GEOGRAPHICAL ANALYSIS

RESEARCH ARTICLE

Toxicity Characteristics of Sewage Treatment Effluents: A Case Study of Vrishabhavathi River

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Abstract

The stream that has always been a reliable source of drinking water is now carrying a lot of treated and untreated domestic, industrial, and agricultural effluents from Bangalore's western suburbs. Due to the ease with which it is accessible in periurban areas, this contaminated water is used in agriculture, which leads to a variety of environmental problems in food chain pollution by heavy metals, which could accumulate and bio accumulate in human health issues. Water samples from the Vrishabhavathi River that surrounds it are subjected to extensive physicochemical characteristics and toxic heavy metal analysis. Most sewage treatment plants are not intended to remove micropollutants like pesticides, medicines, and nano-sized metals, which are a major problem for a sustainable human and ecological system. Instead, they are made to remove organic matter and nutrients from municipal sewage water. Because of the untreated pollutants in STP (sewage treatment plant) effluents, there are still environmental dangers even after contaminants have been removed by wastewater treatment methods In order to assess the efficacy of the wastewater treatment process in reducing toxicity and to determine the concentration of pollutants that may be harmful in STP effluents, this study conducted aquatic toxicity studies of untreated effluents and treated effluents in the Vrishabhavathi River. It is seen that from the groundwater sample results, there is no contamination when compared to surface water.

Keywords: Toxicity; Sewage treatment plant; Effluents; Contaminants

Introduction

A typical sewage treatment plant is made to remove organic matter and nutrients from municipal sewage water; it is not intended to get rid of micro pollutants like pesticides, medications, and nano-sized metals, which are primarily discharged from sewage treatment plants and are a major concern for ecological sustainability. Sediment and other pollutants are transported and dumped into the receiving water body as rainwater or melted snow flows downhill in the watershed. This study's objective is to evaluate the physical and chemical properties and level of metal contamination in the water of the Vrishabhavathi River. The stream that has always been a reliable source of drinking water is now carrying a lot of treated and untreated domestic,

industrial, and agricultural effluents from Bangalore's western suburbs. Due to its easy accessibility in periurban areas, this contaminated water is used in agriculture, which contributes to a number of environmental problems related to food chain pollution by heavy metals, which could lead to problems with human health. Water samples from the Vrishabhavathi River are collected at specific locations and subjected to thorough physicochemical parameters and toxic heavy metal analysis.

For those who lived on the other side of the river, the Vrishabhavathi river used to be a major supply of drinking water. This source has been affected by pollutants that have been released by domestic, agricultural, and industrial effluents. The western section of Bangalore, the largest and most polluted area of the watershed, is currently served by the river as a conduit for sewage and industrial effluents from a variety of enterprises. Both treated and untreated effluents, which may contain a variety of organic pollutants, hazardous heavy metals, etc., are sent to it by Bangalore Water Supply and Sewerage Board treatment facilities. In this regard, research is being done to ascertain the level of pollution and the concentration of heavy metals in the groundwater and the Vrishabhavathi River near Bangalore, where waste water is used to irrigate farmland.

Study Area

The Vrishabhavathi is a tributary of the Arkavathy River. It is located in southwestern part of Bengaluru. The river is located on 12°59'06"N latitude and 77°25'53"E longitude. Vrushbhavathi Basin is typical of the features of peninsular India in that it is made up of ridges, valleys and undulating terrain. Monsoon rainfall is substantial and the tanks and lakes can receive and contain substantial amounts of water from rains. Only thing is to de-clog the natural water flow routes and to restore the bunds of tanks and repair the spillways and put in place legal and administrative measures to preserve the interiors of tanks; free them from construction activities and launch suitable afforestation programs to contain soil erosion, improve the quality of subsoil water and raise if possible medicinal and ornamental trees so that Bangalore gains in its aesthetic appeal.

