http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 6 (12): 1054-1058, 2003
ISSN 1028-8880

Investigation of Quantitative and Qualitative Characteristics of Inflow to the Proposed Urban Lake at the West of Great Tehran

J. Nouri, [1]H. Rahimipour and [2]R. Nezkati
Department of Environmental Health Engineering, School of Public Health,
University of Tehran Medical Sciences, P.O. Box. 14155-6446, Tehran, Iran
[1]Soil Conservation and Watershed Management Research Center, Tehran, Iran
[2]College of the Environment, Research and Science Branch, Islamic Azad University, Tehran, Iran

Abstract: According to the natural and man-made environment of Tehran and based on governmental approval, the largest artificial lake located in far northwest of Great Tehran and into the new made District-22 of Tehran Municipality is being designed. This region with an area of about 10000 ha has been planned as a last connectual limitation of Tehrran. Overflow of the Kan and the Vardavrd Rivers such as the one in 1969 in the Kan-Sologhan region and some other purposes like providing a recreational place to attract tourists and making the weather fresh and humid specially in dry seasons turn out to be the reasons for proposing the construction of an artificial lake. The lake is planned with an area of about 225 ha and 11 million cubic meters volume. The Kan and the Vardavard Rivers, the middle part watershed basins runoff, groundwater, municipal runoff and the waste water of Ekbatan treatment plant are the most important water resources in the area. Annual flow of these resources together is about 120 million cubic meters and there is the possibility of taking 40 million cubic meters of this flow to provide the lake water.To indentify the water quality of resources samples were taken, analysed and statistics of hydrometric stations in the region have been assessed. Comparison between these results and standards proved that the Kan and the Vardavard Rivers, groundwaters and the middle part watershed basins runoff have the highest quality. In Ekbatan treatment plant waste water and municipal runoff total coliform is 1.1×10^{4} MPN 100 ml^{-1} and 2.2×10^{29} MPN 100 ml^{-1}, respectively which is higher than standards and inappropriate to provide the lake water.

Key words: Man-made lake, supply water, water resources, water quality and quantity, environmental factors

Introduction

Artificial lakes in different parts of the world are made to support different aims on the way of runoff, rivers and groundwaters (Reddy, 1996 and Rippey, 1990). Some of these lakes are just made for recreation and to attract tourists, others to control floods, economical benefits, to make the weather more fine and to help aquiculture trends (Halley, 1993; Vander and Diederik, 1998). Inorder to support these aims in the far northwest of Tehran and District-22, the construction of a man-made lake has been planned. The geographical coordination of District-22 is in east longitude of 51°, 23′′, 45½ to 51°, 22", 30½ and north latitude of 35°, 57", 30½ to 35°, 43", 30½. The maximum elevation of this region is about 3900 meters above sea level and the minimum elevation is about 1200 meters and in the exiting part of the Kan and the Chitgar watershed basins. The climate of the region is arid and semiarid. The region consists of two separate watershed basins, the Kan- Sologhan in the east and the Chitgar in the west. This area is surrounded by Latian watershed from west and Hesarak watershed from east (Anonymous, 2000). Two main rivers of this region are the Kan and the Vardavard. The Kan river length is 26 kilometers, with the average gradient of 9% and annual discharge of 80 million cubic meters and the Vardavard river length is 13 kilometers, with the average gradient of 13% and annual discharge of about 18 million cubic meters. The location of the man-made lake is between two Chitgar hills. Fig. 1 shows the location of the lake in the region and in Tehran. To improve hydrometric researches in the region, characteristics of hydrometric stations have been studied (Table 1) and Sira station which is located on the Karaj river and has the longest statistic period of about 43 years (1955 to 1998) has been chosen as a reference station (District-22 Municipality of Tehrn Publication, 2001). This research has been done in 2002 in northwest of Tehran, in District-22.

