be high and had suggested that the PI should suitably revise the project with reduced budget along with revised objectives as recommended by the Committee and resubmit the revised project for funding.

In the 8th meeting of TFAC held on 26.09.2019, the aforesaid revisions were considered. PI had informed that the study will: 1) Map the extent of Alien Invasive timber plantations in the Sky Island system 2) Examine Emerging Infectious Disease in an avian system, across multiple Protected Areas that can serve as a baseline database 3) Examine interactions of Emerging Infectious Disease with the increasing spread of Alien Invasive species. Coverage of Protected Areas: A network of Protected Areas and reserve forests covers the Shola Sky Island landscape. Scope of project has been reduced and project duration increased to 3 years and the budget also has been proposed for 3 years. Genetics component of the study has been dropped. Equipment for genetics has also been deleted. Lab Assistant (1) has been deleted. The total cost of the project has reduced from Rs.102,07,791/- to 78,13,491/-.

It was stated that in this study, the impact of alien invasive species (exotic timber trees like Acacia, Eucalyptus and Pine) on the spread of disease (Avian Malaria – infects only birds) across the Shola Sky Island system would be studied. Detailed maps with high resolution Remote Sensing, and establish plots will be generated which will capture birds (for ~10

minutes) and blood samples collected to understand bird and parasite genetics with advanced Next Generation Sequencing techniques. It was informed that the coverage of area include nine National Parks, twenty Wildlife Sanctuaries and twenty seven Reserve Forest Divisions of the Shola Sky Islands. There has been no systematic examination of avian malaria in these landscapes. A better understanding of the spatio-temporal dynamics of vector-borne disease requires a more nuanced understanding of how the dynamics and distribution of parasites, vectors, and hosts interact in space and time (Lambin et. al 2010). The results will be utilised to develop a model to assess the sensitivity of avian malaria dynamics to alterations in bird community structure, within a GIS framework, and thus identify key species (or functional groups) that critically impact disease dynamics. The identification of such key species (or functional groups) will improve the understanding of disease dynamics in natural communities, and such species (or functional species groups) could also be used as indicators of ecosystem health in the future.

The TFAC had noted that the travel cost is very high i.e. Rs. 20,27,700/- but had observed that the area of coverage extends to nine National Parks, twenty Wildlife Sanctuaries and twenty seven Reserve Forest Divisions on these Shola Sky Islands and agreed to the same.

The TFAC after deliberations had recommended the project for funding.

PI made presentation before the Steering Committee. It was informed that the invasive species like *Eucalyptus*, *Acacia* are increasing; in project area there are 3 *Acacia* species. Birds are having symptoms of Malaria, which has caused extinction of many bird species in other parts of the world. Seven extinction events have been observed leading to severe population decline in insular populations. It was stated that avian malaria infects only birds, but the birds don't get malaria – as the host is Immuno compromised. The total cost of project is Rs.78,13,491/-.

The Committee after deliberations recommended the above project for funding for a total cost of Rs.78,13,491/- subject to the above conditions.

3.7 No.317/2018/RE: Project titled “**Ecological assessment of endemic and threatened Laughingthrushes of the Western Ghats to develop conservation plan for securing their population and habitats**” by PI - Dr. S. Babu, Senior Scientist, Salim Ali Centre for Ornithology and Natural History, Anaikatty, Coimbatore 641108, Tamil Nadu.

PROJECT DETAILS

Duration: The project is for a period of **3 years**.

