

Assessment of environmental degradation of Kalar Kahar Lake, Salt Range, Pakistan due to anthropogenic activities and its remedial measures

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Abstract

Kalar Kahar Lake is one of the important high altitude lakes located in the Salt Range of the Pakistan. It is a famous tourist spot and got a unique status among the wetlands due to residence of a large number of migratory birds. Today this lake is facing environmental degradation due to increase in local population and tourism. A number of water samples were collected from the lake and recharging springs from April 2008 to July 2010 and analyzed by adopting the World Health Organization recommended guidelines. The results indicate that the physical and biological quality of the lake water is greatly degraded due to the sewage water entering in it mostly from the food supplying shops located in the south of the lake and runoff generated from populated area in the north and western boundary of the lake. The chemical quality of the lake is also alarming due to the increasing trend of the contaminants. The chemical quality of the lake water varies greatly over the year which is probably due to the dilution process caused by the heavy rainfall during monsoon period in the catchment area of the lake. The polluted water of Kalar Kahar Lake is a great threat to the life of migratory birds. Huge amount of sedimentation in the lake has greatly reduced the total storage capacity of the lake which is creating hindrance in safe boating facility for tourists especially during the dry season. Suggestions for rehabilitation of Lake Environment have also been given.

Keywords: Geological & hydrological surveys, tourism, water contamination, degradation of wetland.

Introduction

Kalar Kahar Lake is historically one of the important tourist's spot, famous for fruit gardens and holy shrine of Hazrat Hu-Bahu where wild peacocks have special attraction for the visitors. The other tourist attractions are the famous garden, Bagh-e-Safa which was constructed by the Mughal King Babar who was inspired by the landscape beauty of the Kalar Kahar Lake. Takht-e-Babri is a small table land cut from limestone formation & adjusted into a stage platform which is located in the fruit garden from where the Mughal King Babar use to view lake and addresses his army. There are a number of fresh water springs which are used to irrigate fruit gardens and also a perennial source of recharge for Kalar Kahar Lake.

After the construction of motorway during year 1997, the Kalar Kahar Lake has gained special importance because motorway has provided a direct access of major cities of Punjab to the Lake through Kalar Kahar Interchange. Hence the number of tourists increased many folds. To meet the requirements of the tourists the Government initiated several measures such as increase of parking area, construction of new markets in private sector for providing food and other picnic items.

Large scale excavation and mining activities in the mountain slopes located in south east of the lake are under progress since 2008. These excavations are being made to develop terraces for the construction of residential housing colony and development of commercial markets nearby lake.

As a result of these excavations, the soft geological formations such as marl, shale, clays and soft greenish grey sandstone are exposed to the environment. During the heavy precipitation of monsoon season, large scale sediments are being transported from these erodible formations and deposited in the lake. As a result total storage capacity of the lake is greatly affected. Hence vertical column of water in the lake is reduced to 3.5 meter which is decreasing effective boating and fishing facilities.

Kalar Kahar Lake is one of unique wetland located in salt range of Pakistan where every year thousands of migratory birds from Central Asia land and spend 3-4 months from late November to March. It is one of the ideal abode for a number of migratory birds. The important migratory birds which land in Kalar Kahar Lake include Water fowls, Russian ducks and Siberians cranes. The protection of the ecosystem for various species of migratory birds, as well as for healthy tourism it is very essential to keep the pollution free water in the lake, to find the causes and propose protection measures (Floater, 2002). Otherwise the continuation of present situation may result in loss of wetland (Devis & Froend, 1998).

This study is being carried out for the assessment of the threats to the eco system of the lake and suggests rehabilitation measures.

Fig. 1. Location of Kalar Kahar Lake indicating the sampling points (Modified from Survey of Pakistan)

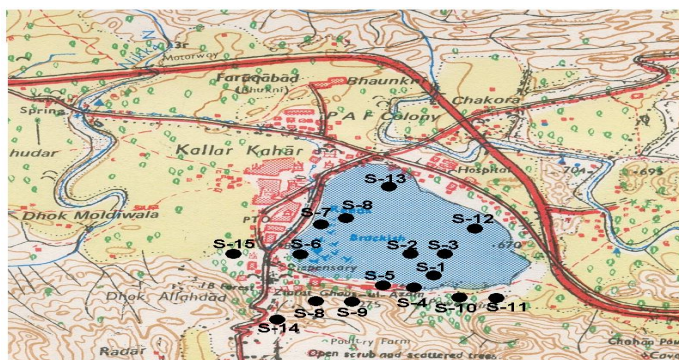


Fig. 2. A panoramic view of Kalar Kahar Lake indicating the fresh excavations, a potential source of sediment



