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Environmental Degradation by Tie and Dye Industries in Pali District (Rajasthan)

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ABSTRACT: Pali is the administrative block of Pali District, situated at the banks of Bandi River, about 72 km from southeast of Jodhpur. There are 3,422 industrial units in Pali District. The industries established in Pali are based on agriculture, mineral-chemical processing, construction materials and leather. Major identified units however are tie and dye, textile processing and chemical industrial wastes are the main sources of the water pollution, industrial wastes are discharged into drains and finally into the Bandi River. As a result, the river water has an organic, pungent smell, dark color, high alkaline pH, very low dissolved oxygen, high BOD and COD, and high amounts of total suspended, dissolved, and volatile solids. The wastewater in the drain also contains phosphates, sulphates, sulphides and chlorides.In Rajasthan, people have a fascination with colorful dresses, which were dyed and printed with herbal dyes by hand process in cottage industries. Now-a-days, mechanical process and chemical dyes are used, which generate pollution of water. At places like Pali, Balotra, Jasol, Bithuja Jodhpur, Sanganer & Bagru, there are concentrations of a large number of small scale units for textile dyeing and printing, where discharged water contains chemical pollutants rendering the surface water and groundwater unpotable and harmful for human consumption, as well as affecting the land close to the disposal points or those irrigated with contaminated water. These are small, illegal textile cottage industries, which are not even registered under the district industry centre. The effluent and contaminated, colored water generated by the single industry of such nature may be small, but considering the fact that these industries are numerous in all three areas of study, their extent of contamination to the ground water and other natural source of water through these non point source can not be ignored. The population of the studied villages ranged from 1,200 to 100,000. The average number of wells contaminated in Pali villages surveyed was reported around 68, that of Balotra were in the range of 1,700, whereas in Jodhpur the averages were about 25. The villages surveyed were spread to a distance of 0.5 to 13 kms from the industrial area (source of contamination) of their respective regions. Most of the wells of the surveyed communities were used for irrigation and bathing/washing purposes, not as drinking water. The communities of the regions complained of suffering from allergies, cases of skin cancer, and eye irritation after using the contaminated well water. Osteoporosis and gastric diseases were also reported common ailments in the affected communities. In Pali, the villagers reported to have around 13,500 hectares of land contaminated by industrial effluent, whereas in Balotra around 400 Bigha of land have been contaminated and made useless for agriculture because of polluting industrial effluents. None of the community is at present planting vegetables for commercial purposes. The communities of Pali and Balotra have reported that their agricultural production/yield has decreased to a highest extent over last 15 years, but in the case of Sangria village at Jodhpur, the communities mentioned increase in wheat production after using the industrial effluent for irrigation purpose. The community of the Balotra and Pali were very much upset with the government's passivity in solving their problem and compensating the losses of agriculture/wells. The High court has directed the state government to conduct a survey of the extent of health and land losses being incurred by the affected villages. The Government has given this task to National Productivity Council, but the report is not heard of at present. Few of the community leaders have filed RTI (Right to Information Acts) to know on the status of the report and the outcome of the study.

Various community meetings has been held in the Sangria, Nagori gate and Tanawara village of the region to make the community aware of the health impacts of the industrially contaminated water and the need to report the same to the health authorities. The education material in Hindi/local language is being developed for the cottage dye industries' workers. The education material aims at bringing the awareness of the worker to the kinds of dye they use, their chemical constituents, and possible health and environmental impacts of these dyes. The biggest achievement of the project has been the meeting of all concerned at one forum and agreeing to address the pollution problem in the area in a collaborative manner. During the formal meetings, many ideas & technically feasible solutions for various problems were discussed not only by the technical experts from Institution but also the government regulatory body. A couple of project proposals were also submitted and need to be discussed further with our TAB. The stakeholders especially the Industry has requested for the following: - Metal recovery from the waste stream - Acid recycle and reusing process - Alternative process/ technology for

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pickling/annealing - Waste minimization - Process modification - Durability of pickling bath - Cutting down the cost/consumption of acid - Effective way of sludge utilization. In the present study the effects of Textile industrial effluent on Bandi river water was investigated at Pali district of Rajasthan. The physicochemical analysis was done for one year and the present reveals that, the pH of River water is more than the standard levels and the other parameters of the river water was found to be higher in concentration. On the basis of these observation it can concluded that the textile industrial effluents was adversely affecting on the river water quality, which affects on aquatic environment and human beings of surroundings.

