NATIONAL MISSION FOR CLEAN GANGA
MINISTRY OF JAL SHAKTI
GOVERNMENT OF INDIA

STRATEGY FOR IMPROVING CONDITION OF WATER BODIES IN THE VICINITY OF PULP AND PAPER INDUSTRIES IN GANGA RIVER BASIN

JUNE 2019

Centre for Ganga River Basin Management and Studies

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NMCG is the implementation wing of National Ganga Council which was setup in October 2016 under the River Ganga Authority order 2016. Initially NMCG was registered as a society on 12th August 2011 under the Societies Registration Act 1860. It acted as implementation arm of National Ganga River Basin Authority (NGRBA) which was constituted under the provisions of the Environment (Protection) Act (EPA) 1986. NGRBA has since been dissolved with effect from the 7th October 2016, consequent to constitution of National Council for Rejuvenation, Protection and Management of River Ganga (referred to as National Ganga Council).

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SUGGESTED CITATION

Strategy for Improving Condition of Water Bodies in the Vicinity of Pulp and Paper Industries in Ganga River Basin by cGanga and NMCG

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PREFACE

The Indian Institute of Technology (IIT) consortium submitted the Ganga River Basin Management Plan (GRBMP) to the National Mission for Clean Ganga (NMCG), Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR, RD & GR), Government of India in 2015. The GRBMP's recommendations were by and large broad-based, strategic measures, and on some aspects detailed, ready-to-implement actions. There was a need to have an action plan that addressed specific issues regarding the river's rejuvenation with technology-based solutions.

Thus, the Centre for Ganga River Basin Management and Studies ("cGanga") was created through a Memorandum of Agreement between the MoWR, RD & GR, Government of India and IIT, Kanpur in April 2016. The objective of cGanga is Continual Scientific Support in the Implementation and Dynamic Evolution of the Ganga River Basin Management Plan.

National Mission for Clean Ganga identified "effectiveness of the Central Pollution Control Board's (CPCB's) 2015 Charter for Water Recycling & Pollution Prevention in Pulp and Paper industry in Uttar Pradesh and Uttarakhand" as an issue of investigation and asked cGanga to carry out an independent study and submit the report.

The CPCB charter had imposed norms and standards for effluent monitoring and discharge. cGanga's task was to comprehensively assess how well these had been implemented and, also, how effective these measures were actually in improving the water bodies in the vicinity in general, and specifically in abetting the pollution from the industries in these two states.

This report describes the objectives and strategic plan, methodology, surveys, analysis, results, suggestions and recommendations of our study on effectiveness of the implementation of CPCB's 2015 Charter. The study was conducted between March 2017 to July 2018.

There are two associated aspects in preparing this report that need to be mentioned. Firstly, the cGanga team spent many months diligently studying, surveying, analysing and discussing various aspects of the Charter's implementation and ground results. Secondly, many other people interacted with us and contributed to this report during various phases of the study. This report is, therefore, the outcome of a cooperative effort between Team cGanga and the various stakeholders of the Ganga River Basin.

The report is intended to be comprehensive and its usefulness would extend much beyond its limited intended purpose in Pulp & Paper industries in Uttrakhand and Uttar Pradesh.

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EXECUTIVE SUMMARY

In 2011 a report titled: "Pulp and Paper Industries in Ganga River Basin: Water Recycling and Pollution Prevention" jointly prepared by Central Pulp and Paper Research Institute (CPPRI), Saharanpur, IIT Roorkee, IIT Delhi and IIT Kanpur with involvement and support from industries was submitted to Central Pollution Control Board (CPCB), New Delhi. This report led to the formulation and subsequent implementation of the Charter 2015.

The National Mission for Clean Ganga (NMCG) assigned the task of assessing the effectiveness of the Charter (CPCB, 2015) implementation to Centre for Ganga River Basin Management & Studies (cGanga). This study was conducted with an objective to have an independent assessment of the efficacy and impact of the implementation of the Charter. The study was planned in consultation with CPCB, NMCG and Industry Association/Clusters and conducted by Team cGanga that involved members from IITs at Roorkee, Delhi and Kanpur. A detailed field survey of 131 Pulp and Paper Industries in Ganga River Basin through 36 random and surprise visits in different shifts was conducted during April 2017 to July 2018. Pulp and Paper Industries (PPIs) of four different broad categories as defined in the Charter were considered. Results were discussed with stakeholders (Industries, CPCB, SPCBs, NMCG, Experts, etc.) prior to the preparation of the report.

OBSERVATIONS

- Charter was by and large effectively implemented; Black liquor is no longer discharged; Barring a few, most industries comply effluent discharge norms; and substantial reduction in BOD/COD/Organic Carbon load on recipient water bodies has been achieved.
- Condition of drains, streams in which effluents are discharged continues to be poor, and groundwater in the vicinity of industries is affected.
- Certain mal practices in a few industries, non-inclusion of certain parameters such as nitrogen and phosphorus in the effluents characteristics in the Charter, and some other external factors contribute to the poor condition of the water bodies in the vicinity of the PPIs.
- Online monitoring as prescribed in the Charter is largely ineffective due to technology issue with sensors of COD, BOD, TSS and governance issues with Flow, pH, DO & TDS sensors.
- Water and Energy balance presented in the report needs to be re-worked with additional information from industries on captive power generation, raw materials input and paper production that was not in the scope of present study.

CONCLUSIONS & RECOMMENDATIONS

- Online effluent quality monitoring has financially loaded industries and has not yielded value for money; May be used by industries voluntarily for diagnostic purposes and should not be made as regulatory requirement.
- Effluents discharged by an industry or group of industries be isolated, discharged in a water body (drain/pond – natural/artificial) and maintenance of the water body of acceptable bio-physical status in public domain be linked to consent to operate the industry (ies).

PREAMBLE

Pulp and paper industries (PPIs) are recognised as one of the main contributors in declining status of various water bodies (surface and sub-surface) in the Ganga River Basin. The Central Pollution Control Board (CPCB) took cognizance of this impact on water bodies and framed a Charter – Water Recycling & Pollution Prevention in Pulp and Paper industry – in February 2015 (CPCB, 2015) based on a study titled: "Pulp and Paper Industries in Ganga River Basin: Water Recycling and Pollution Prevention" jointly conducted by Central Pulp and Paper Research Institute (CPPRI), Saharanpur, IIT Roorkee, IIT Delhi and IIT Kanpur with involvement and support from industries (Tare et al., 2011). The Charter (CPCB, 2015) imposed certain norms for water consumption, protocol for record keeping and surveillance, setting up effluent treatment systems and limits on quality of effluent discharge. The industries were required to set up Effluent Treatment Plants (ETPs) to treat their wastewater and install Real Time Monitoring devices to monitor quantity and quality of effluent discharge. The National Mission for Clean Ganga (NMCG) then assigned the task of assessing the effectiveness of the Charter (CPCB, 2015) implementation to cGanga. This report presents the result of surveys, measurements and observations made by cGanga during various field visits to 131 PPIs in the Ganga River Basin.

THE CENTRAL POLLUTION CONTROL BOARD TOOK COGNIZANCE OF THE IMPACT ON WATER BODIES AND FRAMED A CHARTER – WATER RECYCLING & POLLUTION PREVENTION IN PULP AND PAPER INDUSTRY

INTRODUCTION

The Indian paper industry makes up about three percent of the world's paper production (Indian Paper Manufacturers Association, IPMA, 2018). An IPMA survey estimates that the domestic market size for pulp and paper industry in 2015-16 was 153 lakh metric tonnes, with India's per capita paper consumption being around 13 kg, almost a fourth less than the global average of 57 kg (IECPPA, 2017). An estimated segregation of raw materials in PPIs reveals that 65% of the paper production is from waste paper/ recycled fibre, 24% from wood or bamboo and 11% from wheat straw/ bagasse or other agro-residues (IARPMA, 2014). As per the estimate, the total paper, paperboard and newsprint import in India has risen @ 7.9% per annum from 1.8 million tonnes in 2010-11 to 2.6 million tonnes in 2015-16.

PPIs are considered to be one of the most polluting industries, particularly causing water pollution. With the ever-growing population and rising literacy rates, the demand for paper is increasing. The use of new technologies for producing coloured papers, and the increased purchasing power of urban citizens, has resulted in the increase in production of these varieties. Since the market demand is for paper with maximum brightness and strength, there is increased use of bleaching chemicals like chlorine, hypochlorite and chlorine dioxide.

High strength wastewater is generated at the pulping stage, while the bleaching step generates the most toxic wastewater, because of the use of chlorine. Elemental chlorine produces persistent organic pollutants (POPs) like dioxins, which are recognised as hazardous chemicals (WHO, 2016). The effluent contains dyes, chlorinated compounds, total suspended solids, fatty acids, tannins, resin acids, sulphur and its derivatives. The effluents create Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD), due to the presence of lignin and its derivatives from the raw cellulosic materials. Most of the PPIs discharge partially treated waste into rivers or streams, which pose a threat to the flora and fauna.

In order to curb the pollution and ecological damage, it is necessary to develop a methodology for controlling the effluent discharge and applying Polluter Pays Principle (PPP).

IN ORDER TO CURB THE POLLUTION AND ECOLOGICAL DAMAGE, IT IS NECESSARY TO DEVELOP A METHODOLOGY FOR CONTROLLING THE EFFLUENT DISCHARGE AND APPLYING POLLUTER PAYS PRINCIPLE (PPP).

RATIONALE

This study was initiated with an ultimate objective of evolving strategy for improving condition of water bodies in the vicinity of Pulp and Paper Industries in Ganga River Basin that has visibly declined due to utilization of water and discharge of effluents. Specifically, the report focuses on assessing the effectiveness of the imposition of the Charter by CPCB in 2015 regarding Water Recycling & Pollution Prevention in the Pulp and Paper Industry. The study attempts to find the deviations and gaps between CPCB guidelines as per the Charter and the implementation of these by the industry. 131 PPIs in the Ganga River Basin (in Uttrakhand and Uttar Pradesh) were included. Several special features including a variety of surveys covering wide spatial (states of Uttarakhand and Uttar Pradesh) and temporal (capturing diurnal variation) ranges, advance technology (drones) and interaction with stakeholders through well researched interviews and questionnaire were incorporated.

OBJECTIVES

METHODOLOGY

Figure 1 shows the framework of the study for assessing the efficacy of the imposition of the Charter 2015 by CPCB and evolving strategy for improving status of water bodies in the vicinity of Pulp and Paper Industries in Ganga River Basin. A detailed description of each aspect of the study is discussed in following sections.

