Effect of Urbanization on Meenachil River

M. Aswathi1  Nabam Solen2  Raichu Peter Abraham3  Sange Tsering Bapu4  E. Winni5

1,2,3,4 & 5 UG Student, Dept. of Civil Engineering, Mar Athanasius College of Engineering, Kerala.

Abstract—Meenachil river, formed by several streams originating from the Western Ghats, is flowing through the heart of Kottayam which is 78 km long and has a watershed area of 1208.11 km². This study deals with the different physiochemical characteristics of Meenachil river on its present condition. From the study on the present condition of the river it has been identified that, there are a few serious issues affecting the environment of the basin. Various experiments were conducted on the physical as well as chemical characteristics. From the results obtained, variations in the parametrical values from the Standards marked the need for preventive measures. The paper concludes with certain remedial suggestions for the maintenance of water quality of the river.

Keywords—Meenachil river, Urbanization, Pollution, BOD, Water Quality Index, Standards, Parameters, Remedies.

I. INTRODUCTION

Rivers play an important role in the assimilation and transport of domestic and industrial waste water, which represents constant pollution sources and agricultural runoff which is temporal and commonly affected by climate. Thus the rivers are highly vulnerable to pollution. Therefore it is important to control water pollution, monitor water quality of river basins and to interpret the variations in water quality parameters.

The water quality of river depends on various parameters that are influenced by a wide range of natural processes and human interference. A river may be characterized by morphometric, hydrologic, chemical, biological and sedimentological parameters depending upon its origin, stage of development, hydrogeology and climate. Each river develops its own response to these combined factors along with anthropogenic interferences resulting into major variations of water quality on both time and space. The physico-chemical parameters of a river basin provide first hand information about the pollution status of the basin.

Various methods have been adopted to assess the surface water pollution which includes water quality analysis and estimation of water quality index. Multivariate statistical analysis has been used successfully in hydrochemistry for many years. It allows deriving hidden information from the data set about the possible influence of environment on quality water.

II. LITERATURE REVIEW

Tingpang Ouyang Zhaoyu Zhu and Yaoqiu Kuang(2006) studied the impact of urbanisation on river water quality in the Pearl River delta economic zone, China.

Vikram Bharadawaj, Dhruv Sen Singh and A.K Singh (2009) conducted a study for the assessment of water quality of the Chhoti Gandak River using principle components analysis, Ganga Plain, India. Water samples have been collected from a part of Chotti Gandak River along different points and analysed for various water quality parameter during dry and monsoon periods. Effects of individual waste, municipal sewage and agricultural runoff on Sunamganj portion of Chotti Gandak River, which is significant due to the presence of two major industries – a paper mill and a cement factory. The river was found to be turbid in the monsoon season.

American journal of scientific and industrial research(2010) (Charmine Jerome and Anitha Pius) conducted a study of evaluation of water quality index and its impact on quality of life in an industrial area in Banglore, South India. The deterioration in the ground water quality due to geogenic and anthropogenic activities have drawn great attension as it is the major alternate source of domestic and drinking water supply. The WQI value is ranged from 49.2-409.94

III. STUDY AREA

Meenachil river which is one of the important river of Kottayam district in Kerala, emerges from Western ghats, flows through the taluks of Meenachil, Vaikom and Kottayam. This river has a total length of 78 km and has a catchment area of 1272 sq.km. The entire Meenachil watershed area geographically lies between 90°25' N to 90°55'N latitude and 76°30' E to 77°00' E longitude. The river has a total annual yield of 2349 million cubic meters and an annual utilisable yield of 1110 million cubic meters. The river has 47 sub watersheds and 114 micro watersheds. The river has 38 tributaries including major and minor ones.
A. General

Water samples were collected from ten different locations of Meenachil river basins and were analyzed for various water quality parameters. The methods adopted in this study include Collection of water samples, water quality analysis and estimation of water quality index. The samples were analyzed for various physical as well as chemical parameters like pH, alkalinity, acidity, residual chlorine, DO, BOD, total hardness, chloride and sulphates at selected sampling station which can help to identify the extent of pollution. Sampling and water analysis were carried out as per the standard procedures for the examination of water and wastewater (ALPHA, 2005).

