Rapid Assesment Survey of Kodaikanal Lake

Prepared by
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Rapid Assessment of Kodaikanal Lake

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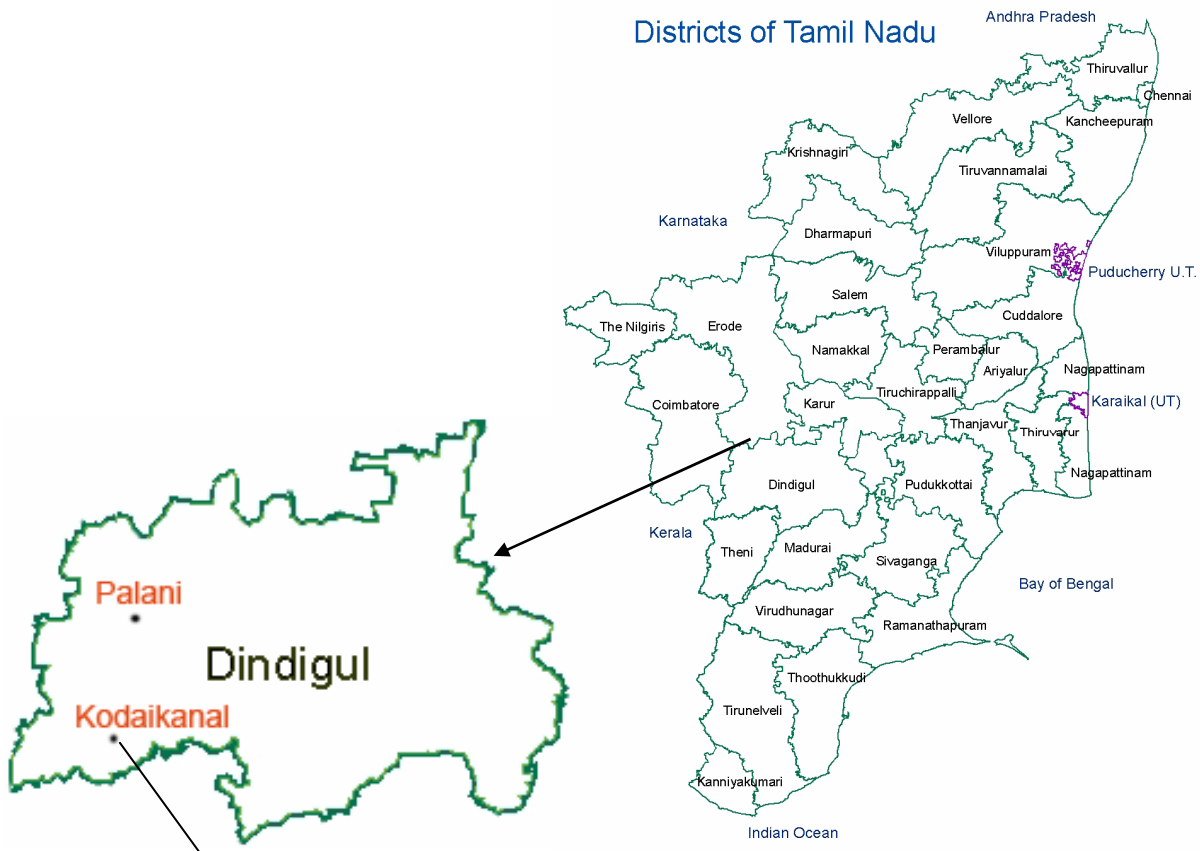
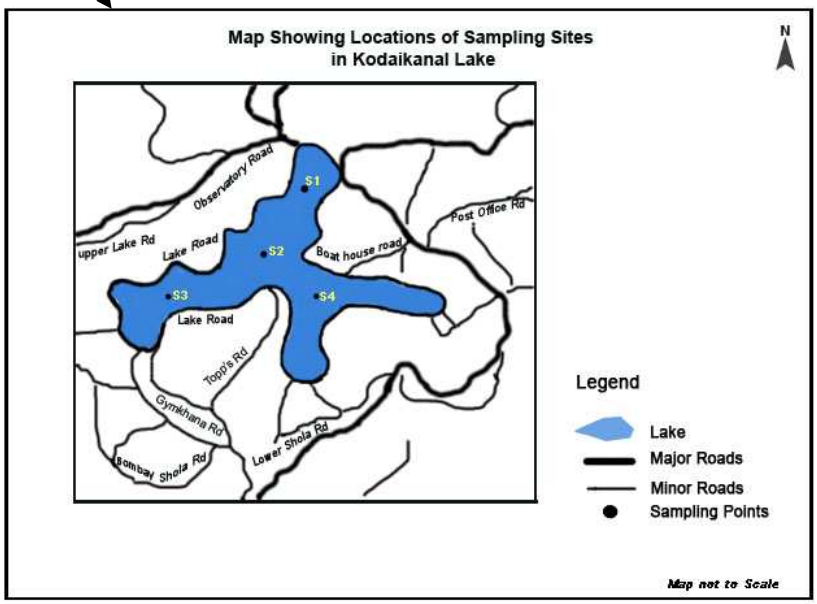
Location of the Kodaikanal Lake