KEYWORDS: Pali, environmental degradation, tie and dye, textile effluent, water pollution, diseases, acid recycle

I.INTRODUCTION

PALI DISTRICT in Rajasthan has over 800 textile industries that employ about 50 per cent of the city's population. The region has been a textile hub since the 1970s, with an annual turnover of over Rs 7,000 crore. But the industries have severely polluted river Bandi on whose banks the city is located.
The 40 km stretch of the river covered in a study by Delhi-based non-profit Centre for Science and Environment (CSE) in June this year bears testimony to the adverse impact the textile sector has had on the town. "The influx of untreated industrial effluents into Bandi has ruined most of the wells in the vicinity. Village residents have been forced to stop agricultural activities within two-three km of the river," says Jaitpur-based activist Lakshman Dhulia.

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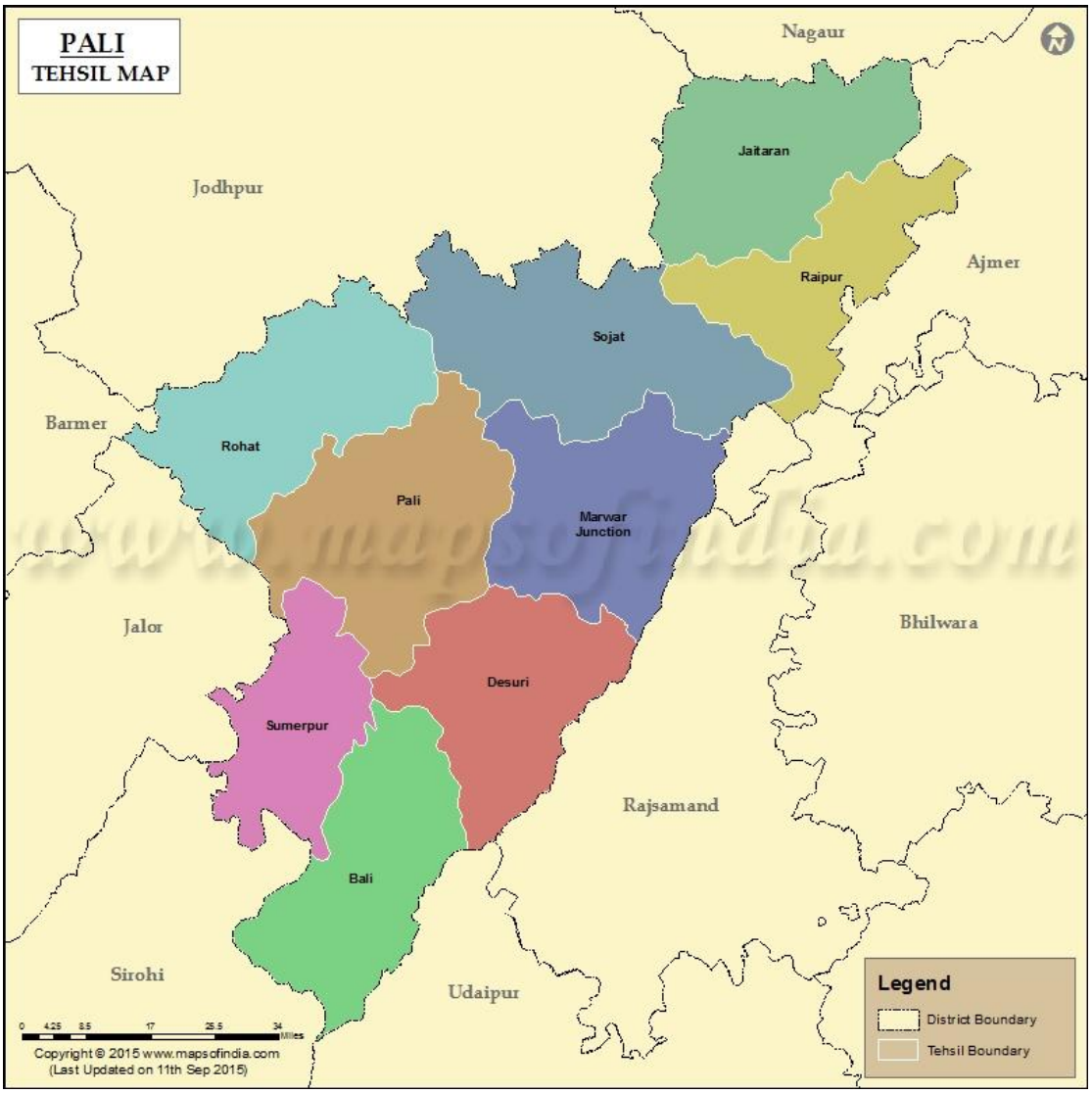

The problem is not new. India's first common effluent treatment plant (CETP) was set up in Pali in 1982 to treat industrial effluents. But not much has changed. "The textile units have expanded over the past 30 years. The water of river Bandi and Nehra dam located downstream stinks due to the discharge of untreated effluents," complains Nathuram Charan, a local farmer.

