Zonation Water Quality of Bamdezh Wetland by Using Surfer Software

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Abstract

The complete and indepth investigation of water quality in Bamdezh wetland of Iran have clearly indicated the increased level of organic pollution in this wetland. The results on increasing level EC, Na^+, Ca^{2+}, Mg^{2+}, K^+, chlorides and sulfates had clearly revealed that the toxic in Bamdezh wetland has become unfit and highly toxic for the survival of aquatic flora and fauna including fishes, mammals etc. There is transformation of fresh water wetland to marine or saline wetland; as a result of this the fresh water life is under pressure, as their habitat is lost. It has favoured the loss in biodiversity, substitution of aquatic life by marine life.

Key words: Bamdezh Wetland, Water Quality Parameters, Flora and Fauna.

Introduction

Wetlands are important part of human environment and vital for their survival, as they provide resources to satisfy their need of water. Novotny and Olem (1994) have described in detail the ecological functions of wetlands and commented on their significance. Mitsch and Gosselink (2000) and Cowardin et al. (1992) have also highlighted the importance of wetlands and explained how they act as filters or purifiers of environmental pollution. They also acts as the "kidneys of the landscape", filter out the pollutants and function as the sink of nutrients by purifying the water through physical, physico-chemical and biochemical processes. The mild slopes in wetlands slow down the velocity of water, which allow the nutrients to sediment and then absorbed by the plants.

The growth of invasive species is frequently favored by the alterations in water regimes e.g. the invasion of the weed *Phyla canescens* is associated with reduced water quantity (Keyte, 1994). Environmental water allocations help in the water management strategies to control the growth of invasive species in wetlands. The environmental water allocations in wetlands also help to protect endangered species or communities of plants and animals.

Wetlands the sensitive biotic habitats, which are not yet realized properly and studied in depth throughout the world including Iran, which has largest area of wetlands. Wetlands are the masterpiece of creation but they are not studied properly. No in depth research is carried out on any wetlands of Iran and hence this study was undertaken. Nowadays in advanced and developing countries wetlands are attempted properly and lot of research work is carried on various aspects of wetlands because of the activities of environmental protection.

Iran, because of diversity of climate and different surface and ground water resources has 22 international wetlands with area equal to 1,379,435 ha. Distribution of wetlands in Iran is not restricted to special region and Iran's wetlands are located in all over the country towards north, south, east and west. In southern west of Iran exist some important wetlands in Khuzestan province. Because of the existence of rivers such as Karoun, Dez, Karkheh, Zohreh etc the wetlands such as Shadegan, Bamdezh, Hor-Alazim, Miangaran etc are present in this province. But in Khuzestan province because of impose of war during 1980-1988 there was economic, social and environmental damages to water resources in the wetlands.

Because of the high potential of Khuzestan province in water resources and soil there is construction of dams as well as establishment of irrigation and drainage networks. As a result of this there is lot of environmental degradation especially in wetlands. The important dams that have been constructed on rivers in Khuzestan province are Dez on Dez river, Karkheh on Karkheh river, Karoun 1, 2, 3 and 4 on Karoun river, Shavoor on Shavoor river and etc. the river water was allocated for agriculture, drinking and industrial purpose and hence there was acute shortage of water in wetlands.

Recently because of draught and discharge of waste water and drain water in Bamdezh wetlands, its ecological situation has become worst. The villages also uplift very high amount of water and add in this condition. Hence investigation on water requirement of wetland is highly essential for the protection of wetlands of Iran in general and Bamdezh in particular.

The important wetlands of Khuzestan province are Shadegan, Bamdezh, Hor-Alazim and Miangaran. Amongst these Bamdezh wetland is very important in Khuzestan province. Water of Shavoor river before discharged to Dez river pass from lowland and this caused the creation of Bamdezh wetland.

According to the main source of Bamdezh wetland this wetland is riverine wetland and according to the Ramsar convention and United State Army Corps of Engineering, Bamdezh wetland is component of riverine and marsh wetland. This wetland as per the water quality is fresh water wetland and permanent one. This wetland has important role in control of flood and over flow of Dez and Shavoor river. Because of this, the wetland in winter act as a storage tank to store overflows of water and in summer discharge water to Dez river. Discharge of waste water by Shavoor river in to the wetland and overdraft of water by villagers are the main degrading factors for this wetland. Previous research was carried out on this wetland by

Afkhami (2004), Bostanzadeh (2003) and Nabavi (2002) but they have not attempted the research on water requirement and planning for the protection of plants and animal life in this wetland.