Introduction:

Kodaikanal is referred to as the "Princess of Hill Stations". Kodaikanal is popularly known as Kodai. It lies in the district of Dindigul, Tamil Nadu, India at an Altitude of 2133 meters above sea level with an area of 21.45 Sq. Kms with Population of 32,931 (2001Censes) Annual Rainfall of 165 Cm (average) heavy rain season is between October and December. The climate is salubrious with summer temperatures of 19.8°C (max) and 11.3°C (min) and winter temperatures of 17.3°C (max) and 8.3°C (min).

I. History of Kodaikanal Lake:

Kodaikanal Lake which forms the heart of the resort is a star shaped lake, covering an area of about 24 hectares. Kodaikanal Lake was created in 1863 by Sir Hendry Levinge. He was previously the Collector of Madurai, who retired and settled in Kodaikanal. He constructed the bund to form a lake and stocked the lake with fish. He brought the first boat from Tuticorin. In 1890, a boat club was formed. In 1910 a new boathouse was constructed. The boat service was opened to the public and tourists in 1932. Since then Kodaikanal has been the most popular hill station of South India. Boat Pageant and flower Show held during the summer festival are now the added attractions for tourists.

II.Topography:

Kodaikanal Lake is in the Palni Hills at an altitude of 2,285 m at 10°14’ N latitude and 77°28’ E longitude. It is starfish-shaped but with four points., centrally located in the town of Kodaikanal and is surrounded by lush green hills of the northwestern Palani Hills range, which is the main watershed for the lake. The area of this lake is about 65 acres (26 ha). The maximum depth is 10 m, the average depth 2 m.

III.Hydrology:

Kodaikanal lake is a freshwater Lake. An earthen dam was constructed to create the lake in a marshy where three streams flowed. The perimeter of the lake is about 4.80 km.Catchment area is 1280.50 Ha. The out flow from the Lake forms the waterfall of 180 foot, called the Silver Cascade, 8 km downstream of the lake outlet. The main source of water for this lake is received form the Rainfall, The annual average Rainfall is 165 Cm.

IV.Facts about Kodaikanal Lake

Kodaikanal lake formed by	: Sir Venci Henry Levinch
Formed on	: 1863
Boaters	: introduced in 1929
Water spread	: 26.30 Ha
Perimeter	: 4.80 Km
Maximum depth	: 11.50 m
Catchment area	: 128.50 Ha
Kodaikanal Lake Conservation Detailed Project Report	

V.Biodiversity:

Fauna: The Lake is inhabited with Pond Skater *Gerris lacustris,* Moorhens *Gallinula chloropus,* Common Kingfisher *Alcedo atthis,* Pond Heron *Ardeola grayii,* Large Pied Wagtail *Motacilla maderaspatensis, Danio aequipinnatus, Rasbora daniconius,* Mosquito fish *Gambusia affinis,* Rosy barb *Puntius conconius* and a few others do inhabit the lake.

