

AN OVERVIEW ON OCCURRENCE OF MACROPHYTES AND FISH DIVERSITY IN STAGNANT WATER BODIES NEAR THERMAL POWER STATION, JAMSHORO, SINDH, PAKISTAN

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Abstract

Macrophytes and fish species are grow in few small water bodies near Thermal Power Plant Jamshoro. The Thermal Power Plant Jamshoro is a major power station located at the right bank of Indus River altitude 25° 28' 30.90" N & 68° 16' 33.09" E on the global map. The research studies on water quality, fish, and macrophytes distribution in the wetlands were carried out. The satellite images of the wetland area indicated the situation of barren land, open water and growth of aquatic vegetation during 1990 barren land was observed 0.732026 while in 2026 0.356503. The growth of macrophytes was observed 0.291447 however it gradually increased up to 0.677029 in the wetland area and the open water during 1990 was spread out 0.11389 and in 2026 0.677029. The occurrence of fish and macrophyte species were examined with certain water quality variables. 10 fish species, 11 macrophyte members and 5 wild plant species were reported from 4 stagnant water bodies of Jamshoro Thermal Power Station. The results of physico-chemical parameters such as temperature (°C) of air and water were noted 33.33±1.23 and 26.78±0.78 respectively, transparency turbidity values 52±4.83 cm, pH is 8.0±0.245, alkalinity (CaCO₃) 183.8±11.2 mg/l, salinity 123±117.6 ppm/l, total dissolved solids (TDS) 1634.8±2355 mg/l and electrical conductivity (EC) of 1095±486 µS/cm. based on scientific results of water quality variables that directly effect aquatic life that are most common in open channels and stagnant bodies. The macrophyte species richness shows the dense formations at various zones of stagnant waters. Most common macrophyte species were recorded; *Cyperus difformis*, *Eichhornia crassipes*, *Lemna minor*, *Lemna major*, *Nymphaea lotus*, *Nelumbo nucifera*, *Najas minor*, *Phragmites karka*, *Scirpus littorals* and

Typha domingensis. However, fish species from stagnant and open channels occurred namely; *Labeo rohita*, *Cirrhinus mrigala*, *Gibelion catla*, *Channa marulius*, *Channa striata*, *Oreochromis mossambicus*, *Oreochromis niloticus*, *Mastacembelus armatus*, *Rita rita*, *Aorichthys aor* and *Wallago attu*. The results of water quality variables, macrophytes and fish species were found slightly higher sides, when compared with recommended values of WHO and NEQS for drinking water. While bioindicators macrophytes and fish species exist indicated the eutrophic condition of the water bodies. The oil, grease globules and other organic traces were also reported at certain places, indicating they might be mixed in water. Therefore, it is suggested that the discharged water should be treated and purified before being released outside of the station.

INTRODUCTION

Jamshoro Thermal Power Station is a major power station located on the right bank of the Indus River altitude 25°28'30.90"N & 68°16'33.09"E on the globe. It is a major power station in Pakistan that uses thermal technology and steam turbines to generate electricity. It is powered by natural gas and oil and consists of four furnace-based units. Electricity not only makes people's lives easier and more comfortable, but it is also crucial to the development of science and technology (Rajper et al., 2016). The thermal power plant is close to a few villages and colonies, such as East Chakkar Rajar Burgage colony, village Haji Imam Baksh Shahani. However, a powerhouse colony is situated near Mohra Jabal which is located on the western side of the power plant in North Petaro (ADB, 2024). Most communities are impacted by the waterway that surrounds the village's 4000-acre open area occupied with water in connection to thermal power plants. The thermal power plant uses fresh water from the River Indus to circulate, cool, wash, and filter the grids. After that, an open canal releases the water into the River Indus. The water supply from Indus River through pipelines 5 km east of the power plant and 4.4 km upstream to the Kotri barrage. The Thermal Power Station uses freshwater directly from the Indus River to clean turbines, floors, equipment, and other plant facilities (Maree et al., 2026). These water channels

feed natural depressions and low-lying soils result in a large quantity of aquatic biota physically developed in the area. One of the most serious environmental issues facing the world today is water contamination, climate change degradation of natural ecosystems due to several factors physically, chemically and biologically (Abbasi et al., 2026). Nearly every industry that uses water for cooling contributes to the problem of thermal pollution, and the water discharge from thermal power station poses a threat to the flora and fauna of the freshwater body where it enters (Shahani et al., 2020). According to current observations, indigenous people have begun raising fish in water bodies near to the vicinity of wastewater. Fish farmers are also applying artificial inorganic fertilizers, organic manuring, and artificial feed to the water to promote fish development. Numerous plants, animals, and microbial species including invasive life forms and natural productivity like phytoplankton, macrophytes, invertebrates, and other elements of biodiversity develop at high densities in the water bodies. The present study examined the growth rate and occurrence of bio indicator species of macrophytes and fish existing in the ecological conditions of stagnant wastewater of the Jamshoro thermal power station along with few suggestions about the way forward for sustainable ecosystem of the commanding area of Jamshoro Thermal Power Station (Fig.1).