Statement of the Problem

Bangalore has grown haphazardly and ill-thought manners turning Vrishabahavathi watershed into filth, overcrowding, polluting, and waste dumping, which are deteriorating human standards of that locality. Market centers, commercial complexes, factories, companies, private and public institutions are producing the waste at a higher level. Inhabitants of Bangalore city are generating plenty of sewage and wastes by adapting western country's way of life and consuming packed goods. Hence, the detailed study of waste Vrishabahavathi watershed and its model is to be done so as to find solutions

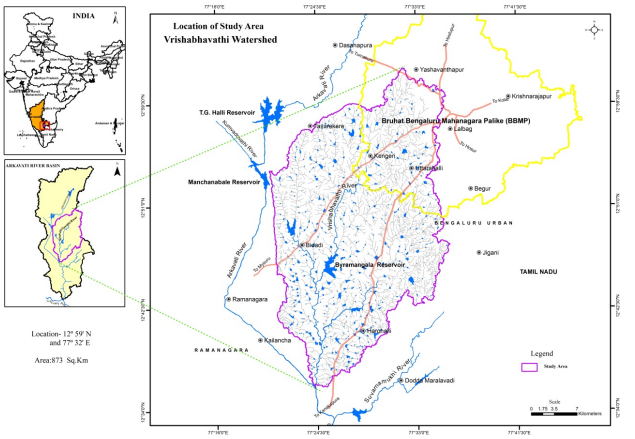


Fig. 1. Location map of Vrishabhavathi watershed

for the problems faced by the city. In the name of highlife and western-culture the Vrishabahavathi watershed has been targeted and in the process it has lost its originality. It is now threatening hazardous disease to the localities of the watershed. Hence, Vrishabahavathi has to be studied, planned and monitored so as to avoid possible threat in coming days.

Significance of the study

It is difficult to overstate the practical and scholarly significance of this work. Bangalore is a vital cog in India's engagement with the global economy; yet the pitfalls of its rapid change are obvious. Failure to ensure management of river valleys will harm the very assets which have forged the city's successes; namely, an amenable and attractive cityscape. A widely held view is that Bangalore is fast being transformed from India's 'garden city' to its 'polluted city'. As the city faces the burden of an ever-increasing number of houses, industries and commercial establishments in the process the Vrishabhavathi valley is targeted. Vrishabhavathi Valley is one that affects severely as it falls under industrial areas. The residues of rapid urbanisation can be seen in terms of slums, squatters and ghettoes scattered here and there in the Vrishabhavathi Valley, placing intense pressures on urban management. In the context of further city expansion, failure to deal with these issues will see the problems of central Bangalore migrate to the periphery

Objective

- Identification of green and blue spots in Catchments area for their sustainable growth.
- To prepare land use maps to understand the impact of urbanization, industrialization
- To suggest waste water treatment plants, check dams, wet lands

- Identification of dangerous zones of effluents release.

Database and Methodology

With the help of geoinformatics & GPS, the spatial data were traced out, that will generate a unique spatial database. A Dimensional Map is also created for the Vrishabhavathi Valley and through a combined methodology involving geoinformatics and on-the-ground survey work ('field analysis'), the key contributing factors to the loss of blue and green spots in the watershed can be identified.

ArcGIS and ERDAS Image Processing software will be used for analyzing and image processing. GPS (Global Positioning system) would be engaged to locate the boundaries of the objects. Following is the flow diagram that depicts the methods of work to be undertaken.