B. GPS survey

A handheld GPS receiver without differential correction is used for locating the coordinates of different sampling stations. The principle behind GPS is the measurement of the distance(or “range”) between the satellites and receiver. It works something like this: If we know our exact distance from a satellite in space, we know we are somewhere on the surface of an imaginary sphere with a radius equal to the distance to the satellite radius. If we known our exact distance from two satellite, we know that we are located somewhere on the line where the two sphere intersect. And, if we take a third and a fourth measurement from two more satellites, we can find our locations. The GPS receiver processes the satellite range measurements and produces its position.

C. Collection of water samples

Water samples were collected from 10 different locations of Meenachil River. Water samples collected in pre-cleaned non-reactive plastic containers and were transported to laboratory. The simplest and most common dip sampling method is used, in which the sample container is dips into the river water.

- **Sampling methods**
  - General equipment - Use only specified equipment, including sample containers and other sampling equipment. In particular, laboratory supplied containers must be used as specified. The use of alternative sample containers or sampling methods will make the sample unusable and the laboratory may reject incorrect samples.

- **Equipment calibrating, cleaning and maintenance**
  - Ensure that sampling equipment is clean and is maintained in good working order before use and at the end of sampling. Generally, you will not need to clean sampling equipment thoroughly, apart from rinsing it at the end of each sampling trip. However, if a site that is particularly contaminated (e.g. if there is an algal bloom, or the site smells strongly of hydrocarbons, sewage or something else) is sampled the equipment must be rinsed prior to sampling at the next site; or ideally leave that site until the end of the sampling run in order to avoid cross contamination with subsequent samples. Equipment must be cleaned periodically to prevent a build-up of dirt.

To do this:
1. Rinse the equipment well in tap water
2. Clean with de-con 90 (a phosphate free detergent)
3. Rinse well with tap water
4. Rinse three times with de-ionised water
5. Allow it to dry.

Ensure all field measurement instruments are fully calibrated before starting sampling (pre-field) and
again once all sampling has been completed (post-field). The results of the calibration should be marked in a 
calibration information box on the field observations form (FOF).

It is preferable to use new, pre-cleaned sampling containers to store samples, but if existing ones need to 
be re-used, rinse with detergent (De-Con 90 is recommended), then very thoroughly wash and rinse with 
deionized or distilled water. Other washing solvents include dilute hydrochloric acid (HCl) (0.1 moles/L 
HCl), which can remove metal contaminants, and dilute ethanol or methanol (5% in distilled water) which 
can be used to remove organic contaminants (only important if sampling for metals or organic parameters).

Important

It is essential that the containers are washed and rinsed very thoroughly with deionized or distilled 
water after using any of the above described solvents to remove completely any trace of these solvents 
before sampling commences. The deionized/distilled/filtered water unit must be checked to ensure it is 
well cleaned and maintained and serviced regularly. Be aware that when using deionized or distilled or 
filtered water for blanks and for rinsing equipment, that this water is free of contaminants.

D. Water quality analysis

Water quality models have proved to be powerful tools in the water resources management as they can 
corporate the complexity of the relevant process in the water body into a utilitarian form for management 
consideration.

Periodic water sampling are done from the different locations of river basin and analysis were carried 
out as per the standard procedure. Water temperature and pH, are measured at site. Concentrations of 
nitrate and phosphate are analyzed using Spectrophotometer. Concentration of heavy metals in surface 
water can be estimated using an Atomic Absorption Spectrophotometer (AAS). Atomic absorption 
spectroscopy (AAS) is a spectro analytical procedure for the qualitative and quantitative determination of 
chemical elements employing the absorption of optical radiation (light) by free atoms in the gaseous state. 
Concentration of chlorides, hardness, sulphates etc can be estimated by standard titration process.

E. Estimation of water quality index

Water quality is a measure of the condition of water relative to the requirements of one or more biotic 
species and or to any human need or purpose. It is most frequently used by reference to a set of standards 
against which compliance can be assessed. The most common standards used to assess water quality related 
to drinking water, safety of human contact and for the health of ecosystems.

