Impact Assessment of Sugar Mills Effluent on LBOD and their Surrounding Groundwater

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***Abstract*: The study was carried out to find the impact of sugar mills effluent on the LBOD Spinal drain and their surrounding groundwater quality. Samples were collected from four sugar mills namely Mirwah, Digri, Khoski, Badin and groundwater samples near the main Spinal drain from RD 157 to RD 187. Mainly, six Physico-chemical parameters such as pH, TDS, TSS, NO_3-, SO_4 - and PO_4 were analyzed in groundwater and sugar mills effluent. The nitrate concentration in groundwater samples varied from 7.47 to 27.74 mg/L. The maximum concentration level of 157 mg/L of sulfate was observed in the sample of RD 157, which is nearest to LBOD. In the study area, results showed all parameters of groundwater were within the range of NEQS, whereas, results of sugar mills discharge were not observed within the range of NEQS. Digri sugar mill effluent was found high in pH about 4.65 which showed highly acidic in nature, TDS values were high in a range of 9860 mg/L in Mirwah sugar mill to lowest in range Khoski sugar mill 3680 mg/L. The maximum phosphate value analyzed in Mirwah sugar mill was 1929.251 mg/L.**

***Keywords*: Impact, Sugar Mills, LBOD, Groundwater quality.**

I. INTRODUCTION

Sugar industries are one of the most polluting industries in a sense of generated wastewater volume in Pakistan [1]. In developing countries estimated about 70 percent wastewater discharge without treatment by industries which will cause water pollution receiving water body [2].The sugar mills for cane processing need a bulk quantity of freshwater, consequently discharging of huge quantity of effluent into the environment [3]. The discharged effluent from industries contains a high quantity of contaminants such as organic and inorganic matter suspended solids, and chemicals. Many of the chemical substances used in the processing of sugar are toxic and could end with a poor quality of the receiving freshwater body if it is not properly treated [4].In Sindh Province, sugar mills were located in the catchment area of the Left Bank Outfall Drain (LBOD) system. It is estimated that about 25 million cubic meters of untreated effluents of these sugar mills discharge directly or indirectly into the LBOD system, wastewater generated from these sugar mills will be discharged into the Spinal Drain through the drainage system of the LBOD network in lower Sindh province [5].

The LBOD drainage system was introduced to manage the groundwater level and improve drainage water from an area of 1.275 million acres of land on the Left Bank of the river Indus in Sindh. This System nowadays is causing concerns about serious threats to the human and environmental systems [6]. However, in district Badin; the system has failed to provide the desired results and has been the cause of serious deterioration to land, groundwater, and submergence of the area by saline water due to intrusion of the sea. The main sources of water pollution which will be the cause of contamination in the system of LBOD include; Dumping and discharge of industrial and municipal solid untreated industrial wastewater discharge from sugar mills and from agriculture lands in the form of fertilizers and pesticides [8]. The wastewater in this way leaches down into the groundwater to change its chemical composition to contaminate aquifers [9]. This water pollution is harmful to human health as well as to local habitats. Therefore, in southern Sindh, the downstream population is exposed to adverse health effects, particularly due to water bodies contaminated [10].

Previous studies conducted on physicochemical parameters of LBOD suggested that the water quality of LBOD in terms of physicochemical parameters is badly polluted. Maheser et al 2017, conducted a study on Physico-chemical parameters, It has been concluded from results that the values of total dissolved solids (TDS) of the collected samples are ranging from 1000-6000 mg/L, which not fit for discharge and not within NEQS limits [11]. In 2015 Qureshi et al reported the impact of Releasing Wastewater of Sugar Industries into Drainage System of LBOD, Sindh, Pakistan. The pH values of the Sugar Mill samples, with the lower and upper NEQS limit, were determined. The results were reported that there are some sugar mills having pH values below the bottom of Ansari, T M Khan, Dewan, and Pangrio. It was concluded that pH values of analyzed samples of sugar mills along with lower and upper NEQS limit. Some sugar mills viz. Ansari, T M Khan, Dewan, and Pangrio show a pH value below the lower limit. TDS values of sugar mills wastewater are ranging from 703 to 16,704 mg/L, and the highest values of TSS from T M Khan Sugar mill is 32,720 mg / L. In Tharparkar and Mirza sugar mills the TSS value is 30,00 mg / L which were at the borderline against the National Environmental quality standard (NEQS) [12]. The work carried out by Maheser et al 2016, on Assessment of water quality LBOD and their environmental concern shows the TDS concentrations vary between 1500 and 23000 mg / L in the samples. These pollutants degraded the LBOD system and presented a serious threat to the and healthy environment [13].

