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Pollution Assessment of Marudhamalai at Coimbatore, Tamilnadu, India

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Abstract:- Subramaniyaswami Temple, Marudamalai is considered as the Seventh House of Lord Murugan is a popular hill temple dedicated to Hindu god Murugan, situated near Coimbatore, Tamil Nadu, India. The origin of the temple is rooted in legendary antiquity and dates back to the age of Surapadama, the demon destroyed by Lord Subramanya referred in SKANDAPURNAM. The inscriptions found in Thirumuruganathaswami Temple, Thirumurganpoondi places the origin of the temple in the 12th century A.D. according to Perur puranam. Today the eco system of Maruthamalai is in very degradable state results of waste dumps, deforestation, pollution and encroachment. Unless urgent measures taken, the entire eco system will be in danger of degradation. This report through light on the environmental problems faced today and possible remedial measures. To know the various problems, we have conducted Environmental Impact Assessment (EIA) study and Environmental Management Plan (EMP) is prepared. The present study aims to assess the present status of the existing ecosystem in the Maruthamalai hill, to have a comprehensive checklist of flora and fauna and suggest suitable conservation measures.

I. INTRODUCTION

Soorapadama, the scourge of the gods aided by his mighty brothers, Singamukha and Tharaka arrayed against them and struck terror in their already agitated minds by his sudden and surprising charges and depredations. Unable to bear the agony and anguish, the gods approached Lord Siva and sought his help. Lord Siva comforted the Gods that Lord Muruga would come to their rescue, root out and destroy Surapadama. The gods should hasten to the Marudhamalai Hills and await the advent of Lord Muruga, their Saviour. Perur puranam also alludes to a king called Kusathvajan, who, it is said, was blessed with a male issue, only after worshipping Marudhamalai Muruga. The Divine Cow Kamadhenu is reported to have grazed in the pastures of the hills of Marudhamalai[1]. Perurpuranam lists the three neighbouring hills, vellingiri, Nili and Marudhamalai as the very manifestations of Lord Siva, Parvathi and Subramanya respectively and the three hills taken together as the very symbol of Somaskanda.

Like most Murugan temples, the temple is situated upon a hillock, part of the Western Ghats about 12 km west from the city of Coimbatore. Thai Poosam, Kiruthigai, Padivizha, Tamil New year, Karthigai theepam, Panguni Uthiram and other Murugan festivals are celebrated[2].

II. ECOLOGICAL IMPORTANTS OF THE MOUNTAIN

The mountain contributes following important eco services

A. Biodiversity (Plant and Animals)

Mountains are home to many species of plants, birds and animals. Hills provide essential habitat for rare or endangered species. It also supports about 40 percent of the birds. Coimbatore's wetlands are no exception. Several of the avian species visit and animals visit Maruthamalai hills and it provide ideal breeding climate. It also provides feeding and breeding ground for the resident and migratory birds and animals.

B. Rain Fall and Groundwater Recharge

Maruthamali hill provide the conducive climate for rain fall of Coimbatore district. Almost many wetlands hold the excess runoff after a storm, and then releasing it slowly. The size, shape, location, and soil type of a wetland determine its capacity to reduce local and downstream flooding. Mountains act like nature's sponges, soaking up rainfall that then filters into the ground acting as groundwater recharge areas when the water table is low, and as groundwater discharge zones when the water table is high. They are directly connected to groundwater and play a vital role in regulating the quantity and quality of groundwater, which is often an important source of water for drinking and irrigation of crops.

C. Water purification and Nutrient Retention

The hill plays a crucial role in the natural cycling of sediments and nutrients in the environment. Wetland prevents nutrients from reaching toxic levels in groundwater used for drinking purposes. It also helps to reduce the risk of eutrophication in water bodies.

D. Aesthetic and Recreation Value

Mountains have recreational, historical, scientific, and cultural values. Maruthamalai attract devotees, nature lovers and nature enthusiasts to whatever little has been left of once green haven in the city. They also provide local employability.

➢ *Present Problems*

As urbanization set in, the entire Maruthamalai Mountain basin was neglected and today presents a dismal state of affairs, with encroachments, sewage, garbage dumping, effluents and deforestation.

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During our preliminary survey on June 26, 2016, we have observed the hill faces following basic environmental problems.

A. Garbage dump

- This mainly consists of
- Non-biodegradable- mainly polyethylene bags and plastic bottles in major quantities
- Bio degradable- Food wastes, papers, plant wastes, garlands etc
- Wastes of mud pot/ cloth/glass bottles
- Coconut husks

B. Sewage

The various items used in temple were washed and directly let into open place near 'Pambati Sidther' temple. No treatment done and the entire area became sewage dump resulting in foul smell. The devotees feel uneasy with the environment.

