

STRATEGIES FOR THE SUSTAINABLE MANAGEMENT OF RIVER VAIGAI IN MADURAI CITY LIMIT

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Abstract

Water is the necessary factor for surviving in the world for each and every human, animal and plant. Water is the essence of life, sustaining every human being on this planet. Without water, the world will simply be with no plants, no animals and no humanity. Nowadays water has become a crisis factor. This is playing a crucial role in our humanity. It is the time to get water from the nature and it is obvious that we get water from nature only. But water bodies in our Madurai city had been depleted in the due course of time. With the monsoon playing hide-and-seek, the drinking water situation is turning chaotic and many parts of the Madurai city are not getting proper water supply. This issue has been discussed in the city councillor's meet and concluded that the action of mixing sewage in the river Vaigai is the main reason for drinking water supply being erratic. So on the way of thinking how to recover these sources, the study is started by taking the River Vaigai as the area of interest, as it is the major source for the city. The need of the hour is to plan some sustainable strategies to recover River Vaigai from being polluted. The study has analyzed the present scenario with the past and with the rivers which has similar characteristics of River Vaigai. The study is being concluded by proposing various plans to recover River vaigai through the principles and strategies followed in River

Hudson (USA) and River Sabarmati (INDIA).

I.INTRODUCTION

Environment is a part of our life. It is the duty of mankind to use the resources in wise manner to prevent the degradation or resources. Even though water is a renewable resource, the quality and quantity once gets affected, it is highly expensive to retain back. In Tamil Nadu most of the farmers have utilized the ground water at the maximum for irrigation. It is mainly because of irregular management of water resources.

Rivers are the main sources of fresh water supply to the community. But now-a-days those rivers are also getting degraded day by day due to the intervention of human as well as industrial activities. Such practices must be avoided to protect the naturally gifted water resources like river water. Because clean and healthy rivers are the life blood of our communities and are vital to our health, safety, and quality of life. Rivers and streams offer endless recreation opportunities, including swimming, fishing, boating, hiking, and wildlife- watching. Whether you need exhilaration, solitude, a much- needed break from the daily grind, or just a pleasant place for a family float or picnic, there's a river out there, beckoning you to come out and play. From the home lands of native Americans to our earliest settlements, explorer routes, and battlefields, to the evolution of music, literature, and art – our nation's culture and heritage is written in the currents of our rivers. Think of Mark Twain on the Mississippi, or Lewis and Clark following the Missouri and Columbia rivers as they travelled west. Our rivers connect us to the past, and the future. So

such an adorable water resource so called as rivers must be protected and kept clean for the uninterrupted water supply. We selected River Vaigai as our project area having the idea of doing some beneficial activities to the surroundings in which we are living and getting benefits out of it.

River Vaigai is originated in the Periyar Plateau of the Western Ghats which is situated on the Eastern slopes of the Varushanadu hills. The famous 'Temple City' – Madurai, one of the ancient cities in region of Pandyas is located on the banks of river vaigai. River Vaigai extends to a distance of approximately 258 kilometers with a drainage basin of 7,031 square kilometers.

The Vaigai basin is one among the 12 basins lying between the Cauvery and Kanyakumari and its course extends till Ramnad.

According to certain reports, it is observed that the basin of river vaigai comprises - Hard crystalline rock masses and Metamorphosed rocks. These types of rocks are basically associated with charnockites and pink granites. The metamorphosed rocks are formed during the Archaean age and they include cordierite, quartzites, granulites, sillimanite bearing gneisses, etc.

A. Profile of the Study Area

- Madurai one of the ancient cities in the Pandya Nadu region is located on the banks of River Vaigai.
- Originated in the Periyar Plateau of the Western Ghats. Situated on the Eastern slopes of the Varushanadu hills.
- 258 kilometres long with a drainage basin of 7,031 square kilometers.
- The Vaigai basin is one among the 12 basins lying between the Cauvery and Kanyakumari.
- Finally, the Vaigai River discharges into Ramnad big tank and some other tanks in the surrounding areas of the Madurai district.

B. Water Resource Department

In the process of modernization, the following works are likely to be taken up by water Resources Department

- 1) Rehabilitation and Modernization of irrigation tanks such as Sluice reconstruction, Weir reconstruction, strengthening the tank bund.