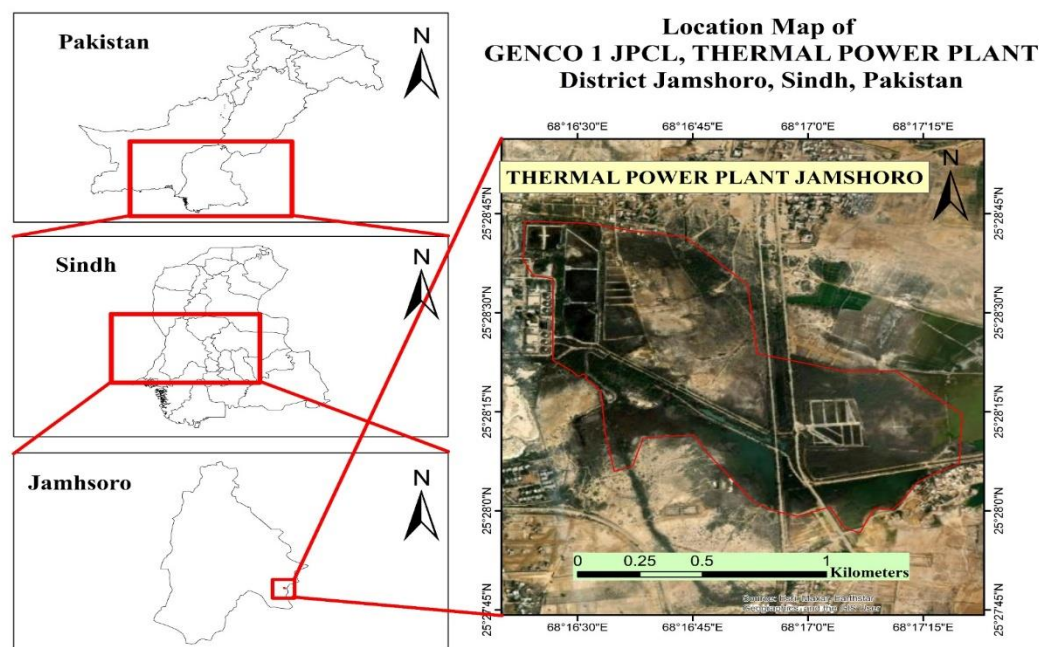


Fig.1. Map of Jamshoro Thermal Power Station

MATERIALS AND METHODS

The survey team visited 4 sites in the area. Site-1 (village Haji Imam Baksh Shahani), situated at eastern side of Thermal Power Station. The Site-2 (Northern area water entrance), Site-3 (Railway line) and Site-4 (Sheikh Farm near RBOD Drain). The schedule of data collection was arranged for sampling of water, macrophytes and fish occurring in the site areas. Water samples were collected in sterilized plastic bottles size 1.5 liters capacity. Samples were preserved in an ice box to bring to laboratory for detailed examination. Temperature ($^{\circ}\text{C}$) of air and water was noted with digital thermometer; Transparency of was noted on spot using Secchi disc lowering in water water. Measurement was noted at point appearance and disappearance in water. The Secchi disc measurements were counted as the centimeter units labeled on string. The pH of water was noted with help of WTW 330i/Set. Salinity, total dissolved solids (TDS) and electrical conductivity (EC) values were noted through WTW 320 digital meter. Alkalinity was measured by titrating standard HCl 0.01N using methyl orange and phenolphthalein as indicators. Macrophytes and fish were collected

using iron and plastic equipment, gears, nets, and sieves that were dropped and lifted in water. Few of them were selected by hand as well as from landing centers. The macrophyte mats and large sized fish were photographed with a digital camera on spot during field visits. Identifications of the specimens was done with the help of taxonomic keys and illustrations published by Cooks (1996), Nazir and Younis (1979), Talwar and Jhingran (1991), Ward and Whipple (1959), and Yungfang (1995). The statistical analysis was conducted using the Microsoft Excel Worksheet as the computer application. Macrophyte maps in stagnant waters were located using satellite data of aquatic vegetation and Google Earth Engine (GEE) and Geographic Information System (GIS) tools like ArcGIS and QGIS.

RESULTS AND DISCUSSION

It is a general fact that life is growing in wetlands, it may be due to nutrient budget. Water quality parameters, producers and consumers as well as decomposers are members of aquatic ecosystems. Therefore, the present study is based on the water

quality, macrophyte assemblages and fish population estimations of the proposed study area.

I. Water Quality Parameters

The average temperature ($^{\circ}\text{C}$) of the air and water are 33.33 ± 1.23 and 26.78 ± 0.78 respectively. The water's transparency ranges recorded 52 ± 4.83 cm, pH is 8.0 ± 0.245 , alkalinity (CaCO_3) mg/l values 183.8 ± 11.2 , salinity ppm 123 ± 117.6 , and total dissolved solids (TDS) 1634.8 ± 2355 mg/l and electrical conductivity (EC) of 1095 ± 486 $\mu\text{S}/\text{cm}$. based on scientific results of water quality variables that directly affect the aquatic life that is most common in open channels, the findings support by one the study (Boyd, 1998) finding that any change in water quality parameters led to a change in aquatic life proliferation. The aquatic environment and water quality deteriorate because of decaying dead matter. The aquatic ecosystems, as well as the quality and availability of resources like water and nutrients, are undoubtedly deteriorated by the change in the physicochemical parameters of the water caused by thermal effluents (Lashari, 2021). It is a common and routine matter that Thermal power generating plants utilize a variety of

chemicals in their operations, and the wastewater that contains thermal effluents is being dumped into open channels in result several varieties of plants and animals grow under natural phenomena. This type of degradation generally happens in less developed countries because of poor management (Mahar et al., 2000b). Physical parameters define the water's temperature and transparency, whereas chemical parameters explain its dissolved components and chemical balance. By comparing these measures with the applicable standards, it is feasible to identify any problems with water quality and determine whether further study or treatment may be required. The present investigation related to the wastewater quality of the thermal power station showed higher level when compared with studies (WHO, 1993; NEQS, 1993). Therefore, discharged wastewater of the station is not fit for human consumption as well as for agriculture, horticulture and aquaculture practices. Because of trace elements and chemicals are accumulating in the bodies and products. However, the wastewater may be treated and purified before utilization for any purpose of intervention.