5.1. STUDY AREA

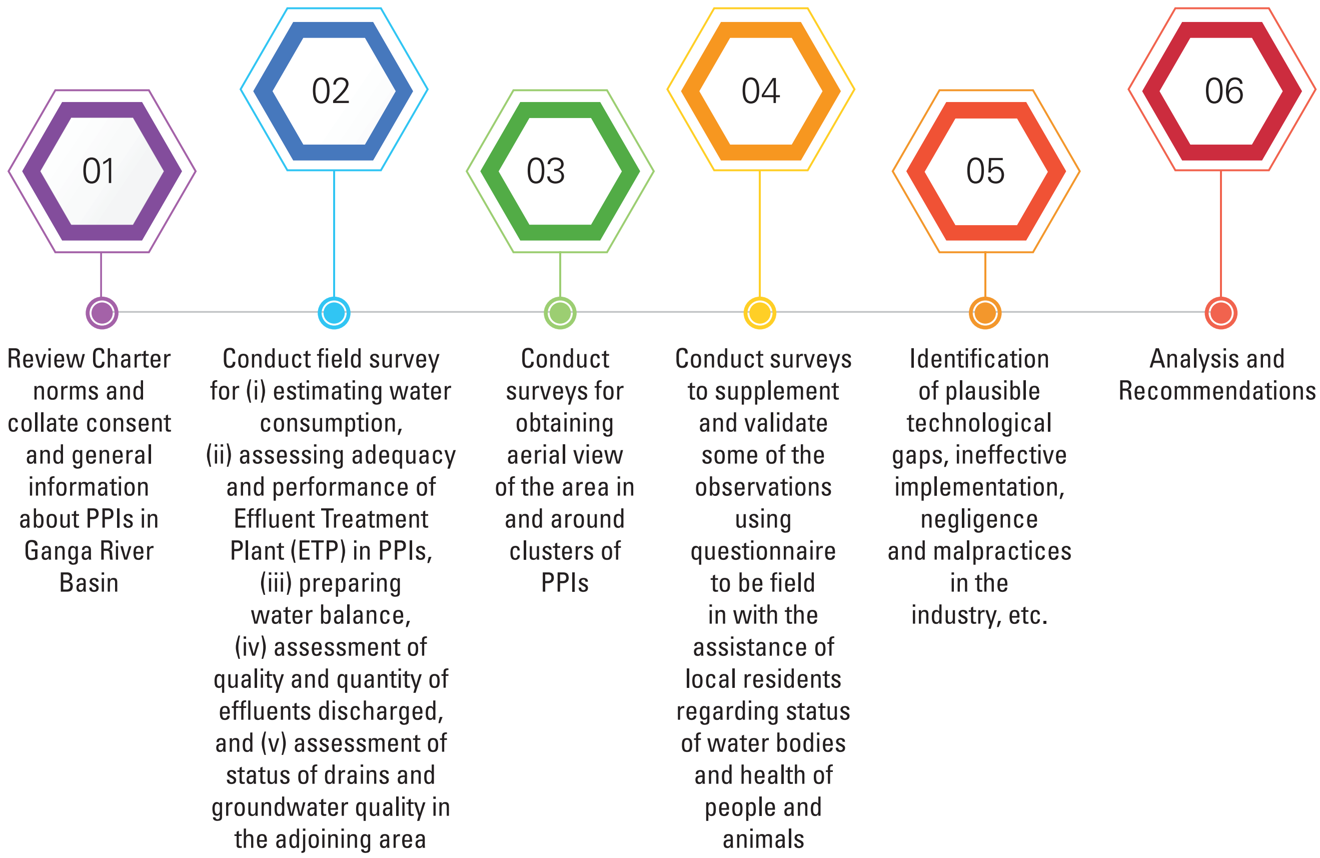
The field work was mainly targeted at the assessment of pollution load from PPIs situated in Uttarakhand and Uttar Pradesh. Overall 131 PPIs were identified, of which 37 were located in Uttarakhand and 94 in Uttar Pradesh. Based on their location, industries were divided in 21 clusters.

Out of 21 identified clusters, two major ones were Kashipur (24 industries, Cluster 1), Meerut (14 industries, Cluster 2 A) and Muzaffarnagar (33 industries, Cluster 2 B). Although Meerut and Muzaffarnagar were in the same cluster (Cluster 2), due to a large number of PPIs in that area (36% of total PPIs), the cluster was divided into Meerut and Muzaffarnagar sub-clusters.

Roughly 54% of the industries lie in these two major clusters. Figure 2 shows the locations of these clusters.

FIGURE-1

FRAMEWORK ADOPTED FOR ASSESSMENT OF EFFECTIVENESS OF CHARTER IMPLEMENTATION BY PPIs



A detailed description of areas covered under each cluster and the list of industries with their operational details are mentioned in Tables 1 and 2.

The study was done during April 2017 to July 2018. It is important to mention that during the study period January-February 2018, most of the industries were temporarily/partly closed on the occasion of Magh Mela as directed by UP Pollution Control Board (UPPCB, 2017).

5.2. DETAILS OF CLUSTERS

The industries in various clusters (Table 1) were also classified as per the norms laid in the Charter (CPCB, 2015). A category-wise illustration of various industries (mentioned in Table 2), based on base material used for paper production and type of pulp and paper produced, is depicted in Figure 3 and operational status of industries and cluster-wise categorisation is presented in Figures 4 and 5.

5.3. EXPERIMENTAL/ SAMPLING DETAILS

A preliminary survey of identified PPIs in Uttarakhand and Uttar Pradesh was first conducted. Industrial effluent samples from the outlet of ETP (Effluent Treatment Plant) and the water samples of recipient drains (both upstream and downstream) were collected. At each industry, diurnal and daily variations of parameters

FIGURE-2

LOCATIONS OF 21 CLUSTERS WITHIN THE ADMINISTRATIVE BOUNDARIES OF THE STATES OF UTTARAKHAND AND UTTAR PRADESH

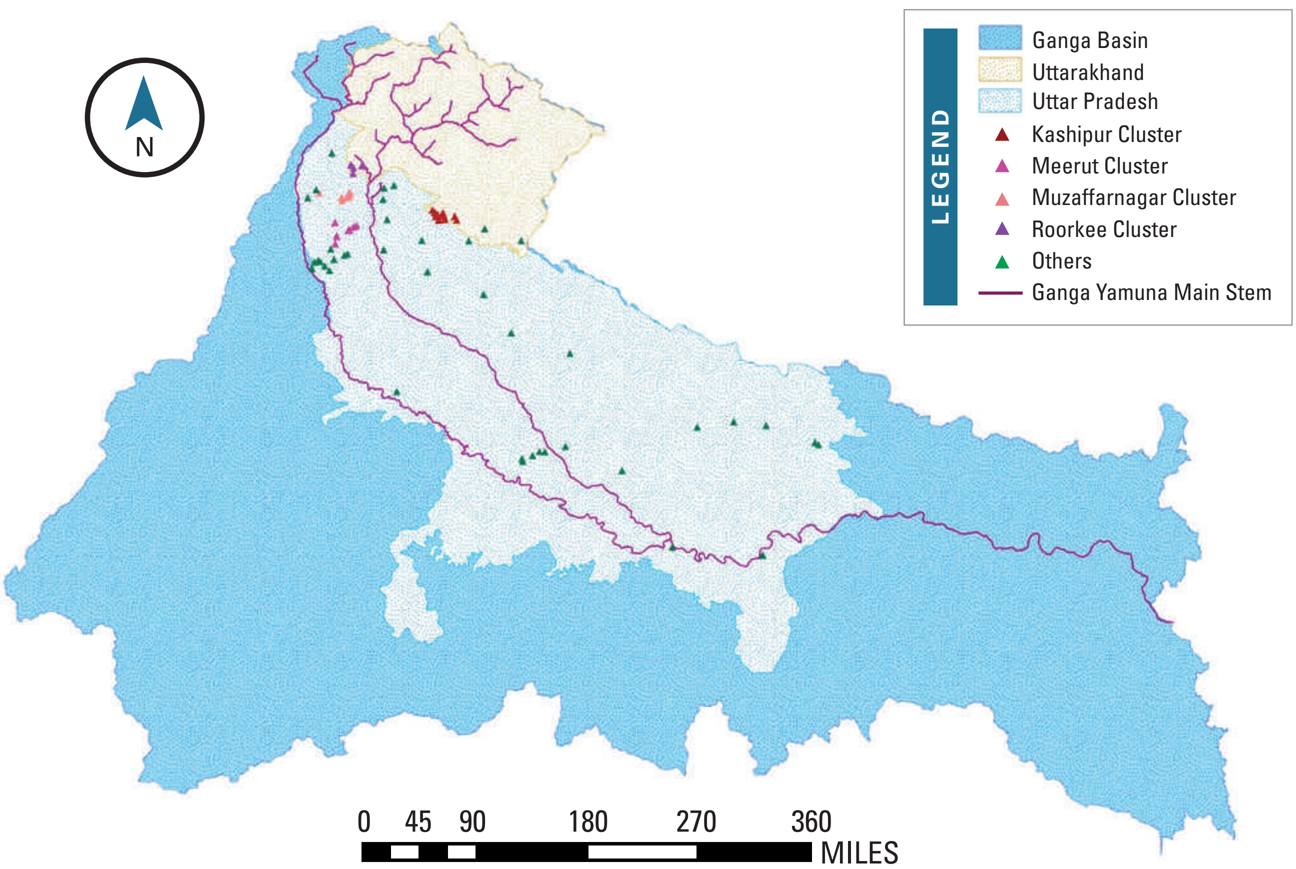
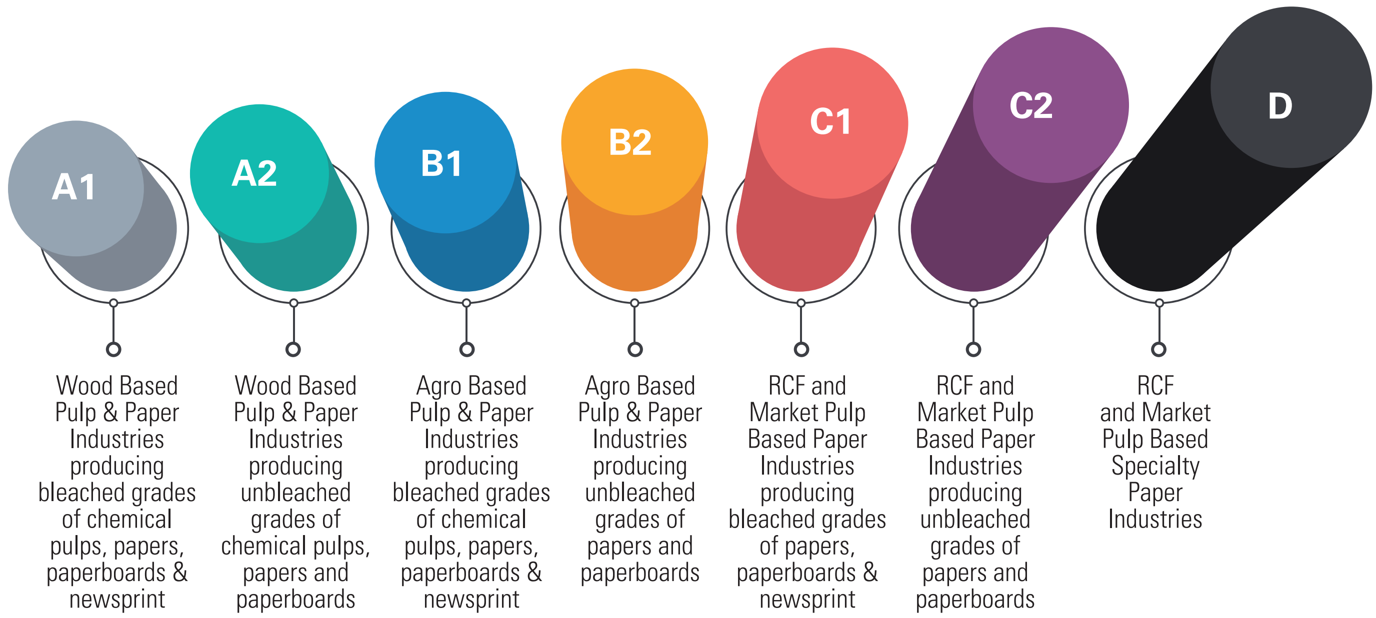