- 2) Construction and Reconstruction of Anicuts.
- 3) Strengthening the Riverbanks.
- 4) Rehabilitation of the Surplus Course.
- 5) Construction of open wells, tube wells and recharging shaft.

C. Geology

According to some reports, it is estimated that the Vaigai River basin comprises:

- Hard crystalline rock masses.
- Metamorphosed rocks.

These types of rocks are basically associated with charnockites and pink granites. The metamorphosed rocks are formed during the archaean age and they include cordierite, quartzites, granulites, sillimanite bearing gneisses, etc.

D. Existing Status of Water Supply System in Madurai

- The groundwater table has shown a progressive decline over the years in Madurai due to various factors. The major factor is the demise of its water bodies, from where concrete structures have sprouted. The disappearance of water carriers and encroachment of the surviving water bodies have ensured that there is inadequate percolation of rainwater.

- At present, an estimated 50 to 60 million litres of waste water is generated in the city daily. A major portion of this water is either let into the ground or the Vaigai or subjected to improper treatment at inadequate facilities. There are even reports of sewage water getting mixed up with drinking water in areas like Karpaga Nagarin K. Pudur. Till the ongoing underground drainage work is completed and the water treatment plants start functioning, the quality of groundwater is going to be abysmally low.

- According to the study, the highest level of TDS (against the desirable level of 500 milligrams per litre) is in Industrial Estate, Kappalur (4,400), followed by K. K. Nagar (2,970), Avaniapuram (2,580), Villapuram Housing Board (2,430), Tirupparankundram (2,060) and New Vilangudi (2,010). Beyond 500 milligrams, water can cause gastrointestinal irritation.

E. Geography and Climate

Madurai is located at 9.93°N 78.12°E. It has an average elevation of 101 meters. The city of Madurai lies on the flat and fertile plain of the

river Vaigai, which runs in the northwest-southeast direction through the city, dividing it into two almost equal halves. The Sirumalai and Nagamalai hills lie to the north and west of Madurai. The land in and around Madurai is utilized largely for agricultural activity, which is fostered by the Periyar Dam. Madurai lies southeast of the western ghats, and the surrounding region occupies the plains of South India and contains several mountain spurs. The soil type in central Madurai is predominantly clay loam, while red loam and black cotton types are widely prevalent in the outer fringes of the city. Paddy is the major crop, followed by pulses, millet, oilseed, cotton and sugarcane. A study based on the data available with the Indian Meteorological Department on Madurai over a period of 62 years indicate rising trend in atmospheric temperature over Madurai city, attributed to urbanization, growth of vehicles and industrial activity. The maximum temperature of 42 °C for the decade of 2001 – 2010 was recorded in 2004 and in 2010.

F. Agriculture

- Small Farmers :58,716
- Marginal Farmers :2,05,771
- Laborers :4,01,867

Total Farming Population : 6,66354

G. Progress on Vaigai River Pageant Project

Great news and progress on the Vaigai River Restoration Pageant Project, an international collaboration and social action art project to raise awareness and restore the Vaigai River in Madurai, India that is in a severe crisis due to pollution, waste dumping, and the drying effects of climate change. The Partner and Sponsor is Dr. Geeta Mehta, President of Asia Initiatives and Professor of Urban Studies and Architecture at Columbia University, just returned from important meetings for the project throughout India. While Geeta was in Madurai DHAN Foundation scheduled the Vaigai River Stakeholders Meeting which went very well and there is a lot of enthusiasm and support from the community for the project. They also confirmed the VRRPP workshops will be hosted and sponsored by the Thiagarajar College of Engineering and Architecture in Madurai.

The Tata/DHAN Academy has requested the workshop series, so we may run the full semester of workshops there as well. Geeta has also offered to develop a 1-2 credit course on the Vaigai River for the Thiagarajar College to be taught by their Professor Chandran. This project is based in these academic institutions and will engage students, community stakeholders, and numerous local folk artisans and performers.

