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# ASSESSMENT OF WATER QUALITY FOR THE DETERMINATION OF EXTENT OF POLLUTION IN MALIR RIVER

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## ABSTRACT

Karachi is the most industrially developed and populous city of Pakistan. A big part of its basin is occupied by alluvial of Malir River which is basically a seasonal river but becomes perennial within the limits of Karachi due to the continuous flow of untreated sewage and industrial effluents through its basin into the Arabian Sea.

The data obtained during this study shows that the most down stream parts of the river are grossly polluted due to the inclusion of sewage and industrial wastes. Present data shows that pollution has not only deteriorated the pristine conditions of this river but it is also causing pollution in Arabian Sea where river finally falls. The data shows increasing trend of nutrients concentration and turbidity from 1994 to 1996. This study provides the base line data and reflects the quality of water in Malir River in middle 1990's. This data can be used to study the extent of pollution in Malir river by comparing it to the recent data (if available) on Malir river.

**Key Word:** Malir River, Pollution, Nutrients.

## INTRODUCTION

Aquatic pollution results in physical, chemical and biological deterioration of water bodies causing destruction of biota. Pakistan has many seasonal rivers in addition to Indus and Balochistan drainage system. Most of these rivers remains dry due to scanty rainfalls specially in the province of Sindh. Some of these rivers have become perennial in their down stream regions due to continuous flow of sewage and industrial waste.

The availability of potable water is now an important issue for Pakistan because of a tremendous increase in human population. Urbanization and industrialization have resulted in the increased demand of water along with high rates of contamination of the water resources in less developed as well as in the developed countries. Most of the small rivers have changed into sewers for the discharge of municipal, agriculture and industrial waste and hence, act as vehicles for the transport of pollutants into the sea.

Malir and Layari rivers are the ephemeral rivers of Karachi. Both of these rivers receive large amount of municipal and industrial wastes from the two biggest industrial areas i.e., LITE and SITE of Karachi. However, before independence of Pakistan Malir river were used to supply the potable water. According to EPA present condition of Malir river is very different from the one existing at the time of partition of the sub-continent when the inhabitants of Karachi and adjacent areas used to dig wells in the bed of this river to obtain potable water.

Determination of water quality is important not only because of its link to the availability of water for various uses but also due to its impact on the human health both directly and indirectly. Various reports were available on the quality of water in Layari river (Begum and Nazneen, 1988; Nazneen *et al*, 1990; 1993 and 1995) but very few information is available on the condition of Malir river. The present study is aimed to assess the water quality of Malir river in selected localities.

## MATERIALS AND METHODS

The course of Malir River within Karachi was selected for this study. Malir River is situated between **24 $^{o}$ 45'N latitude and 67 $^{o}$ 22' E** and the total area of Malir River is 1415 square kilometer. After a preliminary survey of Malir River, four spots namely Murad Memon Goth (spot2), Malir city (spot 3), Drigh road (spot 4) and Qayumabad (spot 5) were selected for sampling. Monthly water sampling was made from spot 2-5 continuously up to three years (1994-1996) while spot 1(Dumlotte) was not included in this study as it remains dry most part of the year.

All the physical parameters pH, and Total Dissolve Solids (TDS) were measured in the field. Temperature of water was recorded by Mercury thermometer fitted in the water sampler. Salinity was determined by Refractometer. The light penetration level were determined by Sacchi disk and the vertical attenuation coefficient was calculated by the formula given by Chhatwal *et al*., (1989). The TDS were estimated by TDS Tester no 173987 (Hanna Inc.).

For the analysis of chemical factors water samples were first immediately filtered on Whatman Filter paper 44. Samples were kept frozen until further analysis. Samples for Dissolve oxygen were fixed immediately after collection in the field and were later determined by Winkler method. Free $CO_2$ was measured by the procedure described by Golterman *et.al*. (1978).

Ammonia, Nitrite, Nitrate, Phosphate and silica were determined by colorimetric method on Orbeco-Hellige Analytical System.