Flora: Blue Water Lilly *Nymphea nouchails.* Hydrilla *Hydrilla verticilliata, Zantedeschia aethiopica*

Threats to the Lake

The picturesque lakes in the hill stations are getting polluted due to the followings

- ✓ *Unrestricted tourism activities*
- ✓ *Damaged fiber glass boats*
- ✓ *Cattle grazing around the lake.*

i. Unrestricted tourism activities

Lakes at several hill stations, which attracted tourists are losing out to thoughtless tourism. Lakes are closed ecosystems. Hence pollution tends to accumulate there. High rate of pollution and silting of the lake are causes of very serious concern. Owing to continued silting, several lakes have reduced their capacity to hold water and their mean depth. Tourists carry water bottles and beverage bottles these bottles are of two types

PET and Glass bottles. Polyethylene terephthalate are widely used for soft drinks and packed drinking water, PET bottles are made up of polymers which cannot be degraded naturally. Glass bottles of alcoholic drinks were found on the shores, they may sink to the bottoms and remains at the floor. Broken bottles at the bottom along with the sediment will pose serious threat while desilting the lake. Other empty food items packed in polyethene covers thrown in and around the lake, the covers which sinks will remain as such.

ii. Damaged fiber glass boats:

Tourists mainly visit the lake for boating purposes. There are two types of boats available they are hand rowing and peddling boats. Most of the boats are made of Fiber Glass. There are two boating clubs involved in tourism boating, Kodaikanal boat club and Tamilnadu Tourism Development Corporation TTDC boat club. After wear and tear the unused and damaged boats are left inside the lake area. Chemical composition is "carbon-epoxy composites", in which the structural element is carbon fiber. Fiberglass is now often used to build Boats Glass fiber don’t decomose easily. They persist in the water for long time and posing serious threat to the lake ecosystem. The Unused and Damaged boats must be removed from the lake to save the lake from further damage.

iii. Cattle grazing around the lake.

Around the lake plenty of grasses and other plants available for grazing. Cows graze around the lake and the excrete the dung around the lake. During rainy season they are washed away to the lake. Cow dung is the undigested residue of herbivorous matter which has passed through the animal's gut. The resultant faecal matter is rich in minerals. Colour ranges from greenish to blackish, often darkening in colour soon after exposure to air. Cow dung can increase the Biochemical Oxygen Demand (BOD) and Decrease the Dissolved Oxygen (DO) content, this condition cause threats to the fishes. Cow dung is rich in nutrients, Increase in nutrient content leads to Eutrophication.

VII. Objectives of the Study:

To assess the Physico-chemical and biological quality of the Kodaikanal lake and to assess whether the lake requires bioremidiation programme.

Methodology:

Sample collection:

During the field visit, water sample were collected from 4 different locations with the help of Kodaikanal municipality. The sampling sites were named as S1, S2,S3 and S4, in each sampling sites 3 samples were collected at different depth (surface, middle and bottom). The water samples were collected during the forenoon and and transported to the Madurai Kamaraj University laboratory for water quality analysis.

Site Selection:

Four different sites were selected based on the topography of the lake, the sites were marked as S1,S2,S3 and S4. The location of the sample points are shown in the Map 2 and exhibited in plate 1.

Sample Analysis Methodology:

The water quality samples were analysed using American Public Health Association (APHA) Standard methods and compared with the National Lake Conservation Programme, CPCB Guidelines.