II. NEED FOR THE STUDY

With the monsoon playing hide and seek, the drinking water situation is turning chaotic and many parts of the Madurai city are not getting proper water supply. This issue has been discussed various government meetings and concluded that the action of mixing sewage in the river Vaigai is the main reason for drinking water supply being erratic. Other problems such as Depletion of water bodies, dumping of industrial and domestic waste, burning of garbage as a part of waste disposal are also the reasons behind the water scar city in Madurai.

III. OBJECTIVES OF THE STUDY

The study aims at the following objectives:

- 1) To assess the current status of river Vaigai in the Madurai city limit.
- 2) To investigate the environmental and social issues for the degradation of the river.
- 3) To propose the sustainable strategies for the management of river Vaigai in the urban stretch.

IV. METHODOLOGY OF THE STUDY

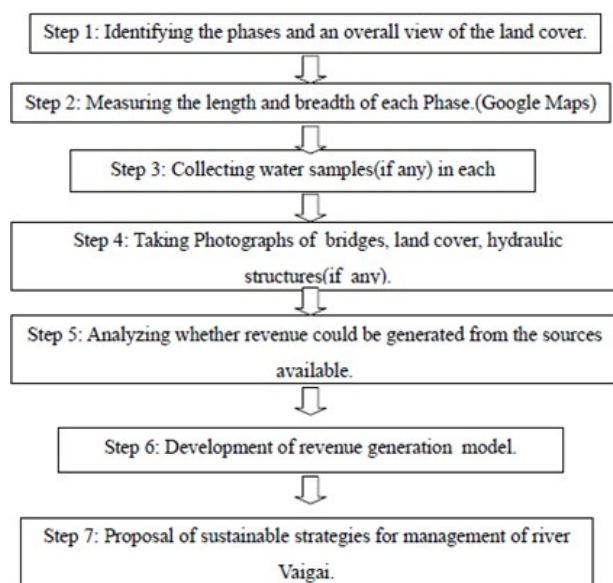


Fig. 1. Methodology Flowchart

The entire stretch of Vaigai river has been divided into 7 phases which is running across Madurai urban city limit. The following are the different phases

1. Phase 1: Vaigai river Bypass bridge AH43 – Bypass road bridge.
2. Phase 2: Bypass road bridge – Arapalayam, Aruldasupuram bridge.
3. Phase 3: Arapalayam Aruldasupuram bridge – Vaigai river railway bridge.
4. Phase 4: Vaigai river railway bridge – Poondhotam – Kalpalambur bridge.
5. Phase 5: Kalpalambur bridge – Albert Victor bridge.
6. Phase 6: Albert Victor bridge – Teppakulam Anna Nagar bridge (PTR bridge).
7. Phase 7: Teppakulam Anna Nagar bridge – Airport - Mattuthavani ringroad.

V. RESULTS AND DISCUSSIONS

A. Analysis of Phase -1

The Phase-1 starts from Vaigai river Bypass bridge AH43 to Bypass road bridge. The total length of the Phase-1 is 7.38 Km. The average width of the river bed in Phase-1 is 0.176 Km. Hence, the total computed area of Phase-1 is 1.30 Sq. Km. The majority of the plantation observed in the land of Phase-1 is Prosopis Juliflora. Prosopis Juliflora is commonly known as 'Veli Karuvelam' which is a major threat to the water conservation.

B. Analysis of Phase -2

The area of Phase-2 ranges from Bypass road bridge to Arapalayam, Aruldasupuram bridge. The total length of the river bed in Phase-2 is 0.96 Km. The average width of the river bed in Phase-2 is 0.30 Km. The total computed area of Phase-2 is 0.299 Sq. Km. The majority of the plantation observed in the land of Phase-2 is Prosopis Juliflora. Water samples were collected from the phase 2.

C. Analysis of Phase -3

The area of Phase-3 ranges from Arapalayam, Aruldasupuram bridge, Vaigai river Railway bridge and Poondhotam. The total length of Phase-3 is 1.11 Km. The average width of Phase-3 is 0.27 Km. The total computed area of Phase-3 is 0.30 Sq. Km. The majority of the plantation in Phase-3 is Prosopis Juliflora.

D. Analysis of Phase -4

The area of Phase-4 ranges between Vaigai river bridge, Poondhotam, and Kalpakkam bridge. The total length of Phase-4 is 1.13 Km.