(Original) Geographical location of the project:

S.No	State	District	Sub - District	Latitude	Longitude
1.	KARNATAKA	KODAGU	NA	11.951	75.948
2.	KERALA	KOLLAM	NA	8.83	77.226
3.	KERALA	KOZHIKODE	NA	11.390	76.055
4.	KERALA	MALAPPURAM	NA	11.263	76.480
5.	KERALA	PALAKKAD	NA	10.932	76.617
6.	KERALA	THIRUVANANTHAPURAM	NA	8.563	77.226

7.	KERALA	WAYANAD	NA	11.590	75.9728
8.	TAMIL NADU	COIMBATORE	NA	10.927	8.417
9.	TAMIL NADU	KANNIYAKUMARI	NA	8.417	77.351
10	TAMIL NADU	THE NILGIRIS	NA	11.461	76.590
11	TAMIL NADU	TIRUNELVELI	NA	8.760	77.289

Objectives of the Project:

1. To assess the structure and composition of vegetation in different habitats of Laughingthrush and phenology of food plants of Laughingthrushes.
2. To elucidate the distribution pattern and abundance of Banasura Laughingthrush *Montecinclajerdoni*, Nilgiri Laughingthrush *Montecinclacachinnans* and Ashambu Laughingthrush *Montecin clameridionalis* in the Western Ghats.
3. To identify the factors that influence the habitat and nest-site selection of these Laughingthrushes
4. To evaluate the extent of anthropogenic pressures on the population of Laughingthrush in the Western Ghats and develop a conservation plan for these species to secure their population and habitats.

Expected outputs of the project:

1. Area of occupancy (AOO) or distribution range of all Laughingthrushes will be demarcated and quantified in the Western Ghats. Important areas for the conservation of all species will be prioritized.
2. Current distribution range of Laughingthrushes will be compared with future climate scenarios and the amount of area reduced in response global warming will also be estimated.
3. A minimum population size of all target species will be estimated within their distribution range. Habitats that support high density of Laughingthrushes and nests will be identified.
4. Anthropogenic pressure that influences either directly or indirectly will be quantified. Implementable recommendation for the conservation and management of the species will be drawn based on the results of the study.
5. A spatial atlas on these species emphasizing population, important areas and threats acting on them will be prepared. It will be distributed to all local stakeholders involved in the conservation of these species.
6. A comprehensive conservation plan for three species will be prepared by compiling both primary and secondary information available.
7. Publication of results as peer-reviewed articles in reputed journals. Research Fellows will be allowed to register for their Ph.D.

Expected outcome of the project:

Data generated and conservation plan prepared on the target species will facilitate the conservationist, forest managers and policy developers to implement effective on-ground Species Recovery Plan (SRP) for Laughingthrushes of the Western Ghats.

Measurable Outcome

1. Species range map of select Laughingthrushes of the Western Ghats.
2. The effect of global warming on species range of endemic Laughingthrushes in different climate scenarios

3. Population size of Laughingthrushes
4. Important areas for the conservation
5. Conservation plan on Laughingthrushes
6. List of man-power trained/involved the project.

The proposal was considered by TFAC in its 4th meeting held on 29.05.2019 and in the 8th meeting of TFAC held on 26.09.2019. The PI had informed that the Western Ghats are hotspots of the world - biological diversity and high-degree of endemism with nearly 40% of India's bird diversity with at least 16 endemics - tropical montane forests (1400 – 2695 m). Montane forests are associated birds endure both regional (habitat loss, monoculture plantation, invasive weeds, developmental activities etc.) and global (global climate change) level intimidations to their life. Restrict and reduce the species ranges (elevation range) to a narrow pocket. Both regional and global level threats on the species range of the Western Ghats endemic birds have not been appraised. Predicting potential distribution of Laughingthrushes (Banasura Laughingthrush, Nilgiri Laughingthrush, Ashambu Laughingthrush Sps out of 27 species of Laughingthrush in India, 5 sps. are found in Western Ghats) will be carried out by compilation of occurrence locations: ebird-India, GBIF, oriental bird images, other published literature, environmental variables- climate, Vegetation and terrain (elevation, slope- Extracted from DEM) would be studied.