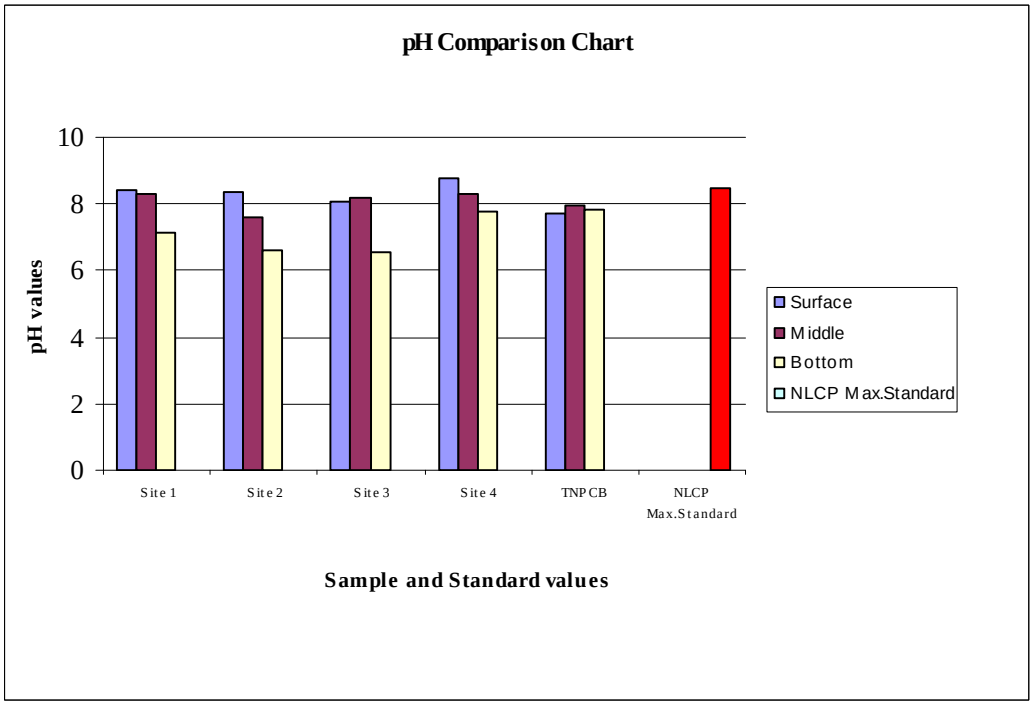
Results and Discussions:

To assess the water quality status of the lake five different parameters namely pH, Dissolved Oxygen(DO), Biological Oxygen Demand(BOD), Total Coliforms and Fecal Coliforms were compared with the TNPCb results and the NLCP standards. The above mention five important parameters are discussed as follows:

I. pH

The pH of the water has an important bearing on both planktons and fish population. The surface water pH of the lake water varied between 80.08-8.79 (Criteria C), the middle layered varied from 7.6 to 8.3 (Criteria C) and the bottom layer varied from 6.55 to 7.8 (Criteria A). The pH value of the TNPCB for surface water sample is 7.4 (Criteria A), the middle layer is 7.96 (Criteria A) and the bottom layer is 7.82 (Criteria A).

Fig 1. pH of the Kodaikanal Lake



II. Dissolved Oxygen

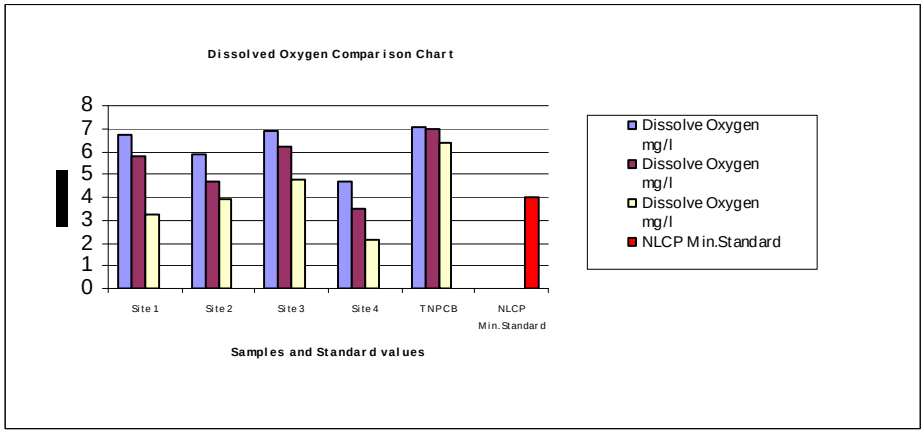
Dissolved oxygen analysis measures the amount of gaseous oxygen (O_2) dissolved in an aqueous solution. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement), and as a waste product of photosynthesis. Dissolved oxygen levels change and vary according to the time of day, the weather and the temperature.