## RESULTS

### Physical parameters

Malir is a river of tropical latitude as its water temperature remains above 16°C even in winter season. During the present study surface water temperature was always found 2-4°C warmer than the deeper water. The basin of Malir river remains dry most of the year before entering Karachi. However it becomes perennial due to the continuous flow of sewage and industrial effluents in Karachi. The water at spot 5 are highly turbid and less transparent as the colour of water mostly appeared black and blackish green at this spot (Table 4). The Salinity in Malir River varies from 3.4-6.4 ‰. The values of pH were around 8 but slightly higher (8.5) at Spot 5 (Table 1).

Table 1. Characterization of Malir River water at SPOT 2. Values are mean of 12 samples/year.±SD

| Parameters | Surface waters (Average values) | | | Depth waters (Average values) | | |
|---|---|---|---|---|---|---|
| | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 |
| Temperature $^{o}$C | 27.33 ± 4.35 | 27.16 ± 4.34 | 28.0 ± 4.57 | 24.75 ± 5.16 | 23.6 ± 4.28 | 25.25 ± 4.02 |
| LPL (meters) | 13.62 ± 2.58 | 15.04 ± 1.84 | 14.08 ± 2.19 | ---- | ---- | ---- |
| VAC (cm) | 0.145 ± 0.02 | 0.12 ± 0.01 | 0.13 ± 0.02 | ---- | ---- | ---- |
| Salinity ‰ | 3.65 ± 0.4 | 3.44 ± 0.32 | 3.66 ± 0.4 | 3.53 ± 0.3 | 3.59 ± 0.34 | 3.48 ± 0.34 |
| pH | 8.2 | 8 | 8 | 8.25 | 8 | 8 |
| TDS | 531.7 ± 12.7 | 468.5± 136.7 | 359.2 ± 172.7 | 383 .3 ± 123.6 | 350 ± 152.3 | 462.5 ± 146.4 |
| Dissolve $O_2$ (mg / l) | 10.5 ±1.14 | 11.8 ± 1.56 | 11.10 ± 1.8 | 9.37 ± 1.06 | 10.22 ±1.27 | 9.46 ± 1.44 |
| Free Co $_2$ (mg /l) | 3.75 ± 1.05 | 3.25 ± 0.96 | 3.33 ±1.3 | 2.25 ±0.61 | 3.33 ±0.76 | 2.91 ± 0.78 |
| Alkalinity (mg /l) | 355.4 ± 70.2 | 262.5 ± 100.8 | 1561.4 ± 84.7 | 364.1 ± 70.9 | 274.6 ± 107.05 | 174.1 ± 149 |
| Ammonia ( mg /l) | 0.73 ± 0.22 | 0.48 ± 0.1 | 0.71 ± 0.14 | 0.63 ± 0.15 | 0.57 ± 0.13 | 0.59 ± 0.19 |
| Nitrite (mg /l) | 0.17 ± 0.05 | 0.088 ± 0.1 | 0.15 ±0.04 | 0.17 ± 0.05 | 0.059 ± 0 | 0.13 ± 0.03 |
| Nitrate (mg /l) | 0.6 ± 0.42 | 0.58 ± 0.28 | 0.64 ± 0.4 | 0.45 ± 0.47 | 0.46 ± 0.43 | 0.6 ± 0.33 |
| Silica ( mg /l) | 61.00 ± 8.51 | 50.04 ± 14.75 | 44.64 ± 9.67 | 47.0 ± 12.99 | 44.47 ± 14.8 | 44.33 ± 8.53 |
| Phosphate ( mg /l) | 3.0 ± 0.56 | 2.98 ± 0.76 | 1.83 ± 0.74 | 2.90 ± 0.62 | 2.06 ± 0.64 | 1.96 ± 0.83 |

LPL: Light penetration level; VAC: Vertical attenuation coefficient; TDS: Total dissolved solids

Table 2. Characterization of Malir River water at SPOT 3. Values are mean of 12 samples/year ±SD
LPL: Light penetration level; VAC: Vertical attenuation coefficient; TDS: Total dissolved solids

