# Socio Economic Feasibility and Eco-Restoration of River Coovum, India

S.Bharathidasan, T.K.Krushnadesikan, S.Kandasamy, and A.Abdul Rahman

***Abstract***---The River Coovum runs in the heart of Chennai city where sewage, biomedical and industrial wastes are discharged resulting in the accumulation of sludge in the bottom and this results in variable environmental parameters. A survey was undertaken on the point of pollution and a site near Mogappair was selected in view of luxurious growth of water hyacinth. The sewage waste was collected, treated and used for kitchen garden. A pilot plant of $1m^3$ capacity was installed along with the $1m^3$ capacity fermentation plant, this facilitates more production of biogas in terms of usage time. Water hyacinth was collected from the river bed and used as a raw material. Before water hyacinth was charged into the biogas plant, fermented cowdung was used to produce anaerobic bacteria. This helped to sustain the bacterial biomass production and the fermented *Eichhronia* sp slurry was introduced and the gas production was monitored. The produced biogas was used as heat and light energy sources. The sludge generated from the biogas plant was used as manure for kitchen garden. This being a model pilot plant, it could be scaled up for social cause as one of the cost effective methods to clean up the River Coovum.

***Keywords***---Bacteria, Biogas, Bio sludge, Cow dung, Eichhornia crassipes.

## I. Introduction

THE Coovum River is the most polluted river of India which ends in the city of Chennai draining into the Bay of Bengal. The river is considered to be the shortest classified river draining into the Bay of Bengal and is only about 72 km long. There are 14,972 families live in 65 slums along Coovum River and there has been huge accumulation of solid waste in the form of bio-sludge. Sewage sludge contains sodium chloride and urea as major constituents, and with macronutrients such as calcium, potassium, magnesium sulphate and phosphate as minor constituents. It is free from hazardous chemical compounds or heavy metals. The total quantities of nutrients in sewage sludge are significant (about 80% of the nitrogen, 50% of the phosphorous and 60% of potassium) when compared to the quantities of nutrients in the mineral fertilizers used in agriculture.

Since the Coovum river is found to be rich in nutrients and therefore eutrophication which results in the luxurious growth of water hyacinth in the selected places of Coovum River is considered as a resource.

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It is known that water hyacinth cause ecological and economic problems by impeding navigation and fishing activities, clogging irrigation systems and by creating a chronic shortage of dissolved oxygen harmful to the fauna and the flora (Malik, 2007). It was also noted that the water hyacinth covers on water bodies reduce the gaseous exchanges that take place at the air/water interface and reduce the photosynthetic activity of submerged plants by hindering the penetration of the sun rays.

The convention on Biological Diversity, in its article 8(h), recommends to prevent the introduction of exotic species and to control or to eradicate those that threaten ecosystems, habitats or species. The efforts expended by communities have not succeeded in eradicating the water hyacinth.

Experts in the field believe that it is difficult to eradicate the water hyacinth, since the conditions that allow it to proliferate are not being controlled (Howard and Matindi, 2003).

The cost of petroleum products and electricity are very high considering the low level of economic activity. Therefore, the utilization of Coovum bio-sludge and water hyacinth biomass to produce energy for modern use represents a good opportunity and a credible alternative.

It is reported that water hyacinth are very rich in hydrocarbons, which is essential for production of methane (The Times of India, Newspaper, February 11, 2013).

River Coovum has played a vital role in religious and historical events. In view of this it is now planned and executed to ecologically restore the river into a clean water way (The Hindu, Newspaper, June 17, 2014) as it was in the past.

## II. Objectives

(a) To environmentally upgrade the River Coovum by removal of sludge and use the sludge and water hyacinth to meet collective energy needs for generating biogas and to make use of the biogas for heating and lighting purposes for the domestic need of Coovum residents.

(b) To utilize the byproducts of biogas plant as manure for kitchen garden.

(c) To use the treated water for hydroponic system, for the development of non-edible plants and grass to provide the better livelihood of residents of Coovum.

## III. Methodology

### *3.1. Fabrication and installation of biogas plant:*

$1m^3$ syntax tank is the digester, while 750 l syntax tank is the gas holder. The digester is provided with facilities to

collect the over flowing liquid waste and also sludge at the bottom. The gas holder is connected with the gas burner for heating and lighting purposes. By using sludge pump, the bio-sludge in the bottom of Coovum River was removed and processed for producing biogas. Similar method was also employed for the water hyacinth which is present in an extensive area of Mogappair, Chennai as a source of raw material. The bio-sludge and water hyacinth were collected, processed and fermented and it was used to produce biogas. A pilot plant use the biogas for heating and lighting purposes and the by-product is formed as source of manure for kitchen garden.

