International Journal of Current Research and Academic Review
ISSN: 2347-3215 Volume 3 Number 4 (April-2015) pp. 234-248
www.ijcrar.com

# Physico-chemical assessment of Waldhuni River Ulhasnagar (Thane, India): A case study

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**KEYWORDS**

Physico-chemical assessment, water body, Temperature, pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD)

**A B S T R A C T**

The contamination of rivers,streams, lakes and underground water by chemical substances which are harmful to living beings is regarded as water pollution.The physico-chemical parameters of the water body are affected by its pollution. The changes in these parameters indicate the quality of water. Hence such parameters of WaldhuniRiver were studied and analyzed for a period of two years during May2010to April2012. The analysis was done for the parameters such as Temperature, pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Carbon dioxide, Total Hardness, Calcium, Magnesium, T S, TDS, &TSS. The results are indicated in the present paper.

## Introduction

The Waldhuni River is a small River originating at Kakola hills, Kakola Lake near Ambernath and unites with Ulhas River near Kalyan. Its total length is 31.8km. The river is so much polluted that it is now referred to as Waldhuni Nallah. It flows through thickly populated area of Ambernath, Ulhasnagar and Vithalwadi and is severely polluted due to domestic and industrial sewage. Patil *et al*(2012) have observed that due to rapid urbanization and industrialization there has been increasing stress of rivers giving rise to water pollution and environmental deterioration. Water was primarily used for domestic needs such as drinking, cooking, washing, bathing etc. But due to industrial and urban development, requirement of water is increased. Good quality of water with high Dissolved oxygen, low BOD and COD, minimum salts dissolved in it is required for living beings. The quality of water is dependent on physical, chemical and biological parameters (Jena *et al*, 2013).Rapid release of municipal and industrial sewage severely decreases aquatic environment. Major sources of water pollution are from municipal water, industrial water, agricultural water, sewage water, etc. Polluted water may contain suspended solids, dissolved inorganic compounds, nitrogen and phosphorous compounds, animal wastes, toxic chemicals, insecticides, pesticides, medical waste, toxic heavy metals and biological pollutants such as pathogenic bacteria, fungi, protozoa, viruses, parasitic worms, etc.(Aggarwal and Arora, 2012).

The increasing industrialization and urbanization all over the world has resulted in pollution of water and in deterioration of its quality. Traditional customs and habits along with the release of domestic waste water, agricultural run-offs and industrial effluents have resulted in deterioration of water quality and loss of its potability. This has also led to the deterioration of groundwater due to the percolation of pollutants under the soil/ground. (Aggarwal and Arora, 2012).

Fresh water is essential for agriculture, industry and human beings and animals. The sources of fresh water on the earth are limited. Without adequate quantity and quality of fresh water sustainable development will not be possible (Kumar, 1997, Mahananda, 2005). Since fresh water resources are getting deteriorated day-by-day at a very faster rate, water quality is a global problem (Mahananda, 2005). The healthy aquatic ecosystem is dependent on the biological diversity and is reflected by its physico-chemical characteristics (Venkatesharaju *et al*, 2010). Microorganisms are widely distributed in nature and diversity of microorganisms may be used as an indicator for organic pollution. (Andrew, 2012).

## Materials and Methods

Water samples were collected for physico-chemical analysis at regular intervals of three months from May2010 to April 2012. The samples for the analysis were collected in sterilized bottles using the standard method of American Public Health Association (APHA-1985).The water samples were collected from the four locations of Waldhuni River.These locations are origin at Kakolalake at kakolagaon, AMP Gate of Ambernath, CHM College Gate at Ulhasnagar and petrol pump of Vitthalwadi. The areas were selected on the basis of Levels and types of pollution. At the point of origin, people use water for house hold purposes and is almost free of pollution. At the second location, there is maximum domestic pollution. At the third location, there are many dye industries, the sewage from the industries from Ambernath containing inorganic wastes, those from dye industries containing dyes, acids, bases etc. are mixed with the water that already contains domestic sewage. The last location is the site just before the meeting point of Waldhuni and Ulhas Rivers. At this point, water contains all sorts of pollutants and is the site of extreme pollution.

The parameters studied and their methods used in the present investigations are given are in detail.

## Results and Discussion

Surface water temperature has direct effecton chemical and biological processes of water body. It also affects the living organisms and their metabolic and physiological processes in aquatic ecosystem. In the present study temperature was found ranging between $27.1^0$C to$34.1^0$C. The surface water temperature varied according to the seasonal fluctuations of atmospheric temperature being higher in pre-monsoon and lower in post monsoon as is observed by Saxena and Chouhan (1993).

The pH was observed in the range 2.1 to 7.5. As there are many dye and other industries along the banks of the rivers the effluents include dye stuff, acids, bases, detergents at different times this results in fluctuations of pH values. pH of water is important for the biotic components because most of the plant and animal species prefer a particular range of pH for their growth and existence. The fungal samples survived better at moderately acidic pH values. According to Shaikh and Yeragi, (2003) pH is considered to be most important factor particularly in the case of the green algae. Das *et al*, (1961), observed that high pH values coincided with plankton peak. The lowest values of pH during rainy season may be due to the dilution of alkaline substances or dissolution of atmospheric carbon dioxide.(Shaikh and Yaragi, 2003).