Hence in depth research on environmental water requirement and planning for the protection of plant and animal life in this wetland was undertaken in present study. The main aim of this study is evaluation of water quality of Bamdezh wetland by using Surfer software in order to determine the effective factors on water quality parameters.

Materials and methods

Bamdezh wetland is located in Khuzestan province of Iran at the distance of about 40 (Km) on northwest site of Ahwaz-Dezful road. Kharkheh river is located on west and Dez river in east of Bamdezh wetland which is located between $48^{0}\ 27^{'}$ to $48^{0}\ 42^{'}$ eastern longitude and $31^{0}\ 38^{'}$ to $31^{0}\ 55^{'}$ northern latitude. The area of this wetland is 44 (Km^{2}) (11 Km X 4 Km).

Bamdezh wetland ecosystem is surrounded by villages like Mazrae 2, Seyed Saleh to the north side, while on the west side there are four important villages like Kaab Abod, Seyed Zahrab, Sadat Tavaher and Ghaleh Sahar and to the south of Bamdezh wetland is Elhaee village. The famous Shavoor Dam is situated towards north side. Bamdezh wetland is a natural wetland, permanent fresh water marsh and recharged with Shavoor river as surface water source. Additionally, it is also recharged through saline ground water (Jamee, 2002). Figure 1 show the satellite image of Bamdezh wetland.

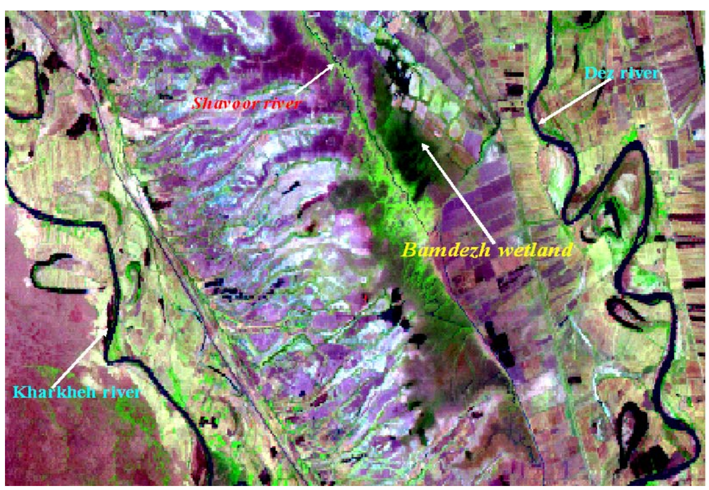

Figure 1. Satellite image of Bamdezh wetland

For the evaluation of variation in water quality parameters between sampling stations Surfer version 9.0 was used. First by using UTM Conversion software the geographic condition (eastern longitude and northern latitude (degree)) was changed to UTM (longitude and latitude (m)). Figure 2 shows the home page of this software.

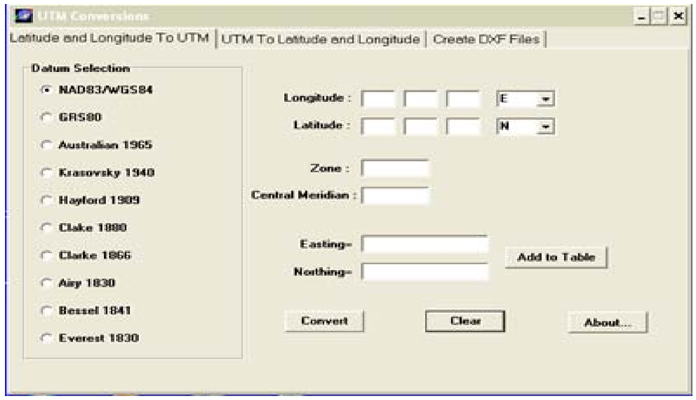

Figure 2: UTM software home page

After that in Surfer software longitude and latitude (m) as X and Y axis and water quality parameter (EC, Na^+, K^+, Ca^{2+}, Mg^{2+},Cl^- and SO_4^{2-}) as Z axis were taken. Figure (3) shows the main page of Surfer software. Finally, 3D surface map for each parameter in whole Bamdezh wetland have been obtained.

