UPSTRAEAM-DOWNSTREAM CONTAMINATION GRADIENT OF THE FLUVIAL URBAN SYSTEM IN CHENNAI

1. INTRODUCTION:

Human beings need water as a main component for their survival, water is a deep necessity for our day to day activities. Water exists in various forms, in the available forms we can only consume the fresh water, and earth has an estimated availability of 1400 million cubic kilometers of water out of which 2.7% is consumable fresh water. In India there are many rivers which support the life form of our nation, some of the important rivers supply water to huge service area. In the recent decades due to the industrial explosion and aggravated water pollution these rivers are in endangered situation including the impact on the aquatic life system in those rivers. Urbanisation and industrialization puts deep and irreversible impact on our aquatic systems which are the life supporting tools of our generation, need to protect them is the need of the hour.

Human activities have brought numerous potentially hazardous trace elements to the environment particularly in the industrial period. These anthropogenically derived elements can be transported through the atmosphere to locations remote from emission sources. Bottom sediments provide an archive of environmental change both within the region and marine ecosystem. The collection of geochemical information not only provides a close sight on the present environmental quality of the system but also serves as a baseline for future investigations.

The scope of the study is,

- ✓ Mapping of the fluvial system, influents and tributaries
- ✓ Identifying potential agricultural, industrial and urban sources of incoming pollution
- ✓ Providing protocol of sampling bed sediments and water
- ✓ Measuring sediments and water proxies
- ✓ Analysing trace element proxies
- ✓ Reconstructing the supposed upstream- downstream contamination gradient
- ✓ Correlating the state of polluted waters to the industrial areas and urban planning

Chennai (N 13º 15′ Latitude and E 80º 17′ Longitude) is a beautiful metropolitan city with high density population and also a major industrial hub in South India. Due to increase in population, consumption of water is also increased and subsequently leads to the generation of enormous quality of waste water. Thus, the wastewater is discharged directly into the rivers like Adyar and Cooum of Chennai city. When discharging industrial effluents, heavy metals are introduced into the aquatic environment; it redistributed throughout the water column, deposited or accumulated in sediments which affects aquatic ecosystems, because of their persistence, toxicity and ability to be incorporated into food chains. Blocking and encroachment of streams and water bodies reduces the water movement and increases the flood height Paved roads

and impervious strata formed as a result of urbanization which increases runoff also a reason to form flood. Floods are a potentially dangerous consequence of sediment accumulation on river beds and in reservoirs. The study is to focus on impact of flood events on heavy metal concentration in the sediments.

2. STUDY AREA:

Chennai, the coastal metropolis of South India, has a network of six main waterways crossing the city. Two of them, the Adyar and the Cooum, are natural rivers flowing eastward and draining into the Bay of Bengal. The other waterways are man-made. One of them is the Buckingham Canal, which runs from Andhra Pradesh to Marakannam, and cuts through Chennai from north to south, intersecting both rivers.

ADYAR RIVER

Adyar River starts from Malaipattu tank (80.00° latitude and 12.93° longitude) near Manimangalam village in Sriperumbudur Taluk at about 15 km west of Tambaram near Chennai. It starts to appear as a stream only from the point where water from Chembarambakkam Lake joins the river. It flows through Kancheepuram, Tiruvallur and Chennai district for about 42.5 km before joining the Bay of Bengal in Adyar, Chennai. The river forms a backwater near the mouth known as "Adyar Creek" due to the formation of sandbar at the mouth. This Creek is a natural channel which carries tidal water back into the sea.