The average width of Phase-4 is 0.23 Km. The total area of Phase-4 is 0.269 Sq.Km. There are no notable plantations in this region

E. Analysis of Phase -5

The area of Phase-5 ranges from Kalpakkam bridge to Albert Victor bridge. The total length of Phase-5 is 0.097 Km. The average width of the river bed in Phase-5 is 0.27 Km. The total computed area of Phase-5 is 0.026 Sq.Km. There are no water and no notable plantation in Phase-5.

F. Analysis of Phase -6

The area of Phase-6 ranges from Albert Victor Bridge to Teppakulam Anna Nagar Bridge (PTR Bridge). The total length of Phase-6 is 2.90 Km. The average width of Phase-6 is 0.18 Km. The total computed area of Phase-6 is 0.55 Sq.Km. There are mild plantations of Prosopis Juliflora in Phase-6.

G. Analysis of Phase -7

The area of Phase-7 ranges from Teppakulam Anna Nagar Bridge, Madurai Airport, Mattuthavani Ring Road Bridge. The total length of Phase-7 is 2.21 Km. The average width of Phase-7 is 0.22 Km. The total computed area of Phase-7 is 0.49 Sq.Km. The major plantation in this phase is Eichhornia Crassipes. Eichhornia Crassipes is commonly known as Water Hyacinth.

H. River as a Source of Revenue

The way we humans make use of our rivers cannot be separated from discussions about ecology. We are, after all, part of the river ecosystem. In fact, our influence on the river ecosystem is much greater than that of any of what we call key stone species.

- The ways by which river is considered as a resource: Fishing and Hunting, Transportation, Power, Mining, Drinking, Irrigation, Waste Disposal, Enjoyment, Plantations Available, River Sand

1) List of Usable Resources in River Vaigai:

1. Drinking:

"Water quality has become a major concern due to ever increasing human developmental activities"

- Representative of three samples were collected from Kunnur (Theni Dt), Vaigai dam and Annai patty to assess the quality of water in river Vaigai.
- The samples were analyzed for various water quality parameters such as Ca, Fe, Na,

Cl, K, SO₄ and PO₄ following the guidelines of WHO and ISI.

- The results of the concentrations of various parameters are in accordance with the standards with WHO and ISI.
- All the parameters like Ca, Fe, Na, K, Cl, SO₄, PO₄ and SiO₂ in river water at all the three places were within maximum permissible limit.
- Hence Vaigai river water is suitable for drinking and irrigation purposes.
- It provides water for the Madurai district and the Dindigul district.
- It provides drinking water to Madurai and Andipatti.
- As river vaigai's water is used to drink, it's said to be source of revenue

2. Irrigation:

Dams - irrigating areas, Madurai District:

- Periyar
- Vaigai
- Sathiyar

3. Farming Population (as per 2001 census):

- Small farmers -58,716
- Marginal farmers -2,05,771
- Agricultural Laborers -4,01,867
- Total farming population -6,66,354.

4. Periyar - Vaigai Ayacutareas:

- Double crop : 13860Ha.
- Single crop : 49500Ha.
- Not only river Vaigai contributes to the irrigation of Madurai district, but it serves to be a driving force for fulfilling the purpose.
- As River Vaigai helps in irrigation process it's also a source of revenue generated.

5. Sewage Disposal:

Methods of disposing sewage effluents:

- Dilution (Disposal in water)
- Effluent Irrigation (Disposal on Land).

6. Dilution (Disposal on water):

- The discharged sewage in to the river water in due course of time is purified by a process named as SELF PURIFICATION PROCESS of natural waters.
- But however sewage must be given minimum amount of treatment before being it into river water.
- It depends upon a factor named as Dilution factor.
- The purification forces depend upon two factors: Physical factors:
 - i) Dilution and Dispersion.

ii) Sedimentation. iii) Sun light.

Chemical Factors:

i) Oxidation. ii) Reduction.

- On saying that sewage can be diluted in to the river we can come to a conclusion that River Vaigai is a resource of disposing sewage.
- We come to this conclusion because the Self-purification velocity of river Vaigai is more comparatively.