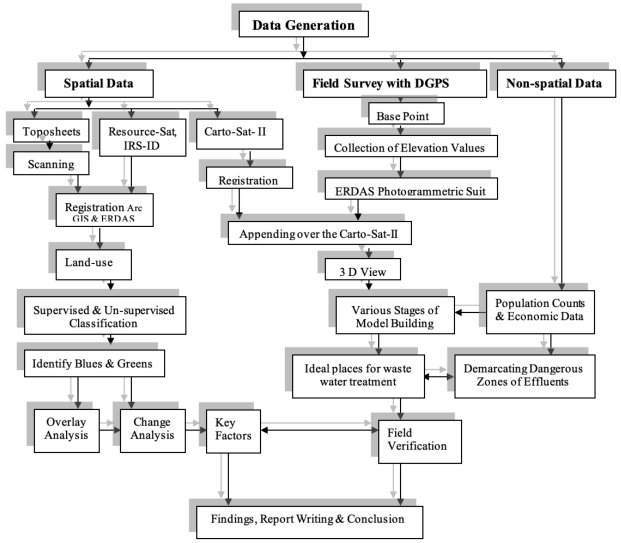


Fig. 2. Methodology: Flow Model

Results & Discussion

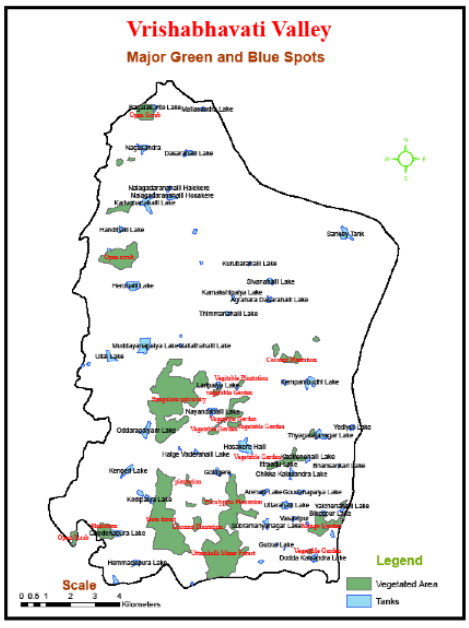
Correlation of Blue and Green Spots

Vrishabavati valley is one of the important valleys in Bangalore city. Its has a good vegetation and water bodies in previous years. Now we saw very less water bodies and vegetated areas because of many reasons to this condition. When the people move towards Bangalore and started living here it's create great problem of shortage of living places. Then people planned to cut the forest and acquire the lake areas to construct an apartments and buildings. Same way every year we losses few amounts of green and blue spots, not only loss but also a pollute all lakes in every year. In these few lakes are vanished and some of highly polluted with toxic and smelled water.

In this valley region we saw a good co-relation in between blue and green patches. Mainly in southern part of vrishabavati valley we found many lakes and vegetated area. It shows the importance of blue spots in development for green spots. In this valley region blue spots are increasing the recharge of underground water in surrounding areas, where good underground and surface water resource available in those areas we saw a good vegetation. In same way northwestern part of the valley also we saw a good amount of blue and green patches, it is also not in good condition.

In middle and eastern part of the valley very less lakes and vegetated areas are available, where very less lakes are found in that areas green places are also very less. These indication shows co-relation of the blue and green spots. In this area we already losses some lakes and few in vanishing stage some of converted in to a residential and play ground.

Vrishabavati valley lakes are not in good condition, all lakes are polluted with debris, toxic materials, chemical water and so on and few of already vanished. All lakes are wanted to treat or cleanness. Now the state government, BDA, BBMP and LDA are planned to thinking invest some amount to develop few lakes in these valley. We request to LDA and BDA to take action to clean and develop all lakes in this valley, not only develop but also a construct attracted park, boating, foot path around the lake and show very much interest to maintain and attract the people towards this lake and create a awareness in people mind to stop pollute and avoid waste materials added to the lake. In same time we request to forest department and BDA to plant more and more plant where waste land are found in the valley and beside roads and streets.



This study was carried out to find out the water shad to identify the major pollutant sources in Vrishabhavathi River. This river originates near the Southwestern end of Bangalore city. This valley is sub divided into 3 major regions for our interpretation. Those are:

1. The upper river valley region
2. Middle valley region
3. Lower valley region

The upper valley region

This upper valley is subdivided into industrial zones, residential and slums which are the source of pollutants. In the northern part major industrial regions are Tumkur road industrial region, Peenya, Yashvanthapura, Rajajinagar industrial regions are the major industrial regions. Within that Peenya Industrial region is creating more pollution, in this region almost all water body is degraded in these days Dasarahalli tank or Chokkasandra Tank is more polluted because of solid waste and chemical discharges by industries. Dasarahalli lake is completely affected due to industries of Peenya the dissolved Oxygen level is less than 30mg/ lts due to industrial effluents from this Industrial region and from nearby residence.

