ICC
Iranian Chemical Communication
Review Article
Payame Noor University of Ilam http://icc.journals.pnu.ac.ir

Investigation of quality of storage dam ilam, identify of pollutant resources and pollutants attitude

Moayed Avazpour[a], Sabah Shiri[a,b,*], Fariba Seifipour[a], Heshmatollah Nourmoradi[a]

[a]*Department of Environmental Health Engineering, Ilam University of Medical Science, Ilam, Iran*

[b]Department of Chemistry, Faculty of Science, Payam Noor University, Tehran, 14 19395-4697, Iran

Received: 27 November 2013 , Accepted: 29 December 2013, Published: 29 December 2013

Abstract

Water quality of dam storage is highly affected by upstream environment and basin. Regarding other conducted studies, there exist various reasons such as some studies and general monitoring of dams which cause some main problems including salinity, chemical and microbial pollution eutrophication, and sedimentation. Chame-Gardalan Storage Dam in Ilam Province is one of the storages which have many environmental issues because of discharge upstream rural wastewaters, animal excreta, agricultural drainage, and leachate. The aim of this study is to signify the quality of Ilam's storage Dam and also to recognize the pollutant resources and to analyze the pollutants' behavior at different times and sites in order to determine dam properties for agricultural and domestic usages. Regarding the importance of the topic, the present study (in the year 2012) is based on the collected information of water quality of the basin, recognition of pollutant resources and measurement of qualitative parameters such as Temperature, TDS, EC, BOD_5, COD, nitrogen, phosphor, and pH in seven periods of time (from May to November). The results show that the total increase in the concentration of all variables along the basin are over double, in particular, Nitrat, Sulfat, BOD, and COD. After analyzing data with some water quality indexes, we analyzed water quality of the storage and some strategies were applied in order to control of effect decrease in the dam storage which, a management program was presented to improve water quality.

Keywords: Ilam Dam, Basin, pollutant resources, BOD, COD.

*Corresponding author: Sabah Shiri
Fax number: +98 (841) 2238489; Tel number: +98 (841) 2238489
E-mail: Sabahshiri5@yahoo.com

Introduction

Monitoring and evaluation of water quality which are considered as the first step in the management of water resources need to determine assessment goals based on defined national rules and control of pollutant sources [1]. Many factors affect water quality of a reservoir, for example, deforestation, extra erosion, entering new species, industrial and domestic wastes, and agricultural runoff, thus, the management of water resources may influence water quality [2]. Dams are infrastructure projects that provide the development of other economic sectors [3]. One of the major goals in construction of dams is drinking water supply. Water stored behind dams can have various forms of pollution, especially biological pollution. This type of water quality is severely affected by drainage activities of its basin [4]. In order to develop the pollution control programs and optimize the utilization of river water, our first step in water quality monitoring of dams is to identify the pollutant sources of them [5]. Biological pollution is one of the most important pollution in lakes and reservoirs that can alter them to marshes [6]. Extra loads of nutrient to water bodies have caused the growth of nitrification problems. It must be pointed out that the prevention of non-point sources is very difficult [7]. Cham-e-Grdalan Dam at 30 km from the city of Ilam has been constructed in the year 2000. This Dam is located on route feeder rivers. The Dam is made merely to supply water to the city of Ilam. The overall goal of this research is , in the first step, to identify the quality and quantity evaluation and identification of pollution sources at different times and places of Ilam dam water and, then, to determine the capability of dam water for urban and agricultural usages. In order to achieve our goal, these specific objectives are considered:

1. Determine the physical quality of water inputs to Ilam dam including temperature, turbidity and electrical conductivity.
2. Determine the chemical quality of water entering to Ilam dam in terms of nitrite, nitrate, phosphate, total hardness, COD, BOD, dissolved oxygen, pH, TDS.
3. Determine the physical quality of water entering Ilam dam including temperature, turbidity and electrical conductivity.
4. Determine the chemical quality of water output of Ilam dam from the point of nitrite, nitrate, phosphate, total hardness, COD, BOD, dissolved oxygen, pH, TDS.
5. Determine the possible strategies in order to reduce the probable pollution load at present and future.