Materials and Methods

To study the quality of water resources in the region, samples have been taken from them and collected in two liter plastic containers. The vessles were tightly packed

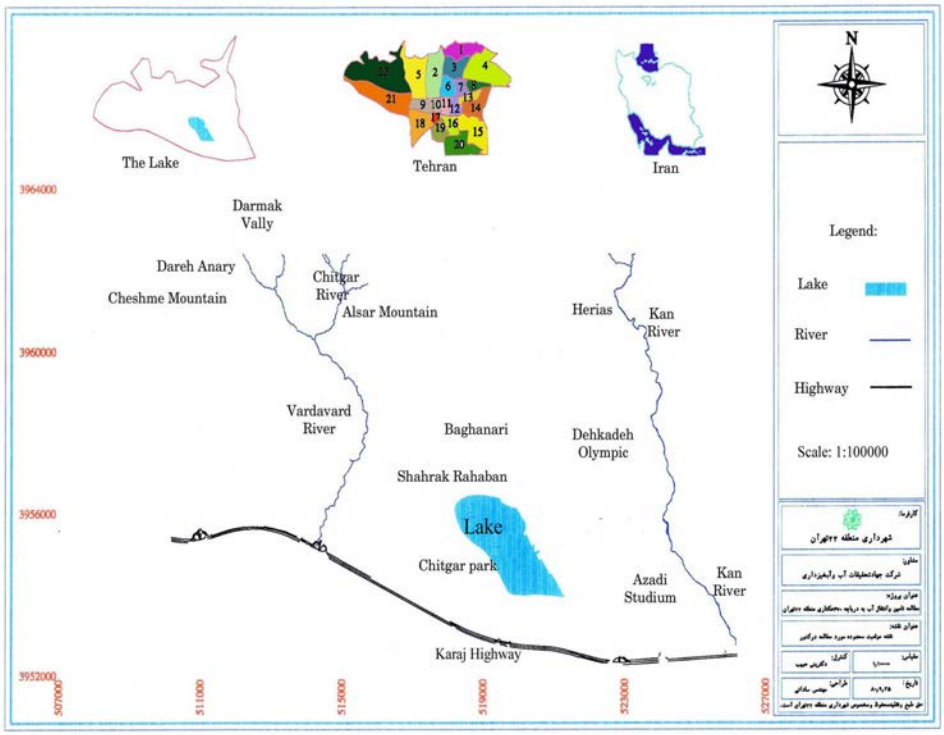

Fig.(1): Map of the man-made lake in District 22 Municipality of Tehran

and kept in cold place. Then they were transferred to the laboratory as quickly as possible and have been analysed for some physical, chemical and biological factors (Khaustov, 1999 and Shariatpanahi, 1992). The analyses consist of electrical conductivity, water hardness, nitrate and phosphate determination, total alkalinity, feacal coliform, pH, TDS, TSS, COD and BOD_5. These samplings and experiments began in the late summer of 2001 to winter of 2001. The results of analyses of municipal runoff from the first flush at the near of the project have been registered. Because of the short period of sampling and analysing, the data of hydrometric stations have been also used.

Results

According to calculations, the Kan and the Vardavard rivers and the middle part watershed runoff have annual average discharge of 80, 16.41-18 and 5.37 Million Cubic Meters (MCM). Groundwater, municipal runoff and wastewater of Ekbatan complex treatment plant have more than 15 million cubic meters discharge per annum.

The volume which provides the man-made lake water is about 11 million cubic meters, because all of the establishments which are needed to take and transfer water to the lake, can be constructed just on one river, so the Kan river has the best conditions to provide and transfer water to the lake. Except than, the Kan river it would be better to consider other water resources, such as the Vardavard river in the region. If this river has been exploited for providing the lake, the destruction of its floods would be decreased considerably, therefore, it is another choice to provide the water of the lake.

The runoff of the middle part watershed is another resource, but because of its sharp slope and almost high expense for taking water, it is not possible to use it as a resource, except two or three ones. The above mentioned resources are the most important ones that can provide water of the lake. Tables 2 and 3 show the possible volume of water taken from the Kan and the Vardavard rivers to maintain the lake reservoir. These two rivers can provide about 13.61 and 9.68 million cubic meters of the lake water, respectively. These figures show the difference between the annual flow frequency of 80 and 50%. The annual flow frequency which is more than 95% is suitable for drinking, about 65% for farming and less than 65% for other usages. So, by subtraction of annual flow of 80 and 50% it would be possible to compute the volume of water which can be taken for the lake. The total volume that can be taken from the Kan and the Vardavard Rivers would be enough to support the volume of 11 million cubic meters, which explains the need of the reservoir. This volume is needed during the first year when the lake reservoir is empty and after fulling it, the volume would be decreased to about 4.7 million cubic meters per year.

