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A review of water pollution abatement strategies in India: The case of Gujarat.

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Abstract

Industrialization is central to generating job opportunities, reducing regional income disparities and enabling poverty eradication in developing countries like India. Goal-9 of the Sustainable Development Goals resonates to this end by stressing on the achievement of inclusive and sustainable industrialization, promoting innovation and resilient infrastructure. This has far reaching implications in terms of achieving water security for the industrially progressive, but naturally water scarce and drought prone state of Gujarat, located in the western part of India.

The objective of this paper is to review water pollution abatement strategies undertaken through various policies in the Gujarat state. This has been attempted within the background of federal water legislations / laws to protect water resources The issue of irreversibility in the quality of surface and ground water resource of the state, already degraded by water pollution has been addressed.

1. Introduction:

1.1 Wastewater :

In Asia and the Pacific, over 85 per cent of untreated wastewater create the risk of a 'silent disaster' due to pollution of surface and groundwater resources and coastal ecosytems (2nd APWS, 2013a, 2013 b as cited by UNWWDR,2016). The Global Environment Risk report 2016, highlights an uneasy link between uncertain climate events and water scarcity causing disruptions in water security. It recognizes water quality risks due to environmental degradation as the third most critical factor impacting the global economy and the quality of life of the people. This implies the building of a "resilience imperative"(World Economic Forum,2016) in water governance across all sectors of the economy- municipal, agriculture and industry, in order to address entitlements of clean water as a human right. Goal 6 of the Sustainable Development Goal addresses the rhetoric by defining the aim of access to clean water as not only restricted to drinking water, sanitation and hygiene, but also preserving the quality and sustainability of water resources worldwide.

In emerging economies like India, the quality of water resources over time have suffered due to waste water effluent from industries and hazardous waste sites , untreated municipal sewage and liquid waste , run off from agricultural fields , poor septage and sanitation practices in the rural and peri urban areas.

In 2015, as part of monitoring of rivers in India, under the GEMS (Global Environmental Monitoring System)1, the Central Pollution Control Board of the Government of India,

[1] The Central Pollution Control Board (CPCB) of India has established a network of monitoring locations on rivers across the country under the Global Environmental Monitoring Systems

reported an increase in the sewage generated from 650 cities and towns located along 302 severely polluted tributaries (of 275 rivers) from 38,000 million litres per day in 2009 to 62,000 million litres per day. An alarming aspect was the widening gap between sewage generated and available treatment capacity from 26,200 million litres per day in 2009 to 38,000 million litres per day in 2015 (CPCB 2016).

The Central Pollution Control Board (CPCB) has identified 920 grossly polluting industries discharging effluent into rivers across the country (MOEF&CC, 2017). Although these industries are required to meet the prescribed effluent quality norms before discharging their treated effluent into water bodies, the small and medium sized enterprises (SMEs) and informal industries which constitutes the manufacturing sector, lack the size and resources to enter the circular economy, unlike the large industries, causing them to often "discharge their wastewater into municipal systems or directly into the environment." (UN- WWDR, 2017)

This slow and often irreversible damage to the quality of surface and ground water due to pollution has contributed to a growing vulnerability in the form of rising loss in livelihoods through poor yields of agricultural crops, extinction of fishing communities; health damages in the form of rising incidences of skin diseases, fluorosis and gastrointestinal tract infections among population as well as exacerbating fresh water shortage in an already water scarce region/state (Chakraborty and Mukhopadhaya, 2014). Water pollution[2] is an example of negative externality prescribes governmental intervention in the form of designing suitable policies for water pollution abatement. In order to sustainably

(GEMS) and Monitoring of Indian National Aquatic Resources System (MINARS). It covers 445 rivers in 1275 locations. (CPCB, 2016).

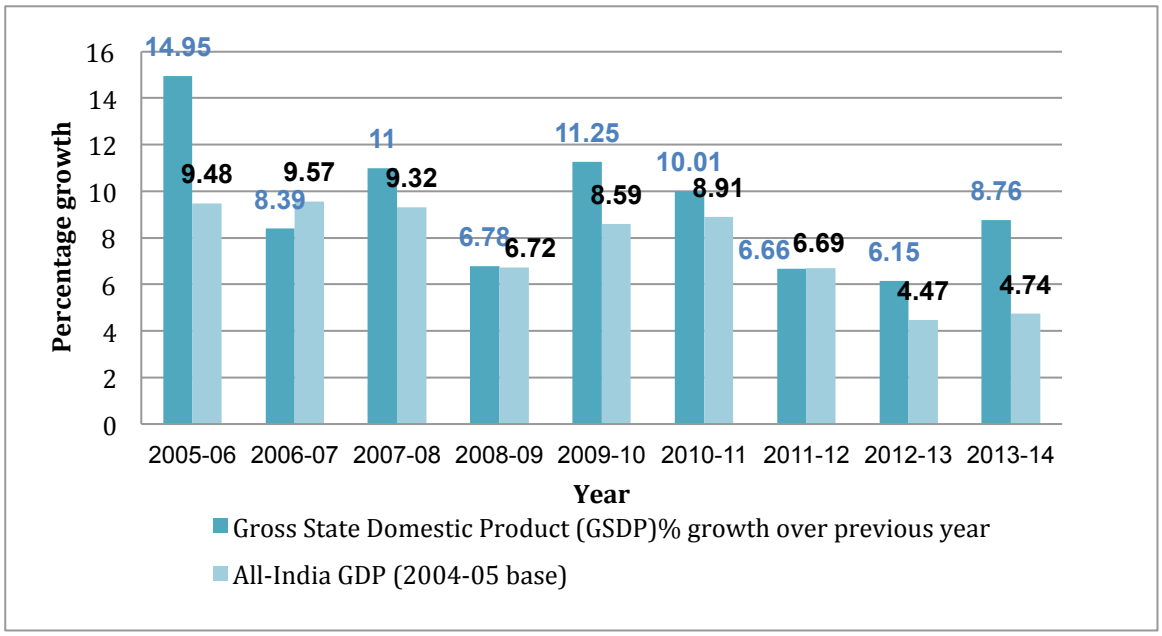
[2] "Pollutant' means any solid, liquid or gaseous substance present in such concentration as may be, or tend to be, harmful to groundwater and impacting human and non-human life."- Water Act, 1974.

manage water globally , it is necessary to review the situation locally (Cramwicket, J. 2016)

1. 2 The economic landscape of Gujarat:

Accounting for just 2.2% of fresh water resources in the country and 5% of population, the drought prone, western Indian state of Gujarat is exemplary for its industrial and agricultural success. The NCAER- Investment Potential Index 2016, highlights Gujarat as one of the top states in the country on parameters such as ease of doing business, labour climate, overall infrastructure such power and water availability for industries, economic climate and business expectations.