6. Determine the optimized utilization methods of the dam to improve the water quality output.

Materials and methods study and identification of current status

The aims of the study of the basin water quality were to assess the water quality of Gol Gol, Chaviz, and Malekshahi Rivers and, then, to determine the entering pollutant load to the reservoir in a short period of time which was done with regard to drinking use, financial and human resources, facilities and influential pollutants. To describe the present status of Basin, we visited the area. First, the drainage area of the dam was determined and, then, the necessary information from different aspects were collected including agriculture, geology, inhabitant areas, industrial centers and location of animals, rivers and stream, etc. This information are shown in detail in Table 1, and figures 1, and 2.

Table 1. Characteristics and required data of sub basins [8,9]

Measure of used pesticide (ton/year)	Measure of used fertilizer (ton/year)		Number of pens	Rural number	Population	Agriculture areas (ha) (Hectare)	Area (km^2)	Sub basin
	Phosphor base fertilizer	Nitrogen base fertilizer						
1.75	240	162	35870	14	7685	171.45	232.37	Gol gol
0.65	66	44	11769	5	1474	46.65	108.98	Chaviz
0.3	46	37	7768	2	1657	44.50	58.65	Ama

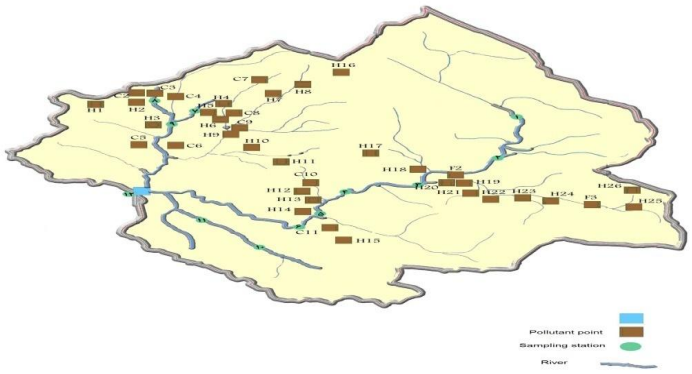


Figure 1. Pollutant source location during drainage basin dam [10]

Determination of quality parameters

After the identification of the area and collecting our data from preliminary studies of the basin status, then the human and animal wastes, agricultural activities, aviculture, poultry slaughterhouses, asphalt plants, stone crusher, greenhouse complexes, waste disposal and effects of land material area were determined as the most important sources of pollutants affecting the quality of surface water resources and groundwater basin.

Table 3. Assessment parameters of water quality related to the application of water and pollutant sources [11]

Parameter	Drinking application	Parameter	Drinking application
Turbidity	**	Nitrate	***
Temperature	-	Phosphate	-
Conductivity	*	COD	-
TDS	*	BOD	**
pH	*	Sodium	*
Dissolved oxygen	*	Potassium	-
Temporary hardness	**	Sulphate	*
Total hardness	**	Chloride	*
Nitrite	***	Fecal coliforms	***

***:highly affected **:moderately affected *:low affected

Determination of sampling stations

In order to determine the sampling stations, the sources of pollutants in the basin have been considered, the self-purification effects of river, the qualitative effects on important sub-branches of the river, the accessibility of stations and, etc. in Chaviz watershed, because the length of the rivers of the dam basin compared with Gol Gol river, so along the river Chaviz three sampling stations

and two stations along the river, but sampling has been.

Sampling and the method of the sample measurement

According to the classification of rivers, the Gol Gol, Chaviz, and Ama accunt as minor surface waters [3]. Because the sampling of these water sources don't require any special technique and assume that these sources are homogeneous and approximately have constant quality and quantity, the samples were taken from the surface of water sources [12]. Since, in sampling periods, we didn't have any considerable activity in the basin and there was not rainfall in these periods, so it is assumed that the changes in water quality were constant and the samples were taken cross-sectional. Samples which were taken seven times per month were expressed as monthly mean.

Read phonetically

Dictionary

Listen

Read phonetically

Dictionary

Listen

Read phonetically

Dictionary

Figure 2. Drainage basin dam and reservoir sampling stations throughout the basin and river

Field measurement results

Results and achievements of the study of Gol Gol, Chaviz, and Malekshahi rivers which are related to Cham-e- Grdalan Dam are mentioned in the tables below. In these tables, the qualitative analysis of the results at three different times of the sub basins is shown. Samples were obtained during the seven months from April until November 2012 for each season a month was selected due to frequency of the results (Tables 4, 5 and 6).