FIGURE-3

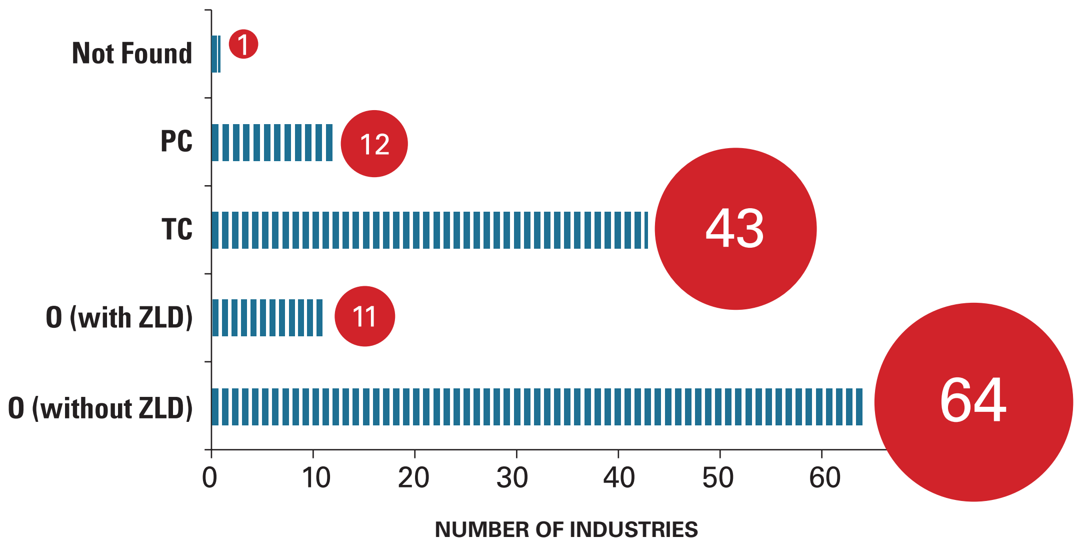
CLASSIFICATION OF PPIs AS PER THE CPCB CHARTER (CPCB, 2015)



**Industries that attract classification in more than one category will be deemed to be in the "highest" among those categories. For example, a mill that is both wood and agro based (A1 & B1) will be classified as A1. The only exception will be industries that also manufacture specialty paper on a daily basis as described elsewhere in this proposed Charter.*

FIGURE-4

OPERATIONAL STATUS OF 131 INDUSTRIES



were captured. Parameters analysed at the outlet included Flow, pH, Colour, Dissolved Oxygen (DO), Total Suspended Solids (TSS), Volatile Suspended Solids (VSS), Total Dissolved Solids (TDS), BOD, COD, Alkalinity, Sulphide, Ammonical Nitrogen (AN), Total Kjeldahl Nitrogen (TKN) and Phosphorus.

For analysing upstream and downstream condition of the drains, the selected analytical parameters were pH, DO, TSS, VSS, TDS, BOD, COD, Alkalinity, Sulphide, AN, TKN and Phosphorus.

TABLE-1

DETAILS OF VARIOUS CLUSTERS

CLUSTER	AREA COVERED	NUMBER OF INDUSTRIES
1	Kashipur	24
2	Meerut (14), Muzaffarnagar (33)	47
3	Roorkee	6
4	Sitapur (1), Kanpur (6)	7
5	Raebareli	1
6	Faizabad (2), Khalilabad (2), Basti (1)	5
7	Deoria	2
8	Varanasi	2
9	Allahabad	1
10	Uddham Singh Nagar	4
11	Bareilly (1), Moradabad (2)	3
12	Baghpat	1
13	Shamli	2
14	Firozabad	3
15	Saharanpur	2
16	Bilaspur	1
17	Ghaziabad (3), Hapur (4), Modinagar (3)	10
18	Gajraula (1), Amroha (2)	3
19	Bijnor (3), Chandpur (1)	4
20	Sahjahnpur	2
21	Khatima	1

TABLE-2

DETAILED LIST OF 131 PULP AND PAPER INDUSTRIES LOCATED IN UTTRAKHAND AND UTTAR PRADESH

S. NO.	CLUSTER	CATEGORY	OPTERATIONAL STATUS*
1	Kashipur	B1	O
2	Kashipur	B1	O
3	Kashipur	B2	O
4	Kashipur	C1	O
5	Kashipur	B2	O
6	Kashipur	C1	O
7	Kashipur	C1	O
8	Kashipur	C1	O
9	Kashipur	C1	O
10	Kashipur	C1	O
11	Kashipur	C1	O
12	Kashipur	C1	O
13	Kashipur	C1	O
14	Kashipur	C2	O
15	Kashipur	C2	O
16	Kashipur	C2	TC
17	Kashipur	C1	TC
18	Kashipur	C2	O/ ZLD
19	Kashipur	B1	PC
20	Kashipur	B1	PC
21	Kashipur	C1	PC
22	Kashipur	C2	TC
23	Kashipur	C1	PC
24	Kashipur	-	Not Found
25	Meerut	C1	O
26	Meerut	-	O
27	Meerut	C1	O
28	Meerut	C2	O
29	Meerut	C2	O
30	Meerut	-	O
31	Meerut	C1	O
32	Meerut	C1	O
33	Meerut	C1	O
34	Meerut	C1	O
35	Meerut	-	TC
36	Meerut	C2	O/ ZLD
37	Meerut	C2	O/ ZLD
38	Meerut	C2	O/ ZLD
39	Muzaffarnagar	C2	O
40	Muzaffarnagar	B2	O

S. NO.	CLUSTER	CATEGORY	OPTERATIONAL STATUS*
41	Muzaffarnagar	C1	O
42	Muzaffarnagar	B2	O
43	Muzaffarnagar	C2	O
44	Muzaffarnagar	B2	O
45	Muzaffarnagar	D	O
46	Muzaffarnagar	C1	O
47	Muzaffarnagar	B1	O
48	Muzaffarnagar	C2	O
49	Muzaffarnagar	C1	O
50	Muzaffarnagar	C2	O
51	Muzaffarnagar	B2	O
52	Muzaffarnagar	C2	O
53	Muzaffarnagar	B2	O
54	Muzaffarnagar	B2	O
55	Muzaffarnagar	C1	TC
56	Muzaffarnagar	C2	O
57	Muzaffarnagar	C2	O
58	Muzaffarnagar	C2	O
59	Muzaffarnagar	-	TC
60	Muzaffarnagar	C2	O
61	Muzaffarnagar	C2	O
62	Muzaffarnagar	C2	TC
63	Muzaffarnagar	C2	O
64	Muzaffarnagar	C2	O
65	Muzaffarnagar	C2	O/ ZLD
66	Muzaffarnagar	C2	O
67	Muzaffarnagar	-	O
68	Muzaffarnagar	-	PC
69	Muzaffarnagar	-	PC
70	Muzaffarnagar	-	PC
71	Muzaffarnagar	C2	PC
72	Roorkee	C1	O
73	Roorkee	C1	O
74	Roorkee	C1	O
75	Roorkee	-	TC
76	Roorkee	C2	O/ ZLD
77	Roorkee	C2	O/ ZLD
78	Sitapur/ Kanpur	C2	O/ ZLD
79	Sitapur/ Kanpur	C2	O
80	Sitapur/ Kanpur	B2	O

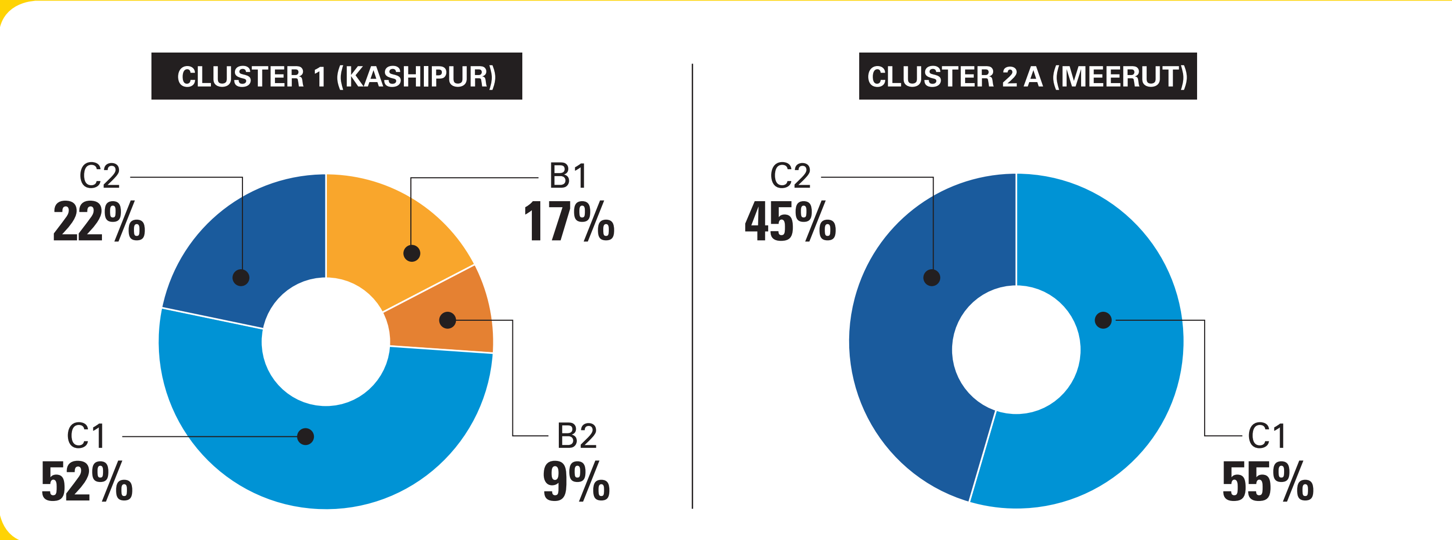
S. NO.	CLUSTER	CATEGORY	OPTERATIONAL STATUS*
81	Sitapur/ Kanpur	C2	TC
82	Sitapur/ Kanpur	C2	O
83	Sitapur/ Kanpur	-	TC
84	Sitapur/ Kanpur	B2	PC
85	Raebareli	B1	TC
86	Faijabad/ Khalilabad/ Basti	B1	O
87	Faijabad/ Khalilabad/ Basti	B1	O
88	Faijabad/ Khalilabad/ Basti	C2	O
89	Faijabad/ Khalilabad/ Basti	B2	O/ZLD
90	Faijabad/ Khalilabad/ Basti	C1	O
91	Deoria	C2	O
92	Deoria	C2	O
93	Varanasi	C1	O
94	Varanasi	-	O/ZLD
95	Allahabad	C2	O/ ZLD
96	U.S. Nagar	C1	PC
97	U.S. Nagar	C1	PC
98	U.S. Nagar	A1	O
99	U.S. Nagar	-	TC
100	Bareilly/ Moradabad	B2	TC
101	Bareilly/ Moradabad	C2	TC
102	Bareilly/ Moradabad	C2	TC
103	Baghpat	C2	TC
104	Shamli	C2	TC
105	Shamli	-	TC
106	Firozabad	C2	TC