The dissolved oxygen was varied from 0.2 to 6 mg/l during study. The dissolved oxygen is found to be maximum in the month of July and minimum in the months of May. In any season, its values are highest at Kakole Lake indicating the purity of water. The values are lowest at the petrol pump site where the pollution levels are highest. Dissolved oxygen in water depends on temperature of water at a given time. All living organisms in water require dissolved oxygen for respiration. Lower values of Dissolved oxygen in summer season are due to higher rate of decomposition of organic matter by microorganisms in water body and reduced water quantity due to evaporation. It is an important parameter indicating the physical and biological processes in water body. (Jena *et al*, 2013). DO is supposed to be an indicator of destruction of organic matter and self-purification capacity of the waster body. The standard for maintaining the aquatic flora and fauna is around 5 mg/l. the values below this, leads to decreasing levels of aquatic life. (Akan *et al*, 2008).

The biochemical oxygen demand was obtained from 1mg/l to 291 mg/l. Biological Oxygen Demand (BOD) is an important parameter that measures the oxygen required for the degradation of organic matter. BOD levels are higher at CHM gate and petrol pump sites and lowest at Kakolelake. The increasing levels of pollutants show the corresponding increase in BOD. Biological oxygen demand increases due to biodegradation of organic materials which depletes oxygen in a water body (Joshi *et al*, 2009).

The chemical oxygen demand was received from 1.2 mg/l to 740mg/l in the months of April while the minimum values were observed in the month of August. In the present investigations, COD values are highest at the petrol pump site where all types of pollutants are also at their highest level. The polluted water samples containing large quantities of chemicals cannot be just assessed by determining BOD. In such cases, the measure of COD determines the quantity of organic matter found in water. This makes COD as an indicator of organic pollution in surface water (Faith, 2006).

The free $CO_2$was received from 29 mg/l to 395 mg/l. Carbon dioxide is the end product of organic carbon degradation in almost all aquatic environments and its variation is often a measure of net ecosystem metabolism(Smith 1993). It is also produced by the interactions of many chemicals released in the water. $CO_2$ is also released by the respiration of aquatic organisms. (Manjare *et al*, 2010)

In the present study total hardness ranged from 35mg/l to 415 mg/l in different seasons. These high values may be due to the addition of calcium and magnesium salts through the industrial effluents, the decrease in water volume due to increase in the rate of evaporation in summer. The results obtained in the present investigations are in accordance with Hujare (2008)who reported high values of total hardness during summer than during rainy season and winter season and Manjare *et al*, (2010).

**Parameters and methods for water samples**

| Sr. No. | Parameters of water analysis | Methods |
|---|---|---|
| 1 | pH | Potentiometric |
| 2 | DO | Azide modification |
| 3 | BOD | Azide modification |
| 4 | COD | Dichromate reflux |
| 5 | Free $CO_2$ | Titrimetric |
| 6 | Total Hardness | Titrimetric |
| 7 | Calcium, Magnesium | Titrimetric |
| 9 | T.S, T.D.S & T.S.S. | Classical (Evaporation) |

**Seasonal variations in temperature of WaldhuniRiver**

| **Years** | **May 2010** | **Aug 2010** | **Nov 2010** | **Feb 2011** | **May 2011** | **Aug 2011** | **Nov 2011** | **Feb 2012** |
|---|---|---|---|---|---|---|---|---|
| **Site** | | | | | | | | |
| Kakola lake | 34.1 | 27.5 | 29.5 | 30.5 | 33.5 | 27.2 | 29.7 | 30.8 |
| Amp gate | 33.4 | 27.1 | 29.3 | 31.4 | 33.8 | 27.5 | 29.1 | 32.1 |
| CHM gate | 33.2 | 27.4 | 29.2 | 30.1 | 33.5 | 27.1 | 28.9 | 30.1 |
| Petrol pump | 32.9 | 27.5 | 29.1 | 30.3 | 33.7 | 27.2 | 28.5 | 30.1 |

**Table 1. Temperature variation in Waldhuni River.**

Significance by two way Analysis of Variance (ANOVA)
Between Sites: F = 0.1054 df= 31
SE between sites: 168.8
Between time period: F = 102.3
SE between time period: 5.537
The probability of this result, assuming the null hypothesis, is less than .0001

**Seasonal variations in pH of Waldhuni River**

| | **May2010** | **Aug2010** | **Nov2010** | **Feb2011** | **May2011** | **Aug2011** | **Nov211** | **Feb2012** |
|---|---|---|---|---|---|---|---|---|
| **Site** | | | | | | | | |
| Kakola lake | 6.5 | 7.4 | 6.2 | 6.3 | 6.5 | 7.5 | 6.6 | 6.1 |
| Amp gate | 6.3 | 6.5 | 6.1 | 4.2 | 4.1 | 6.3 | 5.5 | 5.6 |
| CHM gate | 5.5 | 6.2 | 5.5 | 2.6 | 2.4 | 6.2 | 5.3 | 2.3 |
| Petrolpump | 2.5 | 6.1 | 5.1 | 2.2 | 2.1 | 6.1 | 5.1 | 2.5 |

Significance by two way Analysis of Variance (ANOVA)
Between Sites: F = 6.058 df= 31
SE between sites: 52.07
Between time period: F =2.524
SE between time period: 49.45
The probability of this result, assuming the null hypothesis, is less than .0001