Table 4. Results of quality analysis of total watershed in May 2012

Station / Parameter	unit	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Temperature	ºC	19	21	21	22	18	16	18	18	19	18	19	12
pH	_	7.1	7.6	7.8	7.6	7.6	7.7	8	8.1	7.9	7.8	7.9	8.2
Ec	µs/cm	673	879	977	957	514	450	586	669	750	591	564	514
TDS	_	471	580	645	670	460	415	410	468	488	414	495	460
Turbidity	NTU	4.2	8.6	12	22	15	8	14	22	27	11	14	4.3
Total hardness (Caco$_3$)	mg/l	370	460	527/5	565	240	220	370	385	395	280	280	285
SO_4^{--}	//	105.3	171.5	200.9	240.1	22.54	19.6	71	107.9	99	144.55	90.65	115.5
PO_4^{---}	//	0.003	0.006	0.034	0.09	0.01	0.002	0.07	0.03	0.05	0.009	.009	.001
NO_3	//	3.29	14	22	36	19.6	11	12	38	34	12	18	34
NO_2	//	0.001	0.017	0.04	0.046	0.018	0.008	0.006	0.045	0.04	0.004	0.006	0.07
NH_4	//	0	0.009	0.014	0.012	0.006	0.001	0	0.245	0.01	0.001	0.001	0.004
CL^-	//	7/1	10/65	19.57	23	7.1	7.1	14.2	19.5	20	21.3	12.4	8.86
Na^+	//	5/06	10/17	14.04	12/65	4.91	3.22	29.9	32.2	36	*32/2*	*11/27*	29.9
BOD	//	0	1	2/5	4	1.5	0.8	1	7.5	4	0.8	2	1
COD	//	24	77	24	27	11	*6*	10	29	36	11	17	10
D.O	//	6/6	7	7/2	7/4	7.2*2*	7.6	7.5	6.9*9*	6	7.1	6.9	7.5
Fecal coliforms	MpN/ 100ml	4	15000	46000	54000	5000	550	4300	80000	89000	4000	8000	4300

Table 5. Results of quality analysis of total watershed in August 2012

Station / Parameter	unit	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)

Temperature	ºC	24	21	25	26	20	22	20	20	22	21	21	14
pH	_	7. 1	7.6	7.7	7.5	7.6	7.7	7.6	7.6	7.3	7.3	7.1	7.75
Ec	µs/cm	717	879	967	1120	409	417	549	759	800	531	642	486
TDS	_	466	580	629	728	262	269	384	493	570	340	411	311
Turbidity	NTU	3.8	8.6	14	22	4	18	11	14	16	8	8	7.7
Total hardness (Caco$_3$)	mg/l	355	460	480	550	200	200	275	340	368	245	400	220
SO_4^{--}	//	80.8	121.5	166.6	186.2	6.37	17.15	14.7	22	25	44.1	68.6	102.9
PO_4^{---}	//	0.016	0.006	0.046	0.038	0.001	0.004	0	0.001	0.003	0.002	0.003	0.001
NO_3	//	2.84	14	28.9	41.2	14	44	22	48	46	14	16	36
NO_2	//	0	0.017	0.04	0.09	0.07	0.06	0.037	0.11	0.09	0.01	0.014	0.04
NH_4	//	0.016	0.034	0.046	0.038	0.001	0.004	0.02	0.021	0.02	0.004	0.006	0.01
CL^-	//	10.65	14.2	24.8	28.4	8.87	7.1	15.6	30.3	29	14.2	14.2	10.6
Na^+	//	5	8.74	13.3	16.8	2.76	4.37	9.2	19.8	18	8.74	10.35	11
BOD	//	0	2	3.5	7	0.6	2	3	4.5	4	0.6	1.5	0.2
COD	//	25	26	26	40	6	9	18	29	35	15	21	19
D.O	//	7.2	6.8	7.1	6.8	7.4	7	7.4	7	7.2	7.3	7	7.7
Fecal coliforms	MpN/ 100ml	0	46000	42000	24000	150	2000	9500	44000	48000	2100	9300	40