Methodology

Field reconnaissance surveys were made for collection of data regarding geology, hydrogeology and other related activities affecting the lake (Fig.1). World Health Organization (1984) recommended procedure was adopted for collection and analyses of water samples. The experimental work is composed of estimation of physical, chemical and biological parameters of the water samples from Kalar Kahar Lake and feeding springs.

Geology and hydrology of the Kalar Kahar area

The Kalar Kahar lake is surrounded by hills making semicircle in the southern boundary of the lake where as the north and North West of the lake is composed of the alluvial plains, covered with thick population. Geologically the Kalar Kahar falls in Salt Range which is famous historically for its exposed unique geology and rocks of all ages are exposed in three important sections named, Khewra Gorge, Khewra Choha Saddan Shah Road side section and along Motorway (M-2 section). The rocks exposed in the mountain located in the south of the Kalar Kahar Lake are predominantly composed of sandstone, marl and gypsum overlain by limestone. Probably Sakasar Limestone of Eocene age is un-conformably

lying over the Salt Range formation. Shah (1977) reported that the Salt Range Formation is Pre-Cambrian in age. In the upper horizons of the outcrop, there is 12-15 thick alluvium present at places (Table 1).

The rocks exposed in the east of the lake are composed of soft greenish grey sandstone belonging to Swalik Group. Recently large scale excavations have been made in this formation to create level land for construction of housing scheme and commercial buildings in the surrounding of the lake (Fig.2). Due to these excavations rocks are exposed to the environment and the process of weathering and erosion has been increased many folds in the area. The direct impact of these activities is being found on the water quality of lake.

The area is located in semi-arid zone which receives approximately 30 inches mean annual rain fall during a year. The main source of recharge is precipitation and springs. A number of springs are present at the foot of the mountain in the south of the lake which is important source of recharge.

It is a surprising fact that chemically the quality of Lake Water is still comparatively safe. This is probably due to dilution of heavy seasonal rains in the catchments area of

Table 1. Physical properties of rocks units outcropped in the surroundings of Kalar Kahar Lake.

Name of rock formations	Physical properties
Sandstone	Slightly greenish grey sandstone which is spread over large area in the south east and eastern boundary of the lake. The sandstone is medium to coarse grained, loosely cemented and susceptible to erosion. The grain size increase towards the south eastern exposures. The degree of cementation is very poor and the formation contributing sediments to the lake.
Marl	Red blood to maroon and reddish brown marl exposed in the southern hill due to recent excavation for construction purposes, where it slide down during precipitation indicating low strength which is a potential source of sedimentation for lake if not protected immediately.
Shale	Shale in the study area is of two different colours, in the south eastern hill slope it is reddish brown whereas in the Ziarat Gorge and surrounding area it is dark grey and buff in colour,
Gypsum	Gypsum deposits are also of two types, in the south of lake it is in the form of thin seams where as at the toe of Ziarat hill large deposits are present in the form of big boulders of 5 to 7 feet diameter deposited in the soft matrix of clayey material from where excavations are being made to develop terraces for construction of buildings.
Limestone	Limestone is hard, compact and massive with thick beds however few exposures are nodular in Ziarat Gorge.
Alluvial deposits	Alluvial deposits are 15 to 20 feet thick composed of rounded to sub rounded gravels of few inches diameter, with boulders deposited in clay matrix, mixed with gypsum lumps.

Table 2. Estimation of recharge potential of feeding springs of the lake indicating the seasonal variations.

Spring No.	Location	Discharge of springs measured in (GPM)		
		20-04-2008	31-01-2009	15-07-2009
Spring-1	Ziarat Spring	35	10	42
Spring-2	Bagh Spring	120	28	135
Spring-3	Warni Dnd	80	15	95
Spring-4	Wadi	30	3	38
Spring-5	Katha Spring	182	66	202
Total	-	447	122	512

the reservoir. The major source of recharge of the Lake is the runoff generated from the surrounding hills due to precipitation.

