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Evaluation of Tigris River Quality in Baghdad for the period between (November 2005- October2006)

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Abstract

After war and due to the bad conditions into most services in the country (including water supply).It is decide to study some of important characteristics of Tigris River especially when wastes began to through to the river directly without treatment.

The study concentrated on the characteristics of Tigris River and its suitability to be treated by the plants facilities, especially water hardness and turbidity because they represents the most important factors for water classification and its convenience for public use, then comparing the treated water with the standards for the drinking water.

Relations were found between water parameters like (hardness with conductivity),(hardness with TDS),(Turbidity with TSS) and (conductivity with TDS) and there variation with seasons along year.

Increasing in water turbidity and most of water characteristics were found in February which is the season of rains and high river flow. Water turbidity increased at Al-Wathba and Al-Rasheed water treatment plants, turbidity values reached to 1200 NTU in raw water and 7 NTU for the treated water at AL-Rasheed water treatment plant, this means exceeding the permissible limits.

Concerning water hardness no difference has been found into raw and treated water values, water hardness stay in the same range between (215-465) mg/l .The maximum concentrations found in February at Al-Dora and Al-Rasheed water treatment plants.

تقييم نوعية مياه نهر دجلة في بغداد للفترة بين (نوفمبر2005- اكتوبر2006)

الخلاصـــــــــة

بعد انتهاء الحرب و نتيجة للتخريب والاهمال الحاصل فــي الكثيــر مــن المؤســسات ذات الخــدمات الضرورية في البلد دعت الحاجة الى البحث ودراسة بعض الخواص المهمة في نهر دجلة نتيجة للمطروحات الكثيرة التي بدأت تلقى الى النهر دون معالجتها.

تم التركيز على دراسة خواص نهر دجلة خصوصا كدرة المياه وعسرتها بأعتبارهما من العوامــل المهمــة لتقييم الماء ومعالجته بالامكانيات المتوفرة في المشاريع وبالتــالي تحديــد مــدى صــلاحيته للاســتخدامات البشرية,بعد مقارنة خواص الماء المعالج مع المواصفات المعتمدة لمياه الشرب . كما وجدت علاقــات بــين بعض الخواص (كالعسرة والتوصيلية)و(العسرة والمواد الذائبة)و(الكدرة والمواد العالقة)و(التوصيلية والمــواد الذائبة), وتأثر هذه الخواص مع تغير فصول السنة.

وجدت زيادة في نسبة كدرة المياه في فصل شباط على وجه الخصوص وزيادة معظم خواص المياه في هــذا الفصل الذي هو فصل سقوط الامطار. كما وجدت زيادة نسبة الكدرة في محطتي الوثبــة والرشــيد حيــث وصلت كدرة الماء الخام الى(1200 NTU) والماء المعالج الى (7 NTU) في محطة الرشــيد ممــا يعني تجاوز الحدود المسموح بها في هذه المحطة ,من الجدير بالذكر ان هذه المحطة تقع في منطقة صــناعية مما يعطي احتمالية ارتفاع مستوى الكدرة في هذه المنطقة نتيجة للمطروحات القادمة من الصناعة.

اما بالنسبة لعسرة المياه لم يوجد اختلاف واضح بين عسرة الماء الخام والماء المعالج حيــث ظلــت حــدود العسرة بين (215-465) mg/l ,وجد اعلى تركيز في مستوى العسرة في فصل شباط ايضا في محطتــي الـــــــــــدورة والرشـــــــــيد.

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Introduction

Water is necessary substance for life. The total water that is available for drinking is 0.3% from the total water that is found on the surface of the earth .Rivers, streams, lakes, and reservoirs have long been important source of drinking water .In past, these sources were often heavily contaminated by sewage discharge and unfortunately, were also important in the transmission of communicable diseases such as typhoid and cholera (Craun,1988).

Surface water characteristics, also, change with time and space. Concentrations of impurities increase because of mineral pick up from surface runoff, silt and debris are carried by surface water, often resulting in muddy or turbid streams. Wastes have a major impact on water quality and add greatly to the spectrum of impurities present (Craun,1988).