Table 1. Water quality parameters of wetlands near Jamshoro Thermal Power Station.

S. #	Parameter	WHO/NEQS limits	St. 1	St. 2	St. 3	St. 4	Mean	STD ($\pm$)
1	Time of collection	Not applicable	9:15 am	10:10 am	11:05 am	11:50 am	N/A	N/A
2	Temperature air ($^{\circ}\text{C}$)	N/A	31.6	33.2	34	34.5	33.33	1.27
3	Temperature water ($^{\circ}\text{C}$)	N/A	25.7	26.8	27.1	27.5	26.78	0.78
4	Water transparency/turbidity	N/A	45	53	56	54	52	4.83
5	pH	6.5-8.5	7.8	8.1	7.8	8.3	8.0	0.245
6	Alkalinity (mg/l)	50-250	200	175	182	178	183.8	11.2
7	Salinity NaCl (ppm)	600-1000	31.4	11.8	212.4	236	123	117.6
8	TDS (mg/l)	600-1000	341	816	235	5147	1634.8	2355
9	EC ($\mu\text{S}/\text{cm}$)	100-1000	1605	457	1029	1291	1095	486

Table 1. Water quality - Thermal Powerhouse Jamshoro

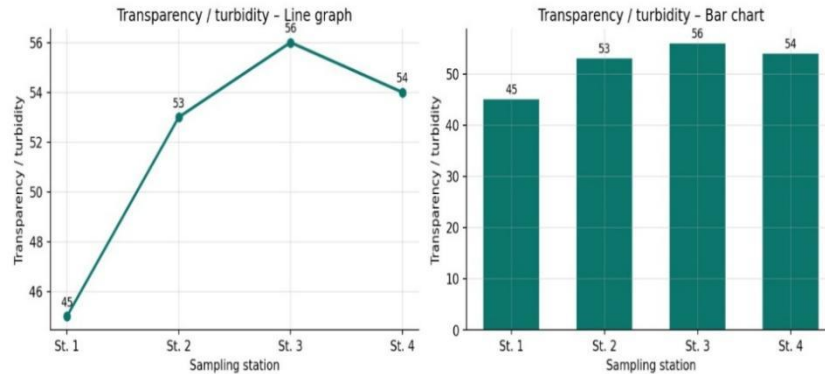


Fig. 2. Transparency of water in wetlands near Jamshoro Thermal Power Station

Table 1. Water quality - Thermal Powerhouse Jamshoro

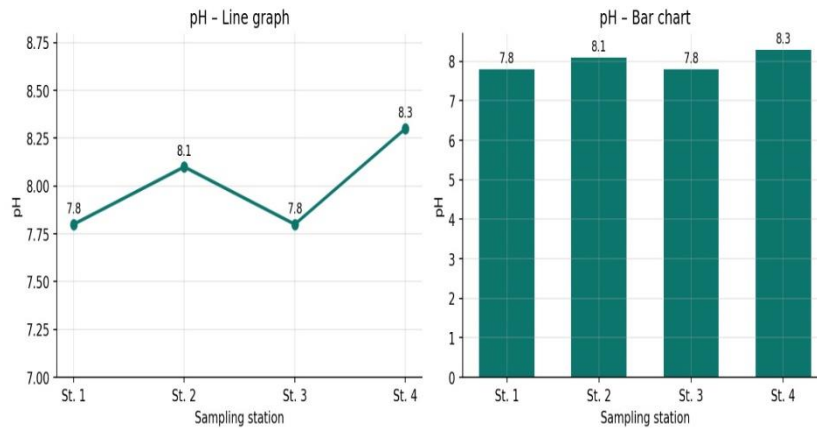


Fig. 3. pH of water in wetlands near Jamshoro Thermal Power Station.