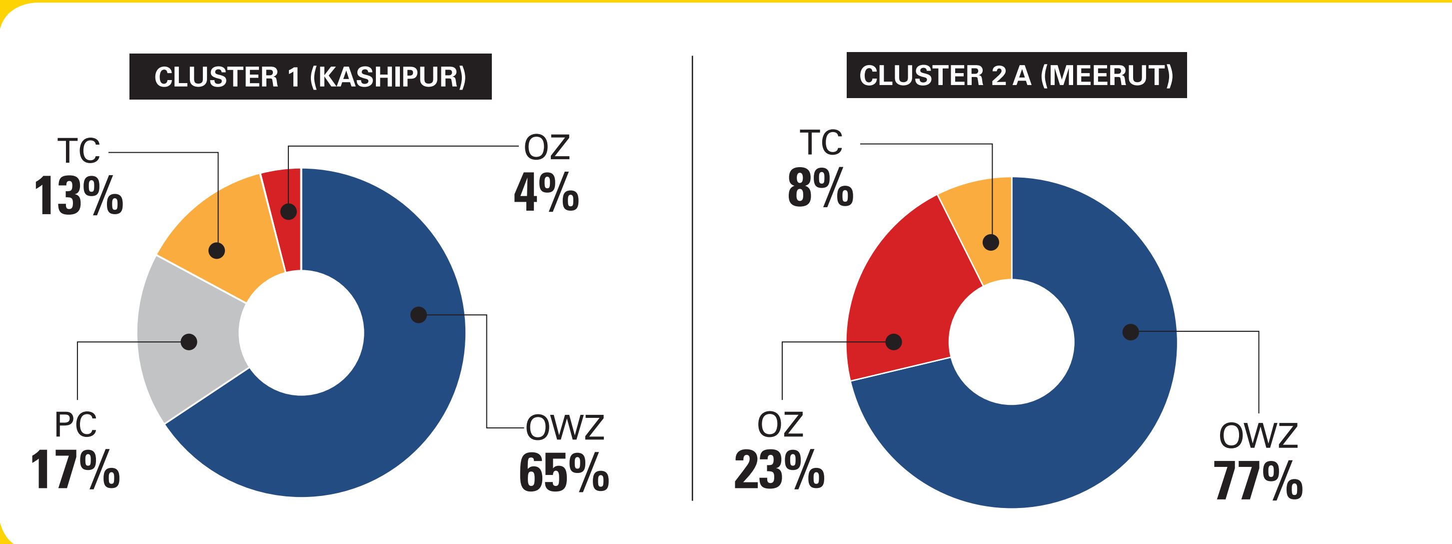
S. NO.	CLUSTER	CATEGORY	OPTERATIONAL STATUS*
107	Firozabad	C2	TC
108	Firozabad	C2	TC
109	Saharanpur	C2	TC
110	Saharanpur	A1	TC
111	Bilaspur	-	TC
112	Ghaziabad/ Hapur/ Modinagar	C2	TC
113	Ghaziabad/ Hapur/ Modinagar	C2	TC
114	Ghaziabad/ Hapur/ Modinagar	C1	TC
115	Ghaziabad/ Hapur/ Modinagar	C1	TC
116	Ghaziabad/ Hapur/ Modinagar	C2	TC
117	Ghaziabad/ Hapur/ Modinagar	C1	TC
118	Ghaziabad/ Hapur/ Modinagar	C2	TC
119	Ghaziabad/ Hapur/ Modinagar	C2	TC
120	Ghaziabad/ Hapur/ Modinagar	-	TC
121	Ghaziabad/ Hapur/ Modinagar	C2	TC
122	Gajraula/ Amroha	C1	TC
123	Gajraula/ Amroha	C1	TC
124	Gajraula/ Amroha	-	TC
125	Bijnor/ Chandpur	B1	TC
126	Bijnor/ Chandpur	-	TC
127	Bijnor/ Chandpur	C2	TC
128	Bijnor/ Chandpur	C1	TC
129	Sahjahnpur	B1	TC
130	Sahjahnpur	B2	TC
131	Khatima	C1	TC

*O = Operational; TC = Temporary Closed; PC = Permanently Closed; O/ ZLD = Operational with Zero Liquid Discharge

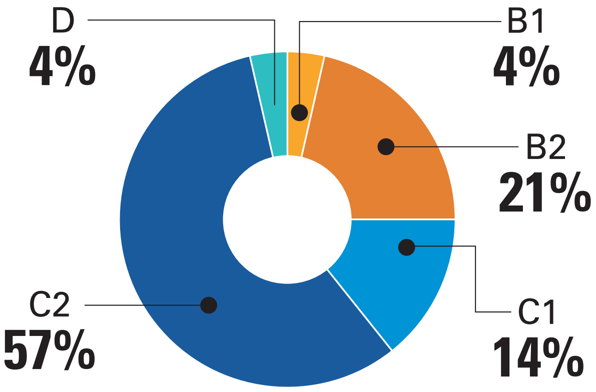
FIGURE-5

CLUSTERWISE CATEGORISATION AND STATUS OF INDUSTRIES

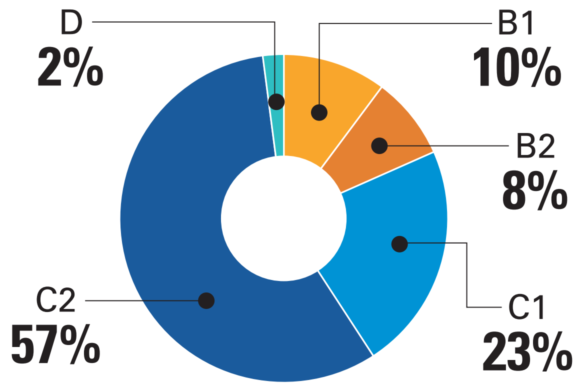




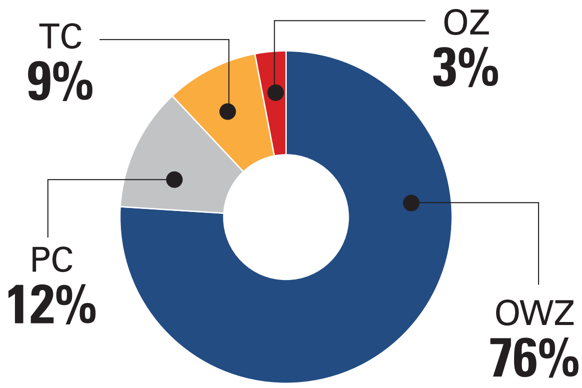
CLUSTER 2 B (MUZAFFARNAGAR)



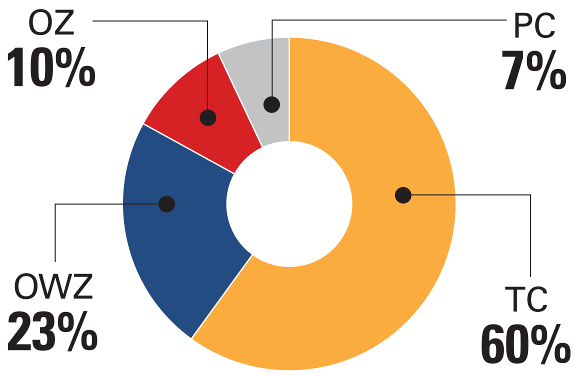
CLUSTER 3-21 (OTHERS)



CLUSTER 2 B (MUZAFFARNAGAR)



CLUSTER 3-21 (OTHERS)



*(*OWZ= Operational without Zero Liquid Discharge; OZ= Operational with Zero Liquid Discharge; TC= Temporary Closed; PC= Permanently Closed)*

TABLE-3

DRINKING WATER STANDARDS (IS 10500) AND EFFLUENT DISCHARGE STANDARDS (EPA,1986)

PARAMETERS	DRINKING WATER STANDARDS		EFFLUENT DISCHARGE STANDARDS	
	Acceptable Value	Permissible limit	Public Sewer	Inland Surface Water
pH	6.5-8.5	No	5.5-9.0	5.5-9.0
Total Dissolve Solids (TDS), mg/L	500	2000	-	-
Volatile Suspended Solids (VSS), mg/L	-	-	-	-
Total Suspended Solids (TSS), mg/L	-	-	600	100
Alkalinity as $CaCO_3$, mg/L	200	600	-	-
Hardness, mg/L	200	600	-	-
Sulphate, mg/L	200	400	-	-
Chloride, mg/L	250	1000	-	-
Ammonical nitrogen (AN) as N, mg/L	-	-	50	50
Total Nitrogen (TN), mg/L	-	-	-	100
Total Phosphorus (as P), mg/L	-	-	-	5.0
Dissolve oxygen (DO), mg/L	-	-	-	-
Biological Oxygen Demand (BOD), mg/L	-	-	350	30
Chemical Oxygen Demand (COD), mg/L	-	-	-	250
Sulphide, mg/L	-	-	-	2.0

Diurnal variation of parameters was captured by dividing the day into three shifts: 6 am - 2 pm (morning-afternoon), 2 pm - 10 pm (afternoon-night) and 10 pm - 6 am (night-morning). The samples were collected randomly in three slots of 8 hours in a day and analysed. Diurnal variation of parameters was captured to develop the overall picture of the industry and its performance during different times of the day. A total of approximately 36 samples were collected separately from the outlets of every plant as well as from the drains receiving the effluent. Apart from sample collection, data related to the effluent discharge, bore well intake, electricity consumption, section-wise water consumption meter readings, logbook data etc., were also collected from all the industries.

Assessment of water consumption was determined from the logbook, as well as from bore-well meter readings. Pollution control facilities such as operating status of aeration tanks, black liquor generation and solid waste management measures were also observed during the visits.
To assess the quality of groundwater, parameters such as pH, TDS, Alkalinity, Hardness, Sulphate, Chloride, AN, TKN and Phosphorus were analysed in the samples collected from hand pumps (including India Mark handpumps and tubewells). Sampling was done once or twice during the sampling period.

5.4. ANALYTICAL METHODS

Effluent discharge or flow was calculated from the observations on calibrated V-notch. On-site

measurement of pH was done. DO, BOD, COD, TSS, TDS, VSS, AN and TKN were measured as per standard methods (APHA, 2017). Acceptable and permissible limits of various parameters for drinking water and effluent discharge, as per Indian Standards IS: 10500 and EPA (1986) have been listed in Table 3.

A questionnaire was also framed to capture the perception of local people on the impact of industries on the surrounding environment. An aerial view of the local drain and the impact of the industrial discharge on the nearby riverine system was captured through drone (Drone Specifications: DJI Phantom 4 Pro RC Quadcopter) survey conducted for almost all the units covered during the study period. A few images of drone survey of selected industries have been presented in a separate volume.

Other information relevant to the industry's production, raw material consumption, online monitoring sensors, fuel consumption, water intake records, quality and grade of paper, energy consumption, ETP specifications, financial documentation (if shared), solid waste management and laboratory facilities were also collated. Section-wise detailed water consumption has also been prepared. It should be noted that effluent discharge from industries which were non-operational or operational with zero liquid discharge (ZLD) were not available and hence, information on such units are not included in this report.