A. Study area

The research area covers the surrounding groundwater of LBOD from RD 187 LBOD to RD 159 KPOD, and sugar mills such as (Mirwah, Digri, Khoski, and Badin) which are located on the catchment area of LBOD system. The LBOD systems in the

regions of Mirpurkhas, Nawabshah and Sanghar districts were constructed to provide waterlogging and the salinity of 1.27 million acres, but with the passage of time sugar mills are constructed, which discharge their effluent without treatment into LBOD systems, currently effluent contaminates surrounding surface and groundwater of LBOD system finally to become part of Arabian Sea.

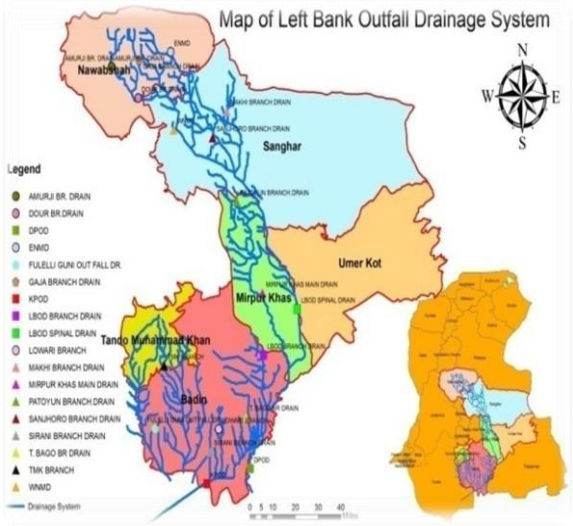
II. MATERIALS & METHODS

A Samples collection & Preservation

Samples were collected from four sugar mills namely Mirwah, Digri, Khoski, Badin before discharging into their disposing locations of LBOD. Similarly, six groundwater samples were collected across the area surrounding RD 187 to RD 157. These samples were collected and preserved at 4 ℃ in clean polyethylene bottles than transported to the Water Quality Laboratory of Environmental Engineering Department Mehran-UET Jamshoro. finally, samples were analyzed for targeted parameters.

B Parameters Analysis

All parameters of water quality are measured in mg/L with the exception of pH. Microsoft Excel 2016 was used to carry out all statistical analyses. Sampling analysis methods and Procedure are depict in table below. Fig.



1: Map of Study area

S: No	Parameters	Standard Methods	Procedure
1	pH	AQUALYTICAL10	pH are measure by inserting pH probe in sample filled beaker.
2	TDS	HQ403DHQ403D 53000000 HACH	Sample filled in beaker insert sensor in sample filled beaker, wait until take it stables reading.
3	TSS	DR Photometer HACH USA	In TSS measurement method the civet of equipment are filled with sample and clean it with tissue paper to take reading at a wave length of 610 nm.
4	Nitrate	US EPA (colorimetric, Brucine)	This method is based upon the reaction of the nitrate ion with brucine sulfate in acid solution. It is measured at wavelength of 410 nm.
5	Sulphate	Standard Method No. 4500-SO_4^{2}	This method uses barium chloride (50mg) to turbid in acid media, then analyzed at a wavelength of 420nm.
6	Phosphate	US EPA methods 365.3	Phosphate determined with two regents. Ammonium molybdate-antimony potassium tartrate solution and ascorbic acid at a wavelength of 650nm.

III. RESULTS

This section presents the results of analyzed groundwater and in sugar mills, wastewater parameters are Nitrate, Sulfate, Phosphate, pH, TDS, TSS are under discussion, that indicates the assessment of Sugar mills' wastewater and its impacts on the surface and subsurface surrounding water of LBOD.