Water quality index may be defined as a rating reflecting the composite influence of a number of water 
quality parameters. It provides a convenient means of summarizing complex water quality data. The index 
generally produces a number between 0 and 100.

The main objective of water quality index is to turn complex water quality data into information that is 
understandable and useable by the public. It gives the public a general idea of the possible problems with 
water in a particular region. The indices are among the most effective ways to communicate the 
informations on water quality trends to the public or to the policy makers and water quality management.
For calculation of WQI, selection of parameters has great importance. Since selection of too many 
parameters might widen the quality index and importance of various parameters depends on the intended 
use of water , twelve physico chemical parameters namely pH, Total hardness, DO, BOD, Change in 
temperature were used to calculate WQI.

\[
WQI = \sum_{i=1}^{n} \left( \frac{q_i \cdot w_i}{w'_i} \right)
\]

Where, WQI stands for water quality ; qi = 100 * V/Si , is the quality index.V is the measured value of the 
parameter and Si is its permissible value, Wi is the weight coefficient ( unit weight) recommended by WHO 
is given in table 3.1. Water quality index and its descriptions are given below.

<table>
<thead>
<tr>
<th>Water quality index</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 50</td>
<td>Bad</td>
</tr>
<tr>
<td>Between 70 and 50</td>
<td>Medium</td>
</tr>
<tr>
<td>Greater than 70</td>
<td>Good</td>
</tr>
</tbody>
</table>
V. RESULTS AND DISCUSSIONS

A. GPS survey

Locations of sampling stations were identified by conducting GPS survey in the study area is given in the table.

Table 2: Details of Sampling Points

<table>
<thead>
<tr>
<th>Sample Code</th>
<th>Denoted By</th>
<th>Sampling Points</th>
<th>Co-ordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A Moonnilavu</td>
<td>N9°44'58.97&quot;, E76°47'0.68&quot;</td>
<td>144 ft</td>
</tr>
<tr>
<td>2</td>
<td>B Payyanithotta</td>
<td>N 9°40'30.66&quot;, E76°49'56.16&quot;</td>
<td>259 ft</td>
</tr>
<tr>
<td>3</td>
<td>C Poonjar</td>
<td>N 9°40'25.44&quot;, E 76°48'48.18&quot;</td>
<td>248 ft</td>
</tr>
<tr>
<td>4</td>
<td>D Aruvithura</td>
<td>N 9°41'36.25&quot;, E 76°46'21.03&quot;</td>
<td>214 ft</td>
</tr>
<tr>
<td>5</td>
<td>E Edathilkadavu</td>
<td>N 9°41'30.85&quot;, E 76°46'13.19&quot;</td>
<td>216 ft</td>
</tr>
<tr>
<td>6</td>
<td>F Vattolikkadavu</td>
<td>N 9°42'1.95&quot;, E 76°43'49.79&quot;</td>
<td>383 ft</td>
</tr>
<tr>
<td>7</td>
<td>G Assisi</td>
<td>N 9°41'54.87&quot;, E 76°43'20&quot;</td>
<td>128 ft</td>
</tr>
<tr>
<td>8</td>
<td>H Tharappel</td>
<td>N 9°42'14.26&quot;, E 76°42'59.94&quot;</td>
<td>219 ft</td>
</tr>
<tr>
<td>9</td>
<td>I Mutholi</td>
<td>N 9°42'1.78&quot;, E 76°40'5.85&quot;</td>
<td>331 ft</td>
</tr>
<tr>
<td>10</td>
<td>J Cherpunkal</td>
<td>N9°41'50.21&quot;, E 76°8'53.91&quot;</td>
<td>286 ft</td>
</tr>
</tbody>
</table>