Table 6. Results of quality analysis of total watershed in November 2012

Station / Parameter	unit	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Temperature	ºC	18	*18*	20	20	17	19	16	16	17	18	18	12
pH	_	7.2	7.7	7.5	7.8	7.1	7.6	8.1	8.2	7.8	7.4	7.8	7.9
Ec	µs/cm	709	935	1002	1028	522	533	649	664	727	502	587	556
TDS	_	461	608	651	668	365	373	454	465	473	351	411	389
Turbidity	NTU	1.4	8	15.8	16	8	18	8	8.6	12	4	5.4	6.1
Total hardness (Caco$_3$)	mg/l	350	477	510	500	266	315	460	475	420	308	325	280
SO_4^{--}	//	71	159.2	183.7	188.6	156..8	107.8	39.2	49	55	75.95	78.4	29.4
PO_4^{---}	//	0.003	0.024	0.031	0.086	0.009	0.01	0.006	0.012	0.01	0	0	0.01
NO_3	//	2.46	4	11	44	6	22	14	55.4	25	8.2	8	44
NO_2	//	0	0.001	0.01	0.025	0.004	0.012	0.008	0.25	0.15	0.004	0.004	0.08
NH_4	//	0	0.001	0.008	0.01	0	0.004	0.007	0.05	0.02	0.001	0	0.02
CL^-	//	10.6	14.2	24.8	24.8	14.2	21.3	17.7	19.5	21	16.3	17.7	10.6
Na^+	//	5.75	10.58	15.87	16.3	10.1	10.58	7.59	8.28	12	11.5	13.8	11.26
BOD	//	0	1	3.5	11	0.8	2.5	3	7	5	1	2	1.2
COD	//	31	36	38	42	6	11	12	26	36	14	23	26
D.O	//	4.76	5	5.48	5.68	6.2	6.21	6.8	6.53	6.2	7.8	7.8	8.36
Fecal coliforms	MpN/ 100ml	0	15000	9300	24000	700	1400	6000	35000	34000	6000	7000	10

Analysis of the field measurment results:

results from Gol Gol watershed sub basin

In the sub basin of Gol Gol, six sampling stations were considered in which the number

1 station is related to the manifestation of Mishkhas source. As it is shown, except the COD and Total Hardness, the concentrations of measured parameters in these stations are low and compatible with standards. According to the interpretation of Langelier and Ryznar, indexes of this water source is corrosive. ListenRead phoneDictionaryIn the Station No. 2 which is situated in the downstream of Darvnd Village, the concentration of the measured parameters increased which may indicate a secondary pollution caused by sewage and animal waste attributed to the upstream villages. Station No. 3 is located after Mahmoud Abad Village. The nitrate, nitrite and phosphate concentration of this station were increased compared to the previous station. Station No. 4 is located after Ja'far Abad Village, the terminal point area of Mishkhas, as shown, the concentrations of all parameters had significant increase which shows the low quality of Gol Gol water. Increase in the concentration parameters such as nitrate, nitrite, phosphate, BOD, and Fecal coliform can represent the pollution of Subshrub with agricultural drainage waters, human and animal wastes. High level of COD can indicate the presence of organic materials. Meanwhile, the results of Ryznar index indicate that the water is stable [13-15]. In Station number 5 which is a manifestation of Gol Gol River, we have the reduction of the relative concentrations of parameters. Here, it is related to the spring water of Gol Gol which is located in riverbed. Moreover, a small Village with a small population is located before the station, so the contamination of rivers as well as human and animal waste has been reduced. On the other hand, self-purification process of the river can lead to pollution reduction. Decreasing the concentration of pollutants in station No. 6 which is situated after Sarjoo village, justified the above mentioned reasons.

Dictionary

1. noun
    1. spring
    2. source
    3. fountain
    4. well
    5. mesh
    6. springhead
    7. font
    8. opening
    9. fount
    10. mineral spring
    11. wellhead

Results of Chaviz watershed sub basins

BOD and COD concentrations of the sub basin have been increased. It can be attributed to the establishment of several dairy farms units, livestock, and agricultural activity and disposable human and animal waste. Poor self-

purification processes of river scan have a negative role too.

Results of Malekshahi watershed sub basins

In this sub-basin, regarding the length of the river sub-basins, we have two sampling stations (station No. 11 after Mehr Village and Station No. 11 after Ama Village). Since, there is no animal husbandry around the basin, so the high nitrite, nitrate and phosphate concentration can be related to water drainage from agricultural, animal and chemical fertilizers on land upstream of the attributed stations. In order to evaluate the quality of discharged water from Ilam Dam which is used as drinking water source, Station No. 12 had been situated in Ilam reservoir output. The high levels of nitrate, nitrite and ammonia concentration indicate low quality water. BOD and COD levels were decreased in the dam outlet due to sedimentation of organic material which indicates that the reservoir can act as the best sedimentation tank.