"Of the 800 textile units in the town, 600 are under Central Pollution Control Board's 'red category', denoting that they are highly polluting units," says Anil Mehta, chairperson, Pali Water Pollution Control Research Foundation (PWPCRF), a local association of industrialists set up in 1994.

The CSE study found that almost all textile units falling under the red category send effluents to the four CETPS of the city without any primary treatment. "As per the pollution control board norms, every industry that falls under the red category and has been given consent to operate needs to have a primary treatment plant," says Pukhraj Patel, president, Sri Kisan Paryavaran Sangharsh Samiti, a Pali-based non-profit working on water pollution and related problems since 2004.

In the study, 45 samples of surface and groundwater from different locations in Pali were tested. Almost 80 per cent of the surface water samples were found unfit for drinking. They were highly alkaline and had a high chemical oxygen demand (COD), indicating dangerous levels of organic pollutants. The levels of total dissolved solids (TDS) were four times higher than the standard (See 'Contamination hubs').

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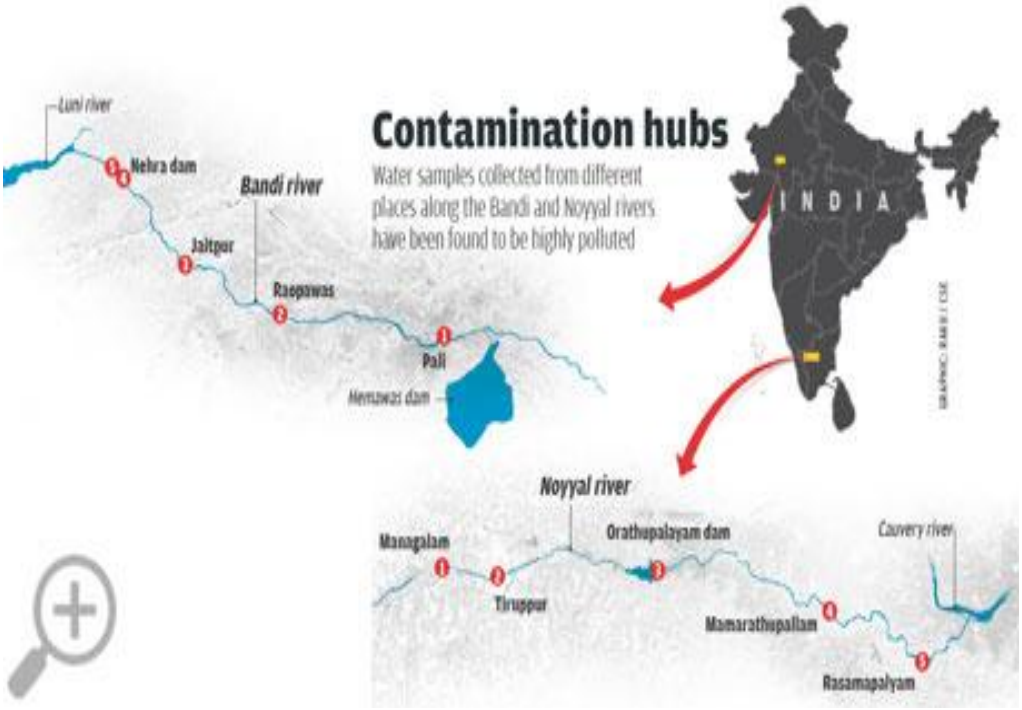

Pali is a city and capital division in Rajasthan state of India. It is the administrative headquarters of Pali District. It is on the bank of the river Bandi and is 70 km (43 mi) south east of West Jodhpur. It is known as "The Industrial City". Pali (formerly known as Pallika and Palli) was a trade centre. In the 11th century AD, Pali was ruled by the Guhilas of Mewar. In the 12th century it became a part of the Nadol kingdom and was ruled by the Chauhans. In 1153 AD it was ruled by Kumarapala and his feudatory Vahadadeva. Then it came under possession of Songara Chauhans of Jalore.

The Rathore dynasty chronicles relate that Siyaji or Sheoji, grandson of Chandra, the last Gahadvala Rathore king of Kannauj, came to Marwar on a pilgrimage to Dwarka in Gujarat, and on halting at the town of Pali he and his followers settled there to fight alongside the Brahmin community from the raids of marauding bands and foreign invaders. rajputs and paliwal brahmins fought bravely against feroz shah in 13th century but couldn't resist its large army cenopath of brahmin warrior is still in pali known as dhola chabutra . His devali with the inscription of 1273 AD was discovered 21 km north west of Pali.