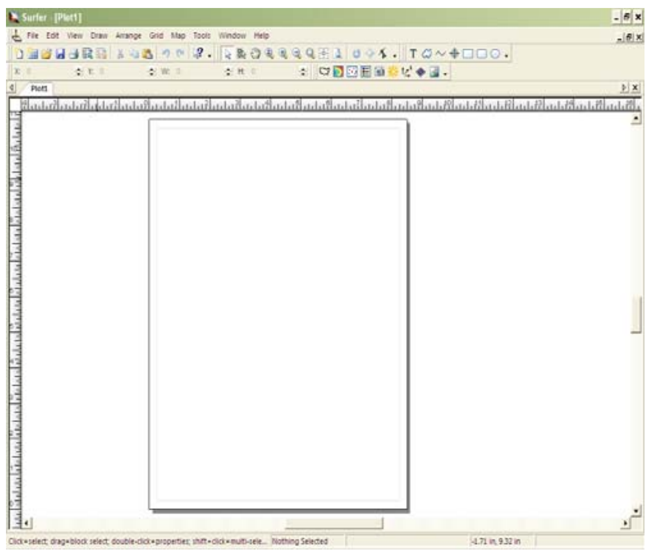

Figure 3: Surfer software main page

As mentioned before for evaluation of water quality each sampling station has been divided into zonation plot of each parameter. By using these plots water quality of Bamdezh wetland was analysed.

Results and Discussion

Grattan et al. (1996) reported that the main dissolved salts in water were of sodium, potassium, calcium, magnesium, chloride and sulfate. Different water quality guidelines have been developed by different researchers for analyzing the water quality in different conditions (Ayers and Westcot, 1994).

For present study four sampling stations were selected: Shavoor dam, which is input of wetland and Tavana canal (Kharoor canal) it is the output of wetland. Two more stations such as Mazraeh and Sadat Tavaher were also selected which are in the main body of wetlands.

Figure 4 shows variation in EC in whole of the wetland. It indicated that from low longitude to high the values of EC usage has been increased and from high latitude to low, EC values were again increased. On the other hand, from north to south and from west to east of wetland the values were also increased.

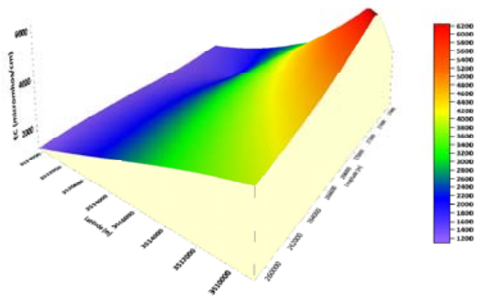

Figure 4: Plot of EC in Bamdezh wetland

Since the distance between input of wetland to Mazraeh, Mazraeh to Sadat Tavaher and Sadat Tavaher to output is 6.3, 1.2 and 3.4 (Km) respectively, can be concluded approximately, the EC of $\frac{2}{3}$ of Bamdezh wetland area was more than 3000 (micromho/cm) during this study. The main reasons for this are meteorological parameters such as; rainfall, evaporation, sunshine and temperature.

Electrical conductivity is a measure of the capacity of water to conduct an electric current. The higher value of conductivity means the water is a better conductor of electricity. The amount of dissolved salts in water will affect the conductivity. The more dissolved mineral salts, the higher will be the conductivity. This is because of the presence of dissolved ions of salts. Conductivity is also increased by increased temperature. High levels of mineral salts in water usually affect survival of the animals, plants and their reproduction. Electrical conductivity increases when more of any one salt including the most common one, sodium chloride, is dissolved in water. For this reason, conductivity is often used as an indirect of the salt concentration in water bodies.

In general, water with more salts is the more productive ones except, of course, where there are limiting nutrients or limiting environmental factors involved. Natural factors can also cause higher conductivity values in the open water e.g. drought conditions can increase the salt concentrations in a water body in two ways: (1) drought can cause higher salt concentrations in the inflowing water and (2) heat and low humidity can increase the rate of evaporation in open water, leaving the water body with a higher concentration of salts. The animal and human wastes (sewage, feed lot effluents etc.) containing salts also cause increase in conductivity which is used to detect the contamination. It is important to keep in mind that elevated conductance may be due to various factors (Mathur et al., 2009).