The acid or basic nature of a solution is measured by pH for the protection of freshwater fishes and invertebrates living in the bottom with a normal range of 6.5 to 8.5 [14]. In the present study, the pH value ranged from the lowest 4.65 of Digri sugar mill up to the highest 8.26 of Army sugar mill, while the pH of Mirwah sugar mill is 7.45 and Khoski sugar mills are in the range of

7.24. Due to acidic nature pH values of Digri sugar mill dose not satisfy the NEQS limits. Fig shows the Army sugar mill pH values are near to the threshold 8.26, are shown in (Fig 1. a).

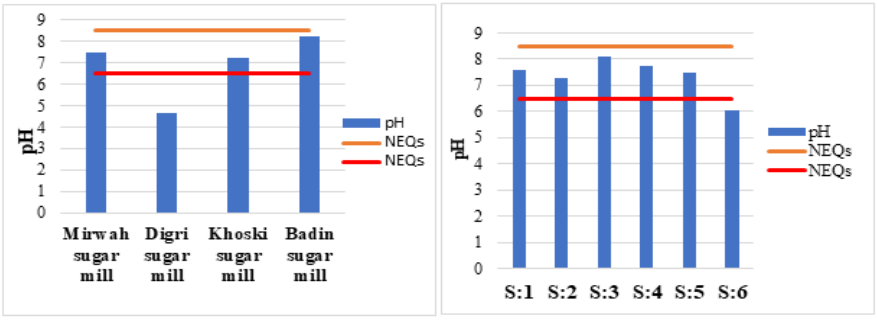


Fig. 1: a) pH value of Sugar mills and 1: b) value of groundwater

The optimum pH required will depend on the water composition and nature of construction material used in the distribution system in different supplies, it is usually in the range 6.5–8.5 [15]. The pH of groundwater samples of LBOD surrounding areas was within range of 6.06 - 8.1. The average pH range was 7.37. The pH of sample locations was within acceptable limits of NEQS.

Total Dissolved Solids (TDS) contain organic matter and inorganic salts dissolved in water. TDS represents an indicator of contamination [16]. TDS values were high in a range of 9860mg/L in Mirwah sugar mill to lowest in range in Khoski sugar mill 3680mg/L. Digri and Army sugar mill indicated TDS values of 5010 mg/L and 7250 mg/L, respectively. The TDS values of all sugar mills samples were found higher than permissible NEQS limit which is 3500mg/L. which allow degrading drainage systems are shown in (Fig 2.a).

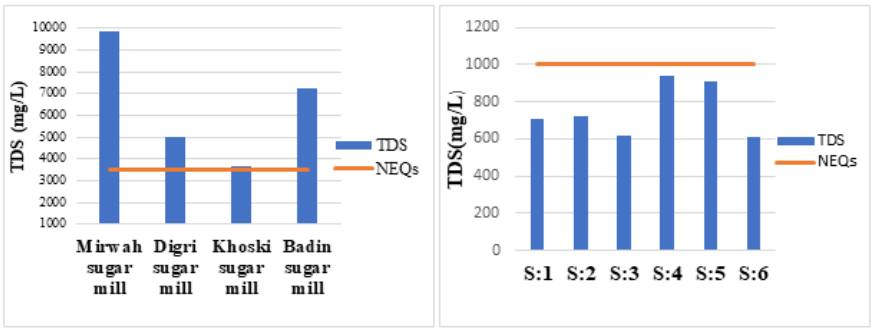


Fig. 2: a) TDS value of Sugar mills and 2: b) value of groundwater

The results of groundwater samples having TDS were within the permissible limits (1000 mg/L) of WHO for drinking water in samples [17]. Sample locations S-3 and S-6 having TDS less than 600mg/L, so they are considered as good in test and other samples had a high value of TDS, near to 1000 mg/L. High values of TDS confirmed that groundwater has been severely affected by water carried by LBOD.

The total suspended solids are esthetically undesirable and create sludge deposits in the water body [18]. TSS results in Digri, Khoski, and Army sugar mills are within permissible NEQS limits and results of samples collected from Mirwah Sugar mill highest values 486 mg/L are not within permissible NEQS limits. It may cause of sludge deposits in the LBOD water body.