Adequate dissolved oxygen is necessary for good water quality. Oxygen is a necessary element to all forms of life. Natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As dissolved oxygen levels in water drop below 5.0 mg/l, aquatic life is put under stress. The lower the concentration, the greater the stress. Oxygen levels that remain below 1-2 mg/l for a few hours can result in large fish kills. Oxygen is needed by virtually all algae and all macrophytes, and for many chemical reactions that are important to lake functioning.

The DO of the surface water varied from 4.7 to 6.9 mg/l (Criteria C), DO of the middle layer varied between 3.5 to 6.2 mg/l (Criteria C) and bottom layer varied form 2.4 to 4.8

mg/l. The TNPCB values for the surface layer is 7.03 mg/l (Criteria A), middle layer is 7.0 (Criteria A) and bottom layer is 6.2 mg/l (Criteria A)

Fig 2. Dissolved Oxygen levels in the Kodaikanal Lake



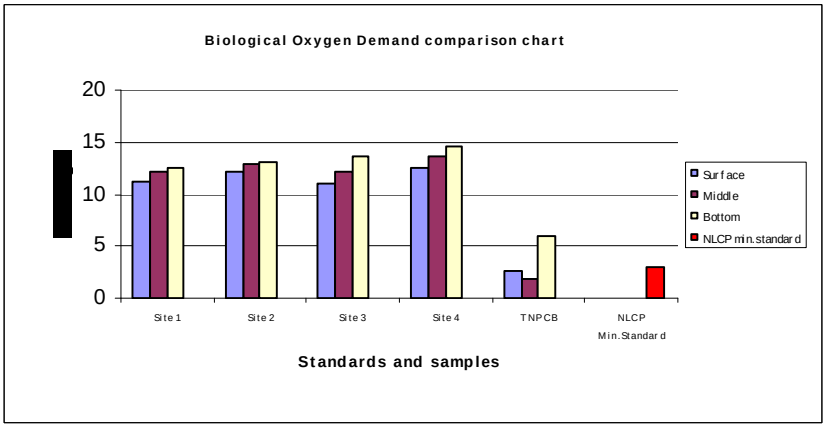
III. Biochemical Oxygen Demand

Biochemical oxygen demand is a measure of the quantity of oxygen used by microorganisms (e.g., aerobic bacteria) in the oxidation of organic matter. Natural sources of organic matter include plant decay and leaf fall. However, plant growth and decay may be unnaturally accelerated when nutrients and sunlight are overly abundant due to human influence. Urban runoff carries pet wastes from streets and sidewalks; nutrients from lawn fertilizers; leaves, grass clippings, and paper from residential areas, which increase oxygen demand. Oxygen consumed in the decomposition process robs other aquatic organisms of the oxygen they need to live. Organisms that are more tolerant of lower dissolved oxygen levels may replace a diversity of more sensitive organisms. BOD directly affects the amount of dissolved oxygen in water bodies. The greater the BOD, the more rapidly oxygen is depleted in water bodies. This means less oxygen is available to higher forms of aquatic life. The consequences of high BOD are the same as those for low dissolved oxygen: aquatic organisms become stressed, suffocate, and die.

BOD is considered as a limiting factor for the living organisms. It is an indicator of organic pollution. In the present study the BOD of the lake varied from 11-14.62 mg/l, but the TNPCB value shows lesser values (2.59 to 5.9 mg/l) when compared with MKU

study. The high concentration of BOD may be due to organic runoff from the nearby sewage outlet, leaf fall and urinary discharge of domestic animals.