Graph 1.2.1 : Gujarat and India: Percent growth in GSDP and GDP (2005-2014) at constant (2004-05 prices)



Source: Data cited from http://niti.gov.in/content/gsdp-constant2004-05prices-percent-growth-2004-05-2014-15

From Graph 1.2.1, growth in Gujarat's gross state domestic product (GSDP) fluctuated but remained higher on an average as compared to all-India percentage growth in GDP (Gross Domestic Product) from 2009-2014.

Table1.2.2 indicates sector wise percentage annual growth rates in the State. A double digit hike in industrial growth rate in 2009-10 witnessed a sharp fall in 2013-14; as agriculture surprisingly shoots up from a negative growth rate in 2012-13 to double digit increase to 28.3% in 2013-14.

Table 1.2.2: Sector-wise annual growth rate in percentage for Gujarat at 2004-05 prices (2007-08 to 2014-15)

Sector	*2007-08*	*2008-09*	*2009-10*	*2010-11*	*2011-12*	*2012-13*	*2013-14*
Industry	10.81	6.52	21.25	3.16	4.53	5.94	3.6
Agriculture and allied activities	8.73	-7.17	-0.74	21.64	5.48	-8.96	28.3
Services	12	11.88	6.09	13.63	8.91	10.56	8.5

Source: Compiled from Statistics for States: Niti Ayog, Government of India. Available online http://niti.gov.in/state-statistics

In the last decade, Gujarat has made commendable progress in ensuring water availability by investing in comprehensive water augmentation measures. It has built the Narmada canal network, constructed check dams and rainwater harvesting structures, among other schemes to combat water stress arising out of its uneven geohydrological landscape and precipitation impacting consistency in water availability across the state . But even as access to water is improving, water resource managers are grappling with the deteriorating quality of her water bodies such as rivers, lakes, creeks and the coastal areas.

Industrialization is central to generating job opportunities, reducing regional income disparities and enabling poverty eradication in developing countries like India. Goal-9 of the Sustainable Development Goals resonates to this end by stressing on the achievement of inclusive and sustainable industrialization, promoting innovation and resilient infrastructure. This has far reaching implications in terms of achieving water security for the industrially progressive, but naturally water scarce and drought prone state of Gujarat, located in the western part of India.

The objective of this paper is to review water pollution abatement strategies undertaken through various policies in the Gujarat state. This has been attempted within the background of federal water legislations / laws to protect water resources. The issue of irreversibility in the quality of surface and ground water resource of the state, already degraded by water pollution has been addressed.

2. Industries and Waste Water

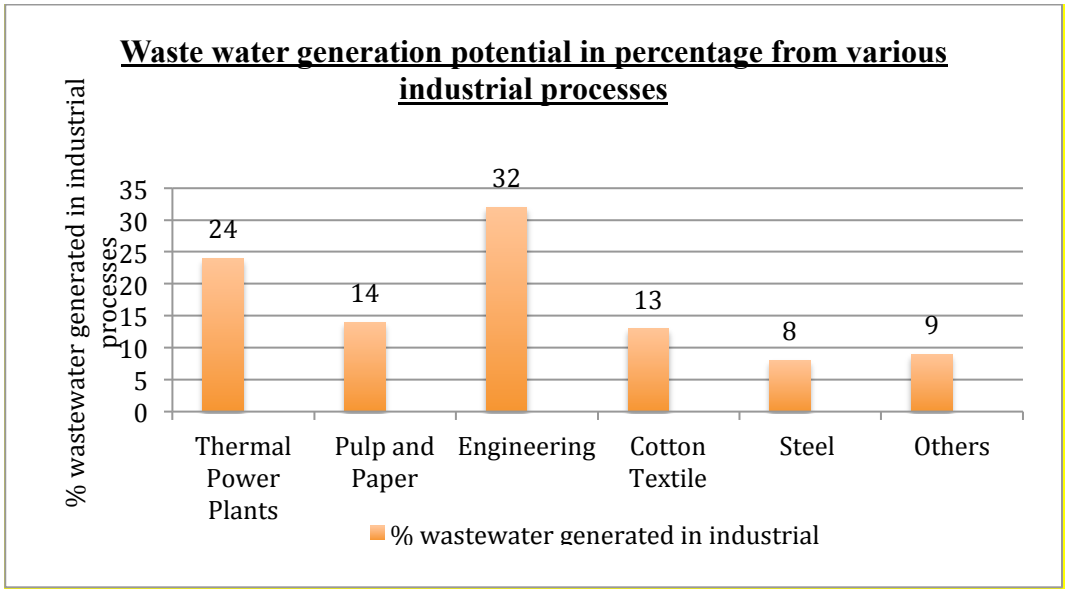
2.1. Waste water from industries in India.

While the demand for water from industries (8%)[3] in India, is not particularly eye-catching unlike other sectors such as agriculture (80 per cent) and the domestic sector (5%), the wastewater discharged from various industrial processes into water bodies "raises the share of industrial water use" (Agrawal and Kumar 2011) by as much as 35-50 percent (Centre of Science and Environment, 2004). Industrial demand for water is determined by the type of industry.

Graph 2.1.1 illustrates the percentage wastewater generation from various industrial processes. It can be noted that whereas thermal power plants, textiles, pulp and paper , iron and steel are highly water intensive sectors- industrial sectors like chlor-alkali, cement, copper, zinc and plastic require little water (Down to Earth, 2004).

[3] There exists discrepancies in the reporting of water consumption by the industries. The Ministry of Water Resources in India puts the figure at 6% , the Central Pollution Control Board at 8% the World Bank estimates the industrial water use at 13% of the total freshwater abstraction in India. Industrial demand for water and energy production in India is forecasted to grow at a rate of 4.2 percent per year, rising from 67 billion cubic metres in 1999 to 228 billion cubic metres by 2015 (page 1, Aggrawal and Kumar, India Infrastructure Report 2011).

Graph 2.1.1: Waste Water generation potential from industry-types



Source: ***http://www.cwc.gov.in/main/downloads/DraftGuideline_Water_Audit.pdf***

Wastewater is generated from industries as :

1. **Production processes** - Process water (as part of industrial processes);

2. **Final Effluent**: as residual wastewater from industries and wastewater treatment

Wastewater generation in India due to industrial processes constitutes 84% of cooling water from thermal power plants and 16% of other industrial process water .

While large and medium industries generate 62% of waste water from their industrial processes , small scale industries emit 38% of industrial process water as effluent.Water intensity in the industrial plants is higher in India where industrial consumption is about 2 to 3.5 times more water per unit of production compared to similar plants operating in other countries, (MOWR, 2017, State of India's Environment , 2015). Table 2.1.2 lists the water intensive industries in India as defined under the Water (Prevention and Control of Pollution) Cess Rules, 1978.

Table 2.1.2: Water –intensive industries in India

1. Ferrous Metallurgical steel
2. Non-ferrous Metallurgical steel
3. Chemical
4. Textiles
5. Paper
6. Fertilizer –Complex fertilizer
7 Processing of animal or vegetable products: Tanneries; Natural rubber; Starch, glucose and related products; Dairy; Jute; Sugar; Maltry; Brewery; Distillery

Source: Water (Prevention and Control of Pollution) Cess Rules, 1978.