| Parameters | Surface waters (Average values) | | | Depth waters (Average values) | | |
|---|---|---|---|---|---|---|
| | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 |
| Water temperature | 27.83 ± 3.58 | 26.5 ± 4.72 | 27.08± 2.64 | 24.25 ± 3.64 | 24.16 ± 4.01 | 24.91 ± 3.25 |
| LPL | 15.83 ± 3.14 | 15.70 ± 1.92 | 15.54 ± 2.66 | ---- | ---- | ----- |
| VAC(cm) | 0.12 ± 0.01 | 0.12 ± 0.01 | 0.12 ± 0.01 | ---- | ---- | ---- |
| Salinity ‰ | 6.01± 0.28 | 6.13 ± 0.47 | 5.85 ± 0.28 | 6.13 ± 0.35 | 5.27 ± 0.47 | 5.72 ± 0.47 |
| pH | 8 | 8 | 8 | 8 | 8 | 8 |
| TDS | 514.2 ± 172.7 | 462.5 ± 146.6 | 531.7 ± 212.7 | 379.2 ± 151.4 | 366.6 ± 130.2 | 383.3 ± 12.6 |
| Dissolved $O_2$ (mg /l) | 8.25 ± 0.67 | 9.13 ± 0.64 | 9.4 ± 0.70 | 7.91 ± 0.68 | 8.01 ± 0.72 | 8.0 ± 0.72 |
| Free Co $_2$ (mg /l) | 3.91 ± 0.78 | 4 ± 0.94 | 3.33 ± 0.87 | 2.33 ± 0.46 | 3.25 ± 0.96 | 3.25 ± 1.22 |
| Alkalinity (mg /l) | 364.5 ± 71.5 | 278.5 ± 88.74 | 179.6 ± 79.7 | 366.2 ± 74.7 | 275.5 ± 69.7 | 200.9 ± 139.8 |
| Ammonia ( mg /l) | 0.82 ± 0.15 | 0.53 ± 0.13 | 0.72 ± 0.21 | 0.68 ± 0.17 | 0.55 ± 0.18 | 0.51 ± 0.1 |
| Nitrite (mg /l) | 0.11 ± 0.03 | 0.082 ± 0 | 0.12 ± 0.04 | 0.11 ± 0.03 | 0.082 ± 0.031 | 0.11 ± 0.03 |
| Nitrate (mg /l) | 0.55 ± 0.35 | 0.55 ± 0.46 | 0.67 ± 0.17 | 0.56 ± 0.49 | 0.47 ± 0.41 | 0.61 ± 0.17 |
| Silica ( mg /l) | 50.99 ± 14.9 | 49.15 ± 12.8 | 49.5 ± 14.9 | 55.72 ± 8.07 | 40.17 ± 13.4 | 48.12 ± 17.13 |
| Phosphate ( mg /l) | 3.49 ± 0.55 | 3.09 ± 0.7 | 2.36 ± 0.23 | 2.56 ± 0.49 | 2.38 ± 0.62 | 2.19 ± 0.36 |

Table 3. Characterization of Malir River water at SPOT 4. Values are mean of 12 samples/yers ±SD

| Parameters | Surface waters (Average values) | | | Depth waters (Average values) | | |
|---|---|---|---|---|---|---|
| | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 |
| Water temperature | 26.41 ± 4.31 | 25.75 ± 3.86 | 23.08 ± 3.82 | 27.16 ± 4.4 | 22.5 ± 2.64 | 24.41 ± 3.91 |
| LPL | 1.25 ± 1.54 | 18.66 ± 1.07 | 16 ± 3.8 | --- | --- | --- |
| VAC (cm) | 0.17 ± 0.01 | 0.12 ± 0.01 | 0.12 ± 0.01 | --- | --- | --- |
| Salinity ‰ | 4.22 ± 0.4 | 3.96 ± 0.53 | 4.3 ± 0.61 | 4.49 ± 0.33 | 4.4 ± 0.35 | 4.33 ± 0.42 |
| pH | 8 | 8 | 8 | 8 | 8 | 8 |
| TDS | 646.7 ± 137.5 | 420.83 ± 155.8 | 580 ± 171 | 580 ± 171 | 429.2 ± 128.7 | 325 ± 167.2 |
| Dissolve $O_2$ (mg /l) | 12. 96 ± 1.28 | 13.01 ± 1.18 | 12.24 ± 1.50 | 11.45 ± 1.48 | 11.23 ± 1.15 | 10.79 ± 0.95 |
| Free $Co_2$ (mg /l) | 3.3 ± 0.74 | 3.08 ± 0.9 | 2.83 ± 0.8 | 1.91 ± 0.3 | 3.5 ± 0.5 | 3.33 ± 0.9 |
| Alkalinity (mg /l) | 341.3 ± 84.8 | 255.5 ± 95.3 | 96.8 ± 71.8 | 357 ± 77.9 | 263.2 ± 96.7 | 123.3 ± 131.8 |
| Ammonia ( mg /l) | 0.71 ± 0.16 | 0.35 ± 0.12 | 0.16 ± 0.12 | 0.59 ± 0.14 | 0.5 ± 0.11 | 0.29 ± 0.13 |
| Nitrite (mg /l) | 0.14 ± 0.03 | 0.103 ± 0 | 0.16 ± 0.04 | 0.14 ± 0.03 | 0.076 ± 0 | 0.11 ± 0.04 |
| Nitrate (mg /l) | 0.52 ± 0.24 | 0.54 ± 0.33 | 0.36 ± 0.09 | 0.36 ± 0.26 | 0.46 ± 0.5 | 0.36 ± 0.1 |
| Silica ( mg /l) | 59.41 ± 12.4 | 56.69 ± 15.6 | 49.9 ± 14.9 | 54.11 ± 14.6 | 46.39 ± 15.6 | 48 ± 17.3 |
| Phosphate ( mg /l) | 2.45 ± 0.6 | 2.77 ± 0.79 | 1.35 ± 0.51 | 2.67 ± 0.64 | 1.94 ± 0.61 | 1.41 ± 0.52 |