Dune (1977) reported that at high flows, the EC values tend to be diluted by surface runoff and for most rivers and wetlands there is an inverse correlation between discharge rate and EC. The agricultural activities such as over fertilization can increase the level of EC than the standard level. The sedimentation as well as erosion is also partly responsible for the higher level of EC (Mansouri, 2000).

UNEP (1994) reported that the possible reasons for higher EC values in resource water of rivers, wetlands etc. might be due to the input of large amount of surface runoff, containing sediments from the catchment areas, with intensive agricultural crops and human habitation.

The figures 5, 6 and 7 illustrated the changes in Na^{+}, Ca^{2+} and Mg^{2+}content at four sampling stations for two years of study.

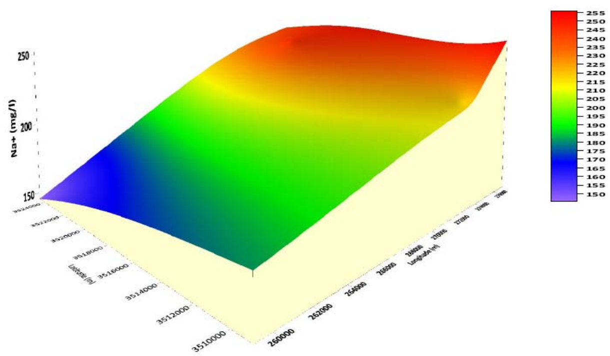

Figure 5: Plot of Na^{+} in Bamdezh wetland

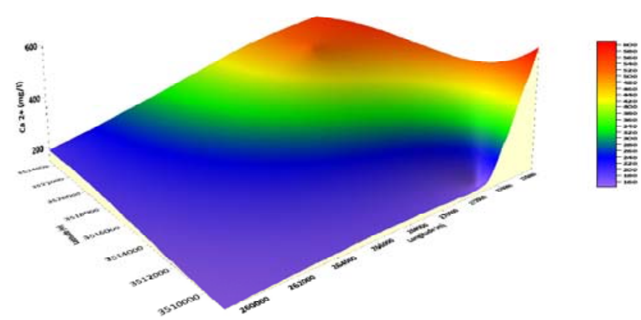

Figure 6: Plot of Ca^{2+} in Bamdezh wetland

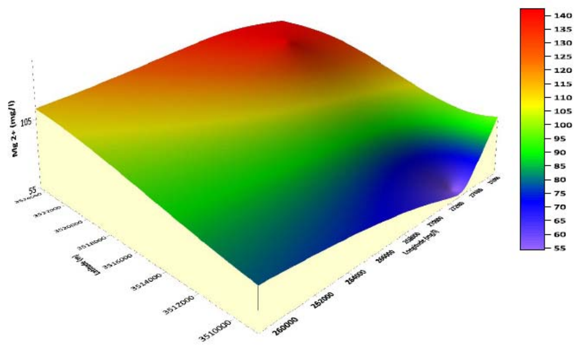

Figure 7: Plot of Mg^{2+} in Bamdezh wetland

As shown in the figure 5 the values of Na^{+} were between 150-180, 180-210 and 210-255 (mg/l). The same figure indicated that during the study period of two years the values of Na^{+} were more than 180 (mg/l). In more than 50% of the area of Bamdezh wetland Ca^{2+} content was between 160-280 (mg/l), while Mg^{2+} content was more than 80 (mg/l), because of this Bamdezh wetland was placed in low grade. But as per the value of Mg^{2+} the grade of this wetland was medium to high.

Sodium is the 6th most abundant element on the earth, which is often associated with chloride. It is essential for all the animals, some microorganisms and plants. Generally, sodium is not considered as the limiting factor for freshwater organisms, unless sodium concentrations reach the level at which freshwater organisms cannot survive. As sodium concentration increase in the water body, there will be continuous transition from freshwater to brackish water and then ultimately, to marine water (Mathur et al., 2009).

