Case Study To Understand The Benefits Of Cleaner Technology By The Assessment Of Water, Air And Soil Quality Around The Sugar Industry In Erode, Tamil Nadu

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Abstract: The moot of the study envisage assessment of Water, Air and soil quality around the sugar industry with the purpose to find whether the impact of pollution from the industrial discharge like Air, water and soil affected the surrounding area, environment - Flora, fauna, agricultural irrigation air, water and soil samples are analyzed and the result shows in the ground water EC-1663 to 277 µmho/cm, Total Hardness-613 to 810 mg/l, TDS-1050 to 1400 mg/l, BOD-35 to 55 mg/l, COD -140 to 260 mg/l, exceeds within WHO Norms, Nitrate exceeds -0.65 to 0.88 mg/l the BIS limits, Surface water EC-2010-2431 µmho/cm, Total hardness-180 to 190 mg/l, Total alkinity-90 to 100 mg/l, BOD-38 to 44 mg/l, COD-106 to 108 mg/l, exceeding the limits with WHO and BIS norms, TDS exceed the limits in Norms of CPCB surface water norms, Air quality NOx, SOx, PM1.0, PM2.5 within the standard of NAAQs, All the Soil samples EC-550 to 900 µmho/cm, Organic carbon-1.12 to 2.39 mg/l exceeds the limits.

Keywords: Cleaner technology, physicochemical parameter, (Surface-ground water, Air, Soil parameter), WHO-BIS, CPCB standards**,**

Introduction

Sugar industry has been classified in solid, liquid, and gas (Pawar et al., 1998) under seventeenth categories of most polluting industries (Red industry) by the central pollution control board (CPCB) in India (CREP-CPCB, 2003)Presently India has nearly 575 sugar mill (GCPC, 2010), that produce about 15 million tons of sugar and 13 million tons of molasses. Sugar mills account in the industries which discharge huge amount of effluent per day without any or partially treatment during the crushing season (Vinish kathuria, 2014). Government has certain norms due to control water because it is the main raw material for production process, in each and every stage of manufacturing has lots of complicity on utilizing water in proper manner. This industry is consumes large amount of fresh and ground water. According to Indian industrial standards, water consumption varies from 1.3 to 4.36 m^3 (Upadhyay et al., 2008). The water generated is about 20 percent of the water requirement. The sugar industry with crushing capacity of 5000 Tons per day requires 10000 m^3 /day of water (COIDS/8/CPCB1980-81). But has been polluting air, soil and odour too. But still Comparative industry document series COINDS has given reports and limits in minimal standards in regulation basis (COINDS, 1989). And in 2015 CPCB had a new notification regarding to water polluting industries, Zero liquid discharge (ZLD) and continuous online emission/effluent monitoring system CEMS (CPCB, 2015). This is the present condition of sugar industries to improve the quality and quantity there are research going on Understanding the linkage between efficiency, Health and safety for house hold, agricultural flora and fauna nearby, the industry, export and import productivity and environmental performance such recycling and reusing technology, co-generation process, cleaner technology, energy and environmental audit is given EPA (Environmental protection agency), (Best available technology) BAT and United nation environment protection (UNEP) by Gujarat cleaner production center manufacturing industries has important implications for good economic performance but still sustainable growth is the need of the hour to protect flora and fauna (GCPC, 2010). A case study of assessment of air, water and soil quality due whether the impact has influenced Agriculture, household etc.

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About the study area

Around the Sugar industry in Oddappalli, Erode (Dt), Tamil Nadu., Lat-11.3428, Long-77.757, Climatic conditions Predominant Annual Wind Direction : East, Southwest, and West Annual mean Max Temp: 33.5^{o}c, Annual mean Min Temp : 22.6 ^{o}C, Nearest river- Cauvery River distance from the industry 400 m, Reserved/Protected forests within 10 km Radius- None within 10 km radius, Topography of the plant site- Plain, Major crops in the study area- Sugarcane, Paddy, Sun flower, Coconut, Millet, cotton, pulses, Cereal and groundnut, Farming land in Ares-5115, Water sources depends on- Ground and surface water., Numbers of household-15012, Population-36500.