Types and Sources of Water Pollution

According to Klein (1957),Hamelink (1994)and Millaku (2008), there are four types of water pollution :

1-Physical pollution which causes change in the watercolor, turbidity, temperature, suspended solids, foam and radioactivity.

2- physical pollution, caused by several substances, particularly hydrogen sulfide and results in the change of taste and odor.

3-Chemical pollution caused by organic and inorganic chemicals and resulting un the change of pH value which increase toxicity by heavy metals, and other toxic material.

4-Biological pollution is caused by viruses, bacteria, protozoa, and helminthes. This type of pollution could be considered very important because it concerns public health.

All these types of pollution are the result of two main sources of water pollution:

1-Domestic Pollution: This includes sanitary discharge, and municipal waste, especially when it is discharged directly to the river without any treatment. This is due to the fact that a lot of organic and inorganic matters, in addition to the large number of microorganisms constitute this waste.

In Baghdad city there are two types of sewerage systems, separated and combined , both are found in both sides of Karkh and Rassafa.

There are some unauthorized discharges points of wastewater sewer and storm water sewer which discharge directly to the river.

2-Industrial Pollution: The primary source of this type of water pollution is the industrial discharges, which are distributed all over Baghdad.

Specifications of Tigris River`s Water in Baghdad City

In the last years Baghdad city increased in population, and this leads to increase the consumption of water. The disposal of large quantities of wastewater from different sources along both sides of Tigris River effects the quality of the river water.

Ali (1978) concluded that Tigris River in Baghdad area is highly polluted comparing with Euphrates and Abu-Graib stream.

Al-Masri and Ali (1985) confirmed that discharging treated and untreated wastewater into river limited the use of water for different uses as it flows down stream.

For evaluating water quality parameters Al-Masri and Ali (1985) were studied some water parameters such as: sulfate, Alkalinity, chloride, calcium, hardness, and magnesium in

Tigris River through Baghdad city. The results of study have indicated that concentrations of hardness, sulfate, and calcium exceeded the allowable limits established by the Iraqi drinking water standards.

Al-Khafaji (1985) studied the suspended and dissolved materials in Tigris River at Baghdad city in the year (1983-1984), he found that the suspended materials in the north of Baghdad ranged between 12 and 14630 mg/l and dissolved materials were between 245 and 971 mg/l . He also concluded that Tigris River water at Baghdad city was hard to very hard (according to hardness concentration), fresh (according to TDS concentration) and suitable for drinking.

Ghadban (1993), concluded that after the war on Iraq in 1991, most water intakes of treatment plants, were heavily polluted by sewage discharges causing ecological damage and public health hazards.

Abd-Ali (1993), also concluded that war on Iraq in 1991, affected the bacteriological quality of the Tigris River in Baghdad especially down river at Dora site, as a result of discharging the material sewage to the river. Tables 1 and 2 shows water classification according to its TDS and hardness concentrations.

Results

Data was supplied by Amant Baghdad, water department. The data covered the period between November/2005 to October/2006 . Relation between water parameter was found as follows:

1- Incessant linear relationship between hardness and conductivity, as shown in figure (1) .After treatment hardness values ranged between 215 mg/l to 465 mg/l, Maximum values appeared at Al-Rasheed and Al-Dora water treatment plants. Water hardness in Tigris River could be classified as hard water according to Twort et al (1994). This is the same conclusion found by Al-Khafaji (1985).

2- Incessant linear relationship between hardness and dissolved solids, this is because of the water ions (anions and cations) which may cause water hardness, figure (2).

3- Also increasing dissolved solids lead to increase water conductivity as shown in figure (3).

4- Figure (4) shows that increasing water turbidity because of the suspended solids found in water. Suspended solids concentration decreased in the sedimentation and filtration processes which lead to decrease water turbidity. After treatment water turbidity ranged between 0.43 NTU to 10.35 NTU, Maximum values appear at Al-Wathba and Al-Rasheed water treatment plants especially in the rainy seasons.