### Seasonal variations in DO of Waldhuni River

| Years | May 2010 | Aug 2010 | Nov 2010 | Feb 2011 | May 2011 | Aug 2011 | Nov 2011 | Feb 2012 |
|---|---|---|---|---|---|---|---|---|
| **Site** | | | | | | | | |
| Kakola lake | 1 | 6 | 5 | 1.5 | 1.5 | 5.6 | 4.1 | 1.9 |
| Amp gate | 0.5 | 3 | 2.2 | 1.1 | 0.4 | 3.5 | 2.1 | 1.2 |
| CHM gate | 0.4 | 2 | 1.2 | 0.6 | 0.3 | 2.4 | 1.3 | 0.2 |
| Petrol pump | 0.4 | 2 | 1.1 | 0.5 | 0.2 | 2.2 | 1 | 0.2 |

Significance by two way Analysis of Variance (ANOVA)
Between Sites: F = 5.622df= 31
SE between sites: 47.94
Between time period: F =3.524
SEbetweentimeperiod: 37.87

The probability of this result, assuming the null hypothesis, is less than .0001

### Seasonal variations in BOD of WaldhuniRiver

| Years | May 2010 | Aug 2010 | Nov 2010 | Feb 2011 | May 2011 | Aug 2011 | Nov 2011 | Feb 2012 |
|---|---|---|---|---|---|---|---|---|
| **Site** | | | | | | | | |
| Kakola lake | 3 | 1 | 1.2 | 1.5 | 4 | 1.2 | 1.4 | 2.5 |
| Amp gate | 115 | 16 | 20 | 24 | 125 | 18 | 22 | 27 |
| CHM gate | 291 | 20 | 27 | 30 | 250 | 21 | 25 | 32 |
| Petrol pump | 248 | 30 | 35 | 38 | 206 | 33 | 40 | 40 |

Significance by two way Analysis of Variance (ANOVA)
Between Sites: F = 2.198df= 31
SE between sites: 1.6122E+05
Between time period: F =4.127
SE between time period: 9.0381E+o4
The probability of this result, assuming the null hypothesis, is less than .0001

**Seasonal variations in COD of WaldhuniRiver**

| Years | May 2010 | Aug 2010 | Nov 2010 | Feb 2011 | May 2011 | Aug 2011 | Nov 2011 | Feb 2012 |
|---|---|---|---|---|---|---|---|---|
| **Site** | | | | | | | | |
| Kakola lake | 7 | 1.2 | 3 | 5 | 8 | 1.5 | 4 | 4.5 |
| Amp gate | 145 | 40 | 62 | 125 | 127 | 42 | 64 | 135 |
| CHM gate | 578 | 60 | 72 | 524 | 544 | 65 | 76 | 556 |
| Petrol pump | 740 | 71 | 86 | 705 | 722 | 69 | 89 | 750 |

Significance by two way Analysis of Variance (ANOVA)
Between Sites: F = 5.812df= 31
SE between sites: 1.3285E+06
Between time period: F =1.805
SE between time period: 1.4122E+06
The probability of this result, assuming the null hypothesis, is less than .0001

**Seasonal variations in $CO_2$ of WaldhuniRiver**

| Years | May 2010 | Aug 2010 | Nov 2010 | Feb 2011 | May 2011 | Aug 2011 | Nov 2011 | Feb 2012 |
|---|---|---|---|---|---|---|---|---|
| **Site** | | | | | | | | |
| Kakola lake | 85 | 35 | 44 | 45 | 75 | 29 | 38 | 47 |
| Amp gate | 359 | 176 | 215 | 227 | 361 | 185 | 210 | 235 |
| CHM gate | 385 | 190 | 220 | 228 | 381 | 189 | 228 | 231 |
| Petrol pump | 388 | 195 | 222 | 236 | 395 | 198 | 240 | 245 |

Significance by two way Analysis of Variance (ANOVA)
Between Sites: F = 18.42 df= 31
SE between sites: 1.2981E+05
Between time period: F =1.389
SE between time period: 2.7466E+05
The probability of this result, assuming the null hypothesis, is less than .0001

**Seasonal variations in Total hardness of WaldhuniRiver**

| Years | May 2010 | Aug 2010 | Nov 2010 | Feb 2011 | May 2011 | Aug 2011 | Nov 2011 | Feb 2012 |
|---|---|---|---|---|---|---|---|---|
| **Site** | | | | | | | | |
| Kakola lake | 160 | 35 | 120 | 147 | 168 | 50 | 125 | 145 |
| Amp gate | 315 | 176 | 200 | 275 | 325 | 70 | 215 | 280 |
| CHM gate | 385 | 246 | 260 | 356 | 399 | 200 | 274 | 378 |
| Petrol pump | 399 | 281 | 286 | 385 | 405 | 250 | 288 | 415 |

Significance by two way Analysis of Variance (ANOVA)
Between Sites: F =15.55 df= 31
SE between sites: 1.4056E+05
Between time period: F =1.770
SE between time period: 2.4718E+05
The probability of this result, assuming the null hypothesis, is less than .0001

**Seasonal variations in Calcium of WaldhuniRiver**

| Years | May 2010 | Aug 2010 | Nov 2010 | Feb 2011 | May 2011 | Aug 2011 | Nov 2011 | Feb 2012 |
|---|---|---|---|---|---|---|---|---|
| **Site** | | | | | | | | |
| Kakola lake | 35 | 10 | 17 | 23 | 33 | 15 | 20 | 29 |
| Amp gate | 97 | 20 | 48 | 55 | 108 | 25 | 45 | 60 |
| CHM gate | 103 | 23 | 72 | 68 | 125 | 30 | 75 | 81 |
| Petrol pump | 107 | 24 | 80 | 96 | 130 | 32 | 86 | 95 |