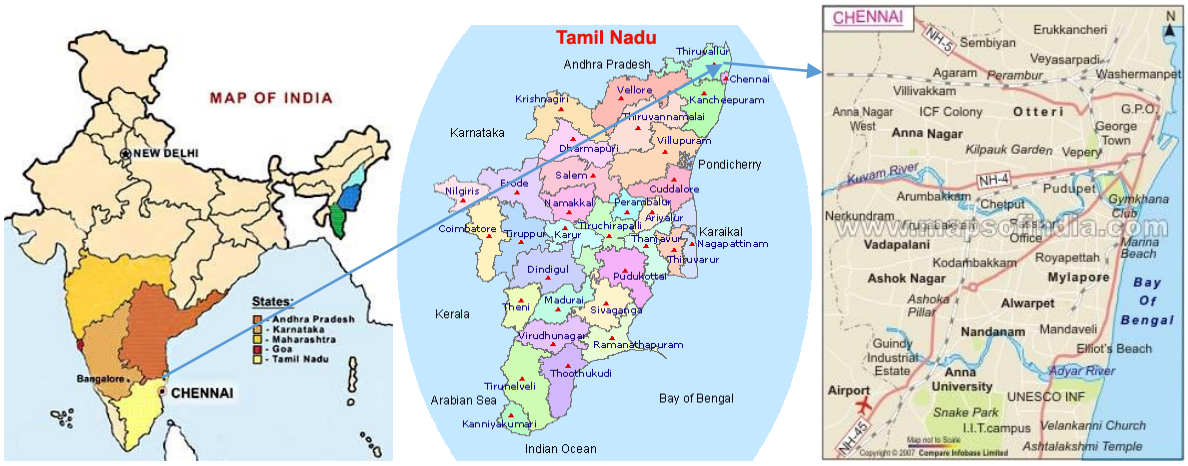

Figure 1: Study area

A mural at the Adyar Poonga exhibition centre shows the wealth of fauna of the original Adyar estuary. As late as the 1960s people fished and bathed in the rivers. Today these waterways are heavily polluted by the indiscriminate dumping of solid waste, by unchecked discharges of untreated industrial effluents and domestic sewage and by the extensive slum encroachments along their banks. Accumulating large volumes of organic sludge, Chennai's polluted waterways have become both an eyesore and a source of disease in the city.

COOUM RIVER

The Cooum River is the most polluted river of India which ends in the city of Chennai (formerly Madras) draining into the Bay of Bengal. Along with the Adyar River running parallel to the south, the river trifurcates the city and separates Northern Chennai from Central Chennai. Its source is in a place by the same name 'Cooum' or 'Koovam' in Trivallur district adjoining Chennai. Of the total length of 72 km, the river flows in urban and peri-urban areas for 30 km and rural areas for 42 km. In Chennai district, the river flows through three corporation zones namely Kilpauk, Nungambakkam and Triplicane for a total length of 16 km.

Owing to intensive use of surface water upstream for agriculture, indiscriminate pumping of groundwater leading to reduced base flow in the river, formation of sand bar at the mouth of the river, discharge of untreated sewage and industrial effluents and encroachment along the banks, the river, especially the downstream, has been highly polluted.