Figure (5) shows the situation of water parameters over the year, from figure appears that all values increased in the period between January and March and in April while minimum values appear in June.

Average turbidity values for water treatment plants shown in figure (6), in this figure raw water turbidity increased at Al-Wathba and Al-Rasheed water treatment plants. This is may be because of the some discharges from hospitals and factories near water treatment plant .Tap water turbidity almost in the same ranges.

Hardness readings show no difference between tap and raw water values, figure (7).Tigris hardness is within the acceptable limits so there is no need for the advanced treatment which lowers water hardness in case of increasing its values out of the allowable limits.

Figures (8) and (9) represent the cumulative frequency graphs for the supplied water hardness and turbidity data respectively. From figure (8) it appears that hardness values were within the allowable limits according to the Iraqi and WHO standards.

Figure (9) shows that 94% from samples were within the Iraqi standards, which calls for 5 NTU. This gives probability of success equals to (80/84 = 0.952).

Table (3) represents Iraqi and WHO drinking water quality standards. Tables (4) and (5) show the descriptive statistics of hardness and turbidity in treated water for seven water treatment plants respectively.

Conclusions:

1. Increasing dissolved solids in water lead to increase hardness and conductivity of water.
2. Increasing suspended solids lead to increase water turbidity especially in rainy seasons and in the areas which have factories an hospitals which discharge its sewage wastes into the river directly.
3. Suspended solids concentration in river should preferably be < 1000 mg/l , if habitually exceeds 1000 mg/l a presettlement tank is indicated.
4. Turbidity from main settling basins should be 2-5 NTU, and at outlet from filters –turbidity < 1NTU.
   Tigris River hardness classified as hard water which causes calcinations on pipes wall. Advanced treatment needed in some factories and industries which use boilers and other parts which affected by water hardness.
5. Most water parameters increase in rainy seasons the months of high river flow resulting from snow melting up in the Tigris catchments.
6. Al-Dora and Al-Rasheed water treatment plants show the maximum values of hardness, while Al-Wathba and Al-Rasheed water treatment plants show the maximum values of turbidity.
7. Expansions and more attention should be taken for all water treatment plants especially Al-Rasheed water treatment plant.

References:

[1]-Abd-Ali. A.H. ,1993, "A Statistical Study on Some Effects of the Aggressive War upon the Quality of Water in the City Baghdad", M.Sc. Thesis, Build. And Const. Dept. University of Technology.

[2]-Ali, A.I. ,1978,"Study the Bacterial Quality of Water in Iraq", M.Sc. Thesis, Agr. College, University of Baghdad.

[3]-Al-Khafaji, J.L.A.,1985, "Study of Dissolved Load in Tigris River within Baghdad", M.Sc. Thesis, University of Baghdad.

[4]-Al-Masri N.A. and Ali A.A. ,1985, "Effect of Domestic and Industrial Wastewater Discharge on Pollutant Variation in River Tigris", Proceeding of Iraq Conference on Engineering,IDE,pp.467-474.

[5]-Craun, F.G. 1988, "Surface Water Supplies and Health", Journal of American and Water Works Association", Vol.80, No.2, pp.40-52.

1- Davis, S.N. and Kerri, K.D. 1966, "Hydrology", John Wiley,INC.

[6]-Ghadban,F.D. 1993, "Evaluation of Some Environmental Effects in Iraq (Water and Wastewater Treatment Plants)", M.Sc. Thesis, College of Eng., University of Baghdad.

[7]-Hamelink, J.L. Published by CRC press, 1994."Bioavailibility Physical,Chemical and Biological Interactions" . www.bookhq.com/compare.