Listen

Read phonetically

Dictionary

Listen

Read phonetically

Dictionary

AAnalysis of data based on measured parameters

1- According to variations of pH in the twelve-fold stations, the first significant one has got an ascending pH along the station. In the station No. 7, 8, and 12, it was observed that the highest pH with the average measure of them was equal to 7.8, 7.9, and 8.1, respectively. It showed the ascending trends of alkalinity water. The lowest pH is seen in Mishkhas Spring.

2- variations in dissolved oxygen (DO) in all three sub basins have got a decreased DO level indicating that we had an increase in BOD and COD and proportional microbial activity we had the reduction of DO in stations No. 4 and 8 in October which were equal to 3.9, and 3.4 mg/L respectively. In Station [12], which is related to the dam outlet, the depth of sampling was 30 meters on the surface of the water, and the amount of average DO was up to 7 mg/L due to the cold layer of the reservoir.

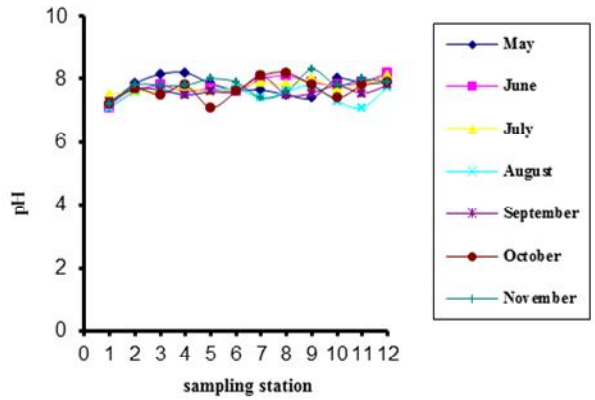


Figure 1.pH variations over the sampling period

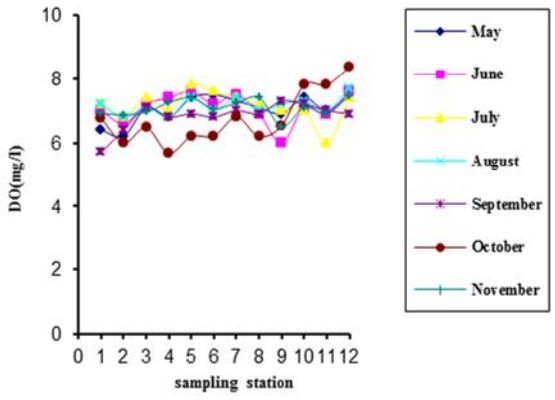


Figure 2. DO variations over the sampling period

3- During the course of a basin, the nitrite and nitrate variations had an upward trend due to the high agricultural activities in the upstream areas. During October, the highest nitrate and nitrite related to 8 and 9 stations, respectively, (stations situated in village Chaviz and Cheshme Kabood) were equal to 55 and 0.25 mg/L. In station No. 12 (dam outlet) we had the highest nitrate and nitrite in October, that were 44 and 0.8 mg/L, respectively.

4- Considering a direct linear relationship between phosphate and nitrate, the phosphate concentration which changes over the basin is exactly the same as that of nitrate. The highest phosphate concentration was related to station No.4, it was in November and was equal to (0.45 mg /L),. Moreover, the high contamination of Gol Gol sub branch was due to animal waste and agricultural drainage.