Material and methods

The methods are taken from the Environmental Impact assessment report (EIA) by CPCB (MoEF-EIA, 2010), the radius of the samples was taken within 6 km as per CPCB, and 6 samples were taken in each parameter. On Primary level taking environmental parameters on field around the industry whether to see the pollution impact affects flora and fauna around the industry (Air, water, soil quality monitoring, sample were taken and tested in lab in Department of Environmental Management in Bharathidasan University, Tiruchirappalli .Samples are not taken in seasonal intervals and taken in the month of

January 2019. Water quality: The Ground water sample were collected around the area in 6 sampling sites and surface water were collected in 2 sampling site as per norm of CPCB given in EIA with 5 km radius from the industrial site. Physico-chemical parameters like, pH, Color, EC, TDS, TSS, Total hardness, Total alkinity, Temperature), Chemical (like, Sodium, Phosphorus, Chloride, Nitrate, Magnesium, Calcium, Sulphate, Fluoride, DO, COD, BOD, Oil and grease and Total coliform are taken and tested using (APHA, 1995) methods. And then Compared per IS: 10500-1983 "Specifications for Drinking Water" for ground water (TNPCB, 2017) and with Class 'C' water quality as per IS: 2296-1982 "Tolerance Limits for Inland Surface water Subject to Pollution" for surface water by CPCB standards (TNPCB, 2017). Further compared with World health organization (WHO) standards drinking water quality (WHO, 2004). Ambient Air quality Monitoring: The standard procedures were adopted as per method suggested to determine the PM2.5, PM10, NOx and SOx. Sampling frequency guidelines Sampling is carried out for various purposes. The regular monitoring campaign of national ambient air quality includes measurement of particulate matter typically for 24 hours a week in 6 sampling site (Revised norms per GSR 826(E) Dated in 16-11-2009 for industrial residential area (NAAQs,-CPCB 2019, TNPCB, 2017). Soil quality monitoring at 6 location twice in the study period: Textural, Physical and nutrient parameter. Soil samples are taken at a 3 depth viz 0-30 cm, 30-60 cm and 60-90 cm were collected pH, Bulk density, Texture class, EC, Organic carbon, Potassium, Phosphorus, Magnesium, Calcium, Chloride, Sodium, Sulphate, Nitrogen tested using (Jackson 1971, Jackson and Ulrich 1960, Alexender, M.1961, Kuprevich and Shecherbakowa , 1972, George et al., 2013) and compared with the soil desirable range.

Sugar industry effluent raw water for reference sample is taken Temp-38°C, Color-Brownish, pH-6.7, EC-2378. µmho/cm 4, BOD-745 mg/l, COD- 2234.6 mg/l, TDS-972.6 mg/l, TSS-522 mg/l, Sulphate-67.5 mg/l, Choride-65.3 mg/l, Sodium-50 mg/l, Phosphate-5.68 mg/l, Sulphide-16.8 mg/l, Nitrogen-5.58 mg/l ,Oil and grease-111,

Table: 1 shows the Air, water and soil samples study area around the sugar industry

Water sample number	Air sample in number	Soil sample in number	Area name	Type of Area	Direction from the plant	Distance Km from Sugar mill
GW_1-S	**AQ_1-S**	**SS_1-S**	Plant site	Industrial CSR	0.4	0
GW_2-S	**AQ_2-S**	**SS_2-S**	Odappalli	Agriculture	SSE	1.0
GW_3-S	**AQ_3-S**	**SS_3-S**	Karudevannpalayam	Housing unit	E	2.5
GW_4-S	**AQ_4-S**	**SS_4-S**	Pallipalayam	Agriculture	NNW	4.0
GW_5-S	**AQ_5-S**	**SS_5-S**	Punjailaksmipuram	Housing unit	S	4.0
GW_6-S	**AQ_6-S**	**SS_6-S**	Viruppanchathiram	Agricultural	NW	5.0
SW1-S	**-**		400 meters from the site on river Cauvery	Agricultural	NW	500m
SW2-S	**-**		Odappalli	Housing unit	SSE	1.0
Abbreviation: SW-Surface water-sugar, AQ-S,-Sugar Air quality and SS-S, Soil Sample in Sugar industry						