C. Open Toilets

There is no proper toilets and hence in most cases devotees use public place to wash/urinate/defecate affecting the basic hygiene environment. This also leads to spreading of diseases and attract stray dogs.

D. Deforestation

Most of the green cover in the vicinity of temple, parking place, road leading to temple from basement have been removed. This leads to rise in temperature, soil erosion, air pollution etc…

E. Encroachment

The encroachment by traders and local residents threaten the very eco system of the temple.

III. ENVIRONMENTAL IMPACT ASSESSMENT STUDY

Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a present status and the proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse[3].

It involves the collection of Baseline data, Physical and chemical parameters which includes, air, water, soil and noise. Biological parameters including flora and fauna also studied. Finally socio economic data of people living in the area studied and analyzed.

IV. MATERIALS AND METHODS

A. Air quality

Noise levels were measured at two different time using Noise level meter (HTC SL 1352). The locations are given below:

Ambient air survey was conducted at Marudhamalai Hills and its surrounding areas using Respirable Dust Sampler APM 460 BL. Particulate Matter (PM_{10}), Sulphur dioxide(SO_2) and oxides of Nitrogen (NO_2) were measured using IS:5182 (PAN – 23) I 2006, IS:5182 (Part. 2): 2006 (First Revision) and IS:5182 (Part. 6): 2006 (First Revision)[4,5] respectively.

Locations and other details are given below:

1.	Near Marudhamalai Temple (Up)
2.	Car Parking Marudhamalai Temple (Up)
3.	Marudhamalai Entrance (Down)
4.	Marudhamalai Mini Bus Stand (Down)

B. Water quality (all sources and waste)

Water Sampling Details & Analysis Details:-

The water and waste water samples were collected from 8 and 2 Different places respectively of Marudhamalai Locality and their important physical and chemical characters were analyzed and reported as per standard methods.

The sampling sites are mentioned below:

Water Samples	
1.	Residential Drinking Water
2.	Temple Drinking Water
3.	Salt Water
4.	Stream Water
5.	Residential Drinking Water
6.	Temple Drinking Water
7.	Office Drinking Water
8.	Municipality Drinking Water
Waste Water Samples	
9.	Temple and Hand Wash Outlet
10.	Marudhamalai Residential Sewage

C. Soil quality (degraded as well as in forest)

Soil Sampling Details & Analysis Details:-

The Soil samples were collected from 5 Different places of Marudhamalai Locality and their important physical and chemical characters were Analyzed and reported as per standard methodology[7, 8, 9]. The sampling spots are furnished below:

1.	Sewage Point
2.	Solid Waste Dump Yard
3.	Inside Forest
4.	STP Plant (Planed Location)
5.	Residential SW Dump Yard

Noise

Marudhamalai Hills and Surrounding	Aadhi Moolasthalam
	Murugan Sannithaanam
	Solid Waste Dump Yard
	Sithar Temple
	Inside Forest
	Commercial Area
	Residential Area
	Temple Office
	Annadhana Hall
	Hair Donation Hall
	Car Parking
	Temple Steps
	School
	Idumban Sannathi
Marudhamalai Entrance and Surroundings	Mini Bus Stand
	Office
	Residential
	Commercial
	Hills Entrance
	Inside Forest

Table 1. Air Monitoring Results

➢ *Biological parameters*

Western Ghats older than Himalayas is one of the 34 Global Hot spots of Biodiversity flora, fauna, landscape and ethnicity[10]. Maruthamalai hills, part of the Southern Western Ghats in Coimbatore district of Tamilnadu lies between 76° 55' E and 11° 0'and 11° 5' N. The forest types of this region classified as dry deciduous[11]. Annual rainfall is around 450 mm and temperature varying between 17°C and 38°C. The altitudinal range between 450 to 975 m above MSL. The soil is generally shallow with sandy loam texture and rocky substratum is available at slope areas[12].

The present study was carried out in June, 2016 and two field visits were made from the foot hills to Temple area. During the field visit information on flora and fauna and its habit, habitat, plants flowering, fruiting was recorded on either side of the road 5 m width.

V. RESULTS AND DISCUSSION

A. Air Quality

According to table 1 it was observed that the values obtained at the different locations are below the prescribed limit. Anyhow while comparing the earlier study[13] suggests that the pollution levels increased two fold.

Parameters	Unit	Locations				CPCB Standards
		1	2	3	4	
PM_{10}	$\mu g/m^3$	34.6	38.2	42.4	48.4	100
SO_2	$\mu g/m^3$	8.2	9.6	13.8	15.6	80
NO_2	$\mu g/m^3$	20.4	19.6	28.6	30.4	80

Table 2. Physico – Chemical Parameters of Water

B. Water Quality (All Sources and Waste)

The results shown in table 2 suggest the water is not of good quality. High TDS of drinking water in residential area needs to be treated. Except the water in the temple and office area, all others needs to be improved.