*3.2. Bio gas production using Coovum bio-sludge:*

The bio-sludge accumulated in the bottom of the River Coovum was dredged using sludge pump. The collected sludge was processed to remove debris and other waste materials other than organic components of the sludge.

The processed bio-sludge was fermented using anaerobic bacteria. However, the anaerobes are already present in the bio-sludge, in which yield of biogas was not appreciable, hence the anaerobic bacteria was produced in order to have sufficient sustained anaerobic bacteria in the system.

Hence, the cow-dung was separately used in a container and after proper fermentation, it was added to the Coovum sludge and biogas production was monitored.

*3.3. Bio gas production using water hyacinth:*

Further, using the same process, the water hyacinth was collected from River Coovum and the yeast was added for fermentation, the fermented hyacinth was combined with the processed bio-sludge. By this process, the continuous biogas production was assured. Thus, the sludge and water hyacinth from the River Coovum were used as raw materials.

Water hyacinth *(Eichhornia crassipes)* (Mart.) (Solms) grows luxuriously in the Coovum, waste water as the raw material was utilized for biogas production irrespective of the fact that the plants are grown under higher or lower nitrogen concentrations and there is no necessity for the C/N ratio to be within optimum range for anaerobic digestion. Further, it is known that several biochemical characteristics of the substrates significantly influence biogas production besides the C/N ratio (Almoustapha *et al* 2009). From the result of the study it seems that the urban agriculture will become a new paradigm in food production and therefore the food security and it has the potential of creating this past economy in tens of millions of new jobs within the next decade.

*3.3.1. Biogas production during the dry, warm season (30-40℃)*

Figure 7 shows the kinetics of daily biogas production and the change in accumulated volume. Although biogas production began on day 8, the gas became combustible only as of day 11 when the fermented materials were charged. As of day increased to 48$^{th}$ day, daily production began to decline steadily. However, after noticing the decline in production of biogas, the exclusive fermenter of the tank was charged to enable for continuous production of biogas. Hence the total volume of biogas produced after 65 days was 151.4m$^3$, that is 2.6m$^3$/day.

*3.4. Treatment of Coovum waste water:*

The Coovum waste water (100litres) was collected and treated by using alum and microbes.

10 litres of waste water was taken in a container and the following procedure was adopted.

1. 10 l + 1% alum
2. 10 l + 1% bacterial biomass
3. 10 l + 1% bacteria cultured using cowdung
4. 10 l + 1% bacterial biomass + aeration
5. 10 l + 1% alum + 1% bacterial biomass
6. 10 l + 1% alum + 1% bacterial biomass + aeration

From the above experimentation, it was observed that the waste water treated with alum, then with bacteria followed by aeration product consisting the result (pH 6.5-8.5, BOD < 50ppm, COD < 300ppm) and this experimental procedure was followed for scaling up the treatment process.

*3.5. Development of Iron removal plant:*

A plain aeration with charcoal contact for oxidising the iron and slow sand filters (6-10 mm size) for iron removal with a gravel media up flow filter, a sand media down flow filter and clear water storage. This method was found to be economical besides easy to operate and maintain.

*3.6. Development of Hydroponics system:*

Hydroponics is the cultivation of plants in water rather than in soil. Nonetheless, it uses only 10% of the water used in conventional agriculture. Treated water containing nutrients is continually circulated in closed loop, and no water is lost through evaporation. Unlike conventional agricultural, plant nutrients cannot escape the system to contaminate water bodies.

A particular hydroponic system that does not employ any growing medium or solids. A thin film of oxygenated water flows at the bottom of an extruded plastic channel 100mm wide and 50mm high. Since the treated water filled with nutrients continually nourishes the roots of the fodder and the fodder is held in place by means of holes at the top of the channel. The productivity was found to be considerable.

*3.7. Treatment of sludge:*

Sludge from Coovum River was collected and treated. The following steps were followed for the treatment of sludge.

Pre-treatment removes all materials that can be easily collected from the raw sludge before this damage or clog the pumps. The tanks are used to settle sludge while grease and oils rise to the surface and are skimmed off. The settled sewage liquor was treated using aerobic biological processes.