Result and discussion

Table: 1, Comparing Ground water samples taken around sugar industry with permissible limits given CPCB

Parameter	Unit	GW_1	GW_2	GW_3	GW_4	GW_5	GW_6	WHO (Drinking water quality) 2004	BIS, Indian Standards (IS 10500:1991)
pH	**--**	7.4	7.1	6.9	6.8	7.3	6.7	6.5-8.5	6.5-8.5
EC	**µmho/cm**	2431	2137	1663	2771	2511	1048	0.3	--
Taste		Salty	Salty	Salty	Salty	Salty	Salty	--	Agreeable
Color	**Hazen**	<5	<5	<5	<5	<5	<5	25	10
Temperature	**°C**	28	28	28	28	28	28	30	--
Turbidity	**NTU**	3.0	3.0	3.0	3.0	3.0	2.0	5.0	**5.0**
Total Hardness	**mg/l**	680	613	800	650	810	700	100	300/600
Total Alkinity	**mg/l**	80	100	70	80	90	100	100	200/600
TSS	**mg/l**	4	5	6	3	3	3	>10	500/2000
TDS	**mg/l**	1100	1060	1050	1400	1206	1090	1000	--
DO	**mg/l**	6.4	5.2	6.0	5.6	7.5	5.2	5	500
BOD	**mg/l**	43	42	40	43	55	35	6	45/500
COD	**mg/l**	220	240	180	140	260	155	10	--
Sodium	**mg/l**	40	33	75	40	35	36	--	--
Calcium	**mg/l**	43	50	65	53	41	66	--	75/200
Potassium	**mg/l**	1	2	2	1	2	0.58	250	
Magnesium	**mg/l**	20	28	29	31	38	38	--	30/100
Chloride	**mg/l**	160	129	110	160	180	170	--	200/600

Nitrate	**mg/l**	0.65	0.72	0.88	0.85	0.94	0.67	--	0.1-0.3
Fluoride	**mg/l**	1.1	0.92	0.80	0.4	0.96	0.91	1.5	1.0/1.5
Sulphate	**mg/l**	39	42	34	42	41	22	--	200/600
Total coliform	**MPN/100ml**	-0-	-0-	-0-	-0-	-0-	-0-	--	Absent