WATER CONSUMPTION AND WATER BALANCE

A complete water balance for each industrial unit was carried out to assess losses through estimates of fresh water intake, the amount of black liquor produced, effluent discharge, etc. There are multiple sources and uses for fresh water in the pulp and paper industries. The number of extraction taps varied from 2 to 10 in numbers, connecting to various processes such as bleaching and chemical stock preparation. Extracted freshwater is used either for wet washing, pulping, bleaching and stock preparation, utilities like power consumption, gardening and miscellaneous activities. Raw materials (e.g. wood, bagasse, etc.) also contain large amounts of water which is input to the initial water content.

6.1. WATER BALANCE

The PPIs intake fresh water from the ground for various processes of paper production. Input water to any industry in paper making process could be direct withdrawal from ground, water contained in raw materials and in-circulation storages. Typical water balance for different types of industries is presented in Figure 6 to 8. The paper making process involved significant water loss from various steps through different units. The evaporation losses mentioned in Figure 6 to 8 are combined evaporation losses from various sections of PPIs. Water content in the product (e.g. paper) is also termed as a loss. The effluent treatment plant (ETP) receives a large portion of water from multiple sections of the industrial unit, which treats and uses part of the water back to the industrial units.

The evaporation losses in various processes vary from 5 to 20% of the fresh water intake, which is dependent on technology, infrastructure and processes in various sub-sections of PPIs. It can also be observed that a

THE PPIs INTAKE FRESH WATER FROM THE GROUND FOR VARIOUS PROCESSES OF PAPER PRODUCTION. INPUT WATER TO ANY INDUSTRY IN PAPER MAKING PROCESS COULD BE DIRECT WITHDRAWAL FROM GROUND, WATER CONTAINED IN RAW MATERIALS AND IN-CIRCULATION STORAGES.

FIGURE-6

INDUSTRY - AGRO BASED (PRODUCTION 140 t/d)

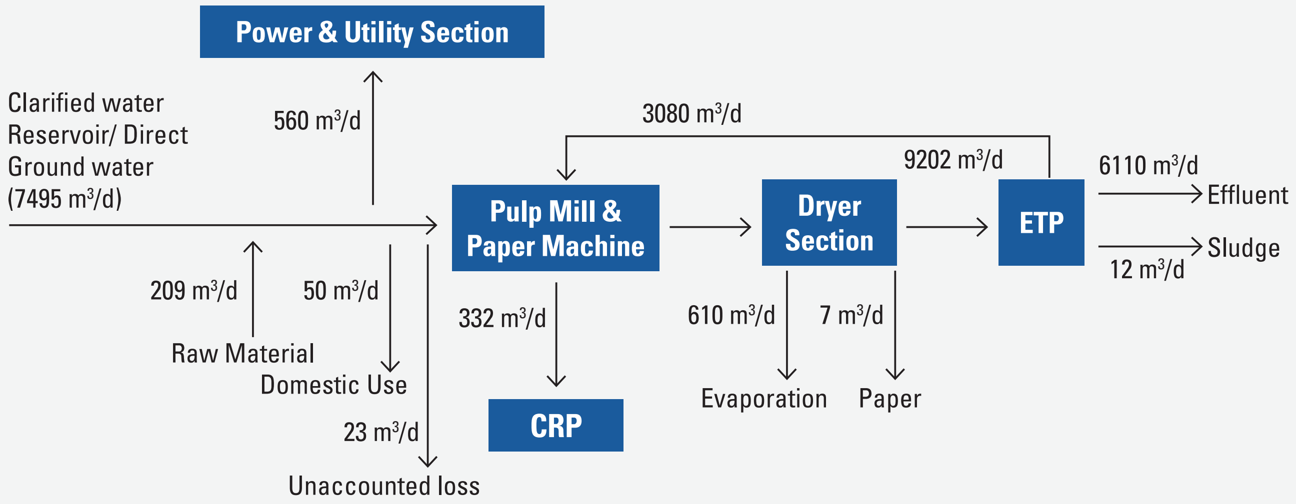


FIGURE-7

INDUSTRY - WSP BASED (PRODUCTION 375 t/d)

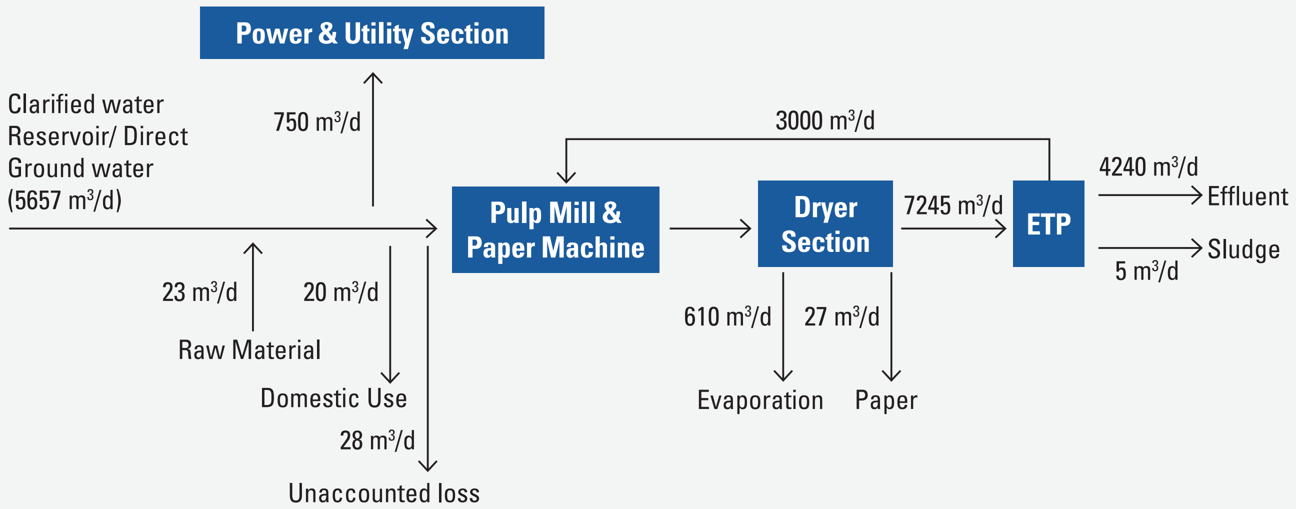


FIGURE-8

INDUSTRY - ZLD BASED (PRODUCTION 120 t/d)

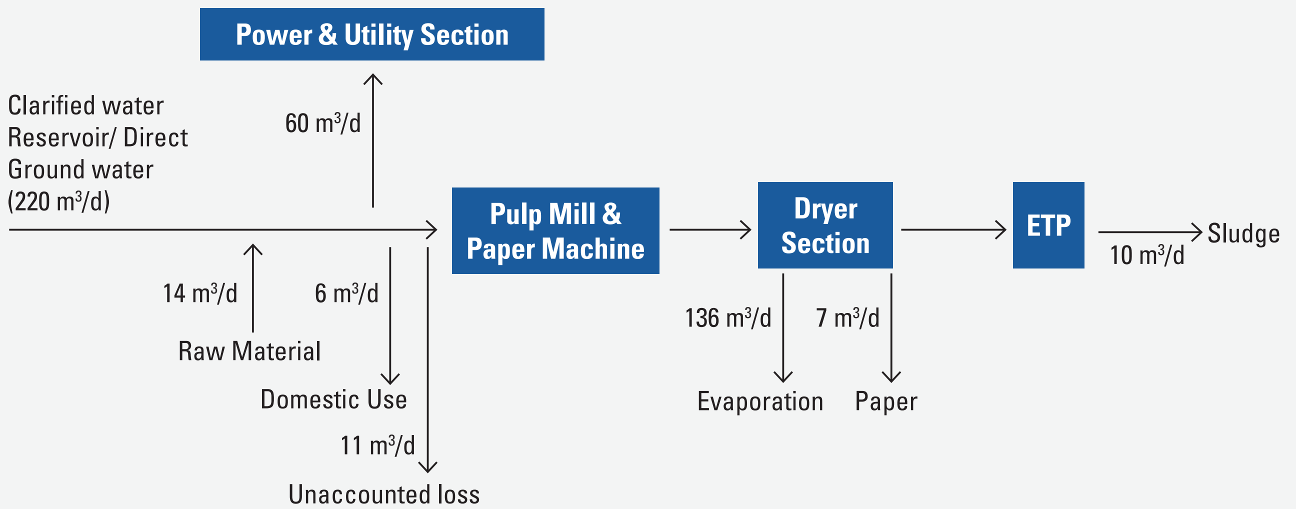
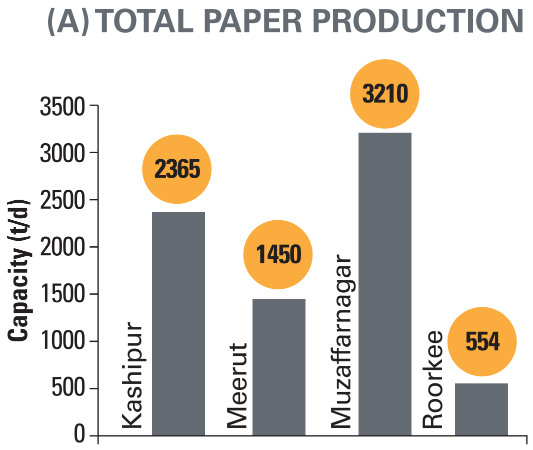