[8]-Iraqi Central Organization for Standardization and Quality Control,

2001"Drinking Water Standards", No.417.
[9]-Klein, 1957,"Aspects of River Pollution", Butterworth Scientific Publication, London.
[10]-Millaku Agron, Plakolli M., Vehapi I., May 2008."The Impact of Biological, Chemical, and Physical Pollution on the Water Quality in River Klina". www.balwois.com/balwois/administration/full-paper/ffp-1263pdf.
[11]-Todd, D.K., 1963, "Groundwater Hydrology", John Wiley, INC.
[12]-Twort, A.C., Law, F.M., Crowley, F.W. and Ratnayaka,D.D.,1994, "Water Supply", 4th edition published in Great Britain.
[13]-Utah Department of Environment Quality, Division of Water Quality Groundwater Protection Section, October 2008. "Public Participation Document, Salt Lake Valley Aquifer Classification". www.waterquality.utah.gov.

Table (1), Description of water according to TDS Concentration in (mg/l)
(After Utah Dept. of Environment Quality (2008),Todd (1963), and Davis (1966))

Class	TDS (mg/l)	Beneficial Use
1	0-500	Pristine and Irreplaceable
2	500-3000	Drinking water quality
3	3000-10000	Limited use
4	>10000	Saline

Table (2), descriptive terms for the hardness expressed as $CaCO_3$
(After Twort et al ,1994)

No.	Hardness level	hardness as $CaCO_3$ mg/l
1	Soft	0-50
2	Moderately Soft	50-100
3	Slightly Hard	100-150
4	Moderately Hard	150-200
5	Hard	Over 200
6	Very Hard	Over 300

Table (3) Iraqi and WHO Drinking Water Quality Standards (After ICSQC, 2001)

Parameter	Unit	Iraq 2001		WHO 1993
		Maximum permissible limits	Maximum allowable limits	
Color	C.U	10	25	15
Turbidity	NTU	5	25	5
Conductivity	µs/cm	-	2000	-
TDS	mg/l	500	1500	1000
pH		6.5-8.5	6.5-9.2	6.5-8.5
Alkalinity	mg/l	125	200	-
Total Hardness ($CaCO_3$)	mg/l	100	500	500
Magnesium (Mg)				
Calcium (Ca)	mg/l	50	150	-
Sodium (Na)	mg/l	75	200	-
Chloride (Cl)	mg/l	-	200	200
Chlorine	mg/l	200	600	250
Iron (Fe)	mg/l	0.3	2	0.6-1
Nitrate (NO_3)	mg/l	0.3	1	0.3
Sulfate (SO_4)	mg/l	-	40	50
	mg/l	200	400	250

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Table (4) Descriptive Statistics of Turbidity in Treated Water for Seven Water Treatment Plants

W.T.P.	Maximum	Minimum	Mean	Std. Error	Std. Deviation	Variance	Skewness	Kurtosis
ALKARKH	2.60	0.43	1.3167	.2165	.74995	.562	.286	-1.131
EAST TIGRIS	2.90	1.04	1.5967	.1725	.59755	.357	1.639	1.745
ALWATHBA	10.35	1.45	3.4917	.6712	2.32498	5.406	2.634	8.088
ALKARAMA	2.70	0.79	1.7292	.1653	.57267	.328	.108	-.799
ALQADISIA	5.50	1.10	2.3417	.3430	1.18817	1.412	1.980	4.400
ALDORA	1.88	0.73	1.2150	.1098	.38051	.145	.601	-.696
ALRASHEED	7.27	1.75	3.6017	.5924	2.05225	4.212	.986	-.607

Table (5) Descriptive Statistics of Hardness in Treated Water for Seven Water Treatment Plants

W.T.P.	Maximum	Minimum	Mean	Std. Error	Std. Deviation	Variance	Skewness	Kurtosis
ALKARKH	326.00	215.00	259.417	9.643	33.405	1115.902	.600	-.173
EAST TIGRIS	363.00	234.00	295.167	11.514	39.886	1590.879	.314	-.366
ALWATHBA	421.00	259.00	353.000	17.105	59.254	3511.091	-.341	-1.411
ALKARAMA	416.00	246.00	347.833	17.594	60.947	3714.515	-.327	-1.435
ALQADISIA	425.00	250.00	353.333	17.451	60.452	3654.424	-.324	-1.413
ALDORA	453.00	265.00	363.667	17.431	60.384	3646.242	-.100	-1.388
ALRASHEED	465.00	249.00	359.333	19.107	66.188	4380.788	-.013	-1.155