Ground Water Quality

Most of the villages in the sample sites have bore well and tube well facilities, as most of the residents of these villages make use of this water for agricultural and other domestic purposes. Therefore, three bore well samples have been considered for sampling. (Table.1) shows compared with the ground water limits given by BIS and WHO drinking water standards .The analysis of results indicates that the pH ranges in between 6.9 to 7.3, Acidic in nature and pH of water in the range of 6.5 to 8.5 is not Harmful to human and does not has direct effect on health also which is well within the standards 6.5 to 8.5 has per norm of WHO and BIS. Total hardness was observed to be ranging from 613 to 810 mg/l, Total hardness is high 500 mg/l standards comparing to WHO and BIS water standards The hardness was found to be exceeding the desirable limit of 100 to 200 mg/l at all the locations. Total hardness-13 to 210 mg/l, Calcium (Ca) and magnesium (Mg) are dissolved from most soils and rocks. (Deshpande and Aher, 2012) Total hardness-513 to 710 mg/l categorized as very hard. Carbonate and bicarbonate concentrations, temporary hardness and alkalinity.(Abdul, Sirajudeen, 2006), Fluorides are found to be within the permissible limit of 1.1 mg/l. Nitrates are found to be exceeding in range of CPCB limits. Calcium is ranging between 41 mg/l and 66mg/l and not exceeding the BIS limit of 75 mg/l at all the locations. DO ranges from 5.2 to 7.5 mg/l compared exceed to WHO and does not exceed the limit BIS indication of increased Pollution by organic wastes from effluent and domestic sewage around these stations (Abdul and Sirajudeen, 2006) BOD sample range from 35 to 55 mg/l shows higher values exceed the limits in 2 sample of WHO and low in BIS due to organic pollution by the intrusion of sugar mill effluent. And the COD content range from 155 to 260 mg/l high in range compare with WHO contamination of water with the sugar mill effluent containing high volatile solids. TSS is ranging between 3 mg/l and 6 mg/l and not exceeding the limit of WHO and BIS at the entire locations, TSS levels are low does indicate the impact of Sugar Mill effluents (Yadav Anoop and Daulta Renu. 2014). Bacteriological studies reveal that no coliform bacteria are present in the any samples. Hence more ground water was used due to less availability of treated waste water for irrigation. This has resulted in increased levels of TDS and hardness in ground water due to over percolation, leaching and recycling in terms of TDS, sodium and chlorides will improve because of steps. Hardness and TDS exceed the limit of WHO and BIS drinking standards it should be further filtrate using reverse osmosis technology in households and then can be used for drinking. TDS-50 to 400 levels exceeds the range between with WHO, percolation other wastes like domestic and agricultural even the water recycled from the sugar industrial effluent can contain high concentration of dissolved solids (Subbarao et al., 1997). Drinking water standards and comparing with BIS, Nitrate- 0.35 to 0.64 mg/l slightly high due to combine effect of agricultural activity and mix of treated sugar mill effluent can respond on the downstream (Deshmukh, 2014).

Table: 2 comparing the Surface water samples taken around sugar industry with permissible limits given CPCB

Parameter	Unit	SW1	SW2	CPCB Norms for surface water	WHO Norms (Drinking water quality) 2004
pH	--	7.8	7.4	6.5-8.5	6.5-8.5
EC	**µmho/cm**	2010	2431	--	0.3
Color	**Hazen**	<4	<5	10-30	25
Temperature	°C	26	27	--	30
TDS	**mg/l**	1134	1100	500-2100	1000
TSS	**mg/l**	1.3	1.4	--	5.0
Turbidity	**mg/l**	4.5	4.5	--	>10
Total hardness	**mg/l**	180	190	--	100
Total Alkinity	**mg/l**	90	100	-	100
DO	**mg/l**	4.0	3.8	4.0-6.0	5.0
BOD	**mg/l**	44	38	2-3	6.0
COD	**mg/l**	108	106		10
Sodium	**mg/l**	41	45	--	-
Potassium	**mg/l**	1	1	--	250
Calcium	**mg/l**	80	96	--	-
Magnesium	**mg/l**	38	35	--	-
Chloride	**mg/l**	160	130	250-600	250/1000
Nitrate	**mg/l**	0.73	0.50	20-50	45
Sulphate	**mg/l**	32	40	400-1000	200/600
Fluorides	**mg/l**	0.6	0.25	1.5	1.5
Oil and grease	--	nil	Nil	0.1	-
Total coliform	**MPN/100ml**	60	140	50-5000	-