7. River Sand:

- Although mining river sand is made illegal in some parts across the country, Sand mining can be done through legal provisions to a certain limit.
- When sand mining is done within the prescribed limits as per the government has released for each and every area in our country it outweighs the disadvantages of sand mining. The following are the three advantages of sand mining:
 - Flood mitigation by providing more storage capacity.
 - Construction Material e.g. Fine Aggregate supply, etc.
 - Revenue in return for the sand supplied for the government.

I. Revenue Generating Model

The Plantations available in the entire river bed crossing the Madurai urban stretch are:

- Prosopis Juliflora.
- Water Hyacinth.

Uses of Prosopis Juliflora:

- The fire wood it supplies.
- The coal it generate under ground.
- Rates of Firewood generated from prosopis juliflora:
 - Rs.2400/ton (*in local markets).

Uses of Water Hyacinth:

- Used to make paper by paper industry.
- Because of its extremely high rate of development, water hyacinth is an excellent source of biomass.
 - One hectare of standing crop thus produces more than 70,000 m³ of biogas.
 - One kg of dry matter can yield 370 liters of bio gas, giving a heating value of 22,000 kJ/m³.

1) Eradication of these Plantations:

1. Prosopis Juliflora:

- Cut it for firewood: Labor wages: Rs.350/day (8 hours to be worked /day).

- Uproot it by Backhoe Loader: Rates Charged: Rs.700/Hour. (including Diesel allowance).

2. Water Hyacinth:

- Chemical control: Application of herbicides for controlling water hyacinth.
- Physical control: Performed by land based machines such as bucket cranes, drag lines, or by water based machinery such as aquatic weedharvester.
- Biological control: Insect Megamelus scutellaris was released by the Agricultural Research Service as a biological control for the invasive species Eichhornia crassipes, more commonly known as waterhyacinth.

J. Implementing the Successful Transformation Projects in River Vaigai

The above two transformation projects have been taken as a model and analyzed how far the proposed ideas and strategies can be implemented in this case. The rivers taken as a model for consideration are: Hudson River, United States and Sabarmati River, India. The similarities and differences between the considered rivers and river Vaigai is mentioned in the table above.

S.NO.	PARAMETERS	RIVER HUDSON	RIVER SABARMATI	RIVER VAIGAI
1	Country	United States	India	India
2	State	New Jersey	Gujarat	Tamil Nadu
3	Length	507 KM	371 KM	258 KM
4	Width	3.3 KM	0.6 KM	0.5 KM
5	Area	1650	222	129
6	Type of Climate	Humid Continental	Diverse Conditions	Hot, Dry – 8 Months Moderate – 4 Months
7	Temperature	Max – 102°F Min – 4	Max – 120°F Min – 38.4°F	Max – 102°F Min - 73°F
8	Water Flow	Maximum to Minimum	Moderate to Minimum	Minimum
9	Types of Contamination	Polychlorinated Biphenyl, Dichloro Diphenyl Tricholoroethane	Escherichia Coli	Synthetic Detergents, Phosphate Contaminants, High TDS
10	Condition of the River Bed	Worse	Worse	Worse

Fig. 2. Way to apply the Successful Strategies

VI. CONCLUSION

In this study environment issues have been observed in the River Vaigai, and suggested various sustainable strategies for the management of the river bed. The following are the conclusions of this study.

- 1) To educate the people by conducting various environmental protection and developmental oriented awareness programs.
- 2) To protect the environment by different ways of increasing the level of ground and surface water by planting the trees.
- 3) To emphasis the efficiencies of natural resources like water, land, sky, gas, and air by proper training regularly to the public through the specialists.
- 4) To insist government sectors, private sectors, youth volunteers and the well-wishers of environmental and ecological scientist for the overall protection of sustainable environment by implementing proper planning and execution of the practices in our day to day life.
- 5) To insist the governmental and non-governmental organizations to stop polluting the river bed in the name of waste disposal.
- 6) Regular inspection and rigorous punishments should be carried out to protect the river bed.
- 7) The corporation has to spare some of its fund for the sustainable maintenance of the river.
- 8) To convert the unusable things in the river bed to useful revenue generating things.

Various other strategies are also available but these steps haven't been linked together to streamline the activity in proper way for the better output.

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