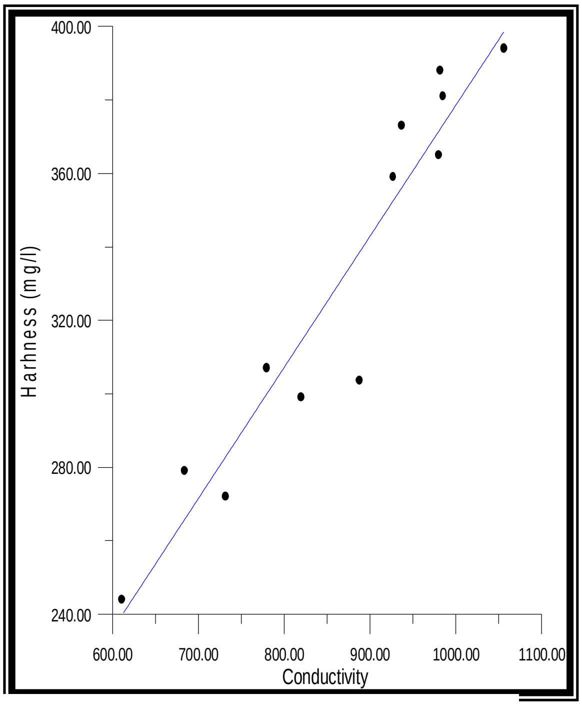

Figure (1), Relation between Hardness and Conductivity in Raw Water of Tigris River

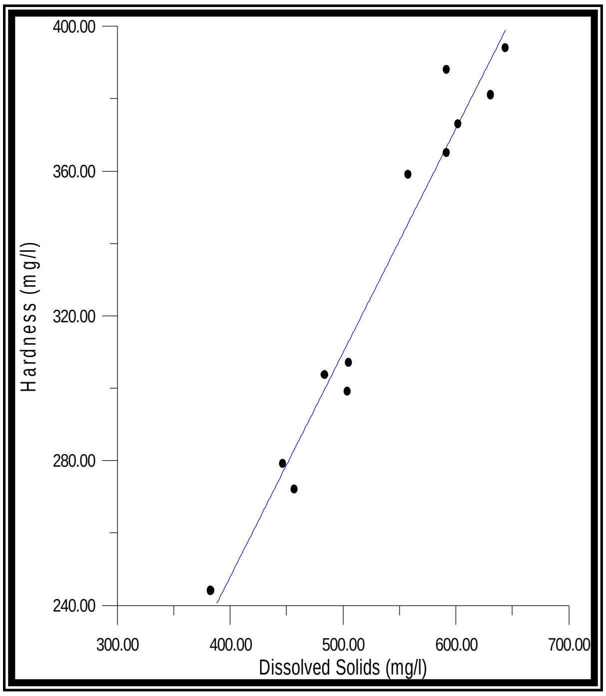

Figure (2), Relation between Hardness and Dissolved Solids in Raw Water of Tigris River