Fig 3. Biological Oxygen Demand levels in the Kodaikanal Lake

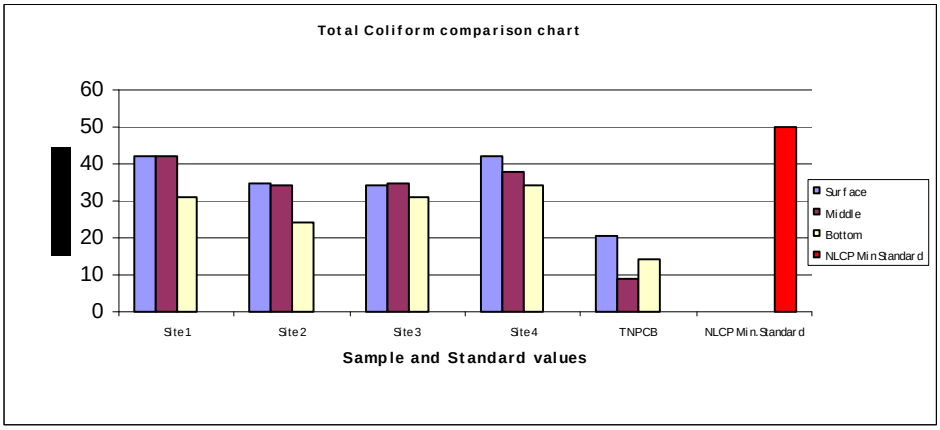


IV .Total Coliform

Coliform bacteria are described and grouped, based on their common origin or characteristics, as either Total or Fecal Coliform. The Total group includes Fecal Coliform bacteria such as *Escherichia coli (E .coli)*, as well as other types of Coliform bacteria that are naturally found in the soil. Coliform organisms are used as indicators of water pollution. The coliform organism is a very common rod-shaped bacterium, not thought of as disease causing to humans. Because pathogenic bacteria in wastes and polluted waters are usually much lower in numbers and much harder to isolate and identify than coliforms, which are usually in high numbers in polluted water, total coliforms is used as a general indicator of potential contamination with pathogenic organisms. However, many coliform bacteria live in the soil, and these organisms may be the source of those that appear in water, especially surface water.

In the present study the coliform count varied between 29 to 42 MPN/100 ml in the surface ,middle and bottom layer falls under Criteria A, The TNPCB value varied between (21 to 42 MPN/100ml). The coliform counts falls under the Criteria A.

Fig 4.Total Coliform levels in the Kodaikanal Lake



V. Fecal coliform

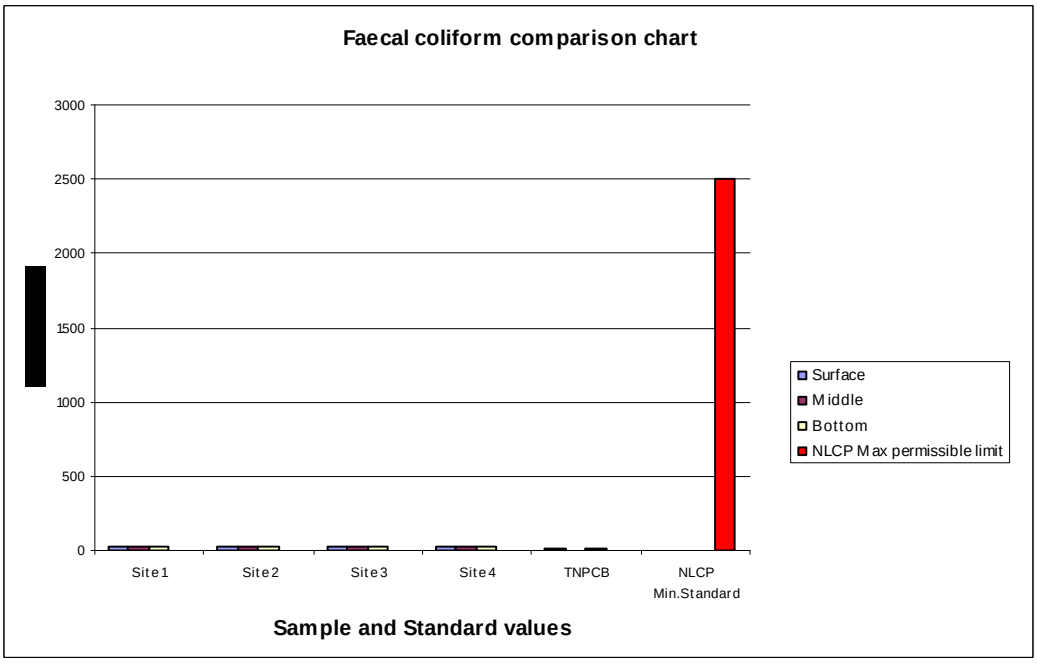
The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals. At the time this occurred, the source water may have been contaminated by pathogens or disease producing bacteria or viruses which can also exist in fecal material. Some waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis and hepatitis A. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Fecal coliform bacteria may occur in ambient water as a result of the overflow of domestic sewage or non-point sources of human and animal waste. High levels of fecal coliform are a good indicator that pathogenic microorganisms may be present. Disease-causing microorganisms can enter the body though cuts in one's skin, or through one's mouth, eyes, ears, or nose. They can result in health problems ranging from common diarrhea and ear infections to deadly diseases such as hepatitis, cholera, or even typhoid fever. Therefore, it is suggested that one does not have total body contact with water containing higher levels of fecal coliform.