In 2008, the Central Pollution Control Board of India (CPCB) reported that an estimated 15438 mld (million liters per day) of total wastewater is generated from all major industrial sources in India. Out of which treatment facilities was available for only 9000 mld (million litres per day) of wastewater (Parivesh, 2008). In April 2017, the Central Water Commission of India (CWC) in its water audit draft outline, highlighted the current statistic of wastewater generated from all major industrial sources at 82446 million litres per day (MLD).

Agro based Industries like Distilleries, Sugar mills and Paper mills are major contributors of organic pollution, whereas the industries generating chemical pollution can be divided into two categories:

1) Those which generate high Total Dissolved Solids (TDS) bearing waste like pharmaceuticals, rayon plants, chemicals, caustic soda, soap and detergents, smelters etc.
2) Those which generage toxic wastes eg pesticides, smelter, inorganic chemicals, organic chemicals, steel plants, pharmaceuticals and tanneries etc.

As industries proliferate , improvement in industrial operation processes to curtail wastage of water becomes an imperative to curb the volume of wastewater emitted out of industrial processes per unit of production.

The National Water Policy of India, 2012, reasons out inefficiencies in water use due to low consciousness about the overall water scarcity and the economic value of water among policy makers in the state. This leads to unregulated water use and in water intensive industries this translates into a greater quantity of waste water discharges.

2.2. Industries and Water Pollution in Gujarat

2.2.1. Industries in Gujarat:

Gujarat is one of the highly industrialized states of India with a strong web of pharmaceutical, petrochemical, textile, automotive, energy, chemical, and other industries (Haldar S. et al, 2013).

Table 2.2.1.a: Gujarat's contribution to India in key products as (%) of total national production

Industrial production from Gujarat	*As percentage of Total production in India*
Soda Ash	91
Diamond Exports	80
Salt	66
Plastics	65
Petrochemicals	62
Crude oil (onshore)	53
Pharmaceuticals	35
Glass and Glass products	30
Chemicals	29
Natural gas	24
Textiles	19

Source: Vibrant Gujarat: Connecting Gujarat to the World: 10-13 Jan 2017 *http://vibrantgujarat.com/writereaddata/images/pdf/destination-gujarat-2017.pdf*

The NCAER- Investment Potential Index 2016, highlights Gujarat as one of the top states in the country on parameters such as ease of doing business, labour climate, overall

infrastructure such power and water availability for industries, economic climate and business expectations. Table 2.2.1.a illustrates the state's percentage contribution into the total volume of production for some key products in India.

Cluster – led industries in the state have played a central role in its economic progress through large scale employment generation, growth in diversified output, income and increase in foreign exchange earnings through export oriented production. Commonly known as industrial estates and Special Economic Zones (SEZ)[4] , these clusters support small, micro and medium enterprises (MSME) as well as large scale industries, in their development. These dedicated industrial zones are government led and provides an array of industrial infrastructure support- land, road, sewage, power and water as well as various legal and environmental clearance facilities which improves their cost effectiveness and ease of investment.

The MSME is a critical generator of employment and the backbone of manufacturing sector in Gujarat. In 2015, total of registered 3,75,130 MSME were reported with an employment potential of 28,31,786 by the Industries Commissionerate of Gujarat.

[4] Special Economic Zone is specifically delineated duty free enclave and shall be deemed to be foreign territory for the purpose of trade and operations and duty and tariffs. The main objectives of the SEZ Act are : (a) generation of additional economic activity (b) promotion of exports of goods and services and (c) promotion of investment from domestic and foreign sources ; (d) creation of employment opportunities; (e) development of infrastructure facilities. (http://ic.gujarat.gov.in/?page_id=430)

Table 2.2.1.b. : Large Industry Groups Projects In Gujarat: as on 30/9/2016

	Projects Commissioned	Projects under Implementation
Metallurgical Industry	372	246
Industrial Machinery	137	50
Transport Equipment	29	20
Other Engineering	437	238
Electrical Tele & Electronics	374	196
Food Processing	355	214
Textiles	1297	741
Chemicals & Petrochemicals	1836	1009
Drugs & Pharmaceuticals	404	194
Glass, Ceramic & Cement	405	314
Infrastructure Projects	107	291
Others	498	520
Total	**6251**	**4033**

Source:h*ttp://ic.gujarat.gov.in/documents/pagecontent/Industry_Groupwise_Analysis_of_large_Project*

Tables 2.2.1.b and 2.2.1.c gives us an idea of the type of industries in Gujarat operating in terms of their size and scale. Most of these industries are water intensive and hence have a high water pollution potential. Non-compliance by industries in Gujarat has largely been

due to stringent command and control regulation and to the prevalence of a large number of small-scale and informal sector manufacturing sectors that are deficient in funds, knowledge, technology and skills to manage discharges from their industrial production processes (Kathuria and Sterner, 2006).

Table 2.2.1.c: Industry Groups under Medium, Small and Micro Enterprises (MSME) in Gujarat 2006-2014

Group wise Registered MSME in Gujarat

Sr. No.	Group	Registrations from 2-10-2006 to 31-3-2014 Micro	Registrations from 2-10-2006 to 31-3-2014 Small	Registrations from 2-10-2006 to 31-3-2014 Medium	Registrations from 2-10-2006 to 31-3-2014 Total
1	Textiles	68171	8206	351	76728
2	Machinery and parts except electrical	20668	2478	81	23227
3	Mining and Quarrying	2778	685	18	3481
4	Food Products	4853	1498	60	6411
5	Chemical & chemical Products	7078	2311	133	9522
6	Wood Products	3043	318	15	3376
7	Rubber & Plastic Products	5414	1518	79	7011
8	Non-metallic mineral Products	3927	1251	174	5352
9	Basic Metal Industries	16908	2615	121	19644
10	Paper Product & Printing	4269	926	67	5262
11	Electrical Machinery and Apparatus	5156	726	25	5907
12	Transport equipment and parts	1906	461	10	2377
13	Leather Products	3641	821	27	4489
14	Beverages, Tobacco & Tobacco Products	1052	166	2	1220
15	Service Activities	25606	1288	79	26973
16	Trading Activities	48200	358	9	48567
17	Other	10597	1503	113	12213
	Total	**233267**	**27129**	**1364**	**261760**

Source: http://ic.gujarat.gov.in/micro-small-medium-enterprises

With a growing scale of industrial activities and inadequate environmental regulation for the protection of air and water resources, overtime, the mindless dumping of toxic, hazardous waste impaired ground water and hampered water quality of all the major and the mini rivers of the state (Kathuria 2005, Murty 1999, Murthy and Kumar 2011, Misra S and Murthy S 1999).