The quality of the lake water is too important other than fulling its reservoir, so the results of qualitative tests are as follows:

Table 1: Specifications of hydrometric stations in the area

			Geographical condition		
Name	River	Station	Longitude	Latitude	Height (m)
Karadj	Gajereh	Gachsar	51-20	36-07	2200
Karadj	Shahrestanak	Karadj doab	51-18	36-01	2020
Jajroud	Karadj	Seara	51-09	36-02	1790
Markazi	Mouroud	Polkhab	51-09	36-02	1790
Markazi	Kolvan	Kolvan (Seara)	51-09	36-01	1790
Jajroud	Kan	Sologhan	51-16	35-47	1430
Jajroud	Farahzad	Dalaghar	51-19	35-52	1650
Jajroud	Kan	Hesarak	51-18	35-47	1570
Jajroud	Darakeh	Hafthozdar	51-23	35-49	1700
Markazi	Darband	Souband	51-25	35-50	1800
Jajroud	Maghsoudbeik	Poltajrish	51-26	35-48	1600
Jajroud	Darband	Papa Resturant	51-25	35-49	1790
Namak Lake	Jajroud	Roudak	51-33	35-51	1690
Jajroud	Kandehrogalando	Najarkola	51-38	35-49	1700
Jajroud	Afjeh	Narvan	51-40	35-50	1750

Table 2: The volume and distribution of monthly water extraction from the Kan River (cms)

Months	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	A.A.D.* (CMS)	A.A.I.**(MCM)
50-80%	0.07	0.36	0.55	0.39	0.48	1.64	3.22	2.01	0.63	0.20	0.09	0.06	0.81	25.50
Proposed	0.00	0.00	0.00	0.30	0.40	1.50	3.00	0.00	0.00	0.00	0.00	0.00	0.43	13.61

Table 3: The volume and distribution of monthly water extraction from the Vardavard River (cms)

Months	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	A.A.D (CMS)	A.A.I.(MCM)
50-80%	0.02	0.08	0.12	0.09	0.11	0.37	0.72	0.45	0.14	0.04	0.02	0.01	0.182	5.60
80%	0.01	0.04	0.09	0.15	0.22	0.52	1.45	1.12	0.18	0.01	0.00	0.00	0.318	9.78
Proposed	0.00	0.00	0.00	0.15	0.2	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.315	9.68

* (AAD) Average Annual Discharge
** (AAI) Average Annual Inflow

Table 4: The average amount of qualitative parameters for the water flow of the Kan River

Total Coliform (MPN 100 ml^{-1})	Total Alkalinity ($mg\ l^{-1}$)	Cations ($meq\ l^{-1}$)	Anions ($meq\ l^{-1}$)	EC ($\mu mhs\ cm^{-1}$)	TDS ($mg\ l^{-1}$)	Total Hardness ($mg\ l^{-1}$)$CaCO_3$	pH	BOD_5 ($mg\ l^{-1}$)	COD ($mg\ l^{-1}$)	Total Nitrogen ($mg\ l^{-1}$)	$PO4^{3-}$ ($mg\ l^{-1}$)
350	150-210	3.075	3.22	539	185	183.5	7.4	7.2	11.3	15.1	0.58

Table 5: The average amounts of qualitative parameters of the Vardavard River

Total Coliform (MPN 100 ml^{-1})	Total Alkalinity ($mg\ l^{-1}$)	Cations ($meq\ l^{-1}$)	Anions ($meq\ l^{-1}$)	EC ($\mu mhs\ cm^{-1}$)	TDS ($mg\ l^{-1}$)	Total Hardness ($mg\ l^{-1}$)$CaCO_3$	pH	BOD_5 ($mg\ l^{-1}$)	COD ($mg\ l^{-1}$)	Total Nitrogen ($mg\ l^{-1}$)	$PO4^{3-}$ ($mg\ l^{-1}$)
200	143	3.53	3.57	347.5	225	173	8.04	2.07	4.62	16.59	0.04