Rao Chunda, tenth in succession from Siyaji Rathore, finally wrested control of Marwar from the Pratiharas. His brother's son and successor, Rao Jodha, moved the capital to the city of Jodhpur, which he founded in 1459. Pali remained a part of the Marwar kingdom until 1949, when the last ruling Maharaja acceded to newly independent India. The oldest temple in Pali is the temple of Somanatha. Maharana Pratap was born in Pali. His birthplace is known as Dhanmandi Pali. Maharan Pratap's Statue inaugurated on 4 June 2011 by District Collector Mr. Neeraj Kumar Pawan.

Geologists trace the existence of Pali to pre-historic age and maintain that it has emerged from the vast western sea spread over a large part of the present day Rajasthan.

Historical relics depict the existence of this area during the Kushana Age, when King Kannishka had conquered Rohat and Jaitaran area, parts of today's Pali district, in 120 AD. Till the end of seventh century A. D., this area was reigned by the Chalukya King Harshavardhana who also conquered Bhinmal and most of the present area of Rajasthan.

After the Arab invasions of India this area was concentrated by Rajput rulers from all over India. During the period from 10th to 15th century, boundaries of Pali extended to adjoining Mewar, Godwad and Marwar. All Rajput rulers resisted the foreign invaders but individually fought for each other's land and leadership.

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After the defeat of PrithviRaj Chauhan, the great warrior against Mohd. Gauri, the Rajput power of the area was disintegrated and Mewar and Godwad area of Pali become the subjects of then ruler of Mewar, Maharana Kumbha. But Pali city which was ruled by its Brahmin rulers known as Paliwal Brahmins now, remained peaceful and progressive.

16th and 17th century saw a number of battles in the surrounding areas of Pali. Shershah suri was defeated by Rajput rulers in the battle of Gini, Mughal emperor Akbar's army had constant battles with Maharana Pratap in Godwad area. Again after the Mughals had conquered almost all of Rajputana, Veer Durga Das Rathore of Marwar made organized efforts to redeem the Marwar area from Aurangzeb, the last Mughal emperor. By then Pali had become subservient to Rathores of Marwar state. Pali was rehabilitated by Maharaja Vijay Singh and soon it became an important commercial center.

Role in struggle for freedom: Under British rule pali played an important role by pioneering the freedom struggle in Marwar. Various Thakurs of pali under the stewardship of Thakur of Auwa, who was the most powerful of all, confronted with the British rule. Auwa fort was surrounded by the British army and then conflicts lasted by 5 days, when at last the fort was possessed by the British army. But this heroic action of Auwa paved the way for continued and organised struggle for freedom.

Pali has been famous for its textile industries. Cotton and Synthetic clothes, and yarn are exported to other states of India at a very cheap price. Some new industries have also been developed such as those of Bangles, Marble cutting, marble finishing, etc. There is a cotton mill named Maharaja Shree Umaid Mills which is the biggest cotton mill of Rajasthan, employing nearly 3000 workers.

One of the biggest composite textile mill of India 'Maharaja Shri Umaid mills' (Estt. in the year 1940) is also situated at pali. Main production of this mill are cotton, Hank yarn etc. which are used to prepare different clothes. Main cloth production are cotton, 2* 2 rubia etc.

There are three industrial areas in Pali, namely, Mandia road industrial area, Industrial area phase 1 & 2, and Punayata industrial area. Mandia Road Industrial Area is the biggest and the oldest of all. Industries such as Jai Mahaveer Textiles, Shankheshwar Corporation, Dhan Shree Fabrics, Keshariyaji Tex Print, Mahamantra Mills India, Maa Ambe Texofine, Mahotsav Fabrics, D.Pawan Fab Tex, sunlight industries, Kundan Tex, K.B Shah, Nakoda Prints, Tulsi Cotton Mills, Mayank Process, Aadeshwar Process, Shree Ganesh Fab Tex, B.B. shah, Shri Arihant Cloth Mills, Shree Rajaram Group of Industries, Kohinoor, Kamal Agencies, Manidhari Impex, Sidhi Vinnayak Petro Chem, Shree Roopmuni Industries, Vam India Organics, Vidhya mills (India), Vidhya industries pvt ltd., Metro industries, Vijaya Fabrics, Manoj textiles, minerwa industries, Sikhwal fabrics, Mohini Process, Jov(Tex) Link, Sonu Group of Industries, Lodha Fabrics, Mega Tex Print, Vinod Group of Industries, M.B finishing, Mahaveer fab tex, Bajrang textiles etc. are among well known and reputed Textile Industries situated at Mandia Road, Pali. Punayata industrial area has been always a question mark on local administration and RIICO because of its setup and evolution. But in the last few years, Punayata Area has turned out to be a major landmark for Industrialist to set up their new business.