Significance by two way Analysis of Variance (ANOVA)
Between Sites: F =6.017df= 31
SE between sites: 2.4603E+04
Between time period: F =3.465
SE between time period: 2.0126+04
The probability of this result, assuming the null hypothesis, is less than .0001

**Seasonal variations in Magnesium of Waldhuni River**

| Years | May 2010 | Aug 2010 | Nov 2010 | Feb 2011 | May 2011 | Aug 2011 | Nov 2011 | Feb 2012 |
|---|---|---|---|---|---|---|---|---|
| **Site** | | | | | | | | |
| Kakola lake | 30.37 | 6.07 | 25.02 | 30.13 | 32.80 | 8.50 | 25.51 | 28.18 |
| Amp gate | 52.97 | 37.90 | 36.93 | 53.46 | 52.73 | 10.93 | 41.31 | 53.46 |
| CHM gate | 68.52 | 54.18 | 45.68 | 69.98 | 66.58 | 41.31 | 48.35 | 72.17 |
| Petrol pump | 70.95 | 62.45 | 50.05 | 70.22 | 66.82 | 52.97 | 49.08 | 77.76 |

Significance by two way Analysis of Variance (ANOVA)
Between Sites: F =17.26df= 31
SE between sites: 4113.
Between time period: F =1.328
SE between time periods: 8449.
The probability of this result, assuming the null hypothesis, is less than .0001

**Seasonal variations in Total salts of Waldhuni River**

| Years | May 2010 | Aug 2010 | Nov 2010 | Feb 2011 | May 2011 | Aug 2011 | Nov 2011 | Feb 2012 |
|---|---|---|---|---|---|---|---|---|
| **Site** | | | | | | | | |
| Kakola lake | 135 | 168 | 195 | 140 | 112 | 165 | 198 | 138 |
| Amp gate | 915 | 960 | 1004 | 918 | 911 | 962 | 1006 | 911 |
| CHM gate | 995 | 1015 | 1046 | 998 | 992 | 1009 | 1048 | 978 |
| Petrol pump | 998 | 1018 | 1052 | 1006 | 995 | 1012 | 1050 | 980 |

Significance by two way Analysis of Variance (ANOVA)
Between Sites: F = 14.46.df= 31
SE between sites: 2.7112E+04
Between time period: F =2.0498E-02
SE between time period: 4.2011E+06
The probability of this result, assuming the null hypothesis, is less than .0001

**Seasonal variations in Total Dissolved Solid of Waldhuni River**

| Years | May 2010 | Aug 2010 | Nov 2010 | Feb 2011 | May 2011 | Aug 2011 | Nov 2011 | Feb 2012 |
|---|---|---|---|---|---|---|---|---|
| **Site** | | | | | | | | |
| Kakola lake | 119 | 145 | 155 | 104 | 102 | 138 | 150 | 108 |
| Amp gate | 878 | 915 | 956 | 878 | 872 | 918 | 952 | 880 |
| CHMgate | 967 | 975 | 998 | 953 | 955 | 977 | 990 | 895 |
| Petrol pump | 978 | 978 | 1005 | 961 | 969 | 980 | 1015 | 928 |

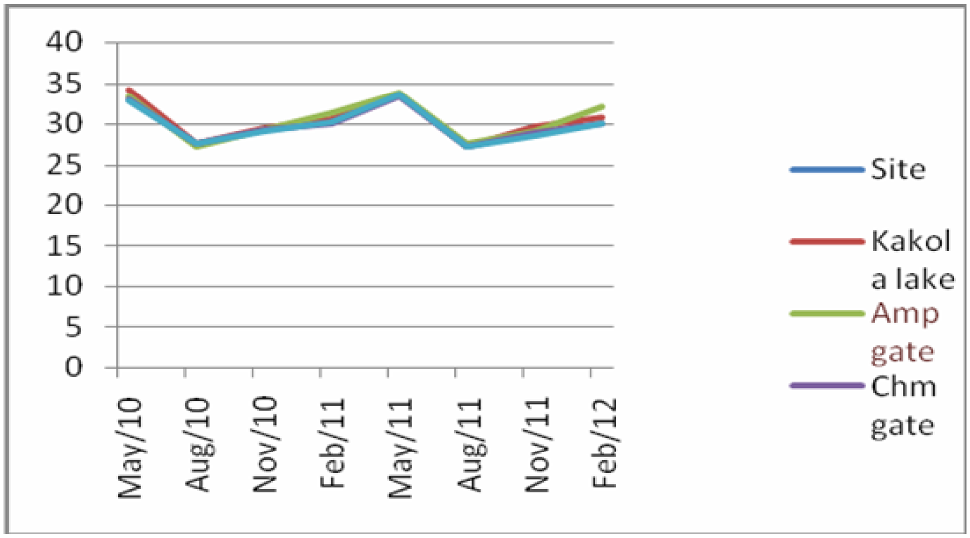
Significance by two way Analysis of Variance (ANOVA)
Between Sites: F =1607 df= 31
SE between sites: 2.3628E+04
Between time period: F =1.6790E-02
SE between time period: 4.0730E+06
The probability of this result, assuming the null hypothesis, is less than .0001

**Seasonal variations in Total Suspended Solid of Waldhuni River**

| Years | May 2010 | Aug 2010 | Nov 2010 | Feb 2011 | May 2011 | Aug 2011 | Nov 2011 | Feb 2012 |
|---|---|---|---|---|---|---|---|---|
| **Site** | | | | | | | | |
| Kakola lake | 16 | 23 | 40 | 36 | 10 | 27 | 48 | 30 |
| Amp gate | 37 | 45 | 48 | 40 | 39 | 44 | 54 | 31 |
| CHM gate | 28 | 40 | 48 | 45 | 37 | 32 | 58 | 83 |
| Petrol pump | 20 | 40 | 47 | 45 | 26 | 32 | 35 | 52 |

Significance by two way Analysis of Variance (ANOVA)
Between Sites: F =2.906 df= 31
SE between sites: 4444.
Between time period: F =2.316
SE between time periods: 3478.