Another major region is Tumkur road industrial region this region is also affected the surrounding watershed areas. There 2 major slum areas I can see in the upper valley those are Dasarahalli and Leggere, this slums and the surrounding areas made this lakes as the dumping places of there urban waste. 2 lakes of Nelgadaranahalli as degraded very badly because of sewage-discharging ponds and garbage-dumping sites. Encroachment, siltation, weeds infestation is taking place in these entire water source, discharge of effluent both industrial and domestic are knelling the death for lakes. These are the major problems facing these regions.

Middle Valley Region

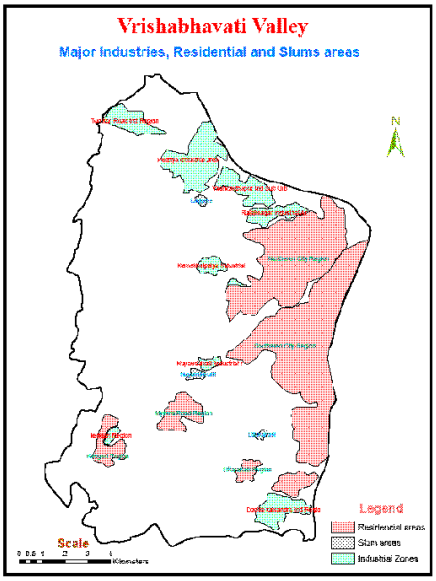
The middle river valley region eastern side is covered by Residential area of Bangalore city. There are two Industrial regions, Kamakshipalya and Nayandanahalli Industrial region. The eastern side of the valley consists of Residential area which is very polluted by most of sewages and residential waste, garbage's, Toxic waste, domestic and Industrial waste water flow through sub stream to mainstream. The stream flow eastern direction to south west direction, Vrishabhavathi river drainage area near Kamakshipalya is very worst condition due to disposal of some solid industrial waste into the stream near Kamakshipalya Industrial area. Likewise the dumping of a huge quantity of the solid waste from commercial establishments like hotels, hostels etc.. Can be seen along the sides of the stream, damage of the sewage system in the middle valley of Vrishabhavati River. Some of the damages are sewer blockages with silt and Debris resulting in the over flow of the sewage in to the river sewage in to the river sewer breakage near panchasheelanagara, Malgalu leading to the mixing of the sewage with the river water, crown collapse that causes sewage leakages in to the river. Nayandanahalli Industrial region Vrishbhavathi valley. This takes its origin near Peenya Industrial town that lies in the n-w region of the Bangalore city. Initially the stream size is small, thereafter the with of the size increases near Basvesswara nagar. The stream is surrounded by various settlements on its both sides. Thus causing a sewage intrusion into stream. Also industrial effluents have contaminated the stream. The stream traverses through Kamlanagar, Kamaksipalya, and Malleswaram. This stretch is comprised of the settlements of various categories viz.. Commercial, industrial activities.

The lakes completely encroached because of the urbanization process those lakes are laripalya, Kurubarahalli Lake, Kamakshipalya lake, Agrahara Dasarahalli lake all these are encroached. Ullal lake, Herohalli Lake is in normal condition and Yadiyur Lake, Thyagarajnagara lakes are in good condition.

Lower Valley Region

This region consist of Nayandanahalli Industrial region. In addition to this few institutions like Bangalore University. Institute for social Economic change, National Law School of India University, Department of Atomic Energy and Sports Authority of India that are discharging the wastewater into the stream.

The another Industrial Zone Doddakallsandra it is also one of the Industrial region due to this region Subramaya nagar, Gublal lake, Doddakalsandra lake, Vasantapurea, Yalchenahalli lake all these lakes are affecting by this region. The lake Ittamadu lake is completely encroached due to Urbanization, Uttarahalli lake weeds intrusion is taken place. The residential regions in this region is Kengeri region, Mysore road and Uttrahalli there regions are the major Residential area.