It was stated that occurrence locations and environmental variables will be checked for spatial autocorrelation and multi-collinearity respectively using SDM toolbox. MaxEnt – Maximum Entropy algorithm (Phillips *et al.*, 2006; Elith *et al.*, 2011) will be followed. Binary layer conversion- 10 percentile training presence/minimum training presence logistic threshold will be followed. Map of potential areas will be masked with area above 1200 m elevation and this will be the base map for further sampling. Grid based occupancy framework will be followed. Two sq km spatial grids will be generated using Geospatial Modelling Environment – overlaid on base map to identify individual sampling unit. Spatial replicate will be applied to estimate detection probability (p) of Laughingthrushes. Grids will be subdivided into four 700 X 700 m sub-grids to calculate. Within each sub-grid, a 500 m transect will be laid – presence and absence of Laughingthrushes and habitat covariates (both sampling and site covariates that influence the detection probability (p) and occupancy (ψ) of Laughingthrushes). Intensive sampling area will be selected based on the results of occupancy survey. Major LULC types within Laughingthrushes distribution range will be prepared from satellite images. Vegetation sampling and phenology, nest-site selection of Laughingthrushes. Maxent models will be generated with additional set of occurrence locations for all species. Conservation plan will be prepared.

The Committee had desired that the PI should first discuss with the concerned State Forest Departments and formulate a joint proposal for the conservation of the Laughingthrushes in Western Ghats and resubmit to the Committee for consideration.

The proposal was reconsidered in the 8th TFAC meeting held on 26.09.2019. It was informed the concerned State Forest Department (Kerala & Tamil Nadu) been incorporated in the project as co-investigators. PCCF of Tamil Nadu has nominated the Director and Addl. PCCF, Advanced Institute for Wildlife Conservation, Chennai as a co-investigator for Tamil Nadu part. Likewise, the PCCF of Kerala has nominated Additional Chief Conservator of Forest, Agastiyavanam Biological Park Circle, as a co-investigator for Kerala part. The consent letter

from the PCCFs of Tamil Nadu and Kerala obtained. NOC from Shri Sanjay Kumar Shrivastava, PCCF, Panagal, Saidpet, Chennai obtained vide letter no WL5A/22942/2019 Dated 21.08.2019 and PCCF(WL) & Chief Wild Life Warden, Thiruvanthpuram vide letter no KFDHQ-3478/2019-CWW/WL/WL-10 dated 22.06.2019.

It was noted that the budget of the project has been reduced from Rs. 93.73/- lakhs to Rs 53.71/- lakhs. The TFAC had also noted that the PI proposed to buy 3 motorcycles under travel cost which cannot be agreed to; the PI may however hire 2 motorcycle for 6-7 months in each of the 3 years for use in field work and the budget of the same should be accordingly revised in travel cost/head. Shri Neeraj Kumar, Additional Principal Chief Conservator of Forest, Kerala State Forest Department would be included as Co-PI in project. A letter from PCCF, Govt of Kerala on his letter head should be submitted to Ministry.

The Committee after deliberations recommended the above project for funding subject to the above conditions.

(Revised) Cost of Project (in Rs. lakhs):

Tenure	1 st Year	2nd Year	3rd Year	Total Budget
3 years	20.01	15.97	17.73	53.71

(Revised) Component-wise break-up of cost of the project (In Rs. lakhs):

COMPONENT	Year 1	Year 2	Year 3	Total Cost
Salary	9.87	9.87	10.54	30.28
Equipment	1.85	0.00	0.00	1.85
Consumables	0.25	0.25	0.25	0.75
Travel Cost	3.58	3.58	3.07	10.63
Contingency	0.25	0.25	0.25	0.75
Institutional Charges	2.51	2.02	2.12	6.65
Any Other	0.80	0.50	1.50	2.80
Total Budget	20.01	15.97	17.73	53.71

(Revised) Details of manpower and equipment required for the project is given below

JRF/SRF-2 (Technical); Field Assistant -2

Details of equipment required under the project are given below:(Revised)

S.No.	Equipment	No of Units
1.	GPS	2
2.	Camera Traps	5

The PI made presentation before the Steering Committee. It was noted that PI has increased travel cost Rs10.63 lakhs and reduced the equipment cost to Rs1.85 lakhs.