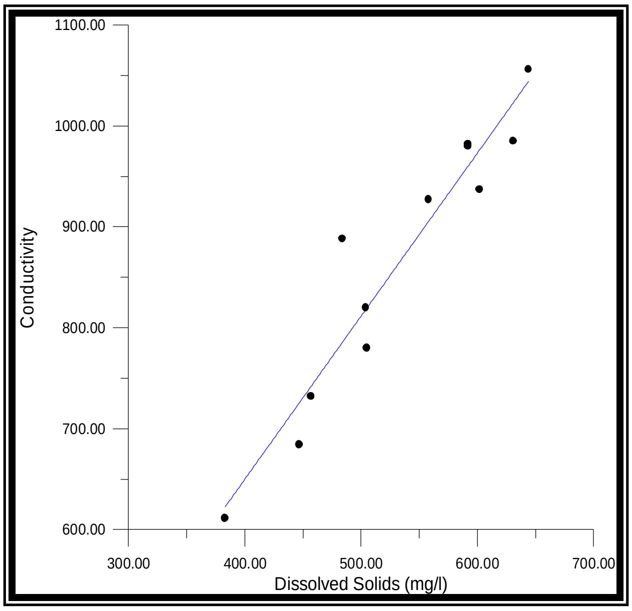

Figure (3), Relation between Conductivity and Dissolved Solids in Raw Water of Tigris River

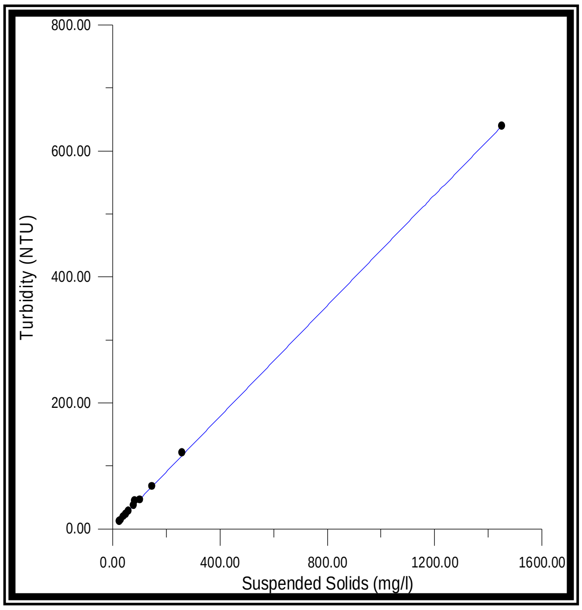

Figure (4), Relation between Turbidity and Suspended Solids in Raw Water of Tigris River