The probability of this result, assuming the null hypothesis, is less than .0001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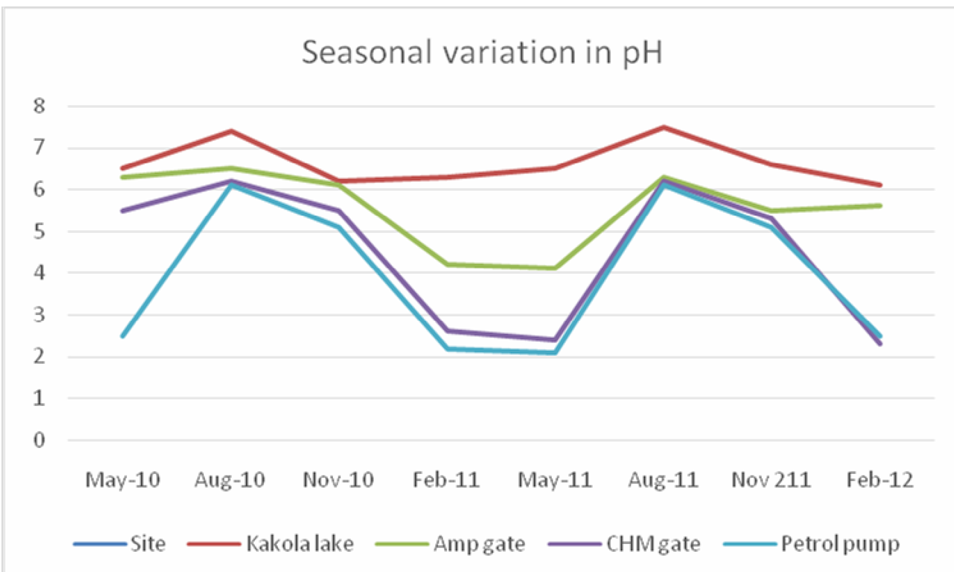
Amp gate
Chm gate