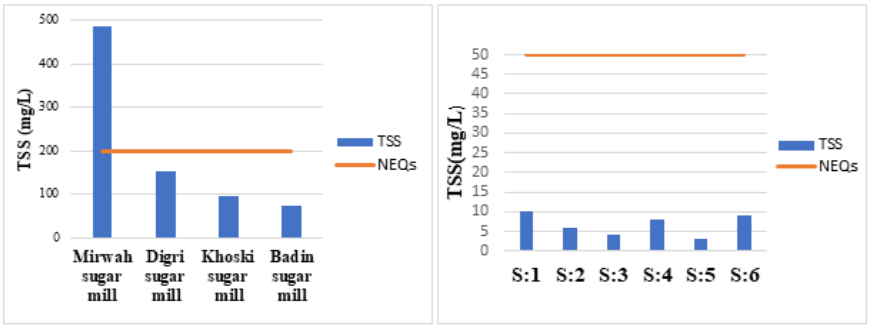
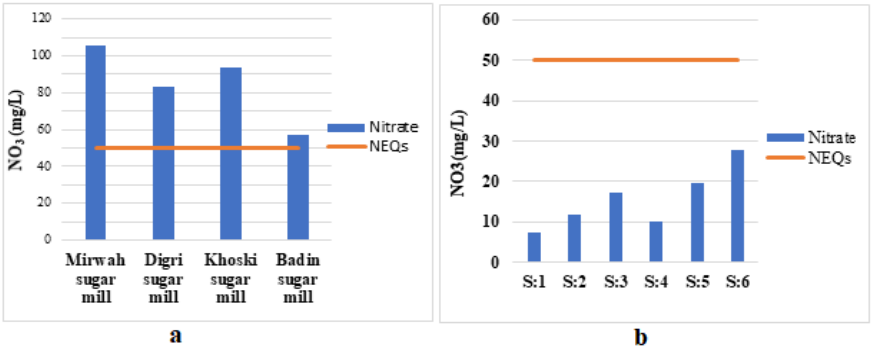


Fig. 3: a) TSS value of Sugar mills and 3: b) value of groundwater

In the study area, the TSS of all the samples is within NEQS limits. In the groundwater sample, the maximum concentration of TSS was found in (S1) 10.00 mg/L and minimum TSS concentrations were found in the groundwater sample (S3) 4mg/L and (S5) 3mg/L, respectively as shown in fig (3.b). A minimum change between groundwater samples has been observed.

Nitrates are the most oxidized sources of nitrogen and are a result of aerobic decomposition [19]. The maximum nitrate was observed as 105 mg/L in Mirwah and minimum as 57 mg/L. Nitrate Levels in Degree sugar mill are 83.352mg/L and 57.235mg/L are found in Khoski sugar mill. The nitrate level in all sugar mills effluent is higher than NEQS permissible limits.



a b

Fig. 4: a) Nitrate value of Sugar mills and 4: b) value of groundwater

Nitrates do not contribute to the problem directly, bacteria in the digestive tract are converted nitrate to highly toxic nitrites, which could result in the baby's blue baby syndrome (methemoglobinemia) [20]. The nitrate concentration in groundwater samples varies from 7.474mg/L to 27.748 mg/L as shown in Fig: 3 b. In downstream high level of nitrate were is observed around the LBOD area. Around LBOD there is a mixing of effluent with the groundwater which is responsible for high orders of nitrate values. Effluent is mixed with groundwater that is responsible for high levels of nitrate levels. Thus, in this area nitrate pollution is the combined effect of agricultural activity sugar mill effluent and LBOD Drain.

Sulphate is one of the main active agent occurring in groundwater. It can reach in water through natural deposits. Sedimentary rocks may be the source to leach way, particularly from deposits of sulphates including gypsum and anhydrate. Effluent from some industries may also be major sources of sulfate for water [21]. The results of sulphate in analyzed samples which are fluctuated between the 60.571 mg/L to 2080.66 mg/L. 2080.66 are the highest level are in Army sugar mill and 60.571mg/L lowest level in Digri sugar mill, while the 365.46mg/L level of sulphate in Mirwah sugar mill is higher than Khoski and Digri low in a range from Badin sugar mill. The NEQS for sulphate discharge is 600mg/L will follow by three sugar mills without Army sugar mill which will cause of sulphate pollution in LBOD Drain.