FIGURE-9



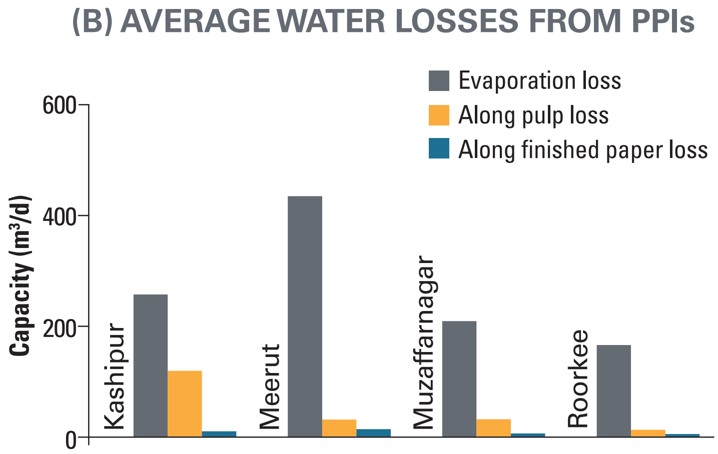
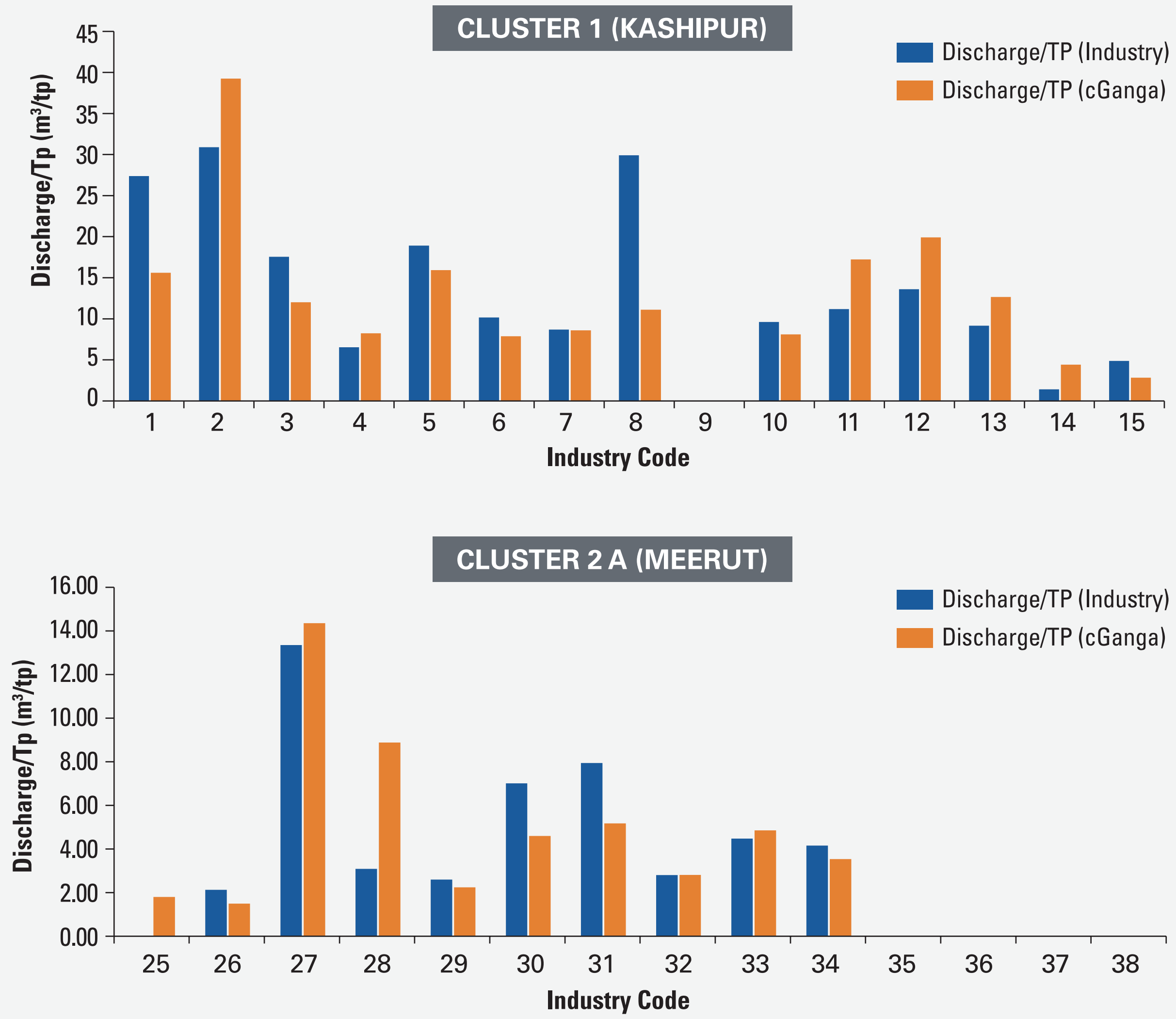
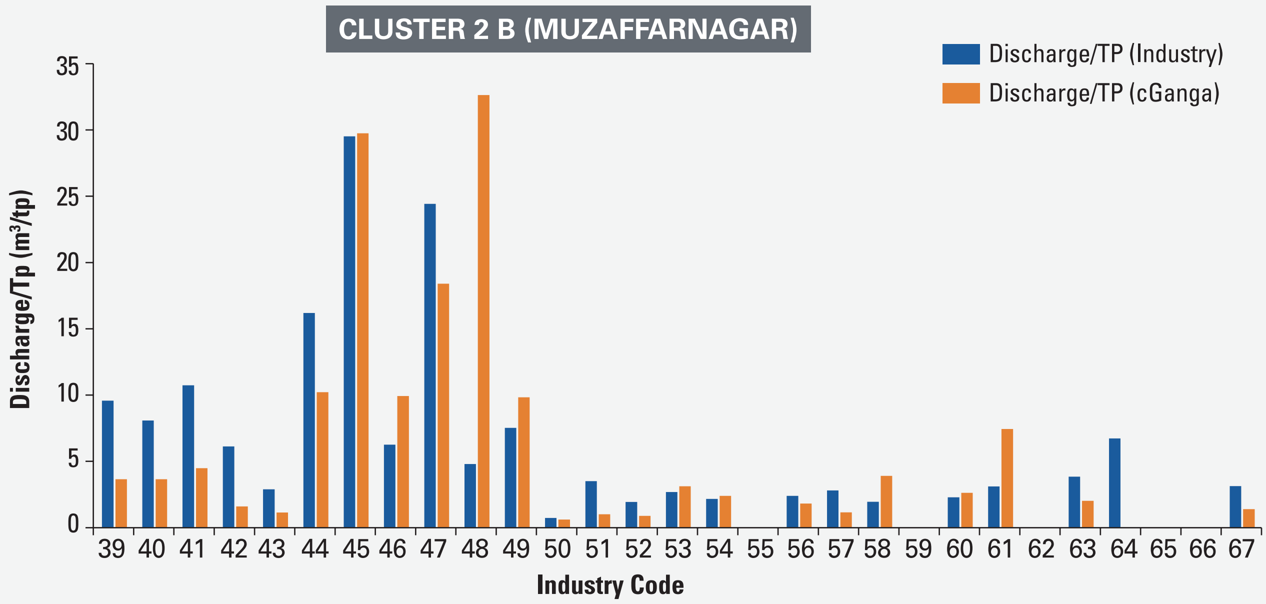


FIGURE-10

DISCHARGE (m³/d) PER UNIT PAPER PRODUCTION (tp/d)



major portion of the treated water is being recycled back to various divisions. The water balance shown in Figure 6 to 8 is only indicative and the numbers can vary with an error of ±10%. This is because there are more than 20 sub-units inside each industry, which recirculate water among each other, from different sources (raw materials, chemicals) or stored water (a large amount of water is already present in the system which is recirculating in the form of water or steam and whose independent measurements are not done). Therefore, while combining flow diagrams (more than 100) in a simple flow diagram, small water transactions might not get included. The water balance was done by keeping major flow transactions. However, these flow charts can give a better picture and estimation of major water transactions



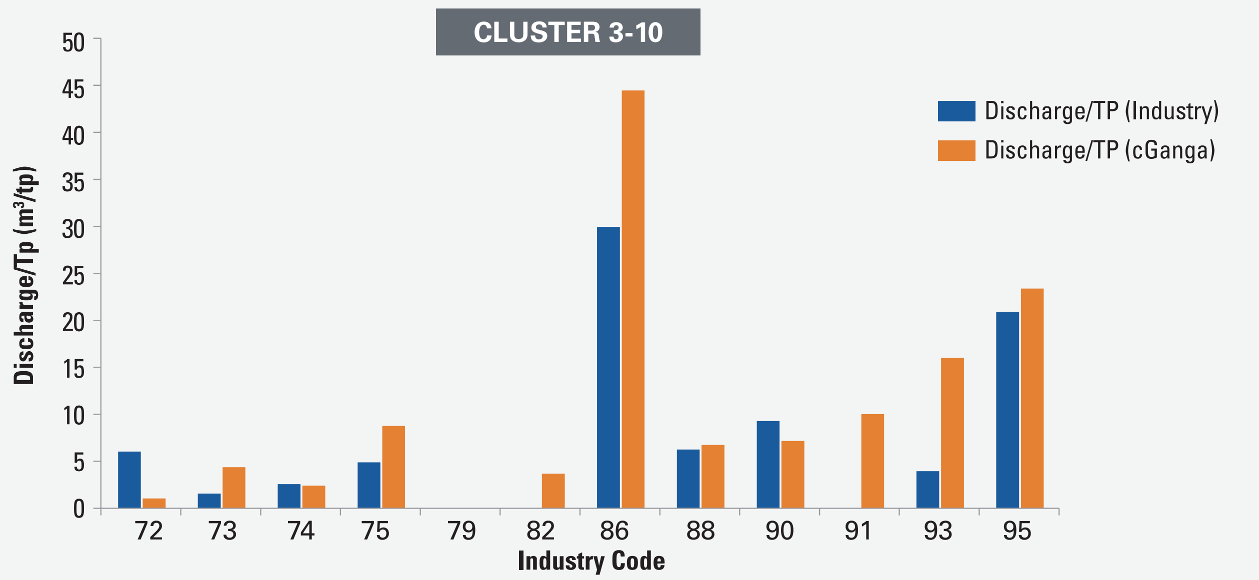
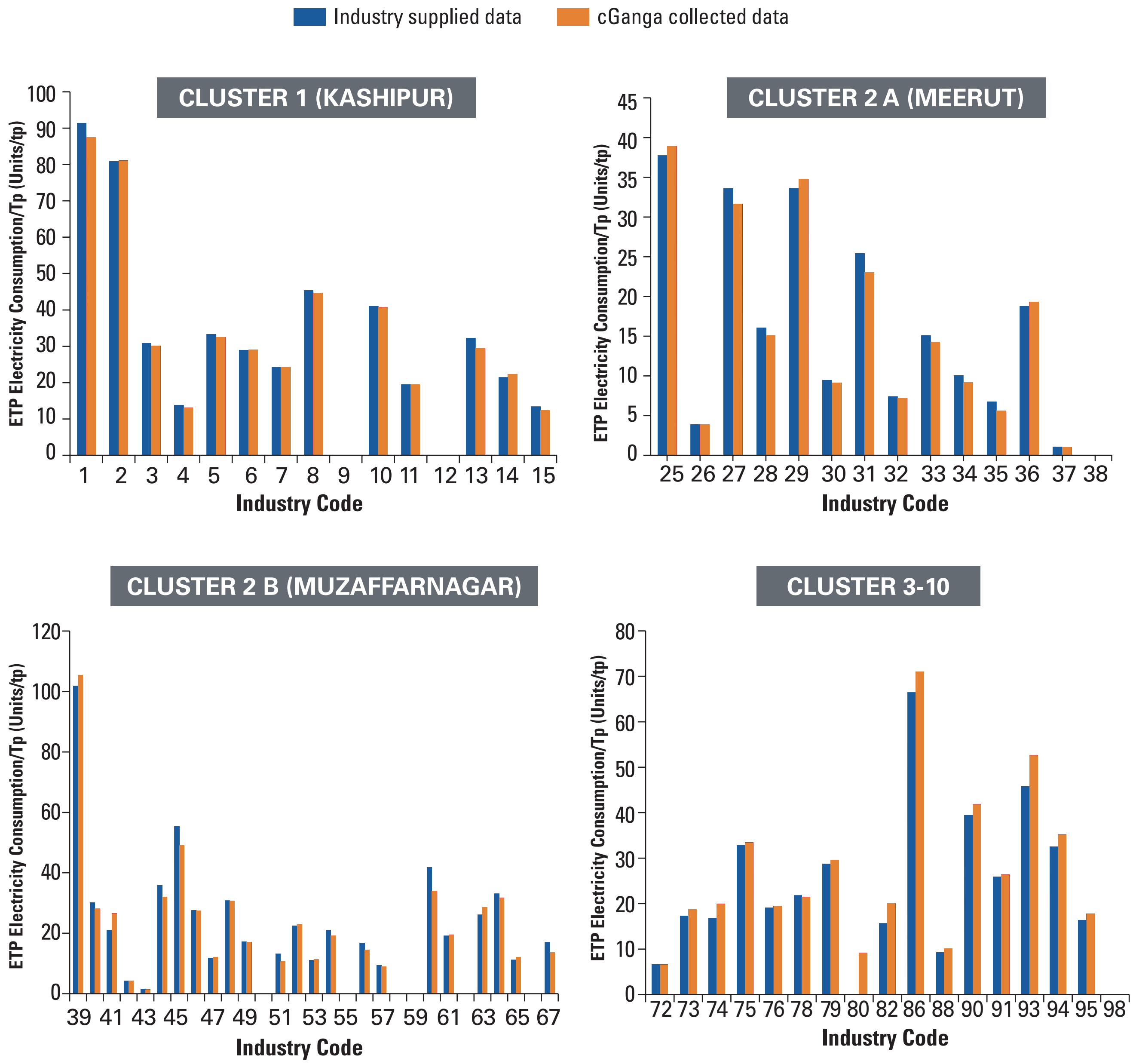


FIGURE-11

ETP ELECTRICITY CONSUMPTION PER UNIT PAPER PRODUCTION



to understand the overall water balance of a particular type of industry.