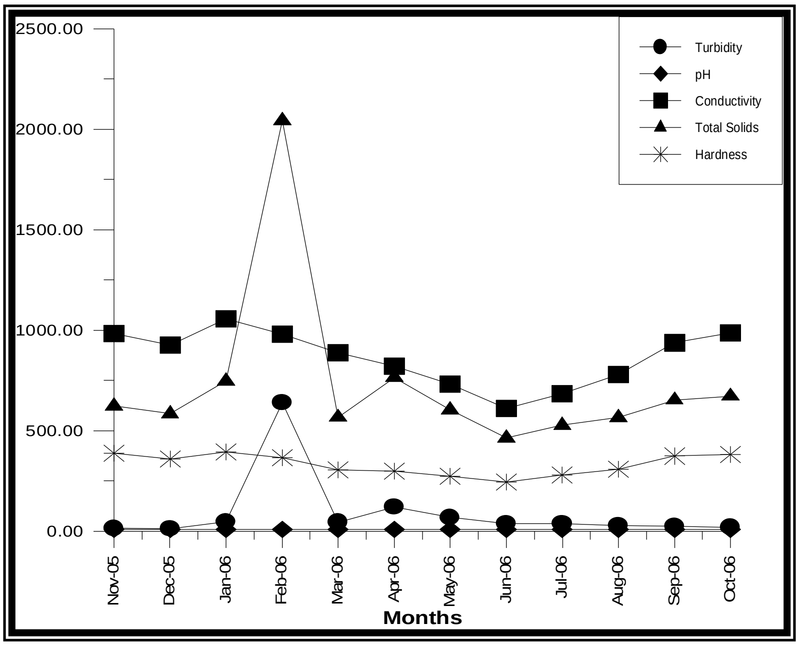

Figure (5) Relation between Water Parameters along Year

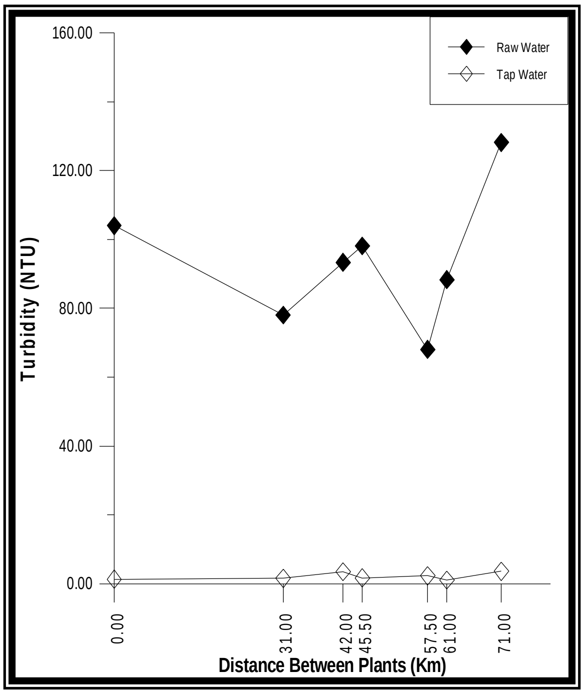

Figure (6), Average Raw and Tap Water Turbidity with Distance for Seven Water Treatment Plants

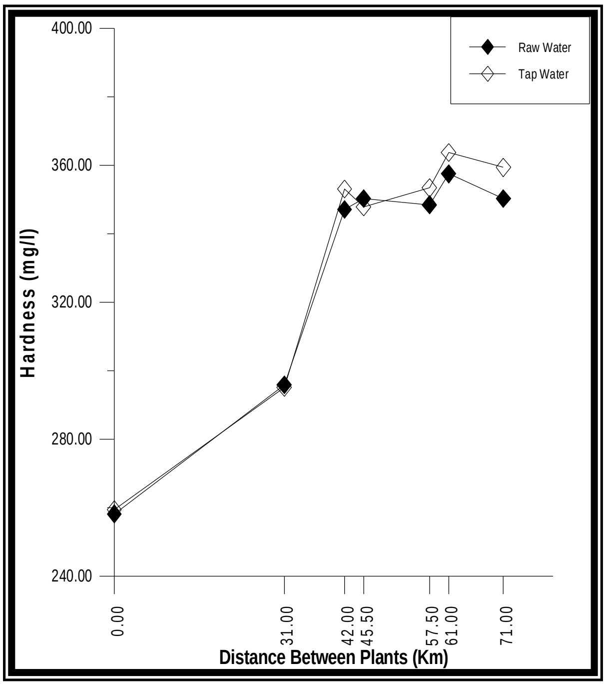

Figure (7), Average Raw and Tap Water Hardness with Distance for Seven Water Treatment Plants