Calcium is dissolved easily in water and is one of the most abundant elements in surface as well as ground water. Freshwater bodies around the world have higher concentration of calcium, when they are located closer to calcium-rich soils and rocks. Calcium concentration worldwide is less than 15 (mg/l), but water bodies close to calcium carbonate rich carbonate rocks often have higher calcium concentration exceeding 30 (mg/l). It enters the aquatic environment primarily through the weathering of rocks like limestone, which is largely composed of calcium compounds. In some circumstances, calcium can also be deposited in water bodies as a result of human activities like extensive use of calcium containing chemicals in agriculture and industry. Calcium has been shown to influence the growth of freshwater plants and animals. It is necessary structural component of plant tissues, animal bones and animal shells. It is involved in many chemical cycles that occur in water bodies (Mathur et al., 2009).

Magnesium is the 8th most abundant natural element on earth and is a common component of water. It is found in many geological formations, including dolomite. It’s an essential nutrient for all organisms and is found in high concentrations in vegetables, algae, fishes and mammals. Natural sources contribute more magnesium to the environment than do all human activities combined. It is found in algal pigments vey known as chlorophylls and used in the metabolism by plants, algae, fungi and bacteria. Fresh water organisms need very little magnesium as compared to its amount present in water. Magnesium concentration shows very less fluctuation in water bodies, because biological demand for magnesium compounds is very low. The elevated level of magnesium content in water makes it as “hard” water (Mansouri, 2000).

Figure 8 shows zonation plot of K^+. Zonation plot of K^+ (figure 8) was similar to zonation plot of Ca^{2+}.

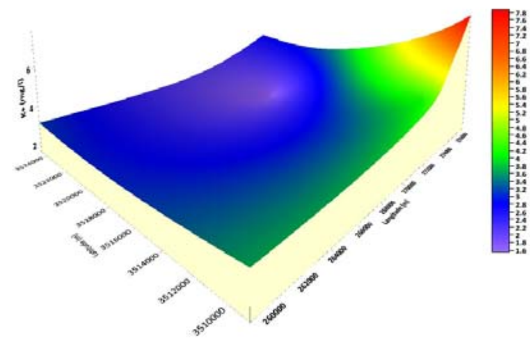

Figure 8: Plot of K^+ in Bamdezh wetland

Potassium is an important major mineral nutrient essential for normal growth and development of plants and animals in Bamdezh wetland. Its average concentration is over 2% of the earth’s crust. There are many natural sources of potassium in aquatic environments like wetlands, for inducing the increase in K^+. The man made sources like industrial effluents and run-off from agricultural areas. Potassium is used extensively in fertilizers and hence the agricultural run off is very rich in K^+ which is added in wetland water. The concentration of potassium in natural surface water is generally less than 10 (mg/l), but it may become as high as 100 (mg/l). Its concentration in fresh water is generally adequate for meeting the nutritional needs of the biological community. Potassium is not considered as a limiting nutrient like that of phosphorus and nitrogen (Shuxia et al., 2003).

Figure 9 presented the variation in Cl^- in whole of wetland. This figure showed the maximum values of Cl^- at eastern north and from eastern north to western south.

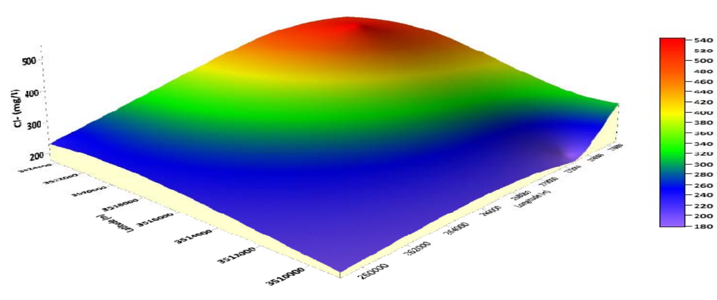

Figure 9: Plot of Cl^- in Bamdezh wetland

Chloride is found in all types of water throughout the world which is an ionized form of the chlorine. The compounds containing chlorides are used extensively in both industry and agriculture. The levels of Cl^- in water bodies are affected by several environmental factors like climate, temperature, humidity, rainfall, evaporation etc. Salts are the primary sources of chloride in water. The chloride salinity of water adversely affects the life of different plants and animals. Some species which are sensitive to the salts die in water due to salinity and others can tolerate the high concentration of salts e.g. halophytes like mangroves (Mathur et al., 2009). Common chlorides include sodium chloride (NaCl) and magnesium chloride ($MgCl_2$). Chlorine alone is highly toxic. Beeton et al. (2002) showed that the source of Cl^- in water is the insecticides and pesticides containing chloride.