The Committee desired that the study should form the basis of a Species Recovery Plan (SRP) for the conservation of laughingthrushes. The Committee after deliberations recommended the project for funding of **Rs. 53.71/-lakhs** subject to the above conditions.

- 3.8** No.313/2018/RE: Project titled “**Population Status, Ecology and Conservation of the Indian Swiftlet (*Aerodramus unicolor*) West Coast and Offshore Islands in the Western Ghats of Maharashtra**” by PI - Dr. ManchiShirish S., Senior Scientist, Salim Ali Centre for Ornithology and Natural History, Anaikatti P.O., Coimbatore 641108
Details of Co-PI: Dr. Ram Pratap Singh, Salim Ali Centre for Ornithology and Natural History, Anaikatti P.O., Coimbatore 641108

Project Details:

Project duration: 3 years

(Revised) Geographical location of the project:

S.No	State	District	Sub -District	Latitude	Longitude
1.	Maharashtra	Mumbai	Mumbai	19.074112	72.877604
2.	Maharashtra	Palgar	NA	19.690419	72.768182
3.	Maharashtra	Raigad	NA	18.670435	73.070386
4.	Maharashtra	Ratnagiri	NA	17.335839	73.452736
5.	Maharashtra	Sindhudurg	NA	16.327180	73.559067
6.	Maharashtra	Thane	NA	19.350525	73.177096

(Revised) Objectives of the Project:

1. To estimate the population and evaluate the distribution pattern of the Indian Swiftlet in the Coastal Districts including offshore islands of Maharashtra
2. To understand breeding ecology (breeding biology and nesting and foraging habitat) of the Indian Swiftlet in the Coastal Districts including offshore islands of Maharashtra.
3. To identify threats, and formulate the Conservation Plan for the Indian Swiftlet in the Coastal Districts including offshore islands of Maharashtra.

(Revised) Expected Outputs of the project:

1. Initiate the Population status and distribution survey and the data collection to identify threats to the species in the region.
2. Population status and distribution survey completed. Species distribution maps generated. Threat analyses on-going. An initiated ecological study of the species at the selected sites. Continuing the data collection to explore threats to the species in the region
3. Population, distribution, breeding ecology, and threats to the species are understood and documented. Conservation plan for the Indian Swiftlet prepared based on the scientific understanding of the species, is submitted to the MoEFCC.

(Revised) Expected outcome of the project:

- i) Information/data generated for conservation and population recovery of the Schedule-I species
- ii) Baseline information for species management throughout its distribution range
- iii) Baseline information on distribution of caves in the Western Districts of Maharashtra

- iv) The study should form the basis of Species Recovery Plan (SRP). The report will also be shared with the concerned State Forest Departments for further required management action.

Break up of cost of Project (In Rs) (as presented before Steering Committee(Revised)

Tenure	1st Year	2nd Year	3rd Year	Total Budget
3 years	18.44	16.04	15.29	49.77

Break up of Project (Revised) (in Rs.)

COMPONENT	Year 1 (In Rs.)	Year 2 (In Rs.)	3rd Year	Total Cost (In Rs.)
Salary	6.84	6.84	6.84	20.52
Equipment	1.50	0.00	0.00	1.50
Consumables	2.00	2.00	1.50	5.50
Travel Cost	3.50	3.00	2.75	9.25
Contingency	1.50	1.00	1.00	3.50
Institutional Charges	0.00	0.00	0.00	0.00
Any Other	3.10	3.20	3.20	9.50
Total Budget	18.44	16.04	15.29	49.77

The details of manpower required for the project is given below:

SRF1 and 2 field Assistants

Details of equipment required under the project are given below: (Revised)

S.N.	Name	No. of units
1.	Binoculars - (Model: Nikon Monarch 5) (for identification of the species in close range)	1
2.	Spotting scopes with accessories – (Model: Vanguard Endeavor HD 20-60x82) (for identification of the species in long range)	1
3.	High-sensitive GPS (Model: Garmin Oregon 750) (for mapping the foraging and nesting locations)	1

The proposal was considered by TFAC in its 4th meeting held on 29.05.2019 and in the 8th meeting of TFAC held on 26.09.2019.