Table 1. Water quality - Thermal Powerhouse Jamshoro

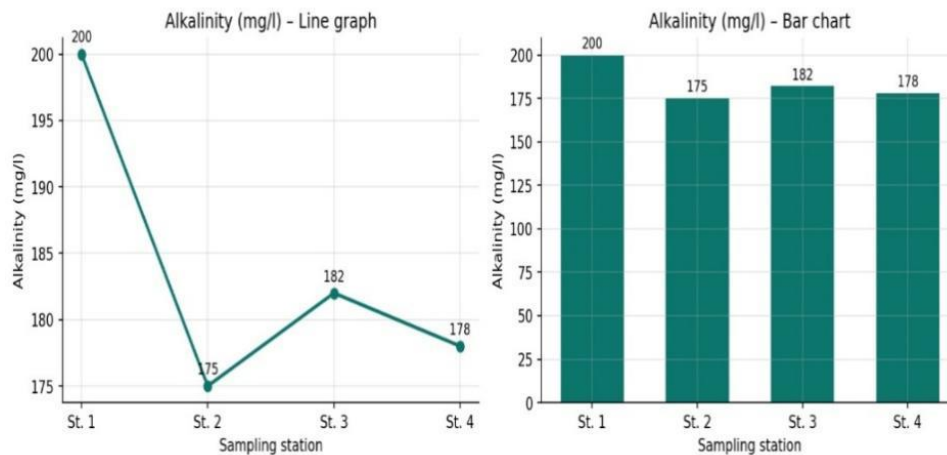


Fig. 4. Alkalinity of water in wetlands near Jamshoro Thermal Power Station

Table 1. Water quality - Thermal Powerhouse Jamshoro

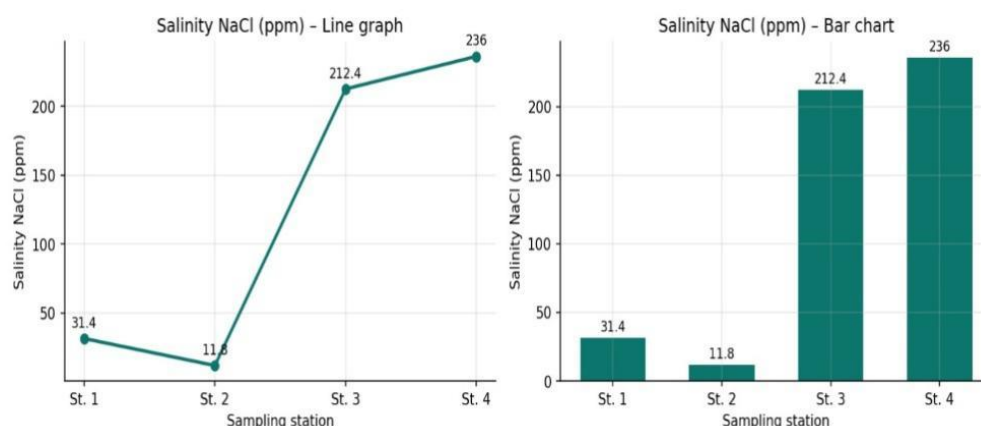


Fig. 5. Salinity of water in wetlands near Jamshoro Thermal Power Station

Table 1. Water quality - Thermal Powerhouse Jamshoro

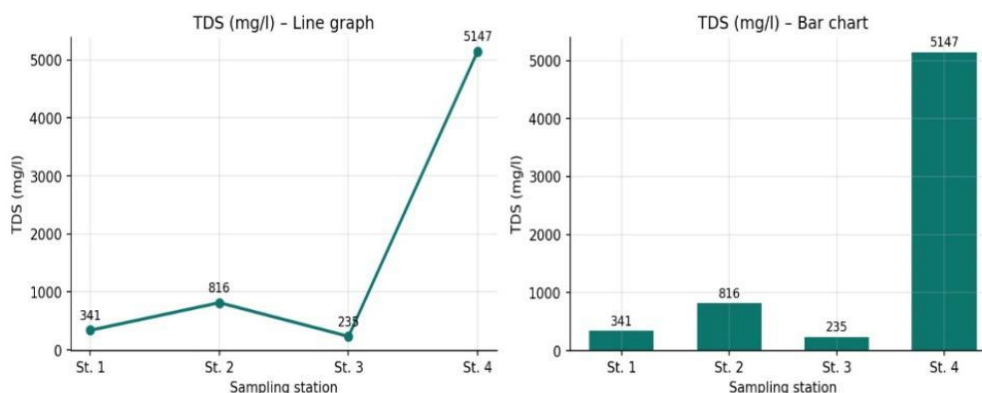


Fig. 6. TDS of water in wetlands near Jamshoro Thermal Power Station

II. Macrophytes

Total 10 species of macrophytes (aquatic plants) recorded from all selected sites of water of Jamshoro Thermal Power Station (Tab.2). Each plant species makes it possible to compare plant abundance and variance among the four locations. The population density of *Phragmites karka* noted with 21.25% among all the listed species. The status of *Typha domingensis* has the highest value among the existing marshy plants with 30%. *Eichhornia crassipes* occurred with 15.75%. This pattern demonstrates that the distribution of aquatic plants differs across the study area. The *Nelumbo nucifera*, *Najas minor*, *Nymphaea lotus*, and *Lemna major* are relatively low with different percentage ranges such

as 1.5%, 2.5%, 1.75%, and 2.25%, respectively. These species had reported values of zero at Sites 3 and 4. The distribution of *Lemna minor* appears to be very regular across the locations, with a mean of 5.75%. Aquatic macrophytes are ecological indicators of the area. The commanding areas' grids 1, 2, 3, and 4 displayed notable macrophyte development. *Typha domingensis*, *Phragmites vallator*, *Epomea aquatica*, and *Scirpus nodulus* are among the macrophytes that have grown excessively on the front side of the depression that receives untreated wastewater that contains sewage water and thermal effluent. Excessive aquatic plant development in the body of water might worsen the water's quality (Odum, 1971). In addition to the fact that the area

is close to towns where the water is shallow and in a standing position, the growth and complexity of macrophytes gives the ecology for a variety of life forms that flourish in this area. The growth of macrophytes was seen to be rich at grid numbers 3

and 4. Humans take every precaution to protect their environment because they are directly and indirectly dependent on a variety of aquatic life (Figs .7 and 8).

Table 2. List of macrophytes occurs in stagnant waters sites near Thermal Power Station Jamshoro.

S. #	Wild plants	Local name of herbs/ shrubs	Site-1	Site-2	Site-3	Site-4
1	<i>Suaeda fruticose</i>	Laani	30%	18%	2%	5%
2	<i>Vachellia nilotica</i>	Babul/ Devi	20%	1%	1%	0.0%
3	<i>Tamarix sp.</i>	Lae	20%	0.0%	0.0%	15%
4	<i>Saccharum spontaneum</i>	Sar-Kana/ Kans grass	20%	15%	0.0%	0.0%
5	<i>Alhagi maurorum</i>	Kandero	20%	10%	10%	0.0%

Table 3. List of plants, herbs, & shrubs recorded from wetlands near Thermal Power Station Jamshoro.