2.2.2 *Water pollution in Gujarat*

There are three primary reasons for water pollution from industries in the state:

1. Water – use inefficiency leading to wastage and increasing effluent;
2. Untreated waste disposal
3. Poor maintenance of existing effluent treatment plant infrastructure causing disposal of highly polluting discharges into the water bodies

Industries in Gujarat are primarily located in the vicinity of water bodies-rivers, lakes, sea creeks or where groundwater is abundant. It provided easy solution of water availability as well as disposal of untreated industrial effluents through dilution in the water courses.

Table 2.2.2 a.: Distribution of industrial estates in Gujarat according to water availability

Geographical region	Total (mn cu m)	Surface water (mn cu m)	Ground water in mn cu m	Storage Capacity of reserviors (Except SS) in mn cu m	% water resources out of total	% Land area	Total Number of functioning industrial estates as in 2013-14
Central and South Gujarat	38105	31750	6355	10400	69	25	91
North Gujarat	6342	2100	4242	2100	11	20	30
Saurashtra	9723	3600	6123	2250	17	33	57
Kachchh	1438	650	788	250	3	22	13
Total	**55608**	**38100**	**17508**	**15000**	**100**	**100**	**191**

Source: https://guj-nwrws.gujarat.gov.in/showpage.aspx?contentid=1512&lang=english and compiled from Industries in Gujarat: Statistical Abstract: 2014. Government of Gujarat

Industries use both surface and ground water. However, since the availability of surface water from the municipalities is not sufficiently guaranteed, industrialists depend on groundwater (Aggarwal and Kumar 2011). This has led to the building up of competing demands on the groundwater aquifers of the state.

Table 2.2.2 a on distribution of industrial estates in Gujarat illustrates this fact, with most number of industrial estates located in water abundant regions. Central and South Gujarat

which constitutes 69% of both surface and ground water resources have 91 functioning industrial estates. In regions with inadequate surface water resources, as in Kachchh, Saurashtra and North Gujarat, added water stress gets created on available ground water resources by competing demands for agriculture , growing urbanization and industrial pressure. Industrial demand for water is linked to the pace of growth in industrial development (CAG 2011, Aggarwal and Kumar 2011).

In 2015, the Central Pollution Control Board of India reported that 74% of the state's 27 monitored rivers, whose tributaries flow along 38 prominent industrial townships and urban centres, including the cities of Ahmedabad, Surat and Vadodara, are severely polluted. (Central Pollution Board, 2015). However, on comparing the Central Pollution Control Board's two reports over the two time frames, on water quality of rivers , namely- 2002-2009 and 2009-2012, indicate a fall in the number of severely polluted stretches for rivers based on BOD (Biological Oxygen Demand) parameter in Gujarat.

Table 2.2.b explain the pollution intensities as measured by the concentration of Biological Oxygen Demand (BOD) as stipulated under national water quality standards for the monitoring of rivers and tributaries in India.

Table 2.2.2. b: Pollution intensity based on BOD (Biological Oxygen Demand) concentration

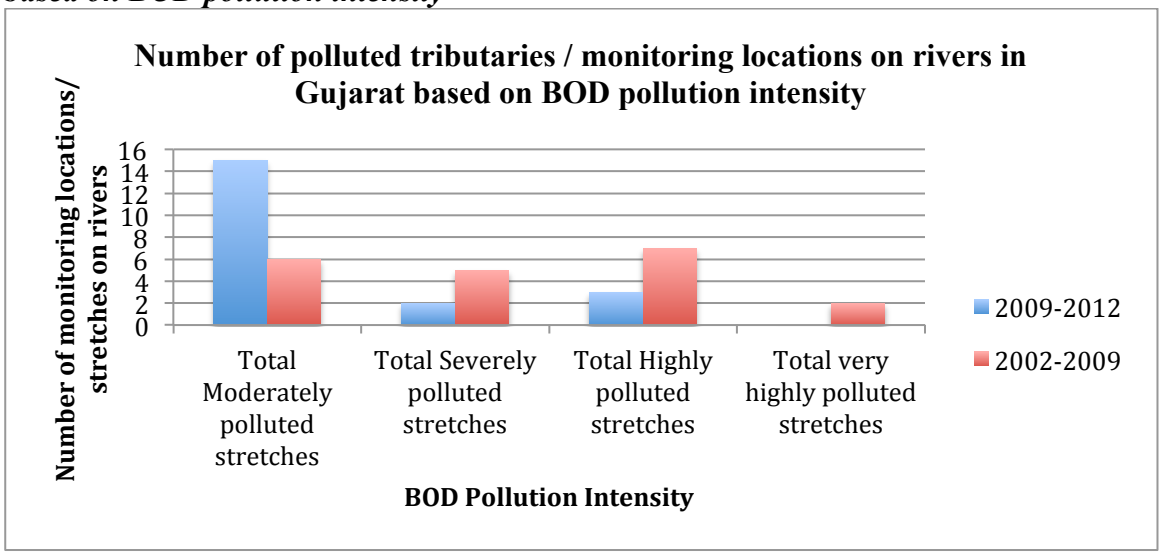
Criteria	**BOD concentration in microgrammes per litre (mg/l)**	**Intensity of pollution**
Priority I	>30	Severely polluted
Priority II	20-30	Very highly polluted
Priority III	10-20	Highly polluted
Priority IV	6-10	Moderately polluted
Priority V	3mg/l-6mg/l	

Source: CPCB, 2015: http://cpcb.nic.in/RESTORATION-OF-POLLUTED-RIVER-STRETCHES.pdf

Graph 2.2.2 c indicates that while the total number of monitoring stations remained the same during the monitoring years: 2002-2008 and 2009-2012, polluted stretches on rivers

showed an improvement in terms of the concentration of BOD leading to a fall in the total number of very highly polluted stretches in Gujarat. However the total number of moderately polluted stretches of the rivers has increased between 2009-2012.

Graph 2.2.2 c: Number of polluted tributaries / monitoring locations on rivers in Gujarat based on BOD pollution intensity



Source: Compiled from CPCB (2009) and CPCB (2015)

Table 2.2.d lists the recently updated primary water quality criteria for bathing water to include a more comprehensive listing of paramaters to determine suitability of the water body for human use. It could be noticed that the water quality criteria for the parameter COD (Chemical Oxygen Demand) has to be less than 10 microgrammes per litre to ensure no contamination from industrial source after treatment (ENVIS, 2015).