The PI had informed that there are three Himalayan Swiftlet *Aerodramus brevirostris*, Indian Swiftlet *Aerodramus unicolor*, Edible-nest Swiftlet *Aerodramus fuciphegus*, Glossy Swiftlet *Collocalia esculenta*. The species are endangered as the nest made with its saliva is a delicacy and is threatening the survival of edible-nest swiftlets throughout their distribution ranges. During the past three to four decades, there has been a high demand in international market for the nest of these bird species, which has led to uncontrolled harvesting and overuse that is directly affecting the populations of these cave-dwelling species.

The present study involves study of the Indian Edible-nest Swiftlet from Western Ghats and the offshore Islets and from southern Maharashtra to Kerala and Sri Lanka. The studies will be carried out by locating caves, estimating population, breeding population and non-breeding population. Using locations of the caves, distribution map of the species will be

generated. Intensive Study Areas (ISA), and Select ISA spatially based on the population size and accessibility would be mapped. Periodic visit will be conducted to the numbered nests to understand breeding biology, chronology and success throughout its distribution. Habitat studies, breeding habitat, foraging habits and habitat. 6 colonies in Northern and 6 colonies in Southern Western Ghats will be selected and Birds will be captured using Mist-Nets Capture at the cave opening during dawn or dusk while leaving or returning to roost. Once capture the bird, collect morphometric data such as lengths of wing, tail, body, bill, tarsus and others Plumage Moulting will be studied. Molecular characterization will be studied.

The TFAC in the 4th meeting held on 29.05.2019 had observed that the PI's objective to study speciation (which is an evolutionary process) cannot be carried out as the work plan outlined does not provide information on speciation. Also, the study involves the Indian Black Swiftlet, and hence the title of the project should specify Indian Swiftlet (Black). The Committee desired that a letter from the State Forest Depts. of the concerned Western Ghats States be obtained. The letters of the State Governments must should clarify that no such study has been undertaken in the past. Habitat modelling needs to be carried out. The Committee desired that the PI should study the distribution pattern and its relationship with local communities, population status, ecological issues, anthropogenic factors. The objectives should be sharply focussed. The title should also require modification. The Committee was of the view that molecular characterisation (genetic study) should be deleted from the scope of the project. The budget should be revised and the PI should also discuss the project with authorities of Nilgiri Biosphere Reserve. The Committee had decided that that the proposal should be revised and submitted online for further consideration.

In the 8th TFAC meeting held on 26.09.2019, PI had informed that the Project has been curtailed to study only one State-viz, Maharashtra. Also, under Objective1-the work involves locating caves using existing literature, discussing with the researchers and local people; estimating population(breeding by nest method & non-breeding by Roost Count Method);using locations of the caves to generate a distribution map of the species; Objective - 2 involves identifying Intensive Study Areas (ISA)-Select ISA spatially based on the population size and accessibility by Conducting periodic visit to the numbered nests. Habitat studies involves Meteorological Data (inside caves);Nest site surface characters, Cave Morphometric Characters and Habitat Modelling etc. Foraging Habits and Habitats and later the Data will be analyzed to understand the crucial foraging habitats for the species. Objective 3-Snowball Survey; Compilation of the outputs of Objectives 1 and 2 Identify the conservation requirements, Prepare the conservation plan for the species. It was informed that the common English name of the study species is recognized by all the national and international authorities and related literatures as Indian Swiftlet. As the scientific name of the species is given in the title, adding 'black' will not serve any purpose. Hence the word "black" is not added in the title. Habitat modelling was already part of the proposal. The letter no. 22(8) Research/CR-39(18-19)/1324-2019-2020 Dated 4.7.2019 received from Principal Chief Conservator of Forest (Wild Life), State Forest Department, Ramgiri, Nagpur Maharashtra obtained. The budget has been revised to Rs.49.77 lakhs from Rs. 438.42 lakhs as all the States except Maharashtra have been deleted from the study.