The monitoring and estimation of the spring's inflows from April 2008 to July 2010 shows that all the springs feeding to the Kalar Kahar Lake can be classified as perennial springs however their discharge varies greatly during the year. The springs are perennial in nature but their discharge varies greatly over the year. Our measurements of these springs through v-notch from 122 to 515 GPM given in Table 2 are confirming the monsoon recharge.

Results and Discussion

The lake water is highly contaminated principal sources of physical contamination are municipal waste caused by tourists who directly disposed off waste food items, tins & plastic packets/shoppers etc during boating (Fig.3 & Table 3) and high rate of sedimentation caused by excavation along the slopes on the nearby hills (Fig.2).

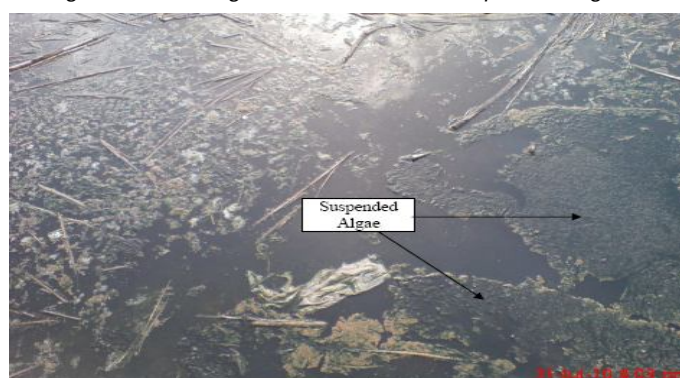
Severe type of microbiological contamination has been recorded (Table 4). The results of water sample tested for coliform and faecal coliform are given in Table 4 show that lake as well as feeding springs are contaminated and sewage contamination has been confirmed. Due to sewage contamination and disposal of physical waste unwanted algal growth causing the blockage of sun light which is affecting the aquatic life of the wetland as indicated in Fig. 4.

The results for chemical analysis of water samples from Kalar Kahar Lake are given in Table 5 which shows that all the samples have crossed recommended limits of World

Fig. 3. Municipal waste disposal by tourists a source of physical contamination



Fig. 4. Microbiological contamination/ suspended algae



Health Organization (WHO, 1984) in term of total dissolved solids. The periodically monitoring of the lake water shows that there is large variation in chemical quality and which is predominantly controlled by the dilution process of monsoon and other precipitation as highlighted in Table 6. Our findings are in line with the results reported by Iqbal *et al.* (2005) and Raza *et al.* (2007).

There should be a complete ban on the tourists to take food items with them during boating the packing material of which are mostly thrown in the lake and cause physical

Table 3. Results of physical parameter of water samples from Kalar Kahar Lake and its recharging springs.

Sample No.	Location	Colour	Temp.(C)	Odor	Taste	Turbidity
S-1	Lake	Light blackish	32	Smell like stagnant water	Not tasted	Slightly muddy
S-2	Lake	Slightly dirty	31	Nil	Not tasted	Slightly muddy
S-3	Lake	dirty	32	Nil	Not tasted	Slightly muddy
S-4	Hand-pump in Private Hotel	Clear	17	Nil	Tasteless	Clear
S-5	Hand-pump in Private Hotel	Clear	18	Nil	Tasteless	Clear
S-6	Lake	dirty	31	Nil	Not tasted	Slightly muddy
S-7	Lake	dirty	31	Nil	Not tasted	Slightly muddy
S-8	Spring-1	colorless	18	Nil	Taste-less	Clear
S-9	Spring-2	colorless	18	Nil	Taste-less	Clear
S-10	Spring-3	colorless	17	Nil	Taste-less	Clear
S-11	Spring-4	colorless	18	Nil	Taste-less	Clear
S-12	Lake	dirty	31	Nil	Not tasted	Slightly muddy
S-13	Lake	dirty	31	Nil	Not tasted	Slightly muddy
S-14	Spring-5	colorless	Not measured	Nil	Not tasted	Clear
S-15	Motor fitted pump	Clear	17	Nil	Taste-less	Clear

Table 4. Estimation of biological contamination in the Kalar Kahar Lake and its recharging springs determined through filter method.