Besides this, many more industries are situated in different areas of Pali district i.e. leather-based industries, agriculture instruments, Chemical Industries, cement industry, minerals-based units like stone crushers etc. Among these, granite industries have recently flourished due to the easy availability of raw material and favorable geographical location.

However, the problem of pollution is imminent. Common Effluent Treatment Plants (CETP) have been established in the last few years to treat the discharged water from various industries.

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Bandi river sampling location	TDS (ppm)	COD (ppm)	Chloride (ppm)	Sulphate (ppm)
1 Pali (upstream)	4,560	219	1,969	417
2 Raopawas/ Karel road	6,190	1,313	1,904	295
3 Jaitpur	6,650	1,330	2,090	440
4 Nehra dam upstream	8,600	718	2,182	605
5 Nehra dam downstream	8,740	648	2,322	650
Surface water standards ISI-IS:2296-1982	500-2,100	---	250	400-1,000
Noyyal river sampling location	**TDS (ppm)**	**Sulphides (ppm)**	**Chloride (ppm)**	**Sulphate (ppm)**
1 Managalam	11,800	0.64	6,947.49	424
2 Tiruppur main town	2,460	24	1,207.43	200.5
3 Orathupalayam dam	1,880	Not detected	873.06	199.5
4 Mamarathupallam	2,240	4.08	835.91	172
5 Rasamapalyam	3,650	0.19	1,151.7	278
Levels in Cauvery*	388	Nil	160.4	67.5

Concentration of chlorides, which impact reproductive rates of freshwater organisms and reduce their lifespan, were nine times higher. On the other hand, the level of dissolved oxygen, necessary for aquatic life, was nearly zero. CSE also tested 21 samples of effluents of mills located in the industrial zones and found that approximately 80 per cent of these samples were highly polluted, with COD levels 11 times higher than standard limits. Effluent samples collected from three CETP outlets were also found to contain low concentrations of phenolic compounds which can cause skin irritation and breathing problems.

CSE had previously investigated Pali in December 2007 and pointed that the major problem in the area was inefficient treatment plants. There are several other problems that ail the process of disposing of industrial waste in Pali. There is no system for the transport of effluents from the textile units to CETPs. Tankers carry them and spillage during transport contaminates the soil. CETPs, which are based on dated technology, are not working at full capacity, treating only 17 million litres of effluents a day against their maximum capacity of 34.68 million litres a day. The sludge rejected after the process, which has all the pollutants trapped, is dried and disposed of in nearby areas."Many industries discharge effluents directly into the river, leading to severe pollution," says Mhuveer Sukerlai, local activist and convener of Sri Kisan Paryavaran Sangharsh Samiti, a Pali-based non-profit working on water pollution related issues since 2004. The industries which do treat effluents follow sub-standard treatment parameters and are reluctant to upgrade their treatment technology. Also, most textile industries in Pali are small scale units and were involved in hand printing of cotton textiles prior to the 1990s. But today 40 per cent of mills in Pali are synthetic textile mills and the dyes used in synthetic fabrics are more difficult to treat because they are acidic in nature. The treatment system has not been able to keep pace with the change of effluent character.Moreover, infrastructure facilities of the state's pollution control board are inadequate. "The regional laboratory is not in Pali. Samples go to Jodhpur and Jaipur for testing. To regulate the 700 dyeing units and other industries, there are only seven officials," says R B Maurya, regional officer of Rajasthan Pollution Control Board.The industry is even defiant of court orders. Hearing a public interest litigation filed in 2004, the Jodhpur High Court in 2007 ordered closure of 126 dyeing units located outside industrial areas. The court had ordered that a new industrial area be developed and units operating outside industrial areas be shut or shifted. But nothing changed and the industries continue to operate.

In 2012, Sri Kisan Paryavaran Sangharsh Samiti filed a case in the Jodhpur high court against textile unit operators, PWPCRF, Rajasthan Pollution Control Board, District Collector of Pali and the government of Rajasthan to suspend the functioning of all the textile units in Pali that were operating without "consent to operate" and to stop the discharge of untreated effluents into the Bandi river. On March 5 this year, the case was transferred to the National Green Tribunal which ordered closure of almost 600 textile units operating without the consent. The order is yet to be implemented because the industry has sought a review.