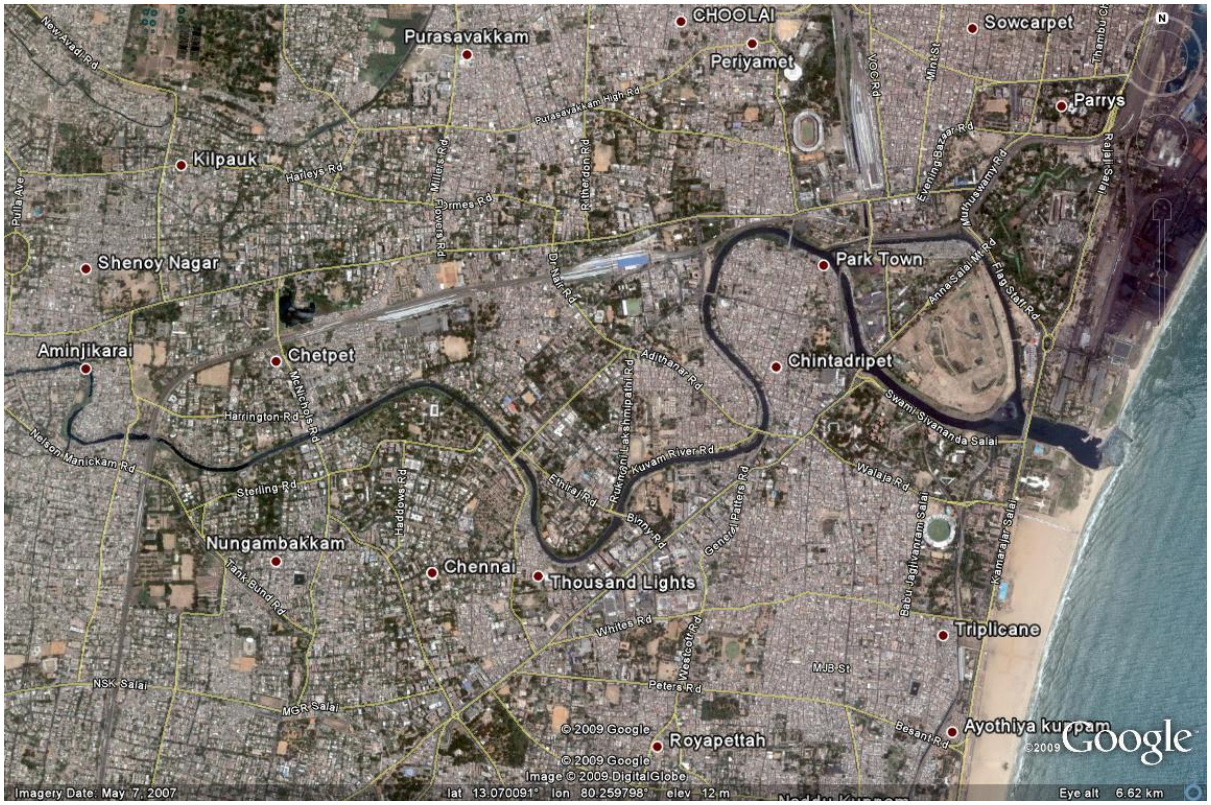

Figure 2: Study area (courtesy Google)

Past History and Present Condition:

Once upon a time the Adyar and the Cooum were in pristine condition with balanced eco-systems and beautiful environments. The river Cooum originates in the village by the same name. The length of the river is about 65 km of which about 18 km falls within the Chennai city limits. The Kesavaram dam on the upstream diverts the water to Chembrambakkam lake, from where the water is supplied to the city for domestic purpose. Not long ago the river boasted of fish and was also used for recreational boating which attracted tourists. The river is described as a “languid

stream" which carries little water except during the monsoon. Presently, the river is highly polluted and malodorous and can be said to have become 'dysfunctional'.

Many reasons can be attributed to the present condition of the river. In addition the population explosion along with the unplanned growth of the city has only compounded the problem. The natural flow in the river is already reduced due to the water diverted from the Kesavaram anicut into the Chembrambakkam lake and the main flow in the river is due to the north-east monsoon during October to December. During the other period the flow in the river is mainly the polluted water discharged into the river.

3. SAMPLE COLLECTION:

Adyar River:

The samples were collected from upstream side to downstream side of the river. In that, it collected from only bed sediment of the river using with core device.

3.1 Chambrambakkam:

Chembarambakkam Lake is situated in the kancheepuram district in Tamil Nadu. It lies between 13º00'54.4" North Latitudes and 80º04'43.6" East Longitudes. In Adyar river starts to appear as a stream only from the point where water from joins the river. Chembrambakkam lake, is one of the water is supplied to the city for domestic purpose. Figure 3.1 shows the sample were taken as near the pumping station of chambarambakkam lake. The sample number as ADY 15.01.

Figure 3.1 sample taken on the Chambarambakkam lake

3.2 Thiruneermalai:

Thiruneermalai is a panchayat town in Kancheepuram district in Tamil Nadu. It is popular for a temple on a hill. This place is very close to Chennai city (4 km from Pallavaram GST road). It lies between 12º57’55.3” North Latitudes and 80º06’35.4” East Longitudes. In this location the many number of automobile, mechanical, plastic etc., industries are available. That industries are emitting the pollution. Figure 3.2 shows the sample were taken as thiruneermalai (Near highway bridges). The sample number is ADY 15.02

Figure 3.2 Sample taken on the Thiruneermalai

3.3 Anakaputhur:

Anakaputhur is a located in the suburbs of Chennai in Kancheepuram district in the state of Tamil Nadu.). It lies between 12º59’08.5” North Latitudes and 80º07’14” East Longitudes.Though situated in Kancheepuram district, the town is actually a neighbourhood of Chennai. Anakaputhur was once famous for its traditional weaving business, which has declined due to modern competition. Now, some natural fibers and textile industries are available. The sample were taken from the under the Highway bridge. The sample number as ADY 15.03. Figure 3.3 shows the sample taken on the Anakaputhur.