LPL: Light penetration level; VAC: Vertical attenuation coefficient; TDS: Total dissolved solids

Table 4. Characterization of Malir River water at SPOT 5. Values are mean of 12 samples/year ±SD

| Parameters | Surface waters (Average values) | | | Depth waters (Average values) | | |
|---|---|---|---|---|---|---|
| | 1994 | 1995 | 1996 | 1994 | 1995 | 1996 |
| Water temperature | 27.3 ± 4.18 | 24.8 ± 3.65 | 27.0 ± 3.95 | 24.3 ± 4.26 | 22.8 ± 4.08 | 24.0 ± 2.76 |
| LPL | 11.04 ± 1.41 | 12.70 ± 2.18 | 13.39 ± 2.95 | --- | --- | --- |
| VAC (cm) | 0.17 ± 0.02 | 0.15 ± 0.01 | 0.14 ± 0.03 | --- | --- | --- |
| Salinity ‰ | 6.15 ± 0.13 | 5.94 ± 0.22 | 6.51 ± 0.45 | 5.9 ± 0.36 | 6.39 ± 0.33 | 6.3 ± 0.44 |
| pH | 8.5 ± 0.51 | 8.5 ± 0.53 | 8.5 ± 0.51 | 8.4 ± 0.5 | 8.5 ± 0.51 | 8.5 ± 0.53 |
| TDS (mg/l) | 98.3 ± 36.6 | 145 ± 76.5 | 90 ± 23.4 | 110 ± 35.2 | 325 ± 167.2 | 98.3 ± 36.6 |
| Dissolve $O_2$ (mg /l) | 4.4 ± 0.67 | 5.21 ± 0.8 | 4.71 ± 0.7 | 3.46 ± 0.3 | 4.06 ± 0.6 | 3.61 ± 0.5 |
| Free $Co_2$ (mg /l) | 4.83 ± 0.21 | 5.58 ± 0.9 | 3.5 ± 1.31 | 3 ± 0.6 | 4.58 ± 0.66 | 3.41 ± 1.23 |
| Alkalinity (mg /l) | 365 ± 71.54 | 278.8 ± 96.9 | 250.9 ± 71.8 | 386.2 ± 85.1 | 314.8 ± 103.9 | 270 ± 139.8 |
| Ammonia ( mg /l) | 0.98 ± 0.08 | 0.8 ± 0.14 | 1.2 ± 0.15 | 0.81 ± 0.16 | 0.7 ± 0.18 | 0.98 ± 0.11 |
| Nitrite (mg /l) | 0.1 ± 0.04 | 0.2 ± 0.031 | 0.34 ± 0.04 | 0.1 ± 0.04 | 0.15 ± 0 | 0.29 ± 0.06 |
| Nitrate (mg /l) | 0.61 ± 0.33 | 0.61 ± 0.41 | 0.9 ± 0.36 | 0.51 ± 0.44 | 0.5 ± 0.34 | 0.82 ± 0.24 |
| Silica ( mg /l) | 60.92 ± 16.1 | 50.1 ± 15.5 | 44.64 ± 15.8 | 46.98 ± 14.6 | 44.47 ± 15.6 | 44.33 ± 16.7 |
| Phosphate ( mg /l) | 3 ± 0.63 | 2.98 ± 0.76 | 1.83 ± 0.57 | 2.75 ± 0.65 | 2.69 ± 0.4 | 3.04 ± 0.7 |