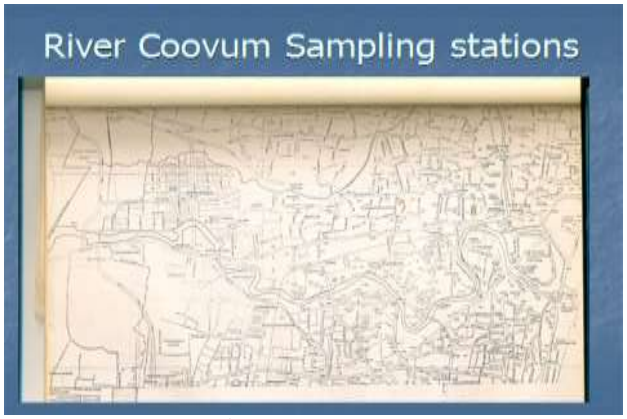

Fig. 1 River Coovum flowing chart showing sampling stations

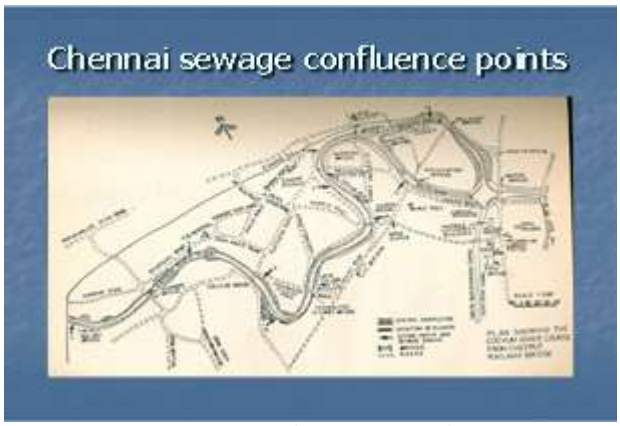

Fig. 2 The sewage confluence points of Chennai.

Fig. 3 The luxurious growth of water hyacinth in Coovum River at Mogappair,Chennai

Fig. 4 Water hyacinth is collected from River Coovum for biogas production

Fig. 5 Biogas producing plant of 1m3capacity

Fig. 6 1m3 biogas plant (L) and fermentation plant using water hyacinth (R) with lighting arrangement (fore ground) using biogas was installed in our college premises

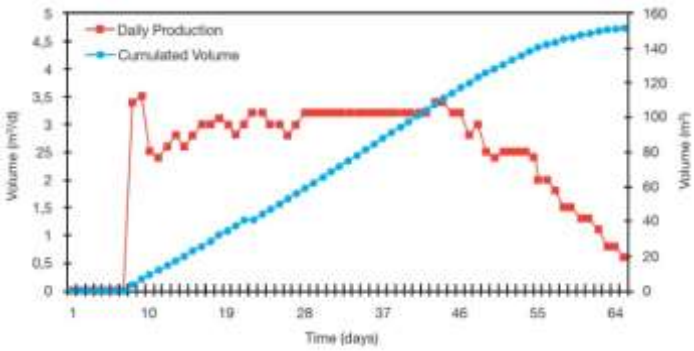

Fig. 7 Kinetics and cumulative production of biogas during warm season (30-40°C)

Fig. 8 The functioning of biogas plant using water hyacinth as raw material is explained

Fig. 9 Waste water is collected from Coovum River and treated

## IV. Benefits

### *4.1. Social Benefits:*

The treated sludge was also made into manure. The environmental issues such as mosquito menaces other breeding of flies are completely avoided. The cost of producing manure is economical and recovering the nutrients and converting the sludge into manure are done at the site itself in order to bring down the cost of the product and saves transportation of raw materials for processing. Manure being applied to kitchen garden, it is confirmed from the field trail that organic manure increases the productivity and enhances the soil health.

### *4.2. Economic Benefits:*

Apart from producing biogas energy, the digested sludge contains nutrients and it is economical to recover the nutrients for cultivation of plants. The cost of production of nutrients is economical when compared to the cost of fertilizer such as urea and super phosphate. The man power required for maintaining the biogas plant and converting sludge into manure are within the specified requirement.

The manure produced by this technology is non-hazardous, safe, ecologically sound and economically viable and increases the overall productivity of the product. There is no odour, neither it contains any pathogens and is considered an effective organic fertilizer in the form of manure.

### *4.3. Beneficiary Tie-up:*

The technology is standardised and will be transferred to the end users through Tamilnadu Drainage and Water Supply Department, NGO's and Women Self Help Group. The residents of Coovum will be involved in the project as beneficiaries for overall ecological development.

## V. Conclusion

### *5.1 Outputs from the project:*

The Coovum bio-sludge and water hyacinth provide energy source as bio gas is used for heating during day light and light during night. Thus removal of sludge in course of time improves water quality and environmental hygiene. When the bio-sludge was dredged, the water flow was found to be increased without stagnation and this pave way for navigation in future..By utilizing the sludge as a source of bio energy there could be an improvement in the socio economic condition of the residents of Coovum. Utilizing treated waste water for fodder development and the digested sludge as manure are the outcome of the project.

## Acknowledgement

We are thankful to our chairman MJF. LN. LEO MUTHU, Mr. SAI PRAKASH LEO MUTHU, CEO, Dr.C.V.JAYAKUMAR, Principal, Dr.A.RAJENDRA PRASAD, Dean R&D of our college for providing us necessary infrastructure facilities at Sri Sai Ram Engineering College and for their constant help, guidance and encouragement received are gratefully acknowledged

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