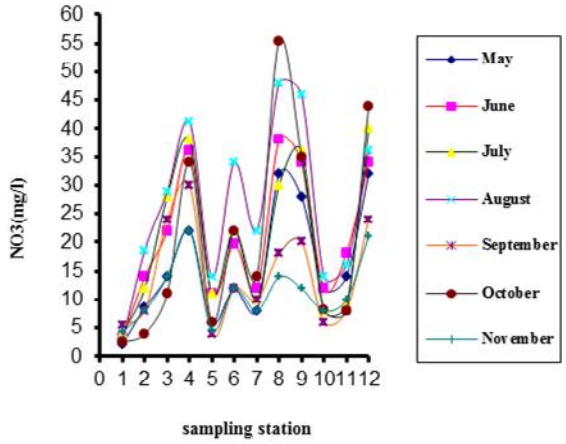


Figure3. NO_3 variations over the sampling period

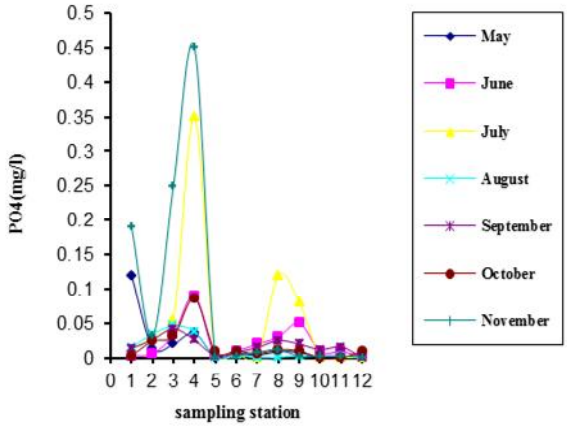
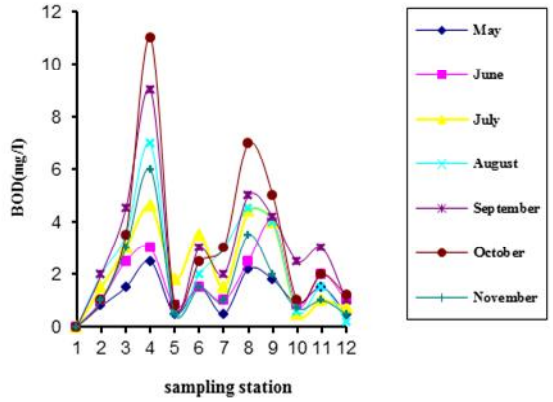


Figure4. PO_4 variations over the sampling period



5- Continuous increase in BOD concentrations was observed during the basin drainage of the station number 1 to 4. Sudden increase in concentration of this parameter in No. 4 revealed that the Gol Gol branch contamination by organic matter is likely due to the presence of rural sanitation and human and animal waste in river. In station No. 5, due to the addition of spring water to the river and also due to self-purification process, BOD concentration was decreased and again in station No. 6, the concentration was increased. The highest concentration of this parameter in Chaviz Watershed was related to No. 8 (1.2 mg/L). In Station No. 12, which is related to dam outlet, the highest concentration of this parameter is 1.2 mg/L. ListenRead phonetically Dictionary

Listen

Read phonetically

Dictionary

6- COD concentration which is increased continuously from station 1 to 4 indicates the contamination of Gol Gol basin by organic materials and other oxideable pollutants such as nitrite compounds. In station No. 5 and 6, the COD of Gol Gol River was decreased because of the self-purification process. A noticeable increase in COD concentration, stations No. 7 to 9 (which was related to Chaviz Basin) is detected. This increase was related to organic matter of a few units live stock and dairy farms which were located in the upstream of the stations. In Ama Malekshahi sub basin, the COD concentration had been ascending from station 10 to 11. In station No. 12, which was related to the dam outlet, the highest COD concentration was related to September (26 mg /L). The highest loud of COD occurred in station NO. 4 which was 42 mg/L.