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Parameters	Unit	Results								CPCB Standard
		1	2	3	4	5	6	7	8	
Colour	Hazen	<5	<5	<5	<5	<5	<5	<5	<5	5.0
Odour	-	-	-	-	-	-	-	-	-	UO
Temperature	°C	26	27	28	26.2	27	29.2	28	30	
pH	-	6.78	7.61	8.66	8.02	7.45	7.42	7.32	8.06	6.50 – 8.50
EC	µS/cm	520	390	1060	1100	1130	114	108	1030	
TDS	mg/l	286	218	583	605	622	63	59	567	500
NO_2	mg/l	0.05	0.05	0.05	0.14	0.05	0.06	0.71	0.06	
NO_3	mg/l	6.7	BDL	BDL	9.3	18.3	1.8	9.8	7.9	45
COD	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	
Na	mg/l	77	68	169	196	192	20	19	173	150
K	mg/l	19	21	63	69	73	9	11	87	
Ca	mg/l	48	36.5	160	135	128	16	16	154	75
Mg	mg/l	18	16.5	16.5	28.2	40.3	3.9	1.9	22.4	30
Cl	mg/l	170	30	108	70	116	14	14	72	250
SO_4	mg/l	6.1	5.0	27	111	21.5	3.5	7.8	42	200
Fe	mg/l	0.34	0.30	0.32	0.40	0.24	0.35	0.67	0.38	0.30
TH	mg/l	192	152	468	452	484	56	40	476	300
PO_4	mg/l	1.32	1.12	1.37	1.25	1.52	1.35	1.23	1.15	-
CO_3	mg/l	-	-	30	-	-	-	-	-	-
HCO_3	mg/l	170	150	100	190	195	30	10	185	-

Table 3. Showing results of waste waters are polluted with lot of organic material. Almost all parameters are high in value and needs immediate treatment, especially in hill area.

Parameters	Unit	Results		CPCB Standard
		1	2	
pH	-	6.66	6.80	6.50 – 8.50
TDS	mg/l	79	130	2100
TSS	mg/l	128	94	-
BOD	mg/l	106	86	30
COD	mg/l	240	360	250
Cl	mg/l	15	50	250
SO_4	mg/l	9.16	23	200
PO_4	mg/l	2.15	1.46	-
Oil and Grease	mg/l	24	18	10

Table 4. Physico – Chemical Parameters of Waste Water

C. Soil Quality:-

The results (table 5) indicate soil contamination has been occurring for longer time. The major concern is contamination of non bio degradable plastics. Unless urgent measures including its ban, the eco system will degrade. It is important to notice during festival times, many lakhs. Devotees use plastic carry bags which ultimately find its place in local forest.

Parameters	Unit	Results				
		1	2	3	4	5
pH (in 5% solution)	-	5.24	7.98	6.78	8.22	8.07
Moisture	%	27.68	22.48	28.61	19.32	21.68
Total Organic Carbon (TOC)	%	12.41	14.36	12.96	14.68	10.67
Sodium (Na)	%	0.88	1.39	1.47	0.73	0.91
Potassium (K)	%	0.51	0.86	1.04	0.53	0.38
Phosphate (PO_4)	%	0.49	0.83	0.61	0.55	0.74
Sulphate (SO_4)	%	3.89	2.63	1.91	2.11	2.43
Total Nitrogen (TN)	%	1.20	0.88	1.03	0.91	1.07
C:N Ratio	%	12.29	19.59	14.98	19.09	12.19
Iron (Fe)	ppm	197	238	326	126	211

Table 5. Analysis of Soil Quality

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D. Noise:-

The results in table 6 suggest that in most of the places the noise levels are higher than the prescribed limit[14]. Hence steps need to be taken for its control.

Location	Noise Level db (A) L. eq.	Noise Standard by CPCB
Marudhamalai Hills and Surroundings		
Aadhi Moolasthalam	68	Sensitive Area Day Time – 50 db (A) Night Time – 40 db (A)
Murugan Sannithaanam	64	
Solid Waste Dump Yard	49	
Sithar Temple	58	
Inside Forest	44	
Commercial Area	57	
Residential Area	51	
Temple Office	52	
Annadhana Hall	63	
Hair Donation	59	
Car Parking	54	
Temple Steps	60	
School	58	
Idumban Sannathi	50	
Marudhamalai Entrance and Surroundings		
Mini Bus Stand	64	Sensitive Area Day Time – 50 db (A) Night Time – 40 db (A)
Office	60	
Residential	54	
Commercial	63	
Hills Entrance	52	
Inside Forest	48	

Table 6. Noise Level Monitoring

VI. FLORA AND FAUNA

A. Flora

In-spite of various anthropogenic pressures in and around Maruthamalai hills, still there is hope to restore the ecosystem. The short term study reveals the presence of 73 species of plants predominantly trees and shrubs species. Of which three notable weeds were recorded viz., Lantana camara, Leucaena leucocephala and Prosopis juliflora. Eradication has to be done in coordination with Forest department. In due course the weed population will take over the present vegetation of Maruthamalai hills.