Figure 3.3 Sample taken on the Anakaputhur

3.4 Polichalur

Polichalur is a census town in Kancheepuram district in the state of Tamil Nadu. It is a suburb of Chennai and is located close to the Chennai Airport at Tirusulam on its south west side. It lies on the south banks of the Adyar River in 12º59’39.2” North Latitudes and 80º08’53.8” East Longitudes. Here some plastic and mechanical industries are available. The sample were taken from the near the Highway bridge. The sample number as ADY 15.04. Figure 3.4 shows the sample taken on the Polichalur.

Figure 3.4 Sample taken on the Polichalur

3.5 Manapakkam

Manapakkam is a census town in Kancheepuram district in the state of Tamil Nadu. Manapakkam is located along the Mount-Poonamallee Road in Chennai. It is now a home to a lot of IT Industries. It lies between 13º00’24.8” North Latitudes and 80º10’48.7” East Longitudes. In this river zone it is full of hard rock area. The sample were taken from the back side of the airport runway. The sample number as ADY 15.05. Figure 3.5 shows the river view of Manapakkam.

Figure 3.5 River view of Manapakkam

3.6 Burma colony

Burma colony (Nandambakkam) is a Neighbourhood of Chennai and a town in the Tambaram taluk of Kanchipuram district in the state of Tamil Nadu. It lies between 13º01’44.9” North Latitudes and 80º11’52.0” East Longitudes. It is renowned for the Chennai Trade Centre and the Surgical Instruments Factory. In this zone people completely encroached from the river and directly disposed from the domestic waste water and garbage’s. The sample were taken from very near to the bridge. The sample number as ADY 15.06. Figure 3.6 shows the river view of Burma colony.

Figure 3.6 River view of Burma colony

3.7 Jafferkhan pet:

Jafferkhanpet is located as Chennai district in the state of Tamil Nadu. It lies between 13º01’34.5” North Latitudes and 80º12’30.7” East Longitudes. In this zone also people completely encroached from the river and directly disposed from the domestic, industrial waste water and garbage’s. The sample were taken from near to the bridge. The sample number as ADY 15.07. Figure 3.7 shows the sample taken on the Jafferkhanpet.

Figure 3.7 Sample taken on the Jafferkhanpet

3.8 Maraimalar adigal bridge

The Maraimalai Adigal Bridge (Saidapet) it is located in Chennai district. It lies between 13º01’04.3” North Latitudes and 80º13’31.3” East Longitudes. In this zone people completely encroached from the river and under bridge area. It is a slum area. The sample were taken from under the highway bridge. The sample number as ADY 15.08. Figure 3.8 shows the sample taken on the saidapet

Figure 3.8 Sample taken on the Saidapet

3.9 Kotturpuram

Kotturpuram is located in Chennai district in Tamil Nadu. It is very near to the adyar estuary. It lies between 13º01’18.0” North Latitudes and 80º14’50.1” East Longitudes. In this zone, they have many number of educational institutions, hospitals, Hotels and boat club etc., available. The sample were taken from the opposite side of Boat club. The sample number as ADY 15.09. Figure 3.9 shows the river view of Kotturpuram.

Figure 3.9 River view of Kotturpuram

3.10 Thiru.Vi.Ka Bridge

Thiru Vi. Ka. Bridge (Adyar) is a road bridge across the Adyar River in Chennai. It lies between 13º00’52.3” North Latitudes and 80º15’35.1” East Longitudes. The Thiru.vi.ka bridge is mouth of Adyar River.it is a sand bars at the edge of the sea. But like the river, is too heavily polluted and its banks have been encroached upon. The languid stream of the Adyar feeds the estuary with pollutants; and what flows out to sea returns with the tides. The sample were taken from under the bridge. The sample number as ADY 15.10. Figure 3.10 shows the sample taken on the Thiru Vi. Ka. Bridge (Adyar).

Figure 3.10 Sample taken on the Thiru Vi. Ka. Bridge (Adyar)

COOUM RIVER

3.11 Thiruverkadu

Thiruverkadu (literally meaning A forest of holy herbs and roots) is a western suburb of Chennai, Tamil Nadu. It comes under Thiruvallur district administration. It lies between 13°04’26.4”North latitudes and 80°06’46.6”East longitudes.The sample were taken from the near the bridge. The sample number as COU 15.11. Figure 3.11 shows the sample taken on the Thiruverkadu.