Seasonal variation in pH
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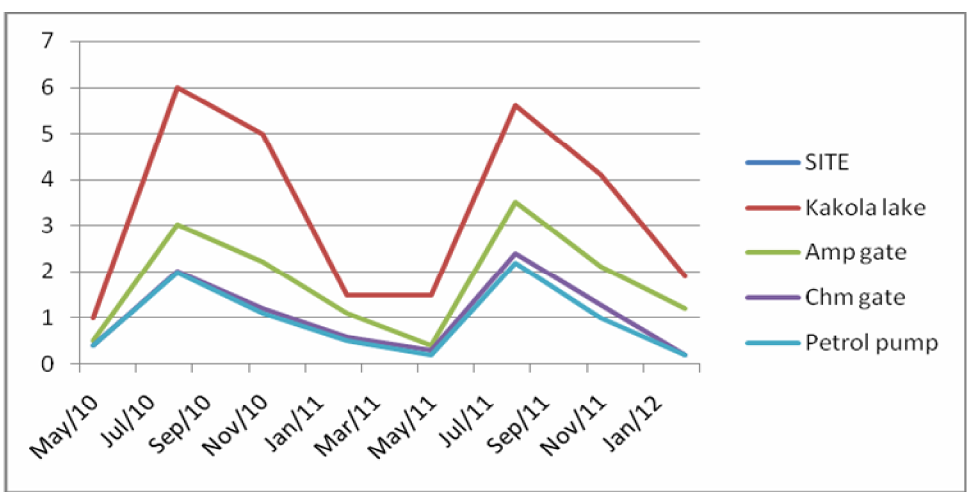
CHM gate
Petrol pump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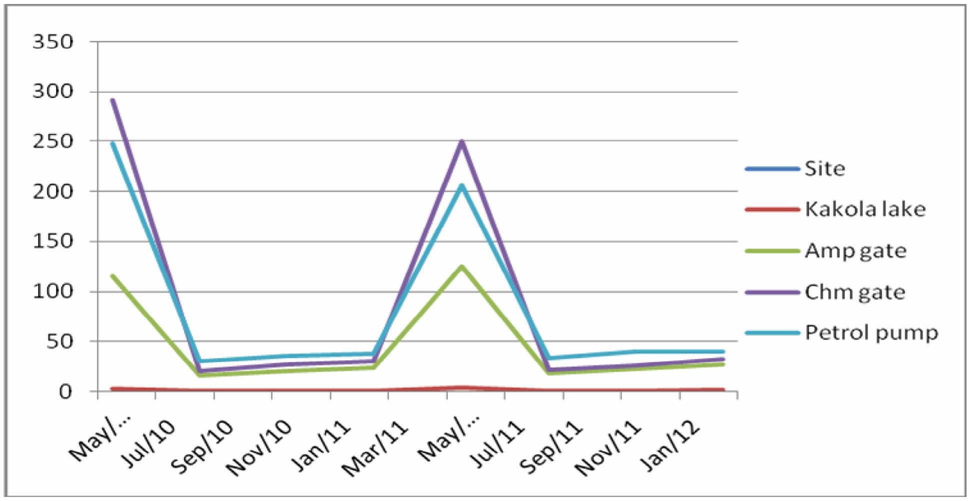
Amp gate
Chm gate
Petrol pump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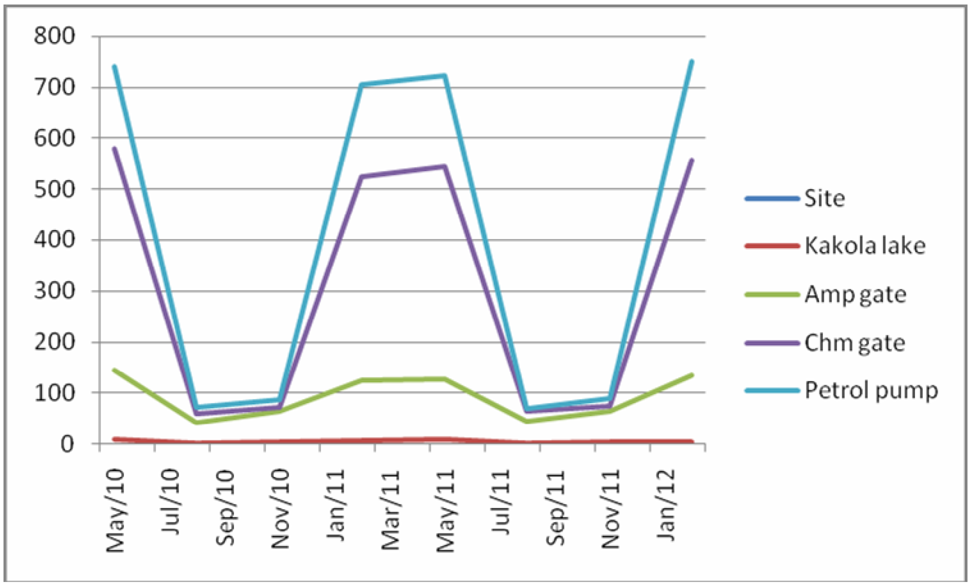
Kakola lake
Amp gate
Chm gate
Petrol pump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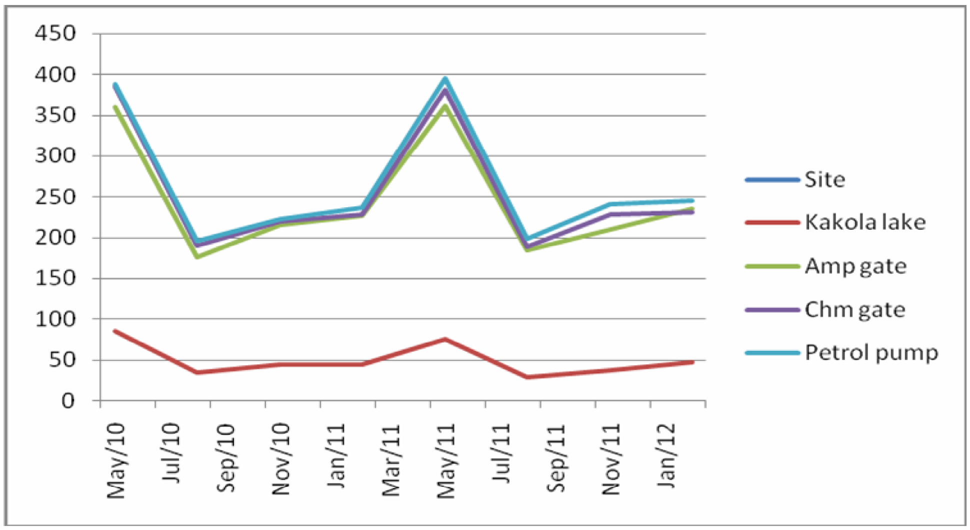
Chm gate
Petrol pump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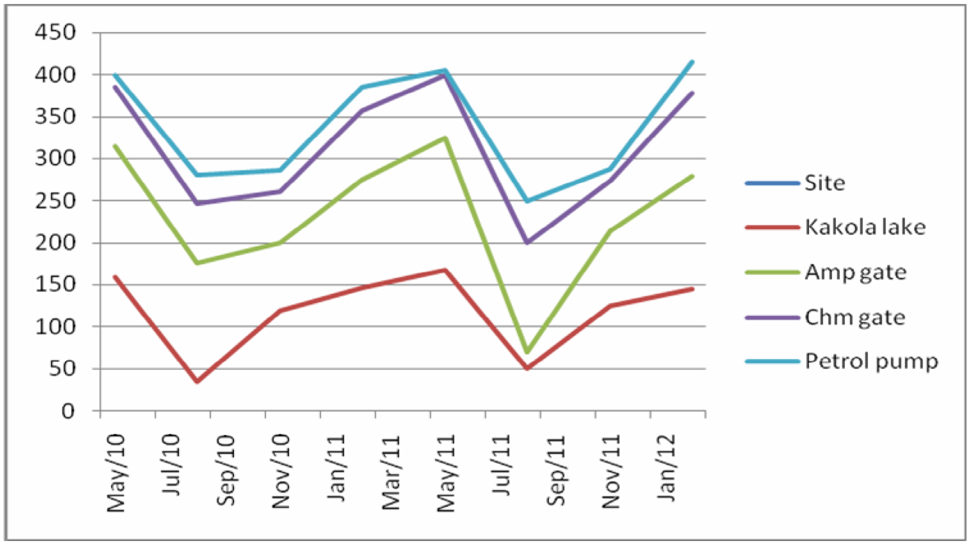