Table 2.2.2 d: Primary Water Quality Criteria for Bathing Water

pH=6.5-8.5;
TSS(Total Suspended Solids mg/l= <10 from sewage or industrial waste origin;
BOD(Bio-chemical Oxygen Demand 3 days, 27degree celsius= 3 or less;
COD (Chemical Oxygen Demand)= less than 10 mg/l

Source: ENVIS, 2015, page 7

In order to determine the suitability of a water body, it is therefore, necessary to not restrict to water quality parameters such as BOD (Biological Oxygen Demand) alone, since other

water quality parameters such as COD (Chemical Oxygen Demand), DO (Dissolved Oxygen), TDS (Total Dissolved Solids), pH could be more critical to determine the quality of the riverine system based on their probable environmental impacts. For instance a study determining the criticality index of water quality parameters for five major rivers in Gujarat- Sabarmati, Narmada, Mahisagar, Tapi, Damanganga (Pimparker M., Tyagi S., Khatri N. and Rawtani D. 2016) highlight the need to focus on certain particular water parameters over others in water quality determination of river stretch. It observes that pH, Total Dissolved Solids (TDS) , total hardness, alkanity, sulphates, chlorides and nitrates generally fall in the excellent category, while COD (Chemical Oxygen Demand) is in extremely critical state at most of all locations of all the five rivers. (M. Pimparkar et al , 2016).

Table 2.2.2 e lists the different water quality parameters of river Sabarmati measured at different locations during 2014. It could be observed that while the river at Miroli is highly polluted with no detectable levels of oxygen for aquatic biodiversity as well as at Vautha (Near Dholka), Ahmedabad; the water quality of the river at Hansol bridge fits designated best use for bathing and propagation of wildlife and fisheries.

Table 2.2.2e:Yearly average 2014-15 for River Sabarmati: Water Quality parameters from different locations

Location	pH	D.O.	BOD	COD
River Sabarmati Kheroj Bridge, Kheroj	8.12	7.5	2	11
River Sabarmati at Railway Bridge, Ahmedabad	8.25	7.3	4.3	22
River Sabarmati at Hansol Bridge	8.34	7.1	1.9	11
River Sabarmati with River Vatrak at Vautha (near Dholka) Ahmedabad	8.21	BDL	27	110
River Sabarmati at Chiloda Bridge	8.18	7.8	1.7	12
River Sabarmati at Miroli, Ahmedabad	7.9	3	38	136

Source: GPCB Annual Report 2014-15

2.3 Water Pollution from Common Effluent Treatment Plants (CETP)s

CETPs (Common Effluent Treatment Plants*)*were introduced in the early 1990s to overcome the issue of inadequate treatment of wastewater emanating from industries who find the maintenance and operation of effluent treatment expensive. This was implemented in some of the Gujarat Industrial Corporation (GIDC) estates for members of industrial clusters located within or in its proximity.

Under the central "Scheme of Assistance for Abatement of Pollution"[5] and the Common Effluent Treatment Plant Scheme, the state of Gujarat received INR 11.06 crore (USD in 2015-16 an increase by INR 5.61 crore from 2013-14 treatment expensive. This was implemented in some of the Gujarat Industrial Corporation (GIDC) estates for industrial clusters located within or in proximity. In 2015, there were a total of 37 CETPs of which 33 CETPs are functional (Annual Report 2014-15). According to MOEF&CC (Ministry of Environment and Forests, Climate Change- GOI, 2016) Gujarat had 30 operational CETPs in 2016. Wastewater discharge from CETPs has drawn considerable media attention due to the amount of Total Dissolved Solids in the treated effluent and issues with operation and maintenance.

3. Water Pollution abatement.

3.1. Legislations for Water Pollution abatement / Institutions and schemes for abatement of water pollution in India:

The institutional foundation for regulation of water pollution from industries is constituted under three main Acts- the Water (Prevention and Control of Pollution) Act 1974[6]

[5] The Scheme of Assistance for Abatement of Pollution was conceptualized during the Seventh Five Year Plan with the primary aim to strengthen the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) for enforcing statutory provisions of pollution abatement. This now part of a Centrally Sponsored Umbrella scheme of 'Pollution Abatement'(MoEF &CC Annual Report 2014-15).

[6] Water is a state subject in the 7th schedule of the Indian Constitution. However, the Water (Prevention and Control of Pollution) Act of 1974 is remarkable for the states' "voluntary

Amendment in 1988[7], the Water Cess Act (1977 – Amendment in 2003) and the Environment (Protection)Act of 1986- amended rules Environment (Protection) (Fifth Amendment) Rules, 2014[8].

The first two Acts and their rules empowers the Pollution Control Boards , both at the Central and the state level , to address water pollution prevention, control and abatement as well generate revenue for the Board for water usage by industries.

The Water (Prevention and Control of Pollution) Act 1974 is designed as a "command and control" regulation , giving the boards , power to establish effluent standards which are enforced for approving, rejecting , or modifying application for consent to discharge effluents into water bodies (Gupta, S. 2014). The Gujarat State Pollution Control Board (GPCB) was formed under the Water (Prevention and Control of Pollution) Act 1974.

Under the Environment (Protection) Act (EPA), 1986, the Central government has the authority " to pursue any means deemed necessary to protect and improve the quality of the

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surrender of legislative authority to the central government (Gupta, S, 2014, page 22) on water pollution.

[7] "The 1988 amendments increased the power of the central board vis-à-vis the state boards under Section 18 of the Act, enabling the central government to take over the functions of a state board that has failed to comply with the directions of the Act. (Gupta, S, 2014)

[8] "In exercise of the powers conferred by sections 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government made rules to amend the Environment (Protection) Rules, 1986, : These rules may be called the Environment (Protection) (Fifth Amendment) Rules, 2014." - http://www.indiaenvironmentportal.org.in/content/401692/environment-protection-fifth-amendment-rules-2014/

environment, including coordinating the activities of the various state governments" (James A.J. and Murty, 1999).

The Central Government has, under the EPA Act 1986, defines industry specific national standards termed MINAS (Minimum National Standards) that needs to be met by all industries for discharge of effluent into water bodies. Stipulated limits of effluent parameters by industries are further defined for industry specific national standards termed MINAS (Minimum National Standards) that needs to be met by all industries for discharge of effluent into water bodies.

Limits of effluent parameters by industries are further defined for discharge into surface water bodies such as rivers, streams and coastal areas. (CPCB 2017, Murty and James 1999). The State Pollution Control Boards/Pollution Control Committees (SPCB/PCC) are required to ensure installation and regular operation of the requisite pollution control facilities and compliance of specified effluent standards in industries and the Common Effluent Treatment Plants (CETPs). - http://cpcb.nic.in/List_GPI_Defaulter_NGRBA.pdf

The Ministry of Environment and Forests & Climate Change of India supplements efforts of the state government in the form of financial assistance through central schemes for abatement of pollution in identified stretches of various rivers under National River Conservation Plan (NRCP) and the National Ganga River Basin Authority (NGRBA) programmes on cost sharing basis.

According to the MOEF&CC, until July 2014, financial assistance of INR 5363.56 crore under these two programmes has been released to various State governments in India for the implementation of various pollution abatement schemes and sewage treatment capacity of 5241.48 million litres per day (mld) has been created (MOEF&CC, 2017).