Figure 3.11 Sample taken on the Thiruverkadu

3.12 Maduravoyal

Maduravoyal is a small township located in the west of Chennai, under Thiruvallur district in Tamil Nadu. It lies between 13°03’44.6”North latitudes and 80°09’30.4”East longitudes. It would run along the banks of the Cooum up to Koyambedu and would end along the Cooum near the Koyambedu grade separator. The sediment sample were taken from here to determine the heavy metal contamination generally bridges acts as a barrier which allows sediment to deposit on their river bed and also many number of developing industries(Mechanical and Automobile) are available in this location. The sample number as COU 15.12. Figure 3.12 shows the river view of Maduravoyal.

Figure 3.12 River view of Maduravoyal

3.13 Thirumangalam

Thirumangalam (near koyambedu) lies on the border of Anna Nagar in Chennai. It lies between 13°04’41.51”North latitudes and 80°11’55.2”East longitudes. Thirumangalam, and Mogappair are on the border of Anna Nagar and often referred as Anna Nagar. Household sewage are discharged into the Cooum river water course at this location. Similarly plastic industries and workshops pertaining to automobiles are highly available these may be the causes for the pollution at this site. Figure 3.13 sediment sample were taken in Thirumangalam (Near highway bridge). The sample number as COU 15.13.

Figure 3.13 River view of Thirumangalam

3.14 Aminjikarai

Aminjikarai (originally Amaindhakarai) is one of the oldest localities in Chennai. It lies between 13°04’25.2”North latitudes and 80°13’20.4”East longitudes. It is located on the banks of the Cooum River. A delta formed from the deposition of the sediment carried by the river Cooum towards its journey to the Bay of Bengal is called Amainda Karai (which means shaped/formed/created land in Tamil) and later on Aminjikarai colloquially. Petrochemical industries and workshops pertaining to automobiles are highly available in this location. Figure 3.14 shows the samples were taken from Aminjikarai. The sample number as COU 15.14.

Figure 3.14 River view of Aminjikarai.

3.15 Choolaimedu

The Cooum river meanders its way across the Chennai city. It lies between 13°04’06.7”North latitudes and 80°13’54.1”East longitudes.Choolaimedu runs through several neighborhoods. Some of the bigger neighborhoods through which the river flows through include Arumbakkam, Aminjikarai, Choolaimedu, Chetpet, Egmore, Chindadripet and Chepauk. Near to this location many fertilizer and plastic

producing industries are available. All effluents coming from these sites were discharged into the nearby Cooum river water course. Figure 3.15 shows the sample were taken as Choolaimedu (Near highway bridges). The sample number as COU 15.15.

Figure 3.15 Sample taken on the Choolaimedu

3.16 Moors road (Nungambakkam)

Nungambakkam is a locality in Chennai, it lies between13°04’06.9”North latitudes and 80°14’33.6”East longitudes. The neighborhood is abound with multi-national commercial establishments, important government offices, foreign consulates, sprawling educational institutions, shopping malls, sporting facilities, tourist spots, star hotels, restaurants, and cultural centers. Nungambakkam is also a prime residential area in Chennai. The river course near this site gets polluted with in Chennai city limits due to letting of sewage and drainage waters by slum dwellers, private parties, etc and also some industrial partly treated or untreated wastes. Figure 3.15 shows the sediment sample were taken as Moors road (Nungambakkam). The sample number as COU 15.16.

Figure 3.16 River view of Moors Road

3.17 College road

College road refers to bridge over the Cooum river at the junction of Pantheon road and Commander in chief road which led to college of St.fort George where civilians study the south Indian languages and which it gave name to college road. The uncontrolled discharge of sewage, garbage, and industrial effluents into the downstream of the river Cooum, percolates through the soil and contaminates the Groundwater sources. Figure 3.17 shows the sediment sample were taken as College road. The sample number as COU 15.17 and it lies between 13°04’0.17”North latitudes and 80°15’17.6”East Longitude.

Figure 3.17 River view of College Road

3.18 Commander in chief road

Ethiraj salai, formerly known as commander-in-chief road has many majestic building belonging to the british area. The topography of the road is very interesting, cooum curving along the periphery of the road and separating from the Binny road and flowing it is way to Chindatripet. In this location it completely encroached form community people. Figure 3.18 shows the sediment sample were taken as commander in chief road. The sample number as COU 15.18 and it lies between 13°03’50.3”North latitudes and 80°15’38.9”East longitudes.