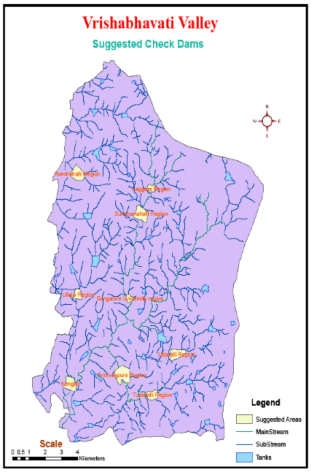


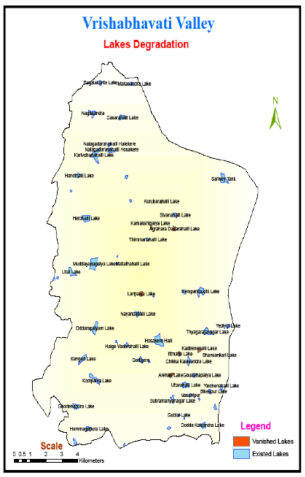
Lakes in Vrushabhavati River Valley

In our study are I have visited all lakes totally 58 lakes in vrishbhabhavati river catchment area, with in that 46 lakes existing at present 12 lakes are completely vanished those are not existing now. At present only 9 lakes are in good condition and 14 lakes are in normal condition, 10 lakes are in highly polluted, 4 lakes are very highly polluted. These things I came to know while visiting those areas. Then I found out cause for pollution in those lakes, and then I are giving some suggestions to reduce pollution in those lakes. Vrishbavathi catchment area has been synonymous with its salubrious climate, Lakes, which have been an inherent part of the ecosystem, also have traditionally served the function of meeting water requirements of the populace, be it for drinking, household uses like washing, for agriculture, fishing and also for religious and cultural purposes. Through using GIS software I are delineate the existing and non-existing tank in the Vrishbhavati river valley. Then I are done some analysis of these lakes like buffer zone of pollution around these lakes.

Check Dams in Vrushbhavathi Catchment Area

Check dams are small, temporary dams constructed across a swale or channel. Check dams can be constructed using gravel, rock, sandbags, logs, or straw bales and are used to slow the velocity of concentrated flow in a channel. By reducing the velocity of the check dams reduce the erosion in the swale or channel. As a secondary function, check dams can also be used to catch sediment from the channel itself or from the contributing drainage area as storm water runoff flows through the structure. However, the use of check dams in a channel should not be a substitute for the use of other sediment-trapping and erosion control measures. As with most other temporary structures, check dams are most effective when used in combination with other storm water and erosion and sediment control measures.





Water Treatment Plants in Vrishbhavati River Valley

For the current study, field visits were made to Bangalore Water Supply and Sewerage Board (BWSSB) and Treatment plants. Various personnel were contacted in this regard. Prior to this a thorough literature survey was done. To understand the method of disposal after treating, a brief case study was carried out for Vrishabavati stream, where in 12 samples were collected from surface as well as groundwater and analyzed for 23 parameters in the Department of Mines and Geology, Bangalore. A thorough survey was made across the stream to locate the wastewater intrusion points from industries and other sources.

Sewerage system in Vrishbhavati River valley

A sewerage system in Bangalore was first established in the late 1920's and early 1930's in the heart of the old city. It was not until 1950, a major programme of sewer construction was commenced; by 1966, more than half the capital expenditures on sewers had been incurred since 1960. Then followed by the major sewerage development under the first three stages of the Cauvery project, extending from the mid 1970's to 1990's. Presently, with the BMA conurbation of 598 Km^2 only the inner core area is sewered. This is an area of about 290 Km^2 which covers four major valleys, (Vrishabhavathi, Koramangala and Challaghatta, Hebbal) and

five minor valleys (K&A Minor Valley, Kathriguppe Minor Valley, Tavarakere Valley, Hebbal Minor Valley I and Hebbal Minor Valley II).

Sewers were introduced in 1922 for conveying domestic and industrial wastewater through underground drainage system. Initially was laid in the heart of the city to densely populated areas. Presently the Bangalore city is equipped with well-designed and regularly maintained underground sewerage system. Stoneware pipes are used for up to 300mm dia sizes and RCC Hume pipes varying in diameter from 300 mm to 1200 mm for sub mains/mains/outfall sewers. To facilitate easy cleaning sewer lines whenever blockages occur, adequate numbers of manholes are provided.