Table 6: The average amounts of qualitative parameters for groundwater resources

Total Coliform (MPN 100 ml^{-1})	Total Alkalinity ($mg\ l^{-1}$)	Cations ($meq\ l^{-1}$)	Anions ($meq\ l^{-1}$)	EC ($\mu mhs\ cm^{-1}$)	TDS ($mg\ l^{-1}$)	Total Hardness ($mg\ l^{-1}$)$CaCO_3$	pH	DO ($mg\ l^{-1}$)	Total Nitrogen ($mg\ l^{-1}$)	$PO4^{3-}$ ($mg\ l^{-1}$)
200	143.07	226	326	665	-	211.82	8	0.86	6.3	0.16

Table 7: The average amounts of qualitative parameters of the middle part watersheds runoff

Total Coliform MPN 100 ml^{-1}	Total Alkalinity (mgl^{-1})	Cations ($mg\ l^{-1}$)	Anions ($mg\ l^{-1}$)	EC ($\mu mhs\ cm^{-1}$)	TDS ($mg\ l^{-1}$)	Total Hardness ($mg\ l^{-1}$)$CaCO_3$	pH
350	200	3.11	3.40	325.2	193	182.2	8.1

Table 8: The average amounts of qualitative parameters for municipal runoffs in the region

Total Coliform (MPN 100 ml^{-1})	EC ($\mu mhs/cm$)	COD ($mg\ l^{-1}$)	BOD_5 ($mg\ l^{-1}$)	DO ($mg\ l^{-1}$)	TSS ($mg\ l^{-1}$)	pH
2.2×10^{29}	936	402	240	0.4	712	6.8

Table 9: The average amounts of qualitative parameters for the wastewater of Ekbatan complex treatment plant

Total Coliform (MPN 100 ml^{-1})	TDS ($mg\ l^{-1}$)	TSS ($mg\ l^{-1}$)	BOD_5 ($mg\ l^{-1}$)	COD ($mg\ l^{-1}$)	pH	Total Nitrogen ($mg\ l^{-1}$)	Total Phosphorus ($mg\ l^{-1}$)
1.1×10^{4}	406	416	14	22	6.69	2.162	3.2

Table 10: Qualitative standards to assess the water quality of proposed resources to support the lake water (1,18,19)

Parameter	Unit	Limitation
Total Alkalinity	mg l^{-1}	10-400
Total Hardness	mg l^{-1}	10-400
pH	-	6.5-8.5
TDS	mg l^{-1}	500
TSS	mg l^{-1}	100
EC	micromohs cm^{-1}	7500
Total Coliform	MPN 100 ml^{-1}	1000
Nutrients	mg l^{-1}	Less than amounts that cause eutrofication
DO	mg l^{-1}	> 2
BOD_5	mg l^{-1}	100
COD	mg l^{-1}	200

The quality of the Kan River: Some sampls were taken from the Kan River at Sologhan station, which were analysed during 1969-1996 (District-22, Municipality of Tehran publication, 2000). According to statistics the amount of qualitative parameters have not had too many changes during those years. The average amount of qualitative factors for the Kan River flow during above mentioned period and the measurements which have been done in this study are shown in Table 4.

The quality of the Vardavard River: There were some samplings and analyses from Vardavard River flow at Chitgar Station, during 1972-1974. The average results of these tests and the measurements which have been done in this study are shown in Table 5. The amount of these factors have not had too many changes during those years (District-22, Municipality of Tehran publication, 2000).

The quality of groundwater resources: The results of measurements of groundwater resources in the region are shown in Table 6.

The quality of the middle part watersheds runoff: There were some samplings and analyses from the middle part watersheds runoff (District-22, Municipality of Tehran Publication, 2001). The results of these analyses are shown in Table 7.

The quality of the minicipal runoff and wastewater of Ekbatan complex treatment plant: The quality of municipal runoff and the wastewater of Ekbatan complex treatment pant has been assessed. The results are shown in Tables 8 and 9.

To compare and discuss about the quality of suggested resources which provide the lake water, some standards and guidelines have been collected and are given in Table 10.