The variation of SO_4^{2-} showed that (figure 10) if this wetland is divided in two parts, the values of this ion in west part are ranging from 400 to 720 (mg/l) and in east part this was between 220-400 (mg/l).

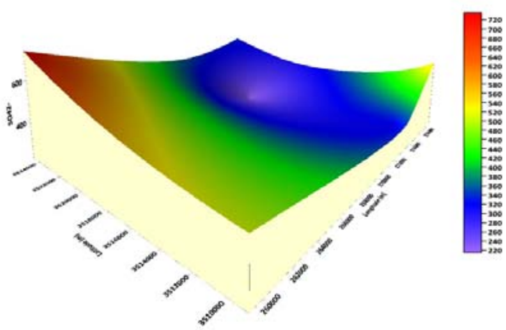

Figure 10: Plot of SO_4^{2-} in Bamdezh wetland

Sulfates are the naturally occurring minerals in soil and rock formations. Dissolved sulfate in surface water may also be derived from the dissolution of gypsum or the oxidation of sulfide minerals (EPA, 2007). Geological study of Bamdezh wetland indicated that it was existing in Cenozoic and Quaternary era of geographical time scale. The main constitutive substances of these formations were sulfates, gypsum, alluvium sediment, sand and conglomerate (Nabavi, 2002).

The concentration of So_4^{2-} in water body is influenced primarily by natural deposits of minerals and organic matter in its watershed. Sulfate is used by all aquatic organisms for building proteins. Sulfur cycling can influence the cycles of other nutrients like iron and phosphorus and can also affect the biological productivity and the distribution of organisms in water body including wetlands. Sulfer bacteria can significantly influence the sulfur cycle in water, under conditions when dissolved oxygen is very lass. Some bacteria may convert sulfate to hydrogen sulfide gas (H_2S) and its high concentrations is toxic to aquatic animals and fishes (Tavakoli and Sabertraftar, 2002).

Conclusion

The water quality of Bamdezh wetland is changing very fast, which is affecting the flora and fauna in it.

- The electrical conductivity is very high indicating high level of dissolved mineral salts in its water. This adversely affects the survival of aquatic plants and animals. Not only has this but it had negative impact on the reproduction of various hydrophytic species of plants and animals.
- Concentration of sodium is quite high in Bamdezh wetland which has made this wetland as low grade once. High concentration of Na is responsible to change the water quality very effectively. The fresh water has changed to brackish and finally to marine once. Once the water becomes marine the fresh water organisms cannot survive in this wetland. Only marine plants and animals can grow and survive in this condition.
- The high level of calcium in the water of Bamdezh wetland might be able to influence the growth of fresh water flora and fauna. But it may be favouring to the animals with shells, as calcium is structural component of their bones and shells.
- The increasing concentration of Mg in water of Bamdezh wetland had transformed the soft water into 'hard' water. Magnesium favours the growth algae fungi, bacteria and some species of aquatic animals like fishes and mammals.
- Potassium is required for normal growth of all plants and animals, including aquatic once. Low level of K^+ is favouring luxuriant growth but at high concentration. It is highly toxic and harmful to the aquatic organisms.
- As compared to other mineral elements in water, the increase in concentration of chloride is very harmful, injurious and toxic to almost all the aquatic plants and animals except halophytes like mangroves, which can tolerate very high concentration of salinity. All the salt sensitive species of plants and animals culminate into death causing severe loss in aquatic biota. Chlorine when combines with other toxic substances such as cyanides, phenols and ammonia, it becomes highly toxic to fishes and other aquatic animals.
- The concentrations of SO_4^{2-} are also very in the water of Bamdezh wetland, which is primarily influenced by natural deposits. The deposits of surface and gypsum indicated that Bamdezh wetland was existing in Cenozoical quaternary era. Sulfate is essential for building of protein molecules in plants and animals hence may be helpful in that process. Surfer is highly influencing the bioge cycling of other nutrients like iron and phosphorous and indirectly affects the availability of those elements. Sulfate has great impact on biological productivity as well as distribution of plants and animals in the Bamdezh wetland. Some bacteria converts sulfate into hydrogen sulfide gas (H_2S) which is very toxic to aquatic animals and fishes in Bamdezh wetland.

Acknowledgments

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