Wastewater generated in the city is drained through three principal valleys of Vrishabavati, drains into the above drainage zones. The primary objective being to drain of the sewage flowing in open drains, storm water drains etc., in order to convey the same to the Sewage treatment plants for treatment before disposal. A recent survey and detailed analysis has revealed some of the sewers at certain stretches are not capable of handling the existing as well as the expected future flows. Further some of the sewers are in critical conditions due to crown corrosion over a period of time and requires immediate replacement to avoid collapse of main sewers. For this reason, a detailed project report has been got up for Rs. 46.27 crores, wherein it is proposed to upgrade the trunk system to convey the estimated sewage flows into all the STP's for treatment and to ensure prevention of pollution of Ponniar and Cauvery rivers. The scheme has been sanctioned under National River Conservation Plan (NRCP) on 70: 30 funding by GOI and GOK respectively.

Bangalore is currently served by three major sewage treatment plants, all providing secondary treatment, with a combined capacity of 403 MLD and two smaller plants with a total capacity of 9 MLD. In addition to these, two tertiary treatment plants are constructed recently with a combined capacity of 70 MLD.

Vrushbhavthi-Valley Treatment Plant

This plant was first commissioned with primary treatment in 1974 (123 MLD), then upgraded in the 1990's to 180 MLD with secondary treatment. A tertiary sewage treatment plant with 60 MLD capacities was commissioned in 2002. It is located in the south of Bangalore on Bangalore- Mysore road. It is designed for raw sewage BOD and SS levels of 350mg/L and 400mg/L. The Plant receives raw sewage of BOD 212mg/L and SS 503mg/L. There is a decrease of 80-85 % in the BOD level. In 2001 the inflow was 105 MLD which was highest compared from 1998-2003 and least was 52 MLD which was encountered in March 2001 due to the rehabilitation work. Average inflow of sewage into the STP is 100 to 120 MLD. The data collected for the month of Jan, 2004 shows that average inflow into plant is 115 MLD. BOD removal is around 84%. Presently, the tertiary treatment is not carried out to its full capacity as there is no revenue generation; on the contrary only 15 MLD is being let into Tertiary unit so as to keep the unit in operation. The secondary treated water is being sporadically used by Toyota Kirloskar through the Tankers to Bidadi industrial plant.

Sewage Estimation

The wastewater essentially depends on the quantity of water supply to the community and water discharged after fouled by a variety of uses. In a developing urban society, the wastewater generation is approximately 30-70 m3 per person per year. Theoretically speaking, the quantity of sewage that is likely to enter the municipal sewers should be equal to the quantity of water supplied. But in actual practice, this is not the precise quantity which appears as sewage, but certain additions and subtraction are to be made. Addition due to unaccounted private water supplies: The accounted water supplied to the public from the public distribution system is not necessarily the only water consumed by the public. Some private tube wells and open wells are also used by the public for their domestic use. Additions due to infiltration: some times the infiltration of water into the sewer can takes place after the rainfall. But the quantity of water infiltrated depends on the permeability of the ground soil. Since these factors cannot precisely compute, the exact quantity of ground water infiltrating cannot be estimated. Sometimes, the strom water drainage may also infiltrate, but this inflow cannot be computed easily and generally left unaccounted without making any extra provision for it. Subtractions due to water losses: The water lost, due to leakage in the distribution system and house connections of the water supply scheme, does not reach the consumer and hence never appears as sewage. Subtractions due to water not entering the sewerage system : Certain amount of water may be used by the public and industries for such uses which may not produce any sewage at all. For ex. Water used in boilers for steam generation, the water sparkled over the roads, streets, lawns and gardens.

Net quantity of sewage produced: The net quantity of sewage produced will be equal to the accounted quantity of water supplied from the public water distribution system plus the additions due to factors (1) and (2) minus the subtractions due to the factors (3) and (4), described above. In India, this value is generally taken as equal to 75 to 80 % of the accounted water consumed. It is seen that BWSSB supplies 864 MLD out of which 38 % is unaccounted due to leakage, thefts, infiltration losses (AUSAID, 2002). As such the quantity of water actually supplied is 531 MLD. In addition to this around 750 MLD of ground water is extracted, so the total quality of water consumed in the city is around 1250 MLD. 80% this goes as sewage, which comes to about 800 MLD. Out of this, approximately around 200-300 MLD is entering the STP's, which is due to the lack of adequate sewerage system. It has

been observed only 50% of the Bangalore City is sewered. The remaining wastewater enters into the streams thereby contaminating it.