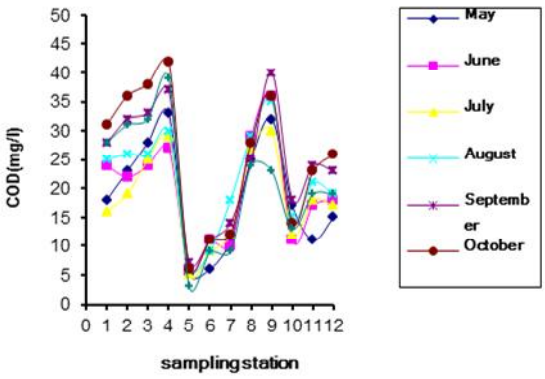


Figure 5. BOD vaiations over the sampling period

Figure 6. COD vaiations over the sampling period

Conclusion

The most important pollutants of Cham-e-Gardalan Dam drainage basin were due to agricultural drainage water, animal wastes, human sewage, solid waste and land crust which entered reservoir from Gol Gol, Chaviz, and Ama Malekshahi rivers and affected water quality. Studies show that the Gol Gol River, with 29 kilometers length, has the highest nutrient, organic and inorganic load into the dam and plays an important role on algae growth which could lead to the purification phenomenon in the reservoir in the future. During the drainage, basin peak pollution rate was seen in No. 4 station which is related to Gol Gol sub basin drainage and the station No. 8 which is related to the Chaviz drainage sub basin. Because the oxygen concentration can indicate the measure of pollution on receptive water, therefore the significant low DO in the same stations in October, equals to 3.9 and 3.4, respectively. During the sampling period, the most significant concentration of entered nitrate, nitrite, phosphate, BOD, COD, and input fecal coliform to the lake was in summer and estimated 55.4 mg/L, 0.25 mg/L, 0.45 mg/L, 11 mg/L,42 mg/L, and 192000MPN/100ml, respectively.

Results of the station No. 12 with the aim of assessing the water quality in the outlet of water reservoir indicate high levels of nitrate and phosphate, especially in October, (44 and 0.01 mg/L, respectively). This indicated that the existence of these nutrients, especially phosphate, has provided the conditions for algae growth which could be resulted in purification phenomenon. Interpretation of Langelier and Ryznar indexes showed that in most stations along with the drainage basin, especially station watershed basin No. 12, water is corrosive which is related to the output of the dam reservoir station. Agricultural drainage waters such as pesticides and fertilizers, which basically causes entrance

of nitrite, nitrate and phosphate to the rivers and the reservoir are factors which result in increasing algae growth. Accordingly, It leads to taste and odor problems in the water. It is worth mentioning that the large number of livestock units on the drainage basin (because ranch is the important source of income of these regions) have the most important role in animal waste contamination of rivers and dam reservoirs. Regarding the establishment of waste disposal site which has been placed in basin dam watershed, leachate moves towards the basin, especially in precipitation periods . Consequently, it leads to increase the pollution of river and reservoir by pollutants of leachate. According to geological condition of the dam catchment basin, ground layers often include Ilam limestone, clay and marl with abundant mineral deposits of gypsum that changes the water quality during the transition to the reservoir and the concentration of its salt increase. In such a way, the transferred water into the dam tank has higher level of hardness compound to the original water.

Acknowledgments

This work has been supported by the Research Council of Ilam University of Medical Science.Listen

Read phonetically

Dictionary

References

[1] M. Ghanadi, *journal of Water and wastewater,* **2000**, *44,* 35-46.

[2] P. Chaves, T. Kojiri, Y .Yamashiki, *Hydrological Proce*, **2003**, *17,* 2769-2793.

[3] S.H. Hashemi, E. Ghasemi Ziarani, Y. Ranjkesh, *J. of Environ. Studies,* **2011**, *37*, 1-89.

[4] A. Ghalibaf, M .Tajrishi, A. Abrishamchi, *Journal of Water and wastewater,* **2000**, *34*, 2-11.

[5] E. Carney, *J. Lake Reserve Manage,* **2009**, *25*, 199-207.

[6] A. Karbasi, *Water and Development,* **2005**, *13*, 81-85.

[7] F. Karaer, A.Kucukballi, *Environmental monitoring and assessment,* **2006**, *114,* 391-417.

[8] S. Isazadeh, M.Tajrishi, A. Abrishamchi, M. Ahmadi, *Journal of Water and Wastewater,* **2005,** *16,* 3-16.

[9] Veterinary office of Ilam, *reports and formation of Cham Gardalan farmers*, **2011**.

[10] Department of Water Affaris Ilam, *Physiographic basin rivers. Ministry of Energy*, West Regional Water, **2000**.

[11] A. Nikonahad, H. Moazed, F. Kazembeigi, *Iranian Journal of Water,* **2009***, 4,* 69-73.

[12] M.G. Hill, Water Quality and Treatmen, *American water works Association*, **1990**, 4th ed

[13] M.G. Hill, Water chemistry and interpretation of water analysis. NALCO *Water Handbook,* In: Kemmer FN (ed) London**, 1988,** 1th ed

[14] D .Champn, water Quality Assessment, A guide to the use of biota, *sediments and water in environmental monitoring,* Chapman & Hall, London*,* **1996**, 2th ed.

[15] A. Herna, *Marine Poll. Bull,* **2004,** *112*, 1130-1141.