Site
Kakola lake
Amp gate
Chm gate
Petrol pump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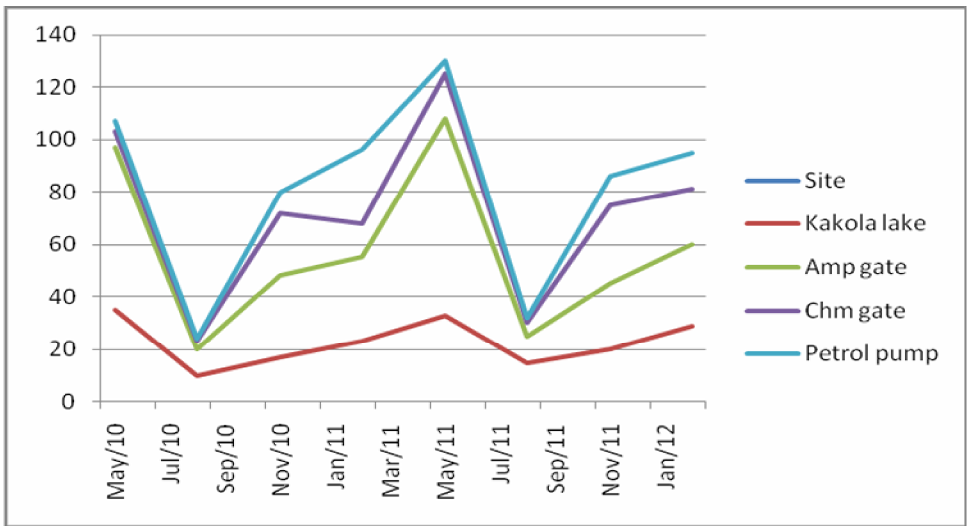
Amp gate
Chm gate
Petrol pump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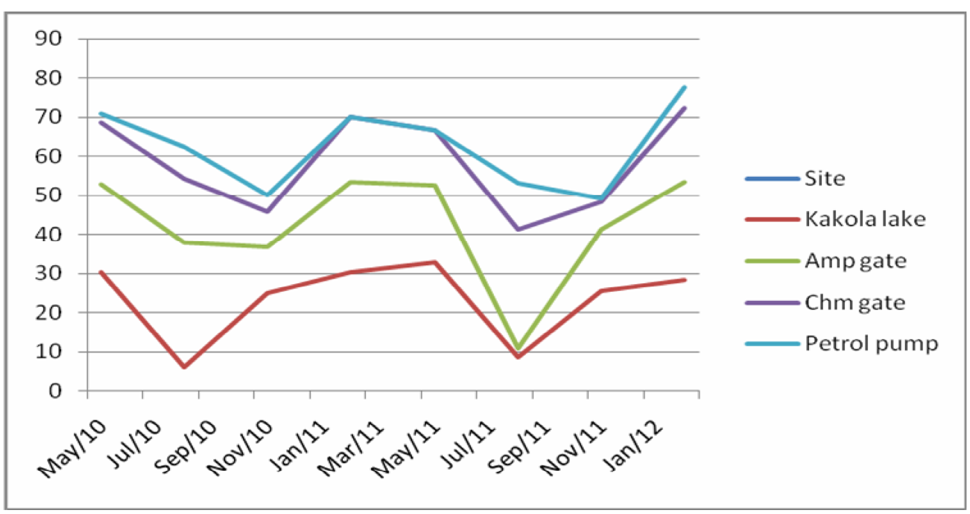
Kakola lake
Amp gate
Chm gate
Petrol pump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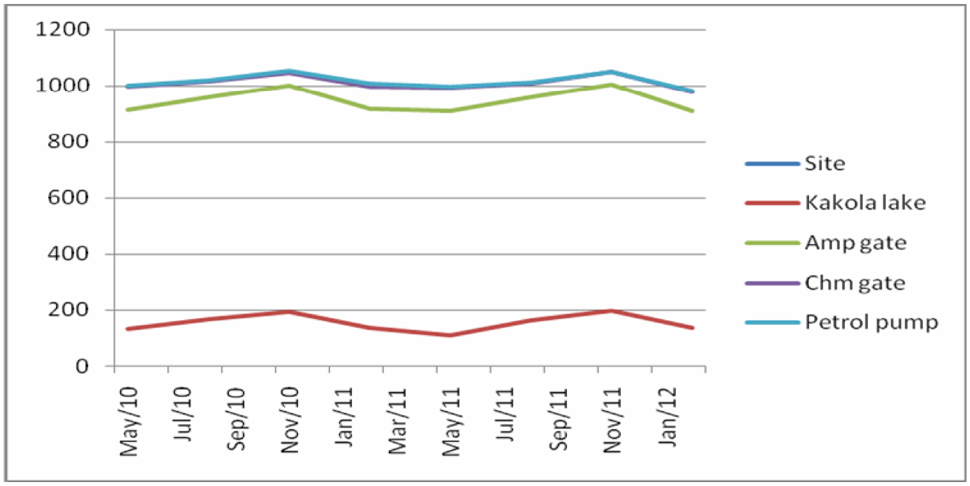
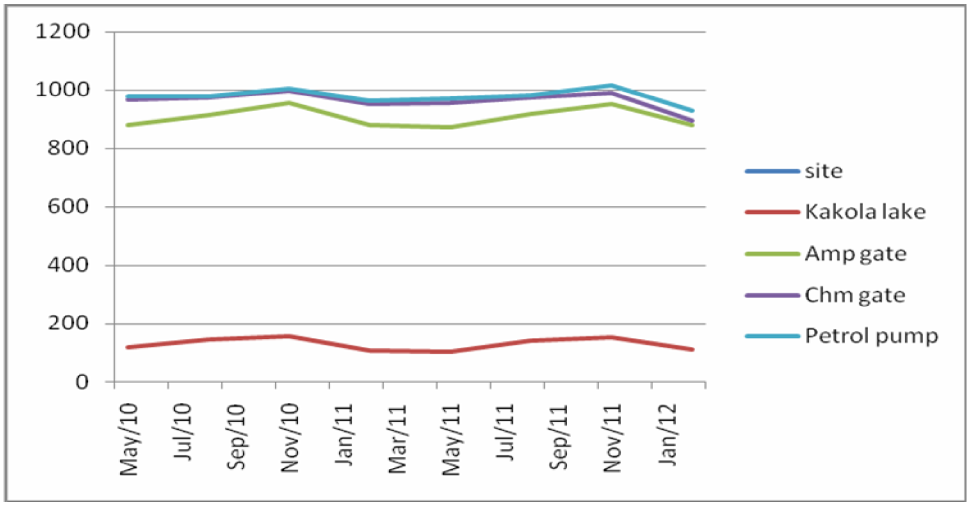
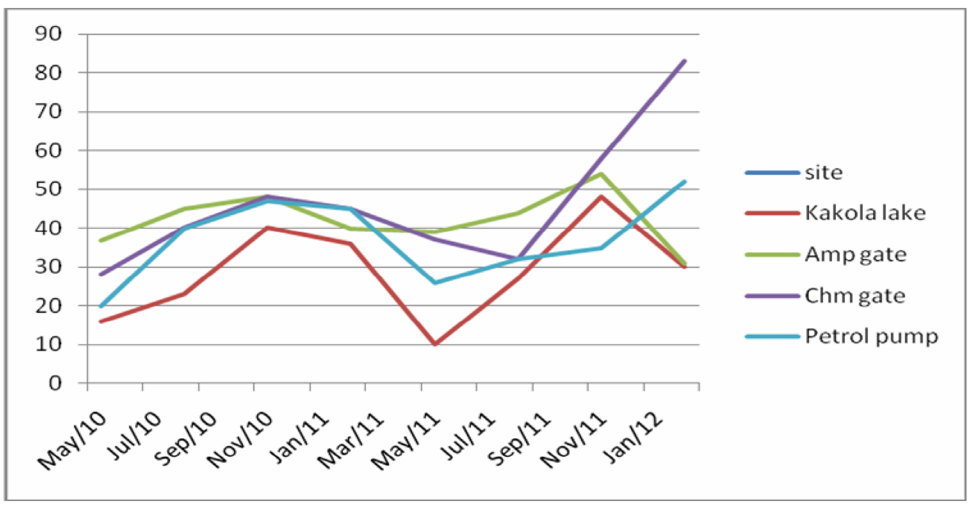
Site
Kakola lake
Amp gate
Chm gate
Petrol pump