Textile units in Pali city continue to release polluted water into the Bandi river, violating a National Green Tribunal (NGT) order staying their operation

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Effluents from textile units in Rajasthan's Pali district pollute the Bandi river.

On October 3 last year, the NGT stayed the operation of about 800 textile units after environmentalists moved the tribunal over pollution of the Bandi river.

The water resources department recently exposed secret operation of some units. In a letter to the regional officer of the Rajasthan Pollution Control Board on March 17, executive engineer Ramnarayan Chaudhary said some textile units in Pali were releasing polluted water into the Bandi, a seasonal river of western Rajasthan.

The river water is stored in Nehda dam, about 40km from Pali city. Choudhary said, "Chemical water is reaching the Nehda dam through Bandi river."

The dam remains filled to its full capacity though water stored during the rainy season was released for irrigation. "This makes it clear that water released from textile units in Pali is reaching the dam," Choudhary said.

The water resources department tested the water quality. "The water in the dam is of no use for consumption and irrigation as its quality has deteriorated," the executive engineer said. "Closure of textile units is just an eyewash."

The quality test reports are stunning, said Mahaveer Singh Sukarlai, an environmentalist who went to the NGT over Bandi river pollution.

"The TDS (total dissolved solids) of the water stored in the dam after the rain was recorded at 560 PPM (parts per million); it has now risen to 2950. The electrical conductivity of the water has increased to 6.3 from 1.7," Sukarlai said.

Around 200 million cubic feet of water has been polluted though the state government focuses on Mukhya Mantri Jal Swavlamban Abhiyan, environmentalists said.

Rajeev Pareek, regional officer of the Rajasthan Pollution Control Board, said a team has been formed to keep an eye on the operation of textile units.

"Electric and water supply to eight textile units, found violating the NGT order, was snapped. Twelve more such units would be deprived of water and electric connections," Pareek said.

"Supply of three-phase electricity to the industrial area will be stopped soon so that the textile units cannot operate secretly." Water pollution can be from anthropogenic (human activities) or geogenic (natural geological phenomena) sources. The major anthropogenic sources are disposal of untreated domestic sewage, industrial effluents and agrochemical

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run-off. Anthropogenic pollution is known to have serious consequences on human health and the environment. The effect on aquatic ecosystem is more noticeable, because water is a good carrier and transports almost everything to distant places. When the pollution loads are too high, the habitat is destroyed; pollutants accumulate bio-concentrates and enter food chains and magnify. As humans occupy the highest level in the food chain, they receive concentrated amounts of the pollutants and these bring out dosedependent responses. Anthropogenic contamination, especially untreated sewage water, can lead to epidemic Outbreaks of cholera, typhoid and other dreadful infectious waterborne diseases. Numerous studies have been conducted all over the world to show pollutant impacts. Anthropogenic contamination, especially untreated sewage water, can lead to epidemic outbreaks of cholera, typhoid and other dreadful infectious waterborne diseases. Industrial pollution involves release of untreated or incompletely treated effluents into the ecosystem. Industrial effluents and solids, and hospital wastes, contain a spectrum of life-threatening contaminants such as heavy metals, pathogens, antibiotics etc. that are dangerous to life. Fluoride contaminations are generally geological in origin. Their contamination is due to the release of fluorides and arsenic from mineral-rich rocks lining the aquifers. Textiles are among the basic needs of human being. The textile industries therefore have great economic significance by virtue of its contribution to overall industrial output and employment generation. This sector has wide spectrum of industries ranging from small scale units that use traditional manufacturing process, to large integrated mills using modern machineries and equipment (CPCB ministry of environment and forestry). Textile industry is one of the most important and rapidly developing industrial sectors in world. The textile industry requires water during various processes. The printing and dying process require great quantities of water that is often discarded into fresh water resources. These effluents, waste products contain about 20% of the dyes such as coloring agents; it contains large quantities of heavy metals, bleaching agents and acids. This causes degradation of water quality, soil fertility and serious diseases on human being in textile industrial region. Textile companies are facing problems in some instances of crisis proportions, in dealing with the effluent that they generate. The solution to the problem will vary from company to company depending on many variables such as the volume and nature of the effluent, location, site geography and finance available. Unfortunately for some companies, the inevitable conclusion will be that there is no viable solution. There will be in-house debates but there should also be frank discussions with all those concerned and those who can help. Pali is situated on the bank of river Bandi. Pali is the district of Rajasthan state and administrative headquarters. The city lies between $25^{O}77'$ N latitude to $73^{O}33'$ E longitude. While Bandi is Latitude $25^{0}15'$ and $25^{0}55'$, Longitude $72^{0}56'$ and $73^{0}57'$. Bandi river is a major tributary of Luni river and flows in almost east to west direction and passes through south of Pali city. Pali is the industrial dying and printing hub of Rajasthan state. At present about 800 textile industries are working.