The TFAC had noted that the PI has restricted the area of study only to the State of Maharashtra as most of the population of Indian Swiftlet are found in Maharashtra. The Committee had desired that detailed ecological studies should be carried out under the project. The PI should study the viable population of Indian Swiftlet, status of poaching, etc.

The population status of Swiftlet should be obtained from State Forest Department, if available. The TFAC had recommended sanction of Bilocular-1, GPS-1, Spotting Scope -1 SRF1 and 2 Field Assistants. The TFAC after deliberations had recommended the project for funding subject to above conditions.

The PI made presentation before the Steering Committee. It was informed that the species is listed under Schedule - I (Wildlife Protection Act 1972) of IUCN. The species is economically important as the nest of Indian Swiftlet found in Maharashtra is delicacy. It was suggested that public participation is necessary for protection of Indian Swiftlet nest to prevent decline of its population. PI should inform public and run awareness campaign for poaching prevention and protecting nest. The study should form the basis of Species Recovery Plan which should be included in the Objectives.

The Committee, after deliberations, recommended the project for funding of Rs. **49.7 lakhs.**

4.0 Any other matter with Permission of the Chair

No item was taken up.

The meeting ended with a Vote of Thanks to the Chair.

LIST OF PARTICIPANTS OF IN THE 7th MEETING OF STEERING COMMITTEE UNDER R&D SCHEME FOR CONSERVATION & DEVELOPMENT HELD ON 24.10.2019

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|----|--|-----|-----|-----|-----|------------------|
| 1. | Shri Ravi Agrawal,
Additional Secretary, MoEFCC | ... | ... | ... | ... | Chairperson |
| 2. | Dr.Kailash Chandra,
Director, Zoological Survey of India | ... | ... | ... | ... | Member |
| 3. | Dr. A.A.Mao, Director, BSI | ... | ... | ... | ... | Member |
| 4. | Shri Manoj Srivastava, Deputy Secretary, IFD
Representing AS&FA | ... | ... | ... | ... | Member |
| 5. | Shri V.P.Yadav, representing Chairman Central
Pollution Control Board | ... | ... | ... | ... | Member |
| 6. | Dr.T.Chandini,
Advisor | ... | ... | ... | ... | Member-Secretary |

Special Invitees:

7. IGF(WL) represented by WL (Technical assistant) –Ms Sima, MoEFCC
8. Shri Suneesh Buxi, DIG (RT), MoEFCC
9. Shri Sandeep Chauhan, Scientist E, BSI in MoEFCC

MoEF&CC

10. Dr.Rubab Jaffer, Joint Director, RE Division
11. Shri Naresh Jaiswal, Under Secretary (RE)
12. Mrs. Akanksha Sachan, ASO (RE)
13. Shri Goldie, Office Assistant, NIC

PROJECT INVESTIGATORS (PIs)/Co-PIs

1. Prof S Jayakumar, Department of Ecology and Environmental Sciences, School of Life Sciences, Pondicherry.
2. Dr. Ajay Kumar, Scientist C, Forest Ecology and Climate Change Division, Rain Forest Research Institute Deovan estate, Sotai Ali, A.T. Road (East), Jorhat, Assam
3. Dr. R. Rani Hema Malini, Professor and Head, Department of Electrical and Electronics Engineering, St. Peters Institute of Higher Education and Research, Avadi, Chennai - 600 054