B. Fauna

Information was gathered from the local about the presence of animals in and around Maruthamalai region. Based on the survey and the indirect information the following list has been prepared. Mammals includes: Elephant (*Elephas maximus*), Indian hedgehog (*Paraechinus micropus*), Sloth bear (*Melursus ursinus*), Wild boar (Sus scrofa), and Tree striped palm squirrel (Funambulus palmarum). Reptiles include Cobra (Naja Naja), saw-scaled viper (Echis carintus), Green snake (Ahaetulla nasuta), Monitor lizard (Varanus bengalensis) and an endemic Kollegal ground gecko (*Geckoella kollegalensis*). Birds such as Black eagle (*Ictinaetus malayensis*). The *black drongo* (Dicrurus macrocercus), *Red-whiskered bulbul* (Pycnonotus jocosus), Jungle crow (Corvus macrorhynchos), Grey patridge (Francolinus pondicerianus) and peafowl (Pavo cristatus).

E. Observation and suitable conservation measures

- Success of any Conservation project lies with the involvement of local people. To convince the local resident and tribal there are few programmes can be implemented:
- A display board of medicinal plants in and around Maruthamalai area emphasizing the medicinal property and its uses.
- Small nursery can be established to disseminate the medicinal wealth of Maruthamalai hills.
- Separate garden for Stars and plants and its saplings can be made available to public.
- Where ever soil erosion is there, Vetiver grass *(Chrysopogon zizanioides)* can be planted to arrest further erosion.

Socio Economic Survey - Direct interview.
Total persons interviewed: 157.

➢ *Major observations:*

- No sufficient and proper toilet facilities available
- Except traders, the income for local tribal residents is low
- Drinking water facility is inadequate
- No proper solid waste disposal methodology available
- No proper sewage disposal facility available.

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Environmental Management Plan

F. Immediate Activity:

- *Cleaning of all above places with scientific segregation.*

For this purpose the volunteers from educational institutes, NGOs, local people and employees from Panchayat/ corporation/ RAF and temple may be involved.

- *A ban on plastic*

Maruthamalai should be declared as plastic free zone by implementing a blanket ban on all types of plastic products in the entire hilly region. Screening shall be conducted on the entrance of the basement of hill. Violators including the merchants shall be monitored by 'Maruthamalai Engal Malai' group and a fine slapped on violators with the basis of 'Polluter Pays Principle'. Meanwhile alternate items should be provided for packing by charging/ donation.

- *Identification of all encroachments*

With the help of temple authorities, encroachments may be identified and pollution prevention methods shall be adapted.

- *Demarcation of the boundary of the temple and construct fencing to prevent garbage disposal.*

There are certain places where usually garbage is discarded. These places shall be fenced and suitable garbage bins shall be provided. These areas shall be converted to garden.

- *Integrated garbage disposal mechanism*

The garbage shall be segregated and disposal shall be done by reuse, incineration, bio compost etc.

*Environmental Management Plan for long time sustainability***:-**

- *Micro sewage treatment plant*

Construction of micro waste water treatment with microbial technology to avoid any waste generation.

- *Bio composting*

Identification of food and other waste source and conversion into organic manure using bio decomposition method.

- Plant native trees/ shrubs around the parking area, temple, foot path to provide shade, stop soil erosion, water retention and water recharge.
- Creation of herbal garden with medicinal plants, climbers, ornamental plants around temple.
- Providing dust bin along walkways and important locations for garbage disposal, specially designed bins/ cage for plastic bottled, organic and inorganic disposal.
- Provision of bio toilets with the help of experts.
- Provision of micro mobile incinerators for disposal of toxic wastes on the spot
- Battery operated mobile waste collectors
- Nature awareness & interpretation centre for devotees and students

VII. SUMMARY AND CONCLUSION

Conservation of the Maruthamalai area can significantly enhance the much wanted and rapidly declining eco system in and around the beautiful mountain. This was one of the major ecological functions possibly conceived by the far-sighted Tamil kings in the past. This 800 years old mountain provides eco services for both human and environment is in degraded stage and may lead to desertification. Once these intimate linkages are damaged or destroyed, it is rarely possible to restore or recreate them. Further the scientific analysis and observations indicate degradation and pollution levels are increased many fold than a decade ago. So it is most important to restore the ecosystem.

The Environmental Impact Assessment (EIA) conducted resulted in arriving Environmental management plan in which suitable suggestions were made to restore the 'ECO SYSTEM'.

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