It provides grants to the State Pollution Control Boards, Pollution Control Committees , Environment Departments of States, Central/State Research Institutes and other

Government agencies/organizations under the scheme of 'Assistance for Abatement of Pollution'[9] to strengthen their technical capability as well as subsidy for setting up of Common Effluent Treatment Plants (CETPs).

Central Pollution Control Board (CPCB) in India monitors the water quality of aquatic resources across the country under a three-tier programme i.e. Global Environmental Monitoring System (GEMS), Monitoring of Indian National Aquatic Resources System (MINARS) and Yamuna Action Plan (YAP). The present water quality monitoring network comprises of 2500 stations covering 28 States and 6 Union Territories across the country. (CPCB, 2016). There are 165 monitoring stations in Gujarat (Table 1).

Water quality parameters for Inland water quality monitoring programme of CPCB, include measurements of basic parameters only (such as pH, bio-chemical oxygen demand (BOD), dissolved oxygen (DO), temperature, chemical oxygen demand (COD), nitrite, nitrate, ammonical nitrogen, total and faecal coli form) (Rajaram and Das, 2008). There are 165 monitoring stations in Gujarat (Table 3.1.1)

Table 3.1.1: Water quality monitoring stations under National Water Quality Monitoring Programme in Gujarat.

Water Bodies Monitored for water quality	Number of Monitoring Stations in Gujarat	Number of Monitoring Stations - All India network
Rivers	53	1275
Lakes	21	190
Tanks	1	12
Ponds	2	79
Canals	2	41
Creek/Sea Water	3	41
Groundwater/Well	83	807
Drain/Industrial drain	0	45

[9] The Scheme of Assistance for Abatement of Pollution was conceptualized during the Seventh Five Year Plan with the primary aim to strengthen the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) for enforcing statutory provisions of pollution abatement. This now part of a Centrally Sponsored Umbrella scheme of 'Pollution Abatement'.

Water Treatment Plant	0	10
Total	**165**	**2500**

Source: http://www.cpcbenvis.nic.in/water_pollution_main.html#. Accessed online May 13, 2017.

3.2 Water Pollution abatement in critically polluted industrial clusters in Gujarat.

In 2010, the MOEF[10] (Ministry of Environment and Forests) of the Government of India (GOI) issued a moratorium on six of the critically polluted industrial clusters of the state[11] - Ankleshwar[12] in Bharuch district, Vapi[13] in Surat district, Vatva[14] and Ahmedabad industrial cluster in the Ahmedabad district, Chitra15 industrial cluster in Bhavnagar district and the Junagadh 16 industrial cluster in the Junagadh district restricting establishment of new industrial units and expansion by existing ones.

[10] MOEF is the Ministry of Environment, Forest and Climate Change (MoEF &CC) of the Government of India. It is the nodal agency in the administrative structure of the Central Government of India, for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programmes. http://www.moef.nic.in/about-ministry/about-ministry. Accessed online 16/6/2016.

[11] In 2010, the Central Pollution Board of India (CPCB) issued moratorium on 43 critically polluted industrial clusters in India.

[12] Comprehensive Environmental Pollution Abatement Action Plan Ankleshwar Industrial Cluster-Gujarat, 2010 - action plan prepared and submitted by the Gujarat Pollution Control Board, Gandhinagar, as desired by the Central Pollution Board(CPCB) of India and MOEF, upon imposing of temporary moratorium on industrial activity in the cluster till August 2010. Accessed online 15/6/2016.

[13] Comprehensive Environmental Pollution Abatement Action Plan Vapi Industrial Cluster-Gujarat, 2010 - action plan prepared and submitted by the Gujarat Pollution Control Board, Gandhinagar, as desired by the Central Pollution Board(CPCB) of India and MOEF upon imposing of temporary moratorium on industrial activity in the cluster till August 2010. Accessed online 15/6/2016.

[14] Comprehensive Environmental Pollution Abatement Action Plan Vatwa Industrial Cluster-Gujarat, 2010 - action plan prepared and submitted by the Gujarat Pollution Control Board, Gandhinagar, as desired by the Central Pollution Board(CPCB) of India and MOEF upon imposing of temporary moratorium on industrial activity in the cluster till August 2010. Accessed online 15/6/2016.

[15] Comprehensive Environmental Pollution Abatement Action Plan Chitra Industrial Cluster-Bhavnagar, Gujarat, 2010 - action plan prepared and submitted by the Gujarat Pollution Control Board, Gandhinagar, as desired by the Central Pollution Board(CPCB) of India and MOEF upon imposing of temporary moratorium on industrial activity in the cluster till August 2010. Accessed online 15/6/2016.

[16] Comprehensive Environmental Pollution Abatement Action Plan of Junagadh Industrial Cluster-Junagadh, Gujarat, 2010 - action plan prepared and submitted by the Gujarat Pollution Control

This was criticized on the grounds of loss in employment and output and huge investments made by the industries in the clean up.. For industries, it led to rising costs in the form of greater regulatory risks and mandatory investments in advanced treatment technology and process modification reducing the attractiveness and eventually competitiveness of business. It led to forced regulatory action by the GPCB and erring industrialists within the clusters to clean up their act.

3.2.1 Pollution abatement Measures

Water pollution abatement strategies for the state fall under the following categories:

- Inducing a circular economy within industrial clusters wherein waste of one industry is resource of the another.
- Using Technology and efficient house keeping to recycle waste water in industrial processes and minimize pollution load for treatment, saving costs and water.
- Institutional and infrastructural investments for clean production in water intensive industries
- Restructuring the old environmental audit scheme to increase accountability of monitoring non compliant water polluting industries in Gujarat

A notable achievement of the Gujarat Pollution Control Board (GPCB) was through the scaling up of its e-governance platform- with the use of the Xtended Green Node software developed by the National Informatics Centre, for monitoring compliance of national water pollution standards by industries. According to the Down to Earth magazine, Oct. 2012, this software has induced greater connectivity with the industries, increasing operational efficiency in the number of inspections conducted without any additional staff recruitment.

Board, Gandhinagar, as desired by the Central Pollution Board(CPCB) of India and MOEF upon imposing of temporary moratorium on industrial activity in the cluster till August 2010. Accessed online 15/6/2016.

According to the 2014-15 annual report of the Gujarat Pollution Control Board, use of pollution abatement technologies by industries, such as the installing of Multiple effect evaporator and Reverse Osmosis for Common Effluent Treatment plants (CETPs), dedicated CETPs for pharmaceutical industries , installation of continuous online effluent monitoring systems in industries has been effective in bringing down wastewater pollution from industries within these clusters. Stringent monitoring by the GPCB has helped in detecting ghost pipe connections of industries for illegal discharge of effluents which were subsequently removed (GPCB Annual Report ,2010-11).