4. Co -PI [Dr. B. Shanthini](#), Professor&Head, Department of Information Technology, St. Peter Institute of Higher Education Technology, Avadi, Chennai 600054
 5. Dr.D.Brindha, Assistant Professor, Department of Civil Engineering, Thiagarajara College of Engineering, Madurai 625105.
 6. Dr. R. Mohana, Asst. Prof., Dept. of Civil Engineering, MepcoSchlenl Engineering College, Sivakasi, Tamil Nadu
 7. Dr. Robin Vijayan, Assistant Professor, Indian Institute of Science Education and Research Tirupati (MoHRD Institution), Karakambadi Road, Tirupati 517501.
 8. Dr. S. Babu, Senior Scientist, Salim Ali Centre for Ornithology and Natural History, Anaikatty, Coimbatore 641108, Tamil Nadu.
 9. Dr. Manchi Shirish S., Senior Scientist, Salim Ali Centre for Ornithology and Natural History, Anaikatti P.O., Coimbatore 641108.
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LIST OF PROJECTS CONSIDERED IN THE 7th MEETING OF STEERING COMMITTEE UNDER R&D SCHEME FOR CONSERVATION & DEVELOPMENT HELD ON 24.10.2019

S. N	Project ID No.	Thematic Area	Title of the Project	Principal Investigator
1.	No. 24/2018/RE	Wildlife Conservation	Assessment of Changes for the Conservation and Management of Sathyamangalam Tiger Reserve	Prof S Jayakumar, Department of Ecology and Environmental Sciences, School of Life Sciences, Pondicherry
2.	No.90/2018/RE	Conservation of Landscapes & Ecosystems	Assessment of Ecosystem Services from Manas National Park, Assam	Dr. Ajay Kumar, Scientist C, Forest Ecology and Climate Change Division, Rain Forest Research Institute Deovan estate, Sotai Ali, A.T. Road (East), Jorhat, Assam
3.	No. 152/2018/RE	Solid Waste Management	Design and Implementation of an Unmanned Aerial vehicle (UAV)-based Platform for Environment Quality monitoring and data analysis using Deep Learning at Solid Waste Disposal Sites	Dr. R. Rani Hema Malini, Professor and Head, Department of Electrical and Electronics Engineering, St. Peters Institute of Higher Education and Research, Avadi, Chennai -600 054
4.	No.151/2018/RE	Solid Waste Management	Pre-feasibility study for Landfill Gas Recovery and Utilization at the Madurai landfill, Tamil Nadu, India	Dr.D.Brindha, Assistant Professor, Department of Civil Engineering, Thiagarajara College of Engineering, Madurai 625105
5.	No.271/2018/RE	Solid Waste Management	Sustainable utilisation of Industrial waste materials for the development of cementless ferrocement precast panels for Impact load	Dr. R. Mohana, Asst. Prof., Dept. of Civil Engineering, Mepco Schlenl Engineering College, Sivakasi, Tamil Nadu
6.	No. 40/2018/RE	Biodiversity Conservation	Emerging infectious disease in birds across a gradient of alien invasive trees mapped using Remote Sensing on Shola Sky Islands	Dr. Robin Vijayan, Assistant Professor, Indian Institute of Science Education and Research Tirupati (MHRD Institution), Karakambadi Road, Tirupati 517501.
7.	No.317/2018/RE	Biodiversity Conservation	Ecological assessment of endemic and threatened Laughingthrushes of the Western Ghats to develop conservation plan for securing their population and habitats	Dr. S. Babu, Senior Scientist, Salim Ali Centre for Ornithology and Natural History, Anaikatty, Coimbatore 641108, Tamil Nadu.
8.	No.313/2018/RE	Biodiversity Conservation	Population Status, Ecology and Conservation of the Indian Swiftlet (<i>Aerodramus unicolor</i>) in the West Coast and Offshore Islands of Maharashtra	Dr. Manchi Shirish S., Senior Scientist, Salim Ali Centre for Ornithology and Natural History, Anaikatti P.O., Coimbatore 641108