Members of two bacteria groups, coliforms and fecal streptococci, are used as indicators of possible sewage contamination because they are commonly found in human and animal feces. Although they are generally not harmful themselves, they indicate the possible presence of pathogenic (disease-causing) bacteria, viruses, and protozoans that also live in human and animal digestive systems. Therefore, their presence in streams

suggests that pathogenic microorganisms might also be present and that swimming and eating shellfish might be a health risk. Since it is difficult, time-consuming, and expensive to test directly for the presence of a large variety of pathogens, water is usually tested for coliforms and fecal streptococci instead.

In the present study the Faecal coliform counts varied between 17 to 26 MPN/100ml in the surface, middle and bottom layers. The TNPCB value varied between 4 to 7 MPN/100ml. The coliform count falls under the Criteria A.

Fig 5.Faecal Coliform levels in the Kodaikanal Lake



Annexure 1

Table.2. Results of Surface water analyis values

Surface					
Parameters	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**TNPCB**
pH	8.43	8.36	8.08	8.79	7.74
Dissolve Oxygen mg/l	6.7	5.9	6.9	4.7	7.025
Biological Oxygen Demand mg/l	11.27	12.11	11.08	12.54	2.57
Total Coliforms MPN/100 ml	33-42	29-35	30-34	39-42	20.5
Fecal Coliforms MPN/100 ml	21-24	17-21	18-24	21-26	6.75

Table.3. Results of Middle water analyis values

Middle					
Parameters	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**TNPCB**
pH	8.28	7.6	8.17	8.3	7.96
Dissolve Oxygen mg/l	5.8	4.7	6.2	3.5	7
Biological Oxygen Demand mg/l	12.12	12.86	12.07	13.58	1.9
Total Coliforms MPN/100 ml	34-42	28-34	31-35	34-38	9
Fecal Coliforms MPN/100 ml	23-26	20-22	21-25	19-24	4

Table.4. Results of Bottom water analyis values

Bottom					
Parameters	**Site 1**	**Site 2**	**Site 3**	**Site 4**	**TNPCB**
pH	7.11	6.62	6.55	7.8	7.82
Dissolve Oxygen mg/l	3.2	3.9	4.8	2.1	6.4
Biological Oxygen Demand mg/l	12.59	13.05	13.72	14.62	5.9
Total Coliforms MPN/100 ml	29-31	21-24	29-31	32-34	14
Fecal Coliforms MPN/100 ml	18-22	18-22	19-22	20-25	7

Annexure 2

Table.5. TNPCB Water Quality Results (January 2009)

January 2009 Result			
Parameters	**Surface**	**Middle**	**Bottom**
pH	7.74	7.96	7.82
Dissolve Oxygen mg/l	7.025	7	6.4
Biological Oxygen Demand mg/l	2.57	1.9	5.9
Total Coliforms MPN/100 ml	20.5	9	14
Fecal Coliforms MPN/100 ml	6.75	4	7