The Calcium range was observed from 10 mg/l to 130 mg/l. It is suggested that total hardness of water samples is mainly due to the presence of the Magnesium salts (Murhekar, 2011). The industrial effluents, especially from the industries from Ambernath are responsible for the release of Calcium and magnesium salts. This causes increase in these ions in water and also results in increase of total hardness of water.

## Magnesium

The magnesium range was observed from 6.07 mg/l to 77.76 mg/l. It is directly related to the values of hardness.

The range of total salts was observed from 112 mg/l to 1052mg/l. It indicates the dissolved and undissolved salts that are mixed in water. The values of total salts, dissolved salts and suspended solids indicate the amount of pollution. (Aggarwal and Arora, 2012). Total salts, total dissolved salts and total suspended solids are in proportion with the soluble and/or precipitated form of Chlorides, Nitrates, sulphates, carbonates and bicarbonate salts of Iron, Calcium, Magnesium and Sodium. (Sen*et al*, 2011).

The range of total dissolved salts was observed from 102 mg/l to 1015 mg/l.It is an indicator of salinity behavior of water. (Mahanananda,2010).

The range of total suspended solidswas observed from 10 mg/l to 83mg/l. This is a direct measure of pollution. (Aggarwal and Arora, 2012).TSS affects the turbidity of water. Other than salts it also involves Fine clay, silt and planktonic organisms. The material from the water body that cannot pass through the 45 µm filteris assumed as TSS. TSS and TDS are affected by the pH as with the change in pH some solute dissolve/ get precipitated. (Ugwu and Wakawa, 2012).

## Conclusion

From the results of present study we conclude that Waldhuni river water is unfit for drinking purposes. It needs the treatment to minimize the contamination of all its pollutants. All the physical and chemical properties of Waldhuni river water were in undesirable limits. The results obtained from the present investigation will be useful in studying remediation treatment of the river. The results of these indicate that the water at present is totally unsafe for any type of use.

## Acknowledgment

The authors are thankful to the Principal, Smt. C. H. M. College, Ulhasnagar.

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