LPL: Light penetration level; VAC: Vertical attenuation coefficient; TDS: Total dissolved solids

**Nutrients**

The highest values of Ammonium in surface and deeper waters were obtained from Spot 5. The lowest value of 0.16 and 0.29 $mg^{-1}L$ were obtained from spot 4 from surface and deeper water respectively (Table 3). Similarly the average values of Nitrate and Nitrite in surface and deeper waters were also slightly higher at spot 5 (Table 4).The concentration of nutrients were comparatively higher in the surface waters of Malir river (Figure). The concentrations of Phosphate were higher in all spots (Figure 1). The higher values of Phosphate in surface water were obtained from Spot 3 (3.49 mg/L and lowest from Sot 4, whereas high value of Phosphate were obtained from the deeper water at Spot 5 (Figure1). The silica contents in Malir river shows little variation in surface water (Figure 2). In deeper water samples the highest value of Silica (55.72 $mg^{-1}L$) were obtained from Spot 3 in 1994 (Table 2).

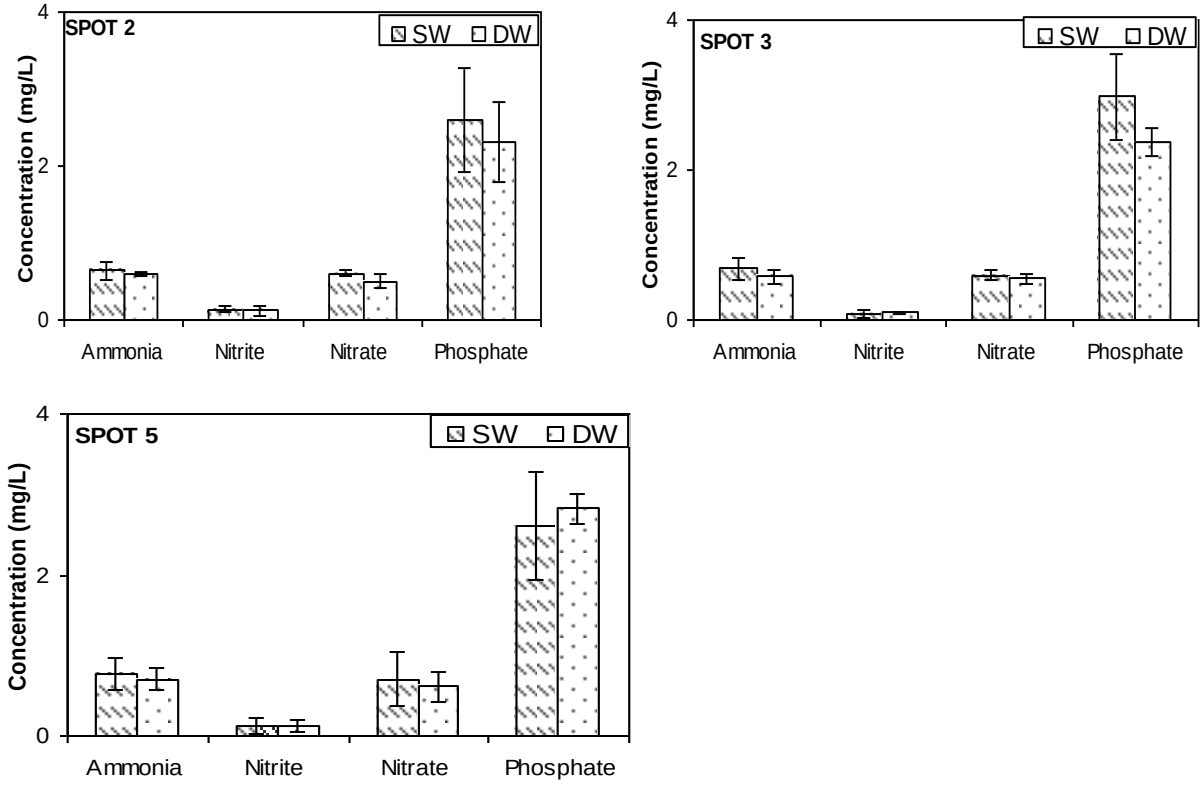


Fig.1. Distribution of nutrients (mean values 1997-1999) at different spots in Malir river. SW: Surface water; DW: Deeper water