Surface Water Quality

Table :3 shows The analysis results indicate that the value SW1 (River sample) and SW2, pond sample is Color SW1 less than 4, Temperature is 26°C, 27°C, pH value of Surface water samples varied from SW1-7.5, SW2-7.Alkaline , Total Alkinity is the slightly the same Total hardness, the difference between the 80 to 90 mg/l urolithiasis, anencephaly, prenatal mortality, some types of cancer, and cardiovascular disorders Exceed the permissible limits WHO (Durvey et al. 1991). The TDS was observed to be between 1134 to 1100 mg/l, which is well within the permissible limit of CPCB 1500-2100 mg/l. But exceeds to WHO standards in difference between 100 to 134 mg/l exceeds the permissible limits WHO, 32 percent of the sample were suitable for irrigation and also can be used has a drinking water. (Davis and Dewiest classification, 1966). less human influence into the river and also chloride contributes in the TDS (Taylor, 1984).which is well within the DO value was 2 to 2.1 observed in the range, low concentration of DO in the fresh water aquatic system indicates presence of high organic load (Yayyntas et al., 2007) . BOD, 38 to 44, COD 106 to 108 The BOD to COD ratio differed in the riverine stretch. The BOD,COD value was more and indicates presence of toxic waste need for tertiary treatment and stabilization fluoride are within the permissible limits Sulphate, Magnesium, Nitrate, Sodium, Potassium, Calcium were found to be with in the permissible limits drinking water and CPCB surface water norms (Table: 2).

Table: 4 Comparing air samples taken around sugar industry with permissible limits given CPCB

Parameter/Area	Unit	AQ_1	AQ_2	AQ_3	AQ_4	AQ_5	AQ_6	NAAQs
SO_X	ug/m^3	46.4	32	12	12	12	12	**80**
NO_X	ug/m^3	40.5	32	32	32	32	32	**80**
PM_{10}	ug/m^3	70	80	60.5	60.5	60	60.5	**100**
PM $_{2.5}$	ug/m^3	42.5	34.5	35.5	13.5	16.5	16.5	**60**
All the parameter are taken on time weighted for 24 hours								

Ambient air quality monitoring

During the monitoring period, each 6, 24-hourly samples of PM2.5, PM10, SOx, NOx, samples are collected and analyzed. Table.3 shows, The following observation are made based on the collected and data are compared with the NAAQ standards.

1. PM2.5 values were monitored in the range 13.5-46.4 ug/m^3 with the mean value of 145.25 ug/m^3 against 6/24-hourly period NAAQ Norm value of 60 ug/m^3.
2. PM10 values were monitored in the range 60-80 ug/m^3 with the mean value of 341.08 ug/m^3 against 6/24-hourly period NAAQ Norm value of 100 ug/m^3.
3. SO2- levels were ranging from 12 ug/m^3 to 46.4 ug/m^3 with the mean value of 116.4 ug/m^3 against NAAQ limits value of 80 ug/m^3.
4. NOx- levels were ranging from 32 ug/m^3 to 40 ug/m^3 with the mean value of 173.83 ug/m^3 against NAAQ limits value of 80 ug/m^3.

PM2.5, PM10, SOx, NOx, samples are within the permissible limits of (NAAQs) in the expect two area AQ_1 , AQ_2 the samples are high around 80 percent within the limits due to pulp and paper industry percent Odor was high due to industry 200 m there is a Paper board industry they have Co-processing unit of soda recovery plant. But still for air pollution control three stage ESP is used and duct control is used in process. But permissible limits within standard itself but still PM2.5, PM10, emitted from the boiler. Recent study was shown that dangerous air pollutants from sugar mills could contaminate the surrounding as far as 1 km away (WHO, 2000). (Isabel et al., 2010). There are lung function abnormalities due to breathing of SO2 and NOx emissions increases. Soil characteristics such as particle size can winter months soil absorbs the fly ash from the stack contamination of surface water and irrigation (Guttikunda and Jawahar, 2012).

Table: 5 comparing the soil samples taken around sugar industry with permissible limits given CPCB