S.#	Macrophytes	Site-1	Site-2	Site-3	Site-4	Mean	Stdv (±)
1	<i>Cyperus difformis</i>	12	10	18	9	12.25	4.04
2	<i>Eichhornia crassipes</i>	4	17	9	33	15.75	12.7
3	<i>Lemna minor</i>	3	6	8	6	5.75	2.06
4	<i>Lemna major</i>	2	4	0	0	1.5	1.91
5	<i>Nymphaea lotus</i>	6	4	0	0	2.5	3
6	<i>Nelumbo nucifera</i>	4	3	0	0	1.75	2.06
7	<i>Najas minor</i>	5	4	0	0	2.25	2.63
8	<i>Phragmites karka</i>	25	13	26	21	21.25	5.91
9	<i>Scirpus littoralis</i>	9	22	26	13	17.5	7.85
10	<i>Typha domingensis</i>	30	17	13	18	19.5	7.32
%	Percentage of plants	100	100	100	100	100	N/A

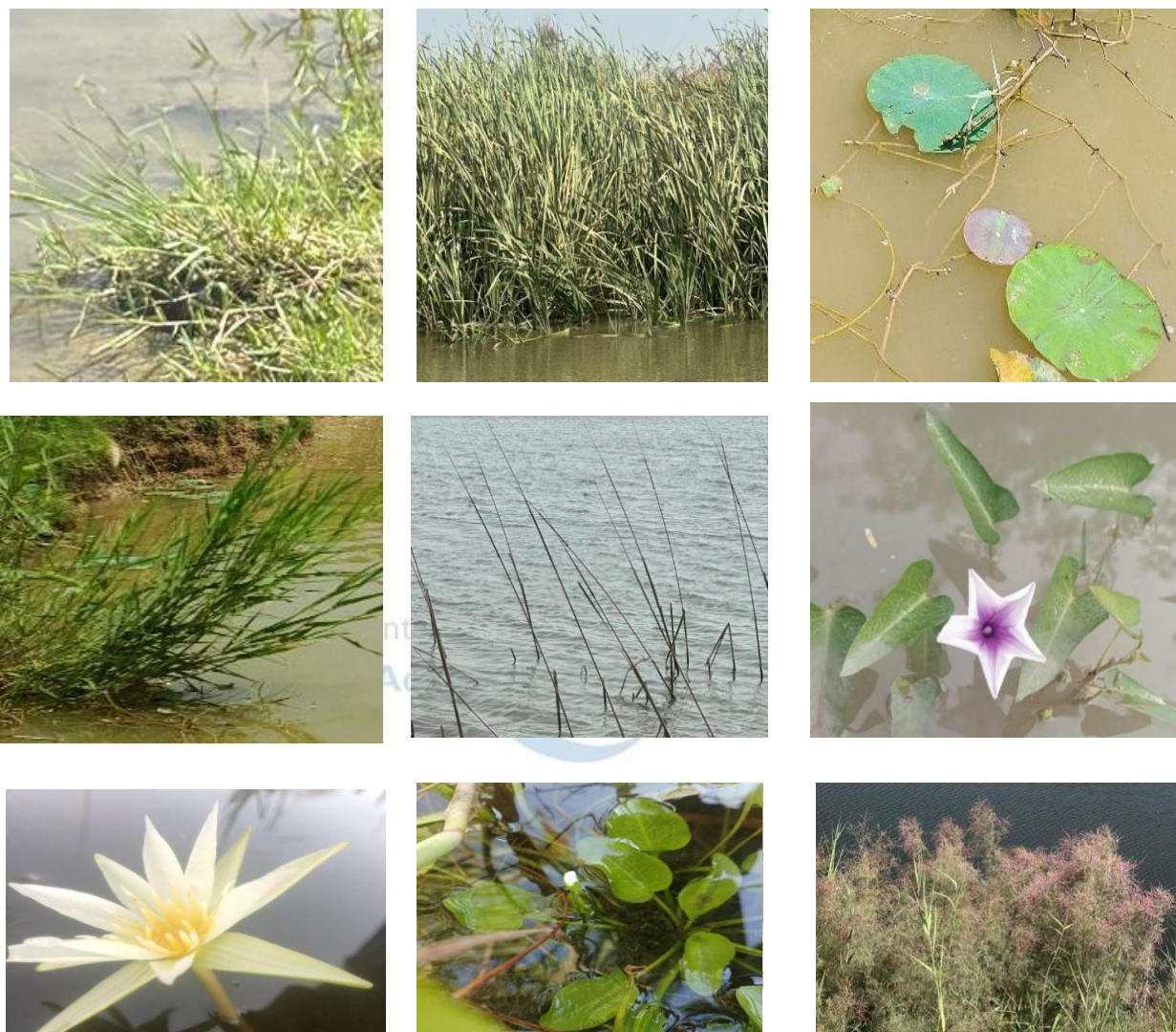


Fig. 7. Macrophyte species recorded from wetlands near Jamshoro Thermal Power Station.