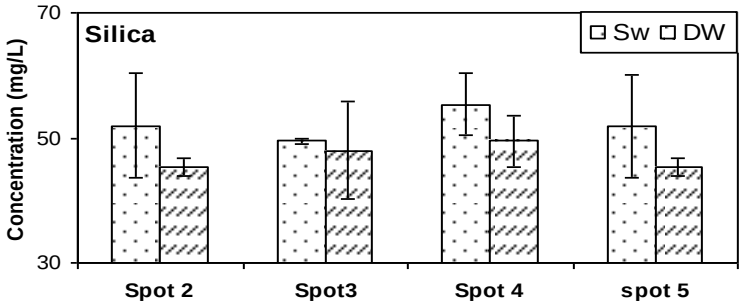


Figure 2. Comparative distribution of Silica (mean values) at different spots in Malir river. SW: Surface water; DW: Deeper water

The higher values of Phosphate in surface water were obtained from Spot 3 (3.49mg/L and lowest from Sot 4, whereas high value of Phosphate were obtained from the deeper water at Spot 5 (Figure1). The silica contents in Malir river shows little variation in surface water (Figure 2). In deeper water samples the highest value of Silica (55.72 $mg^{-1}L$) were obtained from Spot 3 in 1994 (Table 2).

## DISCUSSION

The study shows that the water of Malir river is turbid and the VAC values are slightly higher at spot 4 and 5 which is may be due to the decomposition of organic matter as described by Calijuri *et al*., (1997). Present data of salinity indicate high range of salt contents in the river which is may be due to the flow of various disposals in to the river. Haslam (1991) reported that salinity of rivers increases near the estuaries and also by the flow of various waste disposals in to the river bed. The high value of pH at Spot 5 may be due to the mixing of various industrial and municipal wastes as indicated by Ghose and Sharma, (1989).

Spot 2 indicate the large quantity of dissolve oxygen which results in the luxuriant growth of aquatic weeds. Low oxygen concentration at spot 5 may be due to the inclusion of large amount of sewage and industrial effluents. This spot also contains high contents of total dissolve solids and is highly turbid. The same cases of oxygen depletion in polluted waters were also noticed by Ellis (1937), Elmore *et al*. (1961) and Mishra *et al*. (1990). However, irregularities in the distribution of oxygen both in the surface and deeper water samples occur either due to single or the combination of the factors like temperature, intensity of illumination and photosynthesis as described by Ganapti (1940) and Nazneen (1980).

At Spot 5 the levels of $CO_2$ shows fluctuation in concentration and it is quit higher than dissolved oxygen. High concentration of free $CO_2$ reported to be due to the decomposition of organic matter in a water body rather than its production (Sreenivasan, 1964; Mishra *et al*., 1990). High value of Total alkalinity in the down streams of IB River India was reprted to be due to the alkaline discharge in to the river Mishra *et al*., (1990).

Concentrations of Ammonia, nitirite and nitrate in Malir River are within the range of observed values for streams and rivers given by McCutcheon *et al.*, (1992). However in comparison to nitrite and nitrate, level of ammonia is quite high in Malir River. According to Chapman and Kimstach (1996) high concentration of Ammonia are toxic to aquatic life.

At spot 5 the high value of Silica content in Malir river is due to the presence of sand and gravel and disposal of waste water as indicated by Lind (1974).

**Conclusion**

Spot 5 is polluted due to the industrial and municipal waste, whereas Spot 2and 4 are less polluted. The data shows increasing trend of nutrients concentration and turbidity from 1997 to 1999. This study provides the base line data and reflects the quality of water in Malir River in late 1990's. This data can be used to study the extent of pollution in Malir river by comparing it to the recent data (if available) on Malir river.

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