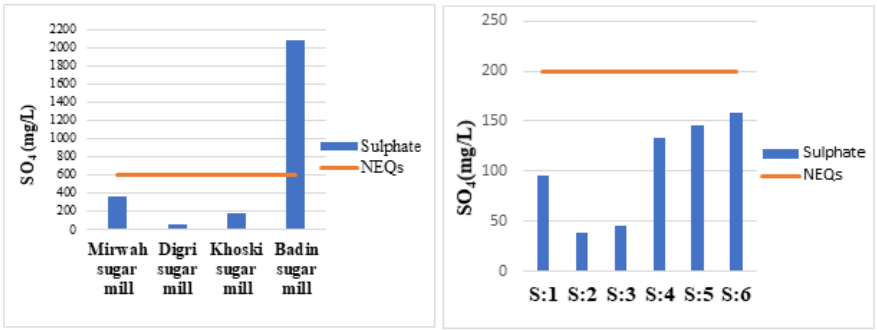


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Fig. 5: a) Sulphate value of Sugar mills and 5: b) value of groundwater

In the present study, it is observed sulphate in groundwater that was 38 mg/L in sample no: 3 and 157 mg/Lit in sample 6 which is near to LBOD respectively, which is within permissible limits of NEQS.

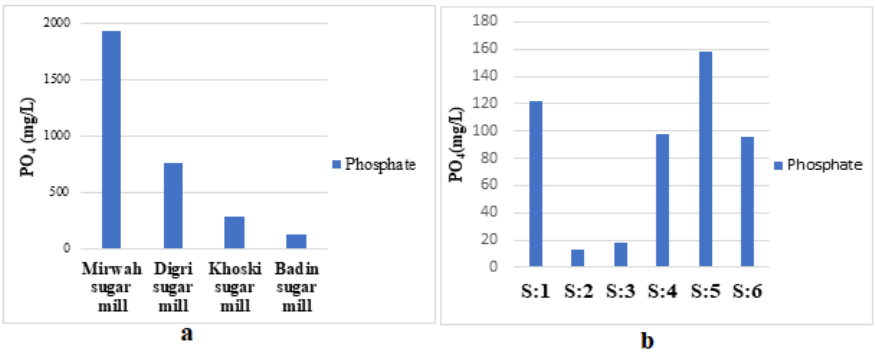

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Fig: 6: a) Phosphate value of Sugar mills and 6: b) value of groundwater

The measured value for Orthophosphate (PO4) indicates that the wastewater sample has a high level of phosphate. The maximum value was recorded in Mirwah sugar mill was 1929.251 mg/L, while in Digri sugar mill wastewater sample was 759 mg/L and 288.435mg/L in Khoski sugar mill whereas the lowest level of phosphate 129.251 mg/L was measured in Army sugar mill. However high levels of phosphate in Mirwah and the lowest level in Army sugar mill. Phosphate may occur in groundwater

as a result of detergents, domestic sewage, and agricultural waste [22]. Usually, groundwater only includes the minimum level of phosphate due to the low solubility of natural phosphate minerals and the phosphate retention ability of soil. In the study area, the phosphate concentration varied between 157 mg/L in (S:5) and 16 mg/L in (S:2) as shown in fig (6.b).

IV. CONCLUSION

The study concludes that from all sugar mills Mirwah sugar mill are main contributor in polluting the LBOD water body. All the parameters TSS, TDS, Nitrate, Sulphate, Phosphate of Mirwah sugar mill are not within NEQS limits. The pH of wastewater in Digri sugar mill, TSS and Sulphate of Badin sugar mills are not within the range of NEQS. Whereas TDS as well as Nitrate of all sugar mills not within the limits of NEQS. The result of groundwater samples was within limits of NEQS. LBOD water body being deteriorated due to a high concentration of sources of pollutants. The high concentration of some physicochemical parameters of sugar mills will cause of degrading of the LBOD water body.

V. RECOMMENDATIONS

This study suggested the following recommendations:

- Wastewater without treatment not to be discharged.
- The wastewater of sugar mills was diluted before discharge.
- In this study, only one-time sugar mills samples are collected, so it is recommended that weekly samples are collected during the Cane crushing season.

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