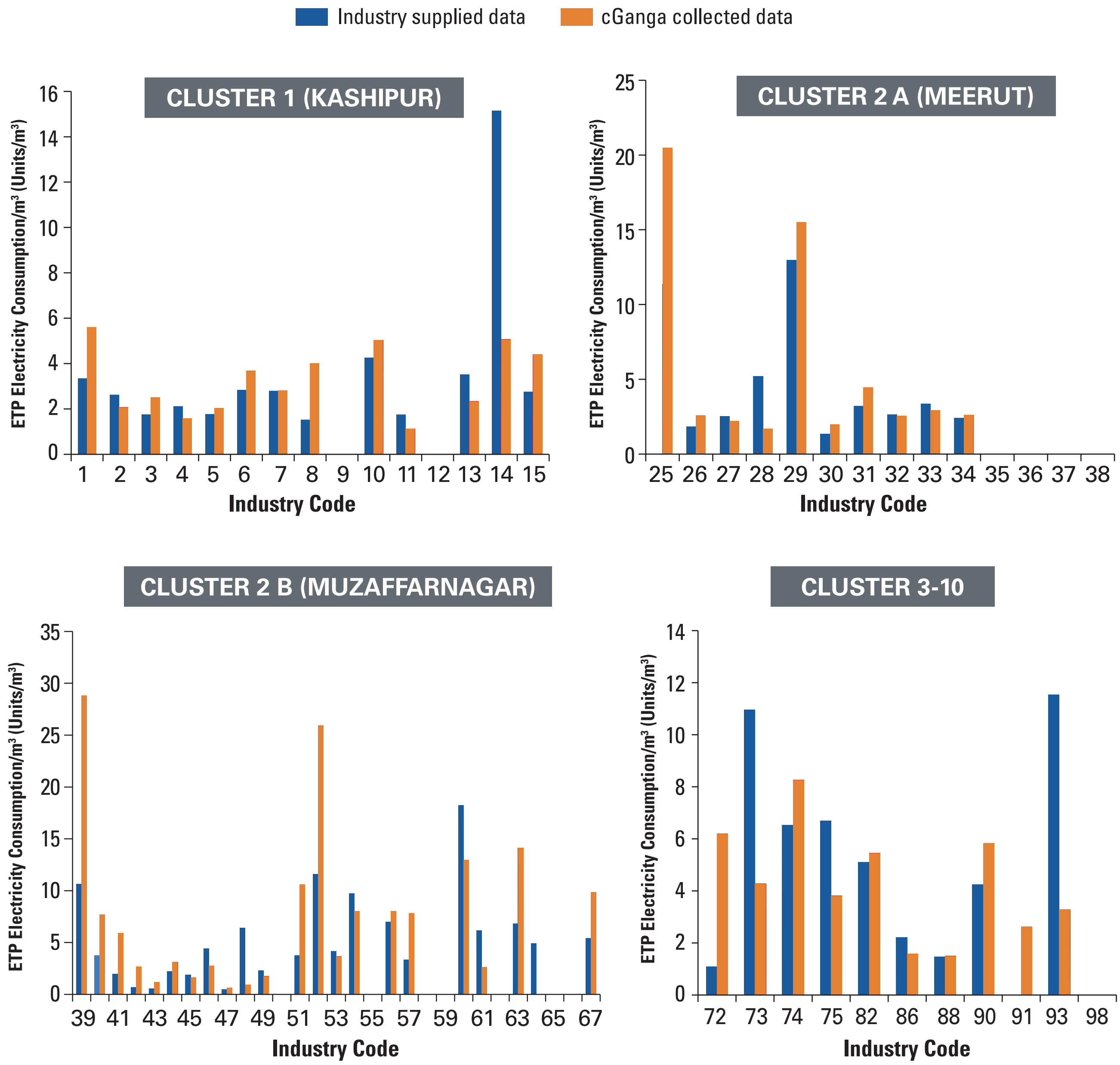
6.2. CLUSTER WISE PRODUCTION AND CONSUMPTION DETAILS

Total paper production and average losses from respective Clusters have been shown in Figure 9. It could be seen that ~74% of the paper production lies in Clusters 1 and 2 (Figure 9A). The average evaporation loss from Meerut sub-cluster was highest, primarily due to the deficient design and technologies involved at various stages of pulping (Figure 9B).

An average discharge of PPIs with respect to paper production has been summarized in Figure 10. Industries which are agro-based are producing higher discharge than waste-paper based industries. It should be noted that those industries where paper production data was not shared or were temporarily closed at the time of visit were indicated as zero on X-axis in all graphs of

FIGURE-12

ETP ELECTRICITY CONSUMPTION PER UNIT DISCHARGE

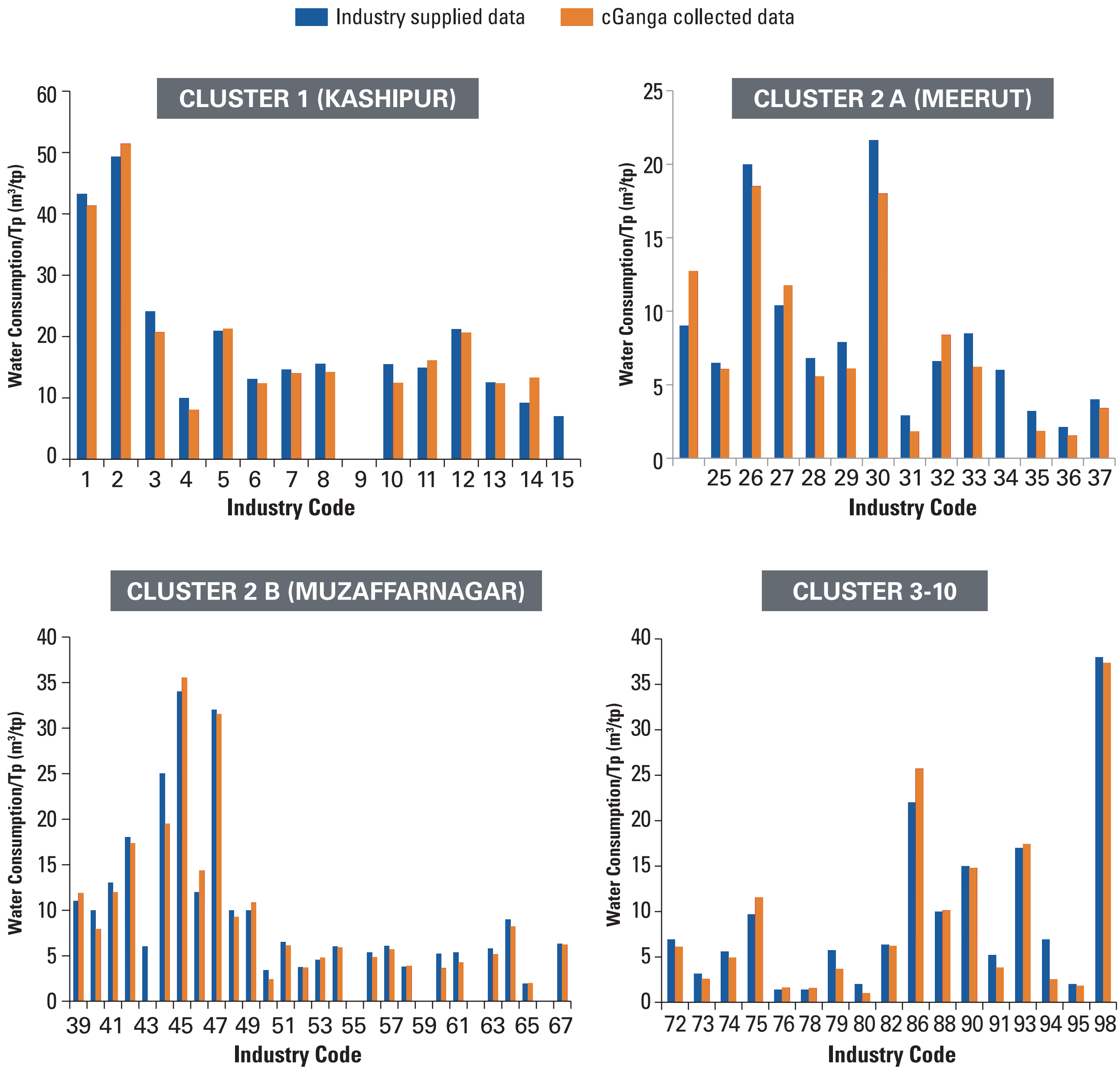


the current section. ETP electricity consumption is also directly proportional to the amount of paper production. Figures 11 and 12 show the relationships between ETP electricity consumption per unit paper production and ETP electricity consumption per unit discharge, respectively. The data presented by industries and measured by cGanga team are found to be within margin of errors in measurements/estimates.

Figure 13 shows water consumption per unit paper production cluster wise. An average consumption of 10 m^3 water/ton of paper production was found for all PPIs. Industries which are using more than 30 m^3 water/ton of paper production are primarily agro-based and wood-based bleached industry. Therefore, higher water extraction by the industries depends on the type of raw material, technologies used and re-use/recycle of water. The groundwater extraction data provided by industries match quite closely

FIGURE-13

WATER CONSUMPTION PER UNIT PAPER PRODUCTION



with cGanga collected data.