Monthly Water sample were collected from two different sampling sites (Pali and Balotra) in the periods of One Year . Water Temperature analyzed by simple thermometer, pH, Transparency by using Sacchi Disc, Total Hardness as Calcium and Magnesium, DO (Dissolved Oxygen), Free CO2, Carbonates, Bicarbonates, Chloride, Salinity, Phosphate, Nitrates, Fluoride by using ELICO NEPHELOMETER CL 52D and SPECTROPHOTOMETER 106 SYSTRONIC by using photometric method, BOD, analyzed by Titrometric method with the help of standard method for water analysis (APHA)

II.DISCUSSION

Temperature is most important parameters of aquatic life during the study periods mean temperature ranges from 25.9 ^{0}C to 42.1 ^{0}C . Highest was observed in May while lowest was in December. Textile industries use different dyes for coloration purposes due to that pH value was always observed as alkaline above 9 while in summer it was up to 10.4. The Textile industries effluents and their courses mainly, hazards caused by dye effluents, which contain both chemical and organic pollutants. Excessive use of chemical dyes should be restricted and should be replaced with vegetable dyes .The huge quantities of wastes and sludge discharged from industries might be responsible for the enrichment of all studied physicochemical parameters at discharging point.

Transparency of Bandi River was near about 9.35 to 20.1. Dissolved oxygen contain of Bandi River was near about observed nil during the study periods slightly occurrences of DO during the Manson periods because rainwater may be aerated river water. The long days and intense sunlight during October seems to accelerate photosynthesis by phytoplankton, utilizing CO2 and giving off oxygen . Carbon dioxide was observed during the Manson while in summer it was may converted in to the carbonate as well as bicarbonates. Bandi river have alkaline pH due to that free Carbon dioxide was converted in to Bicarbonate , and very less is converted in to carbonate hence carbonate values was ranges in between 10 mg/l to 183 mg/l, highest was during the summer while lowest was in manson. High Bicarbonate values recorded during the study periods which was in thousands mg/l. Chloride ions was observed very high due to that the Bandi river water is not suitable for drinking purposes observed values was ranges 1027mg/l to 2020mg/l. From the Chloride we also calculated the value of Salinity which was also ranges from 1961mg/l to 3872mg/l such high amount of salinity was observed in this

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river. For aquatic ecosystems Nitrates and Phosphate is act as a nutrients for living algae, on the basis of such nutritive substances we measures the nature of aquatic body, hence during the study periods nitrates values was ranges 82.4 mg/l to 200 mg/l. The study of Surface water was the highest concentration of cations and anions. Phosphates values ranges between 2.1 mg/l to 8.64mg/l hence we predicted that Bandi river water is unsafe for drinking . In Pali region Fluoride value in water was observed very high above the permissible limit that was ranges from 2.1 mg/l to 3.6 mg/l. The study of the problems related to fluoride on human being. Due to increasing the heavy load of such nutrient in water body their biological oxygen demand also more , hence during the study periods the BOD values ranged 140mg/l to 411mg/l. Many scientists studied the wastewater from industries had a deleterious impact on the water quality of Bandi river. Wastewater was not recommended for irrigation in agricultural fields. Water with high sodium content, high TDS, BOD, COD values is unsuitable for irrigation.

III.RESULTS

Table No. 1. Physico-Chemical Parameters of Bandi River water, Pali.

Month	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	Jun
Temp	32	35.5	34.6	40.5	33.4	37.8	39.5	40.2	43.2	44.1	45.2	39.1
pH	9	10.2	9.5	9.8	9.4	10.3	9.2	9.1	9.0	10.0	10.4	10.5
Trans	19	20	18.3	14.8	15	19	19.6	20	23	18.4	22	28
DO	0.1	0.21	0.23	Ab	Ab	0.2	Ab	Ab	Ab	Ab	0.3	0.4
CO2	45	89	100	76	56	89	38	44	33	97	89	90
TH	703	805	890	943	850	798	786	900	987	999	1023	934
CO3	10	27	35	46	28	35	46	55	29	28	34	30
HCO3	243	304	453	555	675	786	1076	654	1035	788	896	1045
Cl	1089	1209	1387	1256	1765	1498	1087	1456	1398	1967	1067	1056
Salinity	1965	1867	1788	1968	1689	1966	1900	1890	1877	1844	1845	1799
Nitrate	98.2	88.3	100	102	187	134	167	187	197	165	145	166
Phos	5.4	6.0	7.8	8.3	9.0	6.4	4.5	7.1	7.8	8.8	9.1	6.7
F	3.2	2.1	1.9	3.8	3.9	2.3	2.7	2.9	4.5	3.5	4.4	4.1
BOD	123	134	145	152	134	155	162	123	122	111	140	160