Sam. No.	Location	Total coliform MPN	Faecal coliform MPN
S-1	Lake	14	6
S-2	Lake	15	5
S-3	Lake	>40	15
S-4	Hand-pump in Private Hotel	5	0
S-5	Hand-pump in Private Hotel	3	1
S-6	Lake	>45	30
S-7	Lake	-	-
S-8	Spring-1	12	3
S-9	Spring-2	20	5
S-10	Spring-3	13	15
S-11	Spring-4	24	6
S-12	Lake	0	0
S-13	Lake	1	0
S-14	Spring-5	0	0
S-15	Motor fitted pump in dug well	-	-

contamination. In the watershed area especially in the nearby sloping hills large scale plantation should be made to increase recharge of the lake feeding springs and reduce the natural erosion & sliding. Complete removal of the encroachments of local population from northern and western boundary of the lake and restoration of the original regime of the lake, this will help in improvement of the biological quality of the lake. The water of the feeding springs should be re-routed to develop falls which will increase oxygen to control algal bloom and related conditions through aeration.

Conclusions and recommendations

This study indicates that Kalar Kahar Lake is under sever threat of environmental degradations. Due to urbanization and mining activities in the catchments area, physically and

biologically high level contamination has occurred in the lake where as chemically its quality is heading towards alarming situation. The chemical quality of the lake is predominantly controlled by monsoon precipitation which greatly dilutes its total dissolved solids considerably.

This study suggest for remedial measures to eliminate contamination from the lake To protect the endangered species of migrating birds a long term monitoring is also recommended.

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References

- Devis JA and Froend R (1998) Loss and degradation of wetlands in southwestern Australia underlying causes, Cconsequences and solutions. *Wetland Ecol & Managt.* 7, 13-23.
- Floater GJ (2002) A risk model for predicting the effects of lake side development on wildfowl population. *J. Environ. Managt.* 66, 307-316.
- Iqbal F, Raza N, Athar M and Ali M (2005) Contamination of Kalar Kahar Lake by inorganic elements and heavy metals and their temporal variations. *J. Appl. Sci. & Environ. Managt.* 10(2), 95-98.
- Raza N, Niazi SB, Sajid M, Iqbal F and Ali M (2007) Studies on relationship between season and inorganic elements of Kalar Kahar Lake (Chakwal), Pakistan. *J. Bahauddin Zakria Univ. Multan.* 10 (2), 61-68.
- Shah SMI (1977) Stratigraphy of Pakistan. Published by Director General, Geological Survey of Pakistan, Quetta.
- WHO (1984) Guidelines for drinking water quality. World Health Organization, Geneva.

Table 5. Results of chemical parameter of selected water samples from Kalar Kahar Lake and feeding springs.

Sam.No.	pH	EC μ s/cm	TDS mg/l	Cl mg/l	SO ₄ mg/l	CO ₃ mg/l	HCO ₃ mg/l	Ca mg/l	Mg mg/l	Na mg/l	K mg/l
S-1	6.86	870	690	112	56	120	104	40	24	42	18
S-2	6.60	698	489	120	53	122	102	36	29	43	16
S-4	6.76	785	550	130	48	123	103	39	30	29	20
S-5	6.56	880	616	116	49	118	104	38	26	38	16
S-6	6.46	860	602	124	42	116	107	42	24	39	18
S-7	7.86	867	607	178	60	126	116	48	34	40	18
S-8	7.76	980	686	140	65	128	112	54	30	43	12
S-9	7.98	1025	718	146	62	126	114	56	32	44	16
S-10	7.88	978	685	148	60	128	118	49	34	45	18
S-11	7.83	986	690	158	56	130	110	50	30	44	14
S-12	-	1046	732	154	58	124	112	44	36	42	16
S-13	-	896	627	159	40	113	110	34	21	32	17

Table 6. Comparison of average water quality of the lake in terms of total dissolved Solids (TDS) indicating the seasonal effect.

Date of measurement	No. of samples	Average value of total dissolved solids (mg/l)	Remarks
20-04- 2008	7	613	Samples collected just after spring rain falls.
31-01-2009	5	684	Perennial recharge source is reduced to 25 % of average potential
15-07- 2009	5	602	Due to pre monsoon precipitation inflows of the feeding springs increased greatly which caused dilution.
31-07-2010	1	589	Dilution due to heavy rain falls.