Figure 3.18 Sample taken on the Commander in chief road

3.19 Chindadripet

Chindadripet (originally China Tari Pettah) located on the southern bank of the Cooum river,it is a residential-cum-commercial area surrounded by Chepauk, island grounds, Egmore and Annasalai. It lies between 13°04’08.0”North latitudes and 80°16’07.5”East longitudes. In this place the weaver’s colony was set up in the 1730s. The area was low-lying and the river flooded the entire area so there are records of the embankment being raised frequently and dam’s road, which runs parallel to the stream to compensate it. Figure 3.19 shows the sample were taken as Chindadripet. The sample number as 15.19.

Figure 3.19 River view of Chindadripet

3.20 Napier bridge

It is one of Chennai's oldest arch structured bridge built over the Cooum River connecting Fort St.George with the Marina beach. The beauty of the bridge is that one can see the sunrise from the Bay of Bengal and sunset from the Cooum River. It lies between13°00'52.3"North latitudes and 80°15'35.1"East longitudes. The river forks into northern and southern arms both of which join again near the Napier bridge, thus forming an island known as the island grounds. In early days this river water was used for drinking and irrigation needs. But now, Cooum river being one of the greatest boon for the mankind was made into a " curse of Chennai" over the years due to sewerage disposal. There are approximately 337 outlets into the polluted part of the river, mostly executed by Chennai metro water. The river mouth near the Napier bridge gets blocked most of the times, preventing the river water from draining into the Bay of Bengal, hence the sewerage disposed into the river stays in the river and makes it a foul smelling pool. Figure 3.20 shows the sediment sample were collected from near bridge and Sample number as COU 15.20.

Figure 3.20 Sample taken on the Napier's Bridge

BUCKINGHAM CANAL

The Buckingham Canal is a 796 kilometres long fresh water navigation canal, running parallel to the Coromandel Coast of South India from Kakinada in East Godavari district in Andhra Pradesh to Villupuram District in Tamil Nadu. The canal connects most of the natural backwaters along the coast to the port of Chennai. Originally known as Cochrane's canal, the first segment of the canal was constructed as a saltwater navigation canal in 1806, from Madras North to Ennore for a distance of 11 miles. Subsequently, it was extended north to Pulicat Lake, 40 kilometres (24.9 mile) north of Madras. The canal was taken over by the government of Madras Presidency in 1837 and further extended, ultimately reaching 315 kilometres (195.7 mile) north of Madras to Vijayawada on the bank of Krishna River in Andhra Pradesh, and 103 kilometres (64.0 mile) south of Chennai to Marakkanam in Tamil Nadu.

During 1877 and 1878 the people of Madras suffered from the terrible Great Famine and more than six million people perished. The 8-kilometre (5.0 mi) stretch, linking the Adyar and Cooum rivers, was built in 1877-78 at a cost of Rs.3 millions as a famine relief work. The canal was named the Buckingham Canal in 1878 because the link, was built on the orders of the then Governor, the Duke of Buckingham and Chandos. It was first known as the North River by the British and was believed to be partly responsible for reducing tsunami and cyclone damage to much of the Chennai-southern Andhra coastline

3.21 Chepauk

The sediment sample was taken from the chepauk location to determine the contamination of existing industries, thermal power plant and household sewage discharges. The sample location lies between 13°03’51.9”North latitudes and 80°16’50.9”East longitudes. Figure 3.21 shows the sediment sample were collected from near bridge and Sample number as BUCK15.21.

Figure 3.21 River view of Chepauk (Buckingham canal)

3.22 Mandaiveli

Mandaveli is a neighbourhood in Chennai, India. It is also termed usually as Mandavelipakkam which in the Tamil language "Mandhai" is 'herd of cattle' and "Veli" is 'grassland'. Being urbanized area, wastewater generation increased which are directly discharge into this river course. So sediment sample was collected from here for analysis.The collected sample location lies between 13°01’34.7”North latitudes and 80°15’36.5”East longitudes. Figure 3.22 shows the sediment sample were collected from near Manadaiveli railway junction and Sample number as BUCK15.22.

Figure 3.22 Sample taken on the Mandaiveli (Buckingham canal)

RESULTS OF SAMPLE COLLECTION:

After collection of field sediment samples it dried by oven in the laboratory of Centre for Water Resources, Anna University, Chennai.

SUCESSFULLY COLLECTED FOR THE SEDIMENT SAMPLES