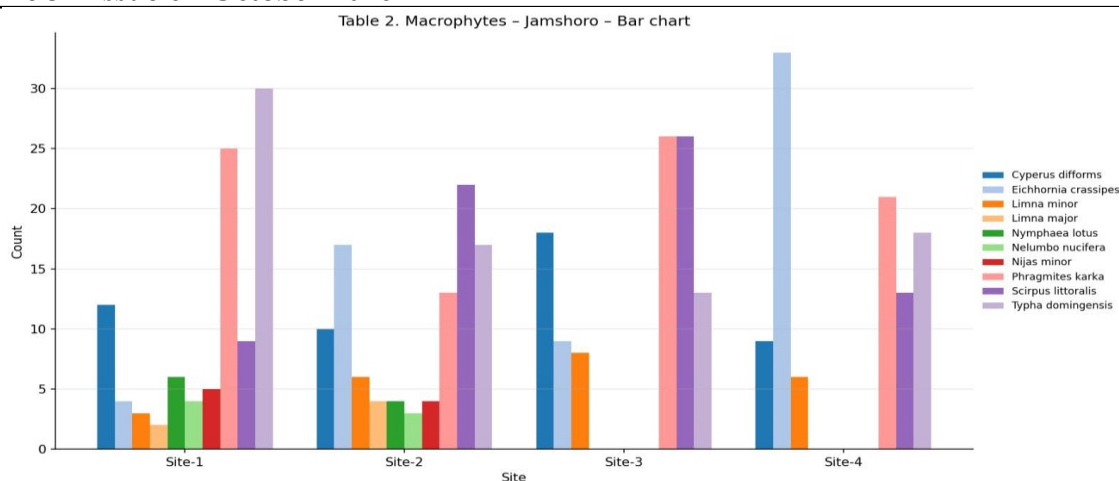


Fig. 8. Bar chart indicating macrophyte species recorded from the four different sides near thermal power station. Every bar represents the count of individual species. *Typha domingensis* was found to be dominant.

III. Occurrence of Fish Species

During the studies, eleven fish species were recorded. The values reflect differences in the frequency or abundance of fish species. The highest population of *Oreochromis niloticus* in each of the four sites was noted at 28%, 25%, 27%, and 24% among the fish community occurring in the region. This implies that it was the most common or frequently reported species in all study sites. *Channa striata* was found to be the second most prevalent species, with values of 18%, 16%, 12%, and 21%, showing a notable rise among the total population estimation. *Oreochromis mossambicus* recorded 12%, 10%, 4%, and 8%, indicating a slight increase. The status of other species like *Channa marulius* showed relatively high values of 9%, 12%, 9%, and 10%, with the highest count. *Labeo rohita* recorded 8%, 6%, 14%, and 9%, it is the tastiest fish among the carp species. Another member of major Indian carp fish is *Cirrhinus mrigala* showed values of 4%, 7%, 12%, and 7% comparatively lowest among other hard fish. Third important member of major Indian carp fish is *Gibelion catla* recorded 3%, 5%, 7%, and 8%. The commercial catfish *Rita rita* reported 7%, 6%, 3%, and 3%, whereas *Aorichthys aor* showed 5%, 3%, 4%, and 2%. A common freshwater shark fish species, *Wallago attu* occurred with ratings of 4%, 7%, 6%, and 6% indicated a slight variation among

the 4 site sampling stations. *Mastacembelus armatus* was the least prevalent species, with counts of 2%, 3%, 2%, and 2% percentages. It was observed that *Oreochromis niloticus* was the most common species that occurred in thermal waste waters, followed by *Channa striata*. Conversely, the lowest amounts were seen in *Mastacembelus armatus* (Tab.4). The variance in counts between species and columns suggests differences in the distribution or abundance of the species among the research groups. In the surrounding low-lying depression, stagnant discharged water contained eleven distinct species of fish, types of freshwater fish that can survive and sometimes reproduce in aquatic environments affected by pollutants, high temperatures, low dissolved oxygen, and changes in the chemistry of the water. Because organic pollutants rose during actions, in results fish populations at fishponds declined (Mahar et al., 2000b). At the same time, a thin coating of oil globules from thermal power plants builds up on the fishpond's surface, and an excessive amount of organic pollution deteriorates the water quality and other factors, which impacts the fish population in the channel (Mahar et al., 2007). Only when the water flow in the open channel is steady can the fish population rebound. *Labeo rohita*, *Cirrhinus mrigala*, *Wallago attu*, and *Aorichthys aor* grew more slowly than similar species found in the River Indus,

despite their abundance in the water bodies of the study area.

Table 4. List of fish species recorded from stagnant water bodies near Thermal Power Station Jamshoro.

S. #	Fish species	Site-1	Site-2	Site-3	Site-4	Mean	Stdv (±)
1	<i>Labeo rohita</i>	8	6	14	9	9.25	3.40
2	<i>Cirrhinus mrigala</i>	4	7	12	7	7.5	3.32
3	<i>Gibelion catla</i>	3	5	7	8	5.75	2.22
4	<i>Channa marulia</i>	9	12	9	10	10	1.41
5	<i>Channa striata</i>	18	16	12	21	16.75	3.77
6	<i>Oreochromis mossambicus</i>	12	10	4	8	8.5	3.41
7	<i>Oreochromis niloticus</i>	28	25	27	24	26	1.82
8	<i>Mastacembelus armatus</i>	2	3	2	2	2.25	0.5
9	<i>Rita rita</i>	7	6	3	3	4.75	2.0
10	<i>Aorichthys aor</i>	5	3	4	2	3.5	1.29
11	<i>Wallago attu</i>	4	7	6	6	5.75	1.25
%	Percentage of fish	100	100	100	100	100	0