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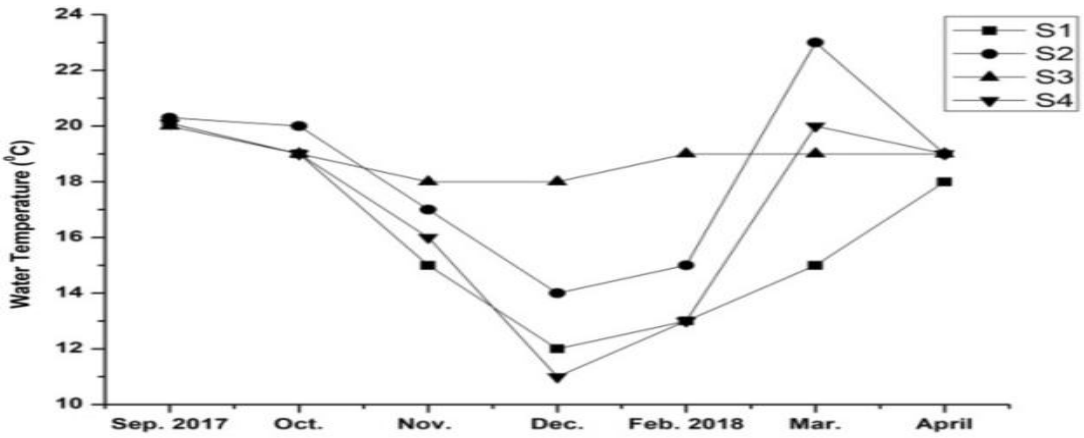
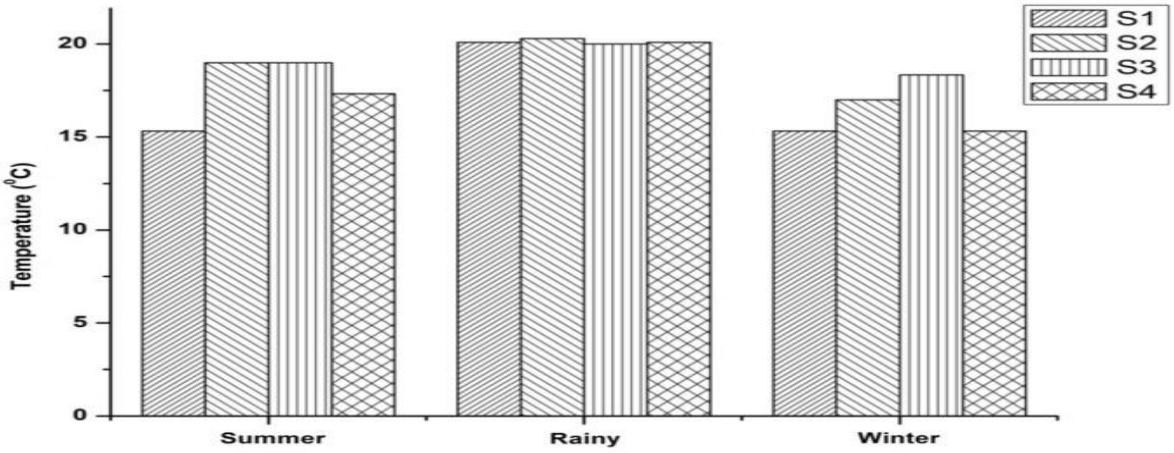


(a) Monthly variation in water temperature at 4 stations



(b) Seasonal variation in water temperature at 4 stations

Mean (average) was calculated taking 4 stations in river in Pali

IV.CONCLUSIONS

The Water Resource Authority and National Environment Management Authority should compel the owners of facilities discharging effluent into Pali River to channel it into the sewer lines or build constructed wetlands. Also, water and sanitation Company should construct wetlands for tertiary treatment of the waste water from sewage treatment plant discharged into River and relocate dumpsite away from the banks of River to reduce leachates draining into this river. There should be regularly monitoring of effluent discharge into the river and enhance enforcement of the waste water management regulations by relevant authorities. The government should channel dye water from for treatment before it is released into Bandi River. Sewerage should be extended to include informal settlements along River to reduce pollution.

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