Annexure 3

Standard given in the NLCP Guidelines

Box 1: Designated Best Use Criteria for Surface Waters (Source: CPCB)

Designated Best Use	Class of criteria	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	1. Total Coliforms OrganismMPN/ 100ml shall be 50 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6mg/l or more 4. Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organised)	B	1. Fecal Coliforms Organism MPN/ 100ml shall be 2500 (Imax permissible), or 1000 (desirable) 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 5mg/l or more 4. Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	1. Total Coliforms Organism MPN/ 100ml shall be 5000 or less 2. pH between 6 to 9 3. Dissolved Oxygen 4mg/l or more 4. Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	D	1. pH between 6.5 to 8.5 2. Dissolved Oxygen 4mg/l or more 3. Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	1. pH between 6.0 to 8.5 2. Electrical Conductivity at 25°C micro mhos/cm Max.2250 3. Sodium absorption Ratio Max. 26 4. Boron Max. 2mg/l

Plate1. Sampling Sites in Kodaikanal Lake

Sampling Site S1

Sampling Site S1

Sampling Site S2

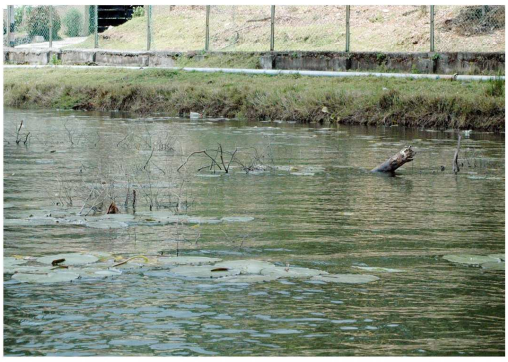
Sampling Site S2

Sampling Site S3

Sampling Site S4

Plate.2. Causes for Degradation of Kodaikanal Lake

Shopping Complex Near the Kodaikanal lake



Fallen tree branches inside the lake

Drowned Dredging machine

Runnoff carrying solid wastes

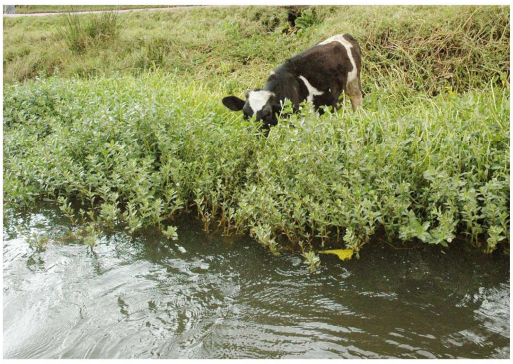
Damaged fiber glass boats

Thrown away plastic bottle by tourists

Plate 3. Causes for lake degradation

Damaged fencing

Cows grazing inside the fenced area



A Calf inside the Lake area

Cow dung on the Lake Bund

Solid waste accumulated due to runoff

Siltation inside the Lake area

Plate 4. Fauna of Kodaikanal Lake

Puntius conconius
Rosy Barb

Tachybaptus ruficollis
Grebe (Dab- chick)

Gambusia affins
Mosquito fish

Ardeola grayii
Indian Pond Heron

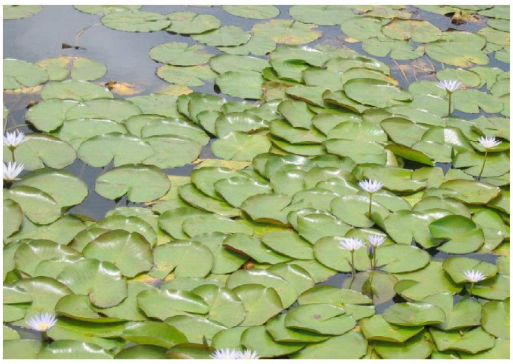
Gerris lacustris
Pond Skater

Motacilla maderaspatensis
Large Pied Wagtail

Plate 5. Kodaikanal Lake

Kodaikanal - lake view

Tourist vehicle around the lake



Nymphaea nouchali, Blue Water lilly cover

Cycling for tourists

Boat tourism

Horse riding for tourists

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