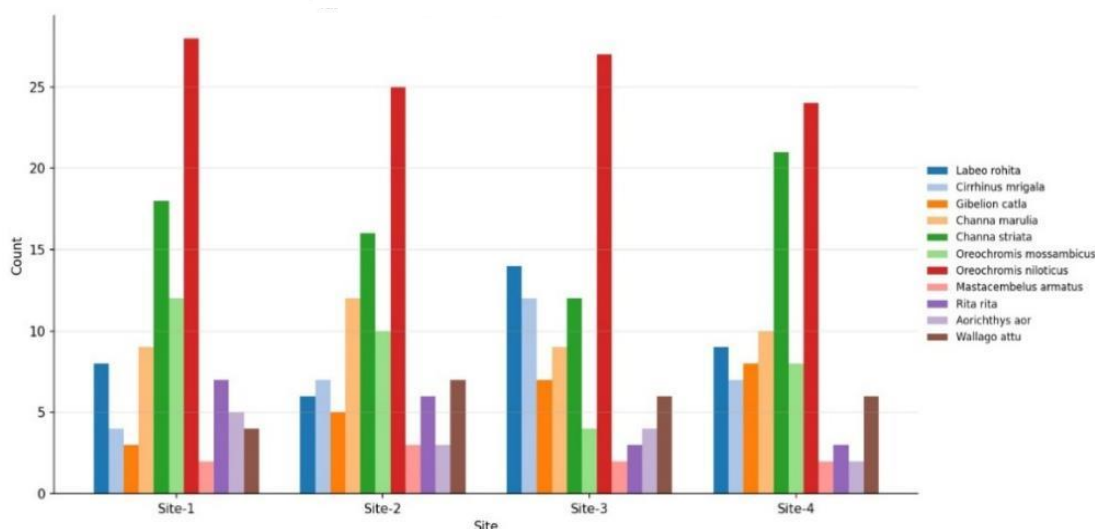


Fig. 9. Abundance and dominance of *Oreochromis niloticus* across all sampling stations

IV. Geographical Information System of Study Area

Figures 10 and 11 display the satellite images of the study area in km² between 1990 and 2026. There was a considerable decrease in barren land, a significant increase in vegetation, and a remarkable decrease in open water area. This may be due to high budget of nutrients discharging from the surrounding areas. The barren area decreased by roughly 51.3% from 0.732026 km² in 1990 to

0.356503 km² in 2026. This decline raises the possibility that a significant portion of the formerly arid region has been converted to different land cover, particularly vegetation. The water area slightly shrank from 0.11389 km² to 0.10415 km² between 1990 and 2026. This indicates a slight change in the area covered by water, with a decrease of roughly 8.6%. On the other hand, the vegetation area grew by almost 132.2%, from 0.291447 km² in 1990 to 0.677029 km² in 2026. This significant

increase points to an increase in vegetated land throughout the research period, either because of

afforestation, natural regeneration, or modifications to land management techniques.

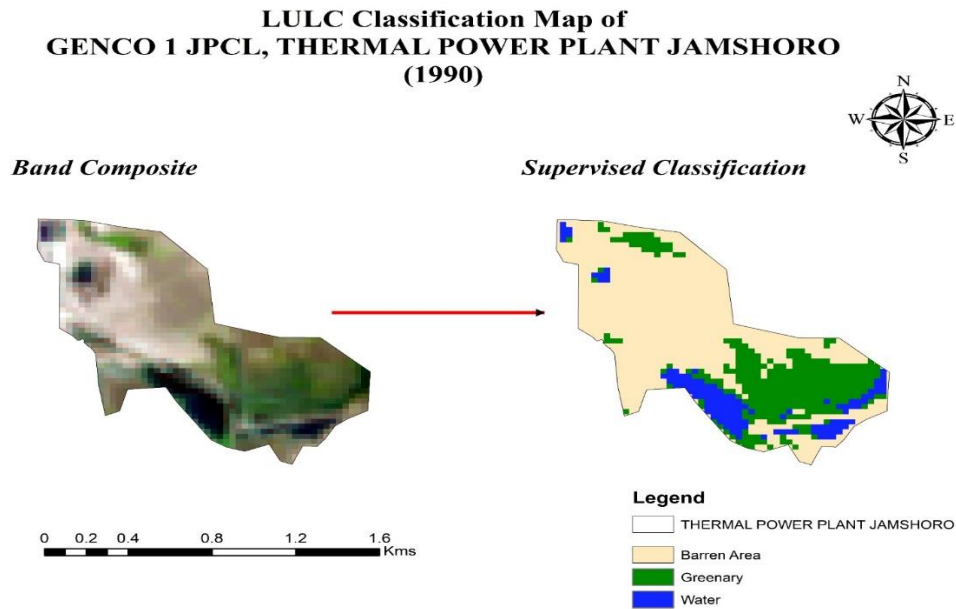


Fig. 10. Macrophyte growth and dispersal in study area near Jamshoro Thermal Power Plant during 1990.