Parameter/Area	unit	SS_1	SS_2	SS_3	SS_4	SS_5	SS_6	Desirable range
Color	**--**	Brown	Light brown	Brown	Brown	Brown	Brown	**--**
Texture class	**--**	Loamy sand	Loamy sand	Loamy sand	Loamy sand	Loamy sand	Clay	**Loam**
Bulk density	**gm/cc**	1.0	1.0	1.2	1.1	1.0	1.3	**--**
pH	**--**	8.5	8.6	8.6	8.9	9.0	8.5	**4.5-9.0**
EC	**µmho/cm**	550	850	760	672	900	830	**0.2-1.0**
Organic carbon	**%**	1.14	1.14	1.12	2.0	2.1	2.39	**>0.75**
Organic matter	**%**	0.15	0.57	1.34	1.75	0.60	0.45	**--**
Nitrogen	**Kg/ha**	92.4	56.5	44	45	34	66	**50-300**
Potassium	**Kg/ha**	136	125	130	143	120	160.8	**120-360**
Phosphorous	**Kg/ha**	86.2	54.6	45.6	45	32	16.8	**15-80**
Magnesium	**Kg/ha**	206	212	210	236	230	210	**--**
Calcium	**Kg/ha**	0.01	0.004	0.004	0.006	0.004	0.005	**--**
Chloride	**Kg/ha**	170	180	160	170	170	200	**--**
Sodium	**Kg/ha**	89.1	110	54.5	77.5	80	70	**--**
Sulphates	**Kg/ha**	70	70	80	90	80	90	**--**

Baseline Soil Status

Table:4 shows the Soil quality parameter, Soil color is observed to be varying between 'light brown' to 'brown'. The texture is observed to be predominantly loamy sand, which is a typical feature of 'Delta plains'. The pH ranges from 8.5 to 9.0 indicates that the soils in the study area are strong alkaline in nature. EC range from 550 to 900 is high harmful for germination, The bulk density is in the range of 1.0 to 1.3 gm/cc. Organic carbon (%) range from 1.12 to 2.29% more than sufficient in the limits. The Nitrogen values are in the range of 34 -92.4 kg/ha indicating that soils have very less to less Nitrogen levels. The Phosphorous values are in the range of 16.8-86.2 kg/ha indicating that soils have less to more than sufficient Phosphorous levels Phosphorous sample SS1 exceeds the limits 16.8-86.2 kg/ha physico-chemical properties of sugar mill effluent polluted soil and find that study sites were deficient in phosphorus (Lohar and Dhagar, 2013), The Potassium values range between 125-160.8 kg/ha, which indicate that the soils have very less to better quantity of Potassium. Waste water contained large quantity of fly ash, which accumulated in the soil and can raise its K content. Too much potassium is not directly toxic to plants but can have adverse effects. (Daulta et al., 2014). The Organic matter (%) values range between 1.12-2.39 percent, which indicate that the soils have very less to sufficient percentage of Organic Carbon. Organic carbon content exceed the desirable ranges from 0.37 to 1.64 percent High percentage of organic carbon which indicate that the soils have less good and sufficient percentage of Organic matter. Find in the sugar mill waste water affected soil. This is because the sugar mill treated effluent contains high level of organic waste. When this water is used for irrigation in agriculture it increases the organic carbon in the soil (Tabriz et al., 2011). EC, Organic matter Nitrogen Potassium Magnesium Calcium Chloride Sodium Sulphates are within the permissible limits has (Renu et al., 2014)

Conclusion

During the present study the obtained data provides simple representation different characteristics such as physical, biological and chemical that reveals the overall water, Air, and soil quality of around the sugar. It indicates that data few of the water quality parameters like EC, Total Hardness, TDS and nitrate are comparatively high exceed the limits in ground water due to over uses of water . Surface Water is non-alkaline in nature and it is suitable for domestic uses when it comes to skin aspects of human beings. The concentration of EC, Total hardness, Total alkinity, BOD, COD exceed the limits. In Air pollution monitoring the result shows within the limits. And in soil pH, EC, Organic carbon exceeds the limits. Due to environment factors this can be change still data has no seasonal variation it could not be determine. This Sugar industry has been using "State of art" technology for pollution control tool, by-upgrading and setting of inbuilt technology too control pollution within the standards permissible limits in air, water and soil there has no exceed in limits and the Physico-chemical parameter shows the industry is using the resource properly by recycling and recirculating without draining, dilution of water into point sources.

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