Findings and Suggestions

The washing of clothes by dhobis and civilians continued entry of domestic sewage in some areas are posing pollution problems. Rapid growth of human population, proliferation of buildings, roads and vehicular traffic in the area have taken a heavy toll of wetlands.

Moreover encroachment, disfiguring by brick/tile industries, waste disposal activities and bad management have threatened the very existence of many of the valuable and productive wetland habitats in these area thereby posing serious threat to the flora and fauna supported by them. The human activities over the years, accumulations of silt and clay have led to changes in the pattern of sediment and water exchange. Because of the human effects on biological processes resulted on mortality or shift balance among species reduced reproductive rates or changing competitive ability. Although there is wide public concern about wise use of wetlands, lack of knowledge of the ecological conditions of these habitats has caused many losses. Etc. As a part of our Project work I made a survey of various water bodies of Vrishabhavathi catchment area. There were mixed results in our study. The various lakes and 'keres' are either well maintained or averagely maintained or thoroughly neglected.

The thoroughly neglected and the least protected lakes are Dasrahalli lake and Nelagadaranahalli Lakes towards Tumkur road, Heroehalli Kere towards the Magadi road, Jnanabharati Lake, Hosakere and Kengeri Upanagara Lake towards Mysore road, these are even though is included under the lake development authority has been ill-maintained with weeds like Eichhornia crassipes (Mart.) Solms**.**, Polygonum glabrum Willd**.**, Alternanthera sessilis etc. flourishing and thriving well. These lakes lacked fencing and any programme for the removal of weeds. These lakes were infested with acres together of water hyacinth and other aquatic weeds. Construction debris and garbage were dumped indiscriminately which also created a foul smell around these water bodies. The level of human interference has far surpassed the natural ecological succession of plants in these lakes. All these will reduce the lifespan of these lakes to the highest extent.

The averagely maintained lakes are Sankey tank, Yadeyur Lake, Kengeri Lake and Madavara Lake. These water bodies are categorized into averagely maintained lakes because only a part of the lake are well maintained whereas the remaining parts are filled with aquatic weeds and also have ended up as a dumping ground for garbage and debris of construction work. Yadeyur lake has a well maintained park which attracts the children, the young, the old, the newly wed, the yet to be wed and one and all. The lake is serene for the most part but filled with weeds, garbage and recently dumped construction debris towards the Tumkur road direction. Steps on war footing should be taken like erecting a fence around the lake and stoppage of dumping of construction debris. With suitable governmental measures and private NGOs-Corporate participation and support Sankey tank would surely become a role model for maintenance of lakes in this area. Though Kengeri Lake has a park like atmosphere, nearly a quarter of the lake is filled with lakes especially towards the banks. More species of ornamental plants and shade trees should be planted in the park, than growing only one of a few species like Lagerstroemia flos-reginae Retz. Herohalli Lake and Kengeri Lake should be deweeded and the surrounding has to be improved with cultivation of more ornamental plants.

Some of the well maintained lakes are still in the process of completion of the beautification works like Sankey tank, Yadeyur Lake and Kengeri Lake. Madavara Lake is also well maintained except for one part that is filled with weeds. Sankey Tank which is at the heart of Bangalore city is the best maintained even though accessibility for general public is minimum. Boating and fishing facility would appeal the general public more. Also the drainage running parallel to one side of the bank of Sankey Lake should be covered up. The Lake Development authority in tie-up with private developers are doing a great job of restoring some of the lakes and trying to build an aesthetic atmosphere especially around the lakes so that they provide and excellent recreational facility for the children and public in general.

Our study also revealed that Kamakshipalya kere and Ittmaduvu Lake, Dharambudi kere have completely disappeared giving rise to a playground Residences and Bus Stand instead on its vicinity.It has also been observed during our study that most of these lakes and keres are being used by the general public to answer the nature's call. I strongly recommend setting up of well-maintained public toilets around these lakes which will help in maintenance of a hygienic environment.