Some of the notable wastewater abatement intiatives taken by the industries as well the Gujarat pollution control Board , are listed as below:

- Use of XGN –software to develop online daily monitoring of hazardous waste from registered industries;
- Waste minimization in cement kilns through co processing of hazards wastes as per CPCB guidelines ;
- Establishment of Common Effluent Treatment Plant in the Vatva industrial cluster with capacity of 16000 million litres per day, with biological process supplemented by electro-oxidation;
- Building of a 55 km effluent channel to convey a capacity of 90,000 cubic meter per day of treated water in the Gulf of Cambay;
- Co-generation of power in Waste –to –Energy power generation project in Kanoria Chemicals , Ankleshwar ;
- Research conducted to see possibilities of using effluent (scrubbed ammonium carbonate solution) as raw material in magnesium carbonate industries)
- Drawing up Action plans and Effluent Treatment plants by Ahmedabad Textile processors Association;

- Installation of Effluent treatment Plants (ETPs) by industries: The polluting industries are required to take Consent to establish and Consent to operate under the Water (Prevention and Control of Pollution) Act, 1974 and it is obligatory for industries to set up effluent treatment plants to treat the effluent to the prescribed norms. The number of industrial units with installed ETPs to treat their wastewater discharge increased from 388 (GPCB Annual Report, 2009-2010) in 2010 to 434 (GPCB Annual Report, 2014-2015). These included installation and commissioning of effluent treatment plants by various industries such as thermal power plant, petrochemicals, dye and dye intermediates , paper and pulp industries etc. The total number of ETPs installed and commissioned up to March 2015 was 8709.
- The Gujarat Cleaner Production Centre (GCPC) established by the Gujarat Industrial Development Corpoaration carried out cleaner production demonstration projects in water intensive industries as Pulp and Paper, Electroplating, Dyes and Dye Intermediates . This helped in reducing BOD, TSS and toxicity of wastewaer reducing treatment costs in Paper and Pulp as well as electroplating industry. Technology upgradation options was made available for Dyes and Dye intermediates for filteration, drying , sulphonation and reduciton in COD.

3.3 Status of Pollution Abatement in critically polluted clusters:

As per the progress report[17] submitted by the Gujarat Pollution Control Board (GPCB) on the status of implementation of pollution abatement initiatives of the various industrial clusters, daed 31st December, 2014, most of the industries had complied to both the short run and the long run demands of the monitoring and compliance rigors put up by the state pollution control board with noticeable results. Environmental pollution of the air and

[17] Status of implementation of Comprehensive Pollution abatement Action Plan. GPCB, 2013.

water fell to record lows prompting the Central authority to lift the ban for some industrial clusters. However, whether the fall in environmental pollution was sufficient to revive the quality of water bodies - both surface and ground water, has not yet been questioned by the regulatory authorities controlling pollution in the state.

Table 3.3.1: Progress on Moratorium imposed on Critically Polluted Areas in Gujarat

Industrial Cluster / Area	CEPI SCORE-2009	CEPI SCORE-2011	CEPI SCORE-2013	Status of Moratorium
Ahmedabad	75.28	78.09	69.54	**Lifted in September 2013**
Bhavnagar	70.99	69.73	62.79	**Lifted in February 2011**
Junagarh	70.82	67.85	52.75	**Lifted in March 2011**
Ankleshwar	88.5	85.75	80.93	**Lifted in November 2016**
Vapi	88.09	90.75	85.31	**Lifted in November 2016**

Source: Progress Report of Critically Polluted Areas.
http://cpcb.nic.in/divisionsofheadoffice/ess/ZO-VADODARA_Ankleshwar_03.09.16.pdf

3.1: The Case of Ankleshwar in the Bharuch district of Gujarat:

Table 3.1.2 below summarises the results from a 2014 appraisal report – "Status of Implementation of Comprehensive Environmental Pollution Abatement Action Plan for Ankleshwar- on progress of water quality of rivers and water bodies in the critically polluted area-Ankleshwar.

Table 3.3.2 : Water Quality of River Amlakhadi at Low Level Bridge- A Trend analysis by GPCB & CPCB

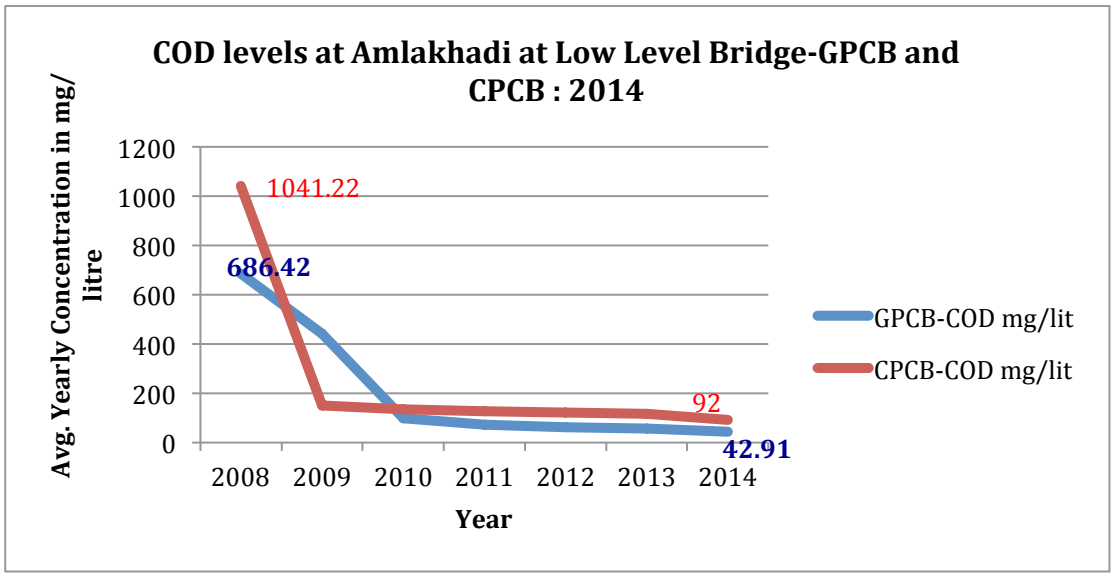
	GPCB ANNUAL AVERAGE VALUES				CPCB ANNUAL AVERAGE VALUES		
YEAR	COD mg/lit	BOD mg/lit	NH3-N mg/lit	**Year**	COD mg/lit	BOD mg/lit	NH3-N mg/lit
2008	686.42	178.83	79.36	**2008**	1041.22	302.89	130.36
2009	441.42	114.75	52.67	**2009**	151.75	42.75	21.875
2010	99.58	25.18	20.53	**2010**	135.5	38	23.325
2011	71.33	11.28	11.92	**2011**	127.175	54.2	50.3
2012	63.17	16.06	9.47	**2012**	123	25.67	11.97
2013	55.83	16.92	6	**2013**	115.58	29.28	13.29

2014	42.91	11.82	7.56	**2014**	92	30.75	12.93

Note: a) GPCB annual average is based on monthly results; b) CPCB annual average is based on quarterly results. Source: GPCB (2014). Status of Implementation of CEPI as on 31/12/2014.