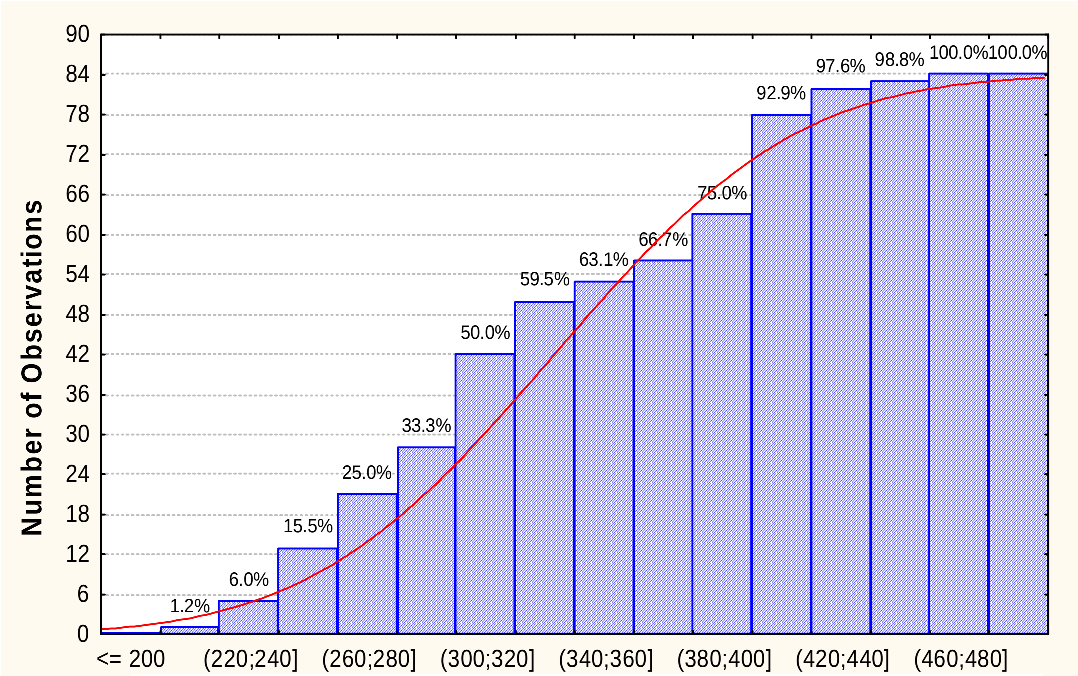

Figure (8), Cumulative Frequency for Hardness in Supplied Water

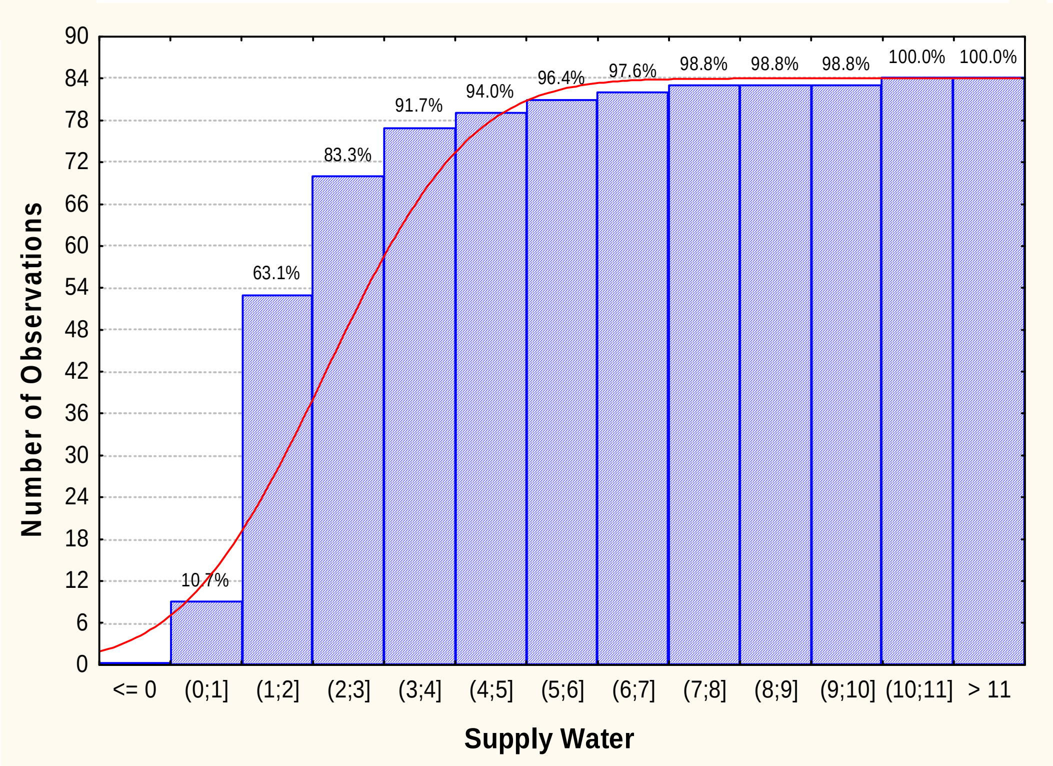

Figure (9), Cumulative Frequency for Turbidity in Supplied Water