Discussion

According to quality measurements of the proposed water resources, the Kan river is one of the most important water resources to maintain the lake. This river can support the lake with about 13.6 million cubic meters per year. By assessing the results of analyses from the points on the river which are predicted to construct channel to transfer water from them and give some extensions to the lake and by comparing these results with standards and guidelines, it will be concluded that the quality and quantity of the Kan river is appropriate to support the lake. By comparison between results and agriculture water standards and Vilcox Diagram, the quality of the Kan river is in the range of C_1-S_1, which means that its quality is really high and appropriate.

One of the other important resources which mentioned before is the Vardavard river. It can support about 11 million cubic meters of the lake water per year. By comparison between experimental results and water standards of agriculture and Vilcox Diagram, the water quality of the Vardavard River is in the range of C_1-S_1 that means its quality is high.The middle part watersheds runoff have also high quality and can support the lake with 5 million cubic meters per year, but because of some reasons which were mentioned before, it is not easy to take water from this resource.

By comparison between the results of groundwater experiments and standards, its quality is high enough. This resource can support the lake with 3.3 million cubic meters per year, but it is one of drinking water resources for the residences of the region and it is not recommended to take water from it.

The quality of municipal runoff have some problems in TSS, BOD_5, COD and total coliform which are higher than maximum permitted limitation given in standards. This shows that there are a lot of microorganisms in municipal runoff that results in the increase of oxidation of organic materials and decrease of dissolved oxygen in the water. The high measures of COD and TSS show that there are some chemical pollutants in water. The high measure of total coliform is the sign of presence of some microbes in the water of this resource, so municipal runoff has an adverse health effect and to use it in order to provide the lake, it's better to treat it which needs high expense.

In the wastewater of Ekbatan complex treatment plant, the measures of TSS and total coliform are higher than maximum permitted limitation given in standards and this may threaten the water quality of lake. The presence of phosphorous and nitrogenous compounds in municipal wastewater which comes from detergent usages is another problem. These nutrients cause algeal bloom and this

may lead to eutrofication, but other proposed resources do not have such a problem.

In a large city, like Tehran which is located in an arid and semiarid climate, the management of water resources plays a very important and vital role. Therefore, construction of a large man-made lake in the northwest of Tehran should support many different aims. Since the wind blows from west to east in the region, one of the most significant impacts of constructing the lake is refreshing the surrounding climate. This impact will be effective in microclimate scale specially in hot and dry seasons.

If the quality of outlets from the lake will be good enough, it could be possible to irrigate green environment around the lake and the plants of Chitgar Park next to it. It's also possible to use it to increase the elevation of groundwater. Aquiculture trends is other recomendation, but this plan depends on the concentration of nitrate, nitrite and phosphorus in the lake water. The concentration of these nutrients is higher than standards in some providing resources.

It is possible to do some water sports, such as fishing and boating in the lake which need too much attention to prevent the increase of nutrients or pollutants in the lake water. Recreation exploitations of the lake coasts should be controlled exactly to prevent water pollution.

References

Anonymous, 2000. Surface Water Hydrology Report. District-22 Municipality of Tehran Publicaton, Tehran, Iran.

Halley, M.C., 1993. Lake water quality management model to evaluate stormwater management. Proceeding of the Symposium on Engineering Hydrology, (SEH'93), San Francisco, CA. USA., pp: 557-562.

Khaustov, A.P., 1999. Method of estimating the subsurface inflow to large basins. Water Res., 17: 248-257.

Reddy, K.R., M.M. Fisher and D. Ivanoff, 1996. Resuspension and diffusive flux of nitrogen and phosphours in a hypereutrophic lake. J. Environ. Qual., 25: 363-371.

Rippey, B., 1990. Implications for the design of artificial lakes of a study of the Craigavon lakes. Water Res., 24: 1085-1089.

Shariatpanahi, M., 1992. A Fundamentals of Water and Wastewater Treatment. Tehran University Publication, Tehran, Iran.

Vander, M. and T. Diederik, 1988. Changes in Sediment phosphorus as a result of eutrophication and oligotrophication in Lake Velume Bthe Netherlands. Water Res. J., 32: 3281-3288.