Table 3: Water Quality Index (WQI) of sampling stations

<table>
<thead>
<tr>
<th>Station Code</th>
<th>Water Quality Index (WQI)</th>
<th>Status of Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>52.18</td>
<td>Medium</td>
</tr>
<tr>
<td>2</td>
<td>48.65</td>
<td>Bad</td>
</tr>
<tr>
<td>3</td>
<td>45.00</td>
<td>Bad</td>
</tr>
<tr>
<td>4</td>
<td>51.94</td>
<td>Medium</td>
</tr>
<tr>
<td>5</td>
<td>44.72</td>
<td>Bad</td>
</tr>
<tr>
<td>6</td>
<td>48.98</td>
<td>Bad</td>
</tr>
<tr>
<td>7</td>
<td>51.12</td>
<td>Medium</td>
</tr>
<tr>
<td>8</td>
<td>50.73</td>
<td>Medium</td>
</tr>
<tr>
<td>9</td>
<td>49.69</td>
<td>Bad</td>
</tr>
<tr>
<td>10</td>
<td>47.68</td>
<td>Bad</td>
</tr>
</tbody>
</table>

As in the table, variations in the parametrical values will highly affect the water quality of the river, aquatic life as well as the population dependent on the river for their daily activities and hence it has to be controlled.

B. Remedial Measures

Some of the remedial measures unspecific of each parameter are:

Sewage should be treated before it is discharged into river or ocean. This is possible through modern techniques. Sewage is first passed through a grinding mechanism. Then it is passed through several settling chamber and neutralized with lime. Upto this stage the process is called primary treatment. The sewage still contains a large number of pathogenic and non-pathogenic organisms, and also sufficient quantity of organic matter. The neutralized effluents are sent to UASB (up-flow anaerobic sludge blanket). In this, the anaerobic bacteria degrade the biodegradable material present in the waste water. This removes foul odor and releases methane, which can be used elsewhere. In this system, the pollution load is reduced upto 85 percent. After this, water is sent to aeration tanks where it is mixed with air and bacteria. Bacteria digest the organic waste material. This is called biological or secondary treatment. Even after the treatment, water is not yet fit for drinking. The harmful microorganisms need to be killed. The final step (tertiary treatment) is, therefore, a disinfection process, to remove final traces of organisms, bacteria, dissolved inorganic solids, etc. For tertiary treatment, methods, such as chlorination, evaporation, and exchange absorption may be employed. These depend upon the required quality of the final treatment.

Apart from the above some of the following practices can also be adopted:
i. Waste food material, paper, decaying vegetables and plastics should not be thrown into open drains.
ii. Effluents from distilleries, and solid wastes containing organic matter should be sent to biogas plants for generation of energy.
iii. Oil slicks should be skimmed off from the surface with suction device. Sawdust may be spread over oil slicks to absorb the oil components.

A physical model (wind induced aerated system) for water purification was implemented which would be transferred to other sites, which are remote and have no access to electricity supply but can utilize wind energy. The water quality improvement through adoption of Photo remediation techniques using Vetiver system from post and pre analyses of the samples has showcased the effectiveness of this project. The river bank erosion at selected sites of the canal banks could be controlled by Riparian vegetation, bio-wall construction, and reducing the availability of suspended sediment load in the water body. Educating local people on how to maintain environment, sustainable utilization of local resources, improved water quality, improvement in bio diversity of the region etc.

VI. CONCLUSION

Water samples were collected from 10 stations and quality parameters were estimated. Water quality index was estimated. Following are the conclusions drawn from the study.

1. Water quality analysis shows that
   - pH varies from 6.57 to 7.1 with an average value of 6.58. Hence water becomes acidic in nature.
   - Hardness of water at Edathil kadavu and Mutholi is higher than other stations due to the effect of waste disposal.
   - Turbidity at Cherpungal is found to be greater than other stations is because of the detached leaves of rubber plantation at the bank and due to presence of muddy plants.
   - DO is found to be very less at Edathil kadavu. Edathil kadavu is located near market place, washing and bathing centre and a small drainage joins the river. Water is contaminated since DO is less BOD level is high at this place.

2. Water Quality index was estimated
   - Water quality index at most of the stations is found to be bad at stations, Assisi, Tharappel, Moonilav, Cherpunkal and Edathilkadavu.

REFERENCES

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