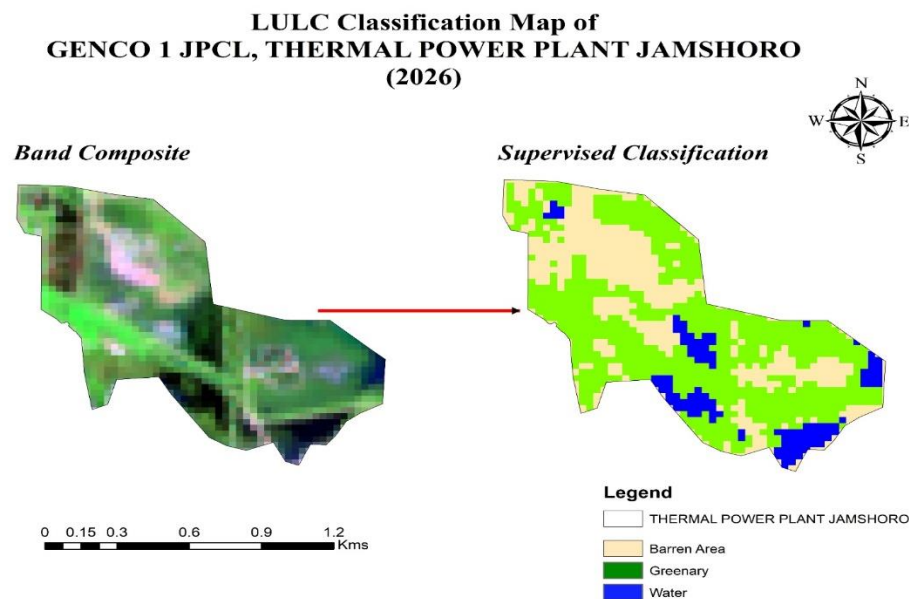
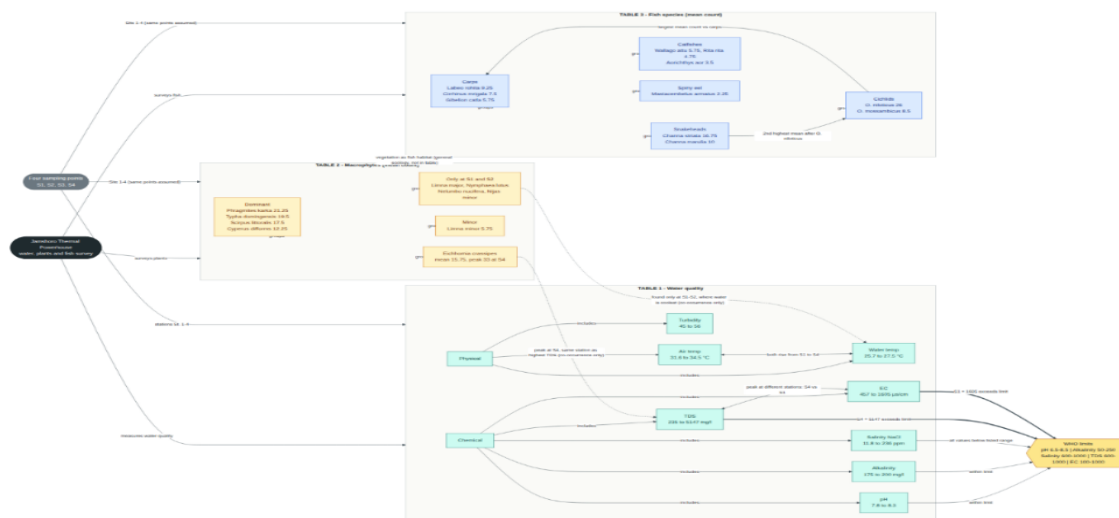


Fig. 11. Macrophyte growth and dispersal during 2026 in the study area near Jamshoro Thermal Power Station.

Physico-chemical parameters of stagnant waters are closely related to biological indicators. As temperatures increase the dissolved oxygen decreases and, in certain situations, an increase in biological oxygen demand (BOD) can influence aquatic animals. The pH and conductivity values can be influenced on the lifeforms. Chemical treatment can bring changes in nutrients. Total dissolved solids (TDS) can alter the concentrations of nutrients. Monitoring turbidity, suspended particles, residual chlorine, and trace metals may be impacted on growth of plants. Aquatic macrophytes, such as submerged, floating, and emergent plants, can respond to thermal discharges

in a variety of ways. Moderate temperature can promote development in certain species, while excessive temperatures or changes in the chemistry of the water may stress or impede plant growth. Nutrient enrichment may promote excessive development, but chemical contamination and altered habitat conditions may reduce species diversity and abundance. Therefore, even if they are also influenced by seasonality, water depth, velocity, and light availability, macrophyte coverage and composition might be useful indicators of environmental changes. Temperature and salt resistant fish species are usually called ecological indicators of contaminated water bodies described in following figures (fig. 12).



Under normal circumstances, the passage of water through open channels greatly benefits living things. However, it had extremely detrimental effects when tainted water was used everywhere. Higher pH, temperature, hardness, TDS, and salinity levels in thermal powerhouse water have a major impact on the development of life forms in stagnant waters and open channel backflow to the Indus River. The open channel water was tasteless and odourless, but occasionally it smelt like plants, making it unsuitable for use as a source of drinking

water (Shahani et al., 2020). The presence of organic contaminants in the water is indicated by the growth of macrophytes. The growth of macrophytes and macro animals, such as salt-tolerant fish species, is stimulated by the physico-chemical factors (Lashari et al., 2021). Thermal power plants tend to speed up biological processes and encourage the growth of aquatic plants and the population of other eutrophic life forms that are typically found in open water flows when fresh water passes through them and wastewater is released (Maree et al., 2026). The excessive growth,

development density, and complexity of many living forms, including those found in open channels, are accurately depicted in one study (Jahangir et al., 2013). As a result, they are considered the pollution indicators for the water way. The continuous interference of residential sewage water and thermal effluents has increased the concentrations of nutrients within the channel, causing eutrophication in the depression and channels. Furthermore, it is noted that the grids at the distal end of the River Indus are more vulnerable than those close to the thermal power plants. The cause could be the synchronization of sewage water carrying sludge material with itself, which raises the channel's nutritional content. The water quality has also been impacted by deterioration. The flow of the Indus River was greatly affected, as was the biodiversity of the open channel. In the eastern portion of the thermal power plant Jamshoro, water seeping from open channels periphery wetlands have caused land degradation in several spots during the research period. The high oil concentration was noted during open channel sampling. The residents utilize this canal for washing, bathing, and fishing. As was seen during sampling, water from open canals is also utilized for agricultural cultivation in different places. The results of water samples are within the ranges of NEQS (1993). The oil & grease globules and other organic traces were also reported mixed in water (Shahani et al., 2020). The present findings are confirmed with the findings, still oil globules reported in discharging water of the station. It has been suggested that fish quality existing in the wastewater drainage of Jamshoro thermal power station is not suitable for human consumption. It has been suggested that discharged water from the station should be treated and purified before utilizing it in agriculture, aquaculture and horticulture.

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