Chemical oxygen of the river depicted by COD levels and organic pollution by Biological oxygen demand (BOD) parameters indicate the perilous state of the river which is unfit for any human use as per the national designated standards for water quality.

Graph 3.3.3.: Comparing annual averages of Chemical Oxygen Demand (COD) : GPCB (Gujarat Pollution Control Board) and CPCB (Central Pollution Control Board)



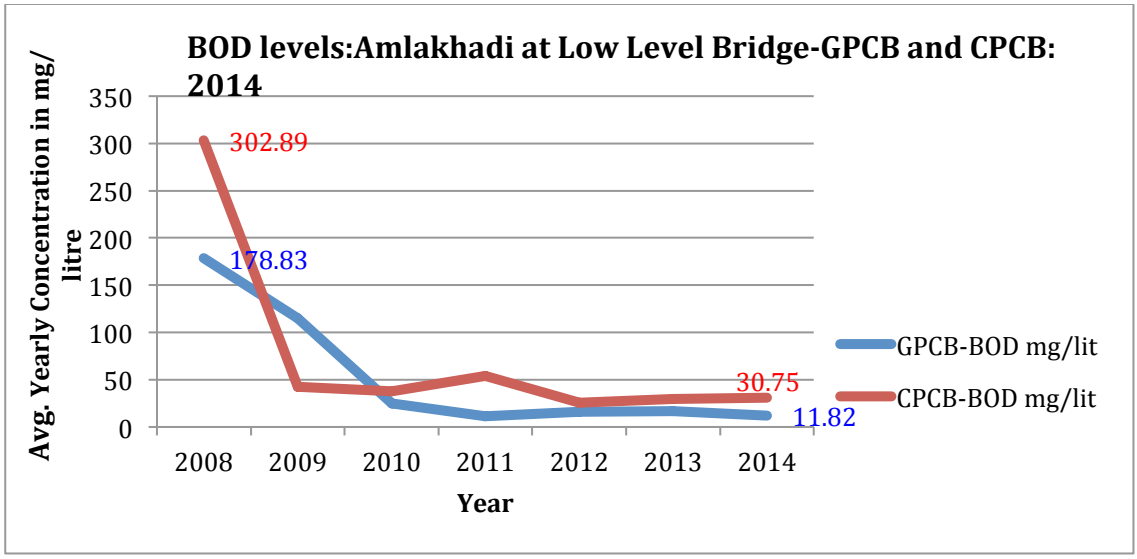
Source: Status of Implementation of Comprehensive Environmental Pollution Abatement Action Plan for Ankleshwar, 2014

Graph 3.3.3 show discrepancies in the yearly averages as analysed by the Gujarat Pollution Control Board (GPCB- based on monthly results) and the Central Pollution Control Board (CPCB- based on quarterly results). The criticality of the COD estimate is highlighted showing the level of chemical pollution in the river Amlakhadi within the Ankleshwar industrial cluster in 2014 .

Graph 3.3.4 indicates the high estimates of Biological Oxygen demand of the creek inspite of a drastic fall in the parameter over the years. It remains unfit for any human use.

Based on *Table 3.3.5,* it can be reasonably assessed that inspite of having lifted the moratorium from Ankleshwar- a critically polluted industrial cluster- in November , 2016 (Vora,2016) http://www.thehindubusinessline.com/economy/moratorium-on-expansion-new-investments-lifted-in-ankleshwar-vapi/article9389638.ece) the monitored water bodies are yet to fit the stipulated water quality criteria for any human use.

Graph 3.3.4: Comparing annual averages of Biological Oxygen Demand (BOD) : GPCB and CPCB



Source: Status of Implementation of Comprehensive Environmental Pollution Abatement Action Plan for Ankleshwar, 2014.

Table 3.3.5 : Water Quality monitoring results of surface water in CPA (Critically Polluted Area) Ankleshwar- 18.10.2016

Water Bodies	pH	TSS	DO	BOD	COD
Sanjali Village Lake	7.28	76	0.5	6.2	40
Amlakhadi	7.09	53	1.5	51	92
Van Khadi	7.34	41	6.7	8.9	16
Amravati river, Rajpipla road	8.08	7	8.8	0.7	18
Chaprakhadi	7.6	67	0.8	29.3	95
Narmada river	8.36	338	9.2	3.4	17

http://cpcb.nic.in/divisionsofheadoffice/ess/ZO-VADODARA_Ankleshwar_03.09.16.pdf

To tackle the issue of polluted water bodies from industrial sources, Rajaram and Das (2003), calls for a paradigm shift in regulatory policy- from uniform discharge standards dictated by end of pipe solutions to waste water discharges towards a localized carrying capacity of water bodies based policy. This to take in cognizance the location specific state of water bodies rather than the uniform minimum acceptable standard (MINAS) for industrial effluents.

To address water pollution from industries, the Gujarat Water Policy in 2015, prescribed provision of financial assistance to industries for effluent treatment and curbing excessive uses with metered supplies and water audits. Following this, the state's new industrial policy for 2015 has introduced various financial incentive schemes ,for the next five years, allowing investments up to INR 50 crore (USD 7.5 million) in pollution abatement infrastructure, including common effluent treatment plants, and technology to recycle treated wastewater for industrial use. It incentivizes pollution treatment infrastructure and the adoption of environmental technologies for highly polluting small-scale and medium-scale manufacturing units. However , we will not know for some time if these measures have truly worked to mitigate water pollution and revive the water bodies in Gujarat.

4. The way forward

In developing countries like India, industrial development lies at the core of poverty eradication through job creation and reducing regional income disparities . This has positive implications for enhancing quality of living and in the advancement of sustainable economic development. To this end, Goal 9 of the UN SDG 2016 calls for industries to pursue sustainability through investing in innovative technologies , resilient infrastructure – "to promote regulations and establish standards that ensure company projects and initiatives are sustainably managed." (UN-2016) at the local level.

"Water scarcity may mean that even the most efficient operations may be too heavy a burden on local conditions; in the same way, if water is locally plentiful, expensive

conservation methods may not be cost-effective. So companies must understand their water needs in relation to the local situation to make intelligent decisions" (Cramwickel J. 2016)

Mitigating water pollution by 2030 by halving the proportion of untreated , increased recycling and safe reuse forms one of the critical agendas under the sustainable development goal 6.3 and to that end sustainable industrial initiatives can coordinate advances in technology and manufacturing in water pollution abatement , creating jobs and economic growth while ensuring sustainable production systems with minimal water footprints .

Under the Vibrant Gujarat Summit 2017, Gujarat attracted important national and international brownfields investments and projects in chemicals, petro-chemicals, and pharmaceuticals. As the urgency to tackle water quality issues due to industrial pressures escalates, sustainable industrialization would require a comprehensive water conservation blueprint that integrates industrial activities into the water resource constraints of the state. To this end addressing the issue of restoration of the polluted water bodies with active participation from industries and local government could be an integral step in water resource governance of the state.

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