Too rapid and thoroughly unplanned urbanization of Bangalore has resulted in the disappearance of playgrounds, parks, etc., which provides a vital source for the relaxation and recreation of the toiling public. It is suggested that a co-ordinated effort from the Lake Development authority (LDA), Forest Department, BDA, BMP, BWSSB, KSPCB and the Fisheries Department should be there to preserve these lakes to improve the aesthetic sense of the city and also to prevent these lakes from being encroached by unauthorized land grabbers. The concerned councilors, MPs, MLAs and other people representatives of the wards concerned should take a proactive step in preserving and sustaining these lakes. KSPCB should conduct periodical physicochemical studies on these lakes and identify the quality of water, so that the water can be used for agriculture, pisciculture, water

sports, etc.

The Fisheries Department should introduce variety of fishes periodically into these feasible lakes and keres which would not only be a source of livelihood for many unemployed but would also assist in maintaining the eco-balance of these lakes. Boating and fishing clubs should be established to encourage and to popularize the water sports. Swimming clubs with membership to interested public would play a huge role in attracting the public of that area where the lakes are situated. The funds raised this way could be used for the maintenance and developmental activities of these lakes.

Conclusion

From the above discussion, by reusing the wastewater I find that the city not only meets the supply and demand gap but also reduces pressure on ground water draft. Currently the surface water supplied to the city is 864 MLD out of which 38% goes as unaccounted and the actual supply remains around 530 MLD. In addition to this the ground water draft in the city is estimated as 750 MLD (Total water consumption in the city is 1250 MLD). It is also seen that the city generates Waste water in the range 800 MLD (considering 80% of the total consumption as waste), to the contrary the actual waste water treated from all the 4 STP's is 200-300 MLD. This is because the city is not fully sewered (around 50 % sewered) and many sewers are in critical condition due to corrosion and require immediate replacement. The areas where there is no underground sewerage (UGD) system are letting there waste water into the water bodies like streams and lakes pollution them as said in the earlier section on Vrishabhavathi case study. In order to treat the remaining, adequate treatment plants have to be generated, it should also be ensured that adequate pipe network should be installed connecting the tanks.

As per BWSSB sources, there are seven STP s under construction stage that is completed in 2005 and there are plans for full coverage of UGD of the city. Since the conventional treatment plant are very cost effective and requires energy and manpower, Decentralized waste water treatment systems (DEWATS11) plants can be implemented in slums, industries and apartments. A DEWATS plant helps to treat waste water with a wide range at affordable prices and makes it more environmentally acceptable. The treated wastewater will be fulfillment of discharge standards and environmental laws and non-dependent on energy with minimal maintenance. The DEWATS plant has been successfully implemented in slum of Ullalu upannagara. Once this is implemented then the treated water can be used for various secondary purposed as said above. As said earlier, the consumption of fresh water is high for non-potable purposes, the concerned authorities should think of dual water supply which is in practice in many of the other countries like Singapore etc. so the burden on the fresh water can be reduced and the demand of the Bangalore can be surely met by wastewater reuse for secondary purposes.

The Vrishabavathi stream, which runs through Bangalore, is an evidence of groundwater being contaminated. Samples (15 no's) taken across the stream has revealed that among 14 parameters, most of the parameters exceed the permissible limits in surface water samples. This clearly indicates that water is highly polluted. The main source of high BOD and COD content in the water samples may be attributed to the flow of industrial effluents from the industries and also domestic sewage. It is seen that from the groundwater sample results, there is no contamination when compared to surface water. From the household survey made, people in these regions are mostly relying on corporation water as they feel bad odours in the groundwater; the respondents have also experienced hardness in water. There are also cases of different water-borne diseases in the vicinity, which has led to the establishment of separate associations. The contamination is also through commercial establishments- hotels, meat stalls, saloons etc. that has contaminated the stream, and thus making it useless for utilization. To counteract the quality aspects, defluoridation tanks, adequate treatment plants, Relaying of distribution pipe networks, de-silting of tanks may solve the problem.