6.3. BLACK LIQUOR PRODUCTION

The black liquor discharged from PPIs is an aqueous solution of lignin residues, hemicellulose, and the inorganic chemicals used during the process. It is quite toxic to aquatic life. Figure 14 shows the variation of cluster-wise black liquor generation by industries with time. As per the CPCB guidelines, it was made mandatory for all industries to install chemical recovery plant (CRP). No permission was granted to run digesters for pulping by PPIs without having CRP. This brought a major change in black liquor discharge as can be seen from Figure 14. Before the installation of CRPs, a maximum of 2,000 and 6,000 m³/d of black liquor was discharged into the areas of Kashipur and Muzaffarnagar regions, respectively. After CRP installation, the black liquor discharge has reduced to zero since 2013 and 2014 in Kashipur and Muzaffarnagar, respectively. Such high amounts of

FIGURE-14

BLACK LIQUOR PRODUCTION

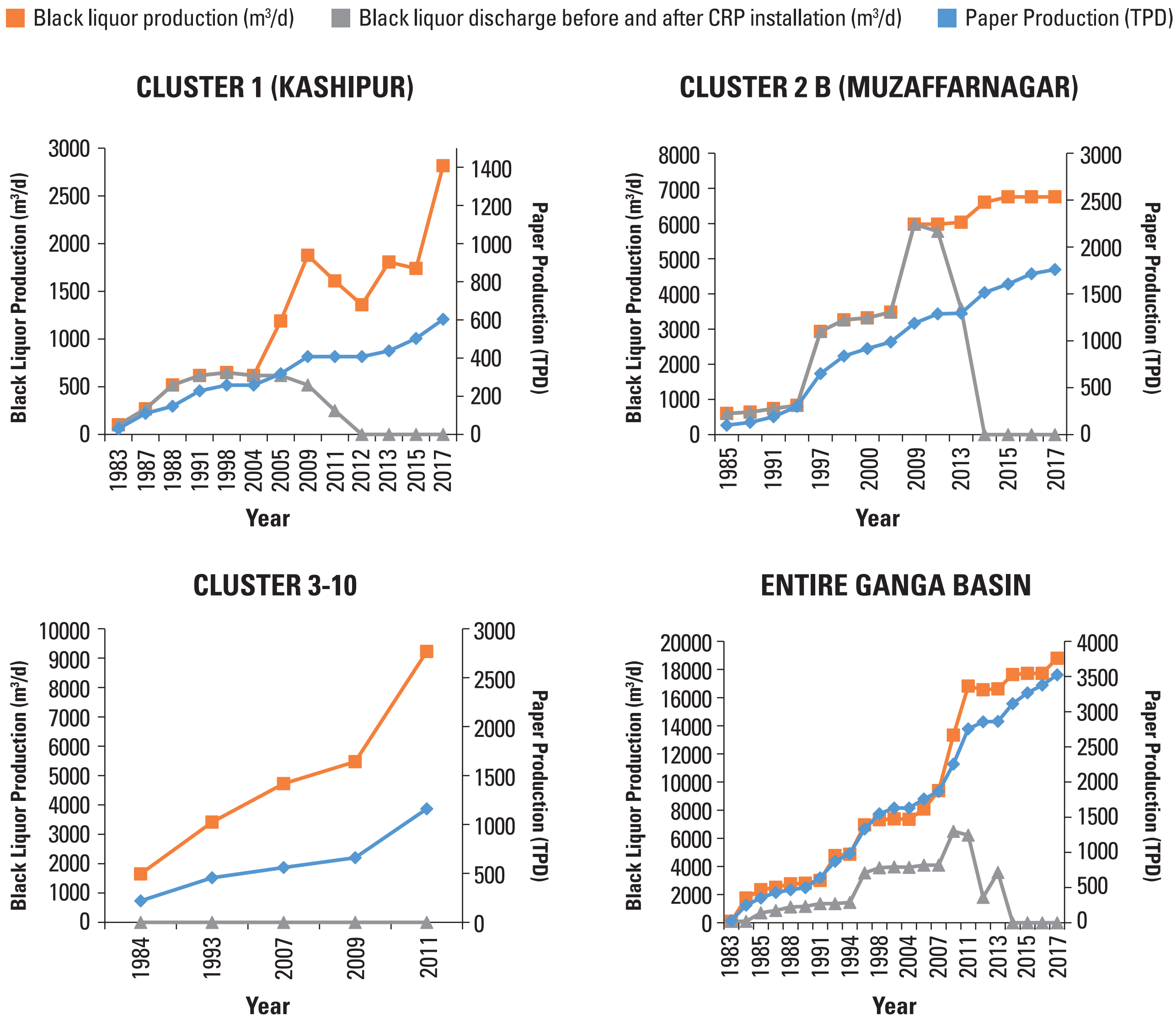


TABLE-4

NUMBER OF INDUSTRIES THAT CHANGED FROM AGRO-BASED TO RCP OVER LAST 15 YEARS

	Kashipur	Meerut	Muzaffarnagar	Roorkee
TOTAL NUMBER OF INDUSTRIES	24	14	33	6
AGRO-BASED INDUSTRIES 15 YEARS BACK	6	0	10	0
CURRENT AGRO-BASED INDUSTRIES	4	0	7	0
CHANGED FROM AGRO TO RCP	2	0	3	0

black liquor discharge in the tributaries of Ganga, till a few years back have resulted in ecological damages that could be observed from the current status of river and its catchment areas in those clusters. Clusters 3-10 had installed CRPs earlier.

Therefore, the policy of installation of CRPs by every industry was a very appreciable step by the government, which has resulted in positive impacts that can be seen on the ground. It has tremendously reduced the black liquor discharge from 18,797 m^3/d to zero from the year 2011 onwards in Uttarakhand and Uttar Pradesh region of Ganga river basin.

In addition to the CRP installation, many industries have also been converted from agro-based to recycled paper (RCP) based production. A list of industries that has been transformed from agro to RCF over last 15 years in various clusters has been listed in Table 4.

ASSESSMENT OF EFFLUENT QUALITY AND POLLUTION LOAD

In order to assess compliance to the norms given in the Charter (CPCB, 2015) and estimate reduction in pollution load due to the implementation of the Charter (CPCB, 2015), ETP effluent from every industry was monitored. Eight parameters, namely Flow, DO, VSS, TSS, BOD, COD, Nitrogen and Phosphorus were monitored at the outlet of the industry. The industries have also set-up laboratories for analysis of effluents as per one of the mandates of the Charter (CPCB, 2015) and also analysed some samples for certain parameters. This helped in comparison of the outcome of the analysis carried out by the industry and the Team cGanga, and commenting on the capacity of the industry to analyse ETP effluents. The parameters monitored by the industry included Flow, pH, TDS, TSS, BOD and COD. Norms laid down in the Charter (CPCB, 2015) for these effluents have been shown in Table 5.

Figure 15 shows a typical variation of these parameters in the effluent of an industry. Industry wise analysis is presented in a separate volume. Results of the analysis carried out by the industry are comparable to those done by Team cGanga and suggests that laboratories established by most industries as per the Charter (CPCB, 2015) have the capacity to analyse various effluent quality parameters.

Photograph at the top of effluent quality graphs (Figure 15) presents the visual condition of V-notch discharging the effluent at different times of a day.

7.1. EFFLUENT QUALITY

Combined statistical plots representing median values of effluent quality parameters at Kashipur (Cluster 1),

THE INDUSTRIES HAVE ALSO SET-UP LABORATORIES FOR ANALYSIS OF EFFLUENTS AS PER ONE OF THE MANDATES OF THE CHARTER (CPCB, 2015) AND ALSO ANALYSED SOME SAMPLES FOR CERTAIN PARAMETERS.

TABLE-5

NORMS FOR TREATED EFFLUENT QUALITY FOR PPIs IN GANGA RIVER BASIN STATES

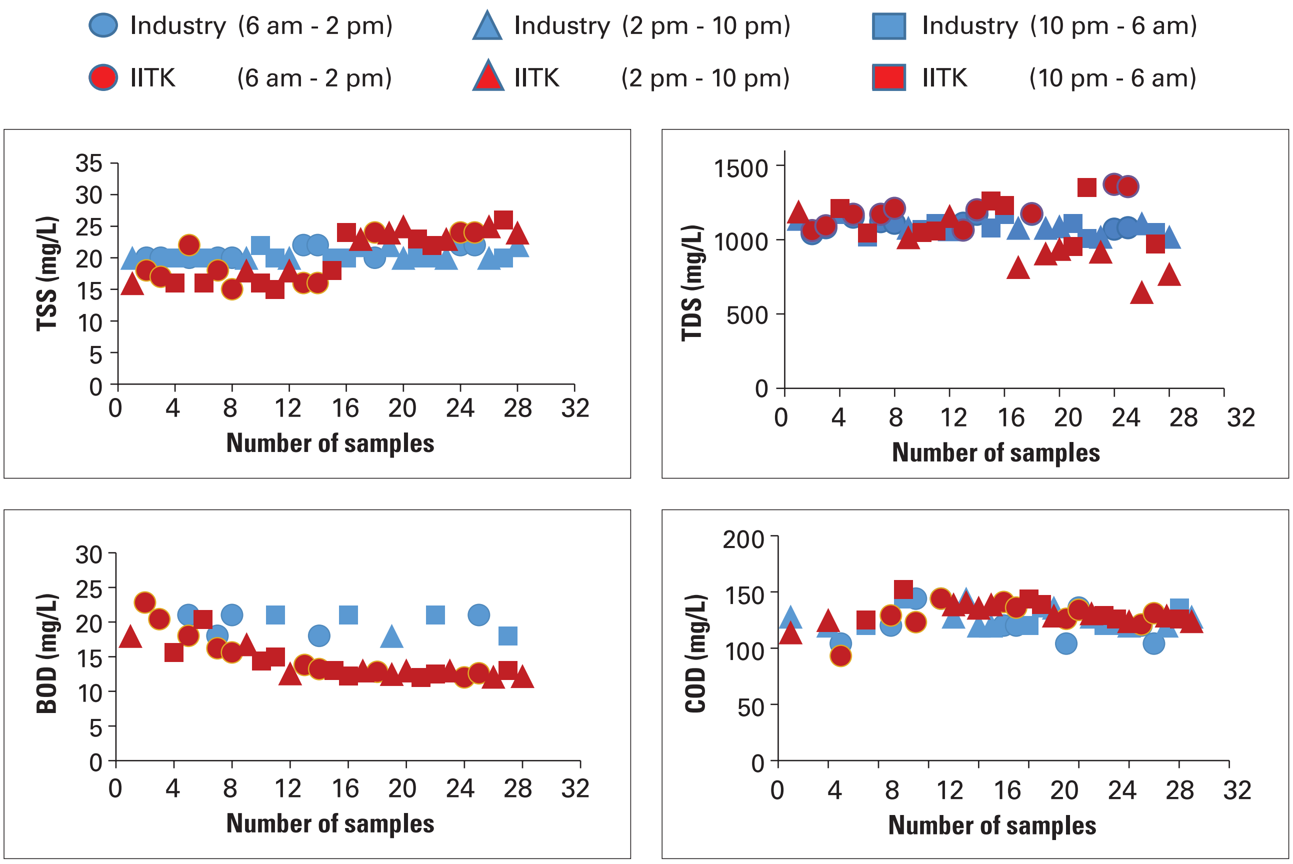
PARAMETERS	pH	TSS (mg/L)	BOD (mg/L)	COD (mg/L)	TDS (mg/L)	COLOUR (PCU)*
INTEGRATED PULP AND PAPER INDUSTRIES MANUFACTURING CHEMICAL PULP	6.5-8.5	30	20	200	1800	250
RCF AND MARKET PULP BASED PULP AND PAPER INDUSTRIES	6.5-8.5	30	20	150	1600	150

**PCU= Platinum Cobalt Color Unit*

FIGURE-15

COMPARISON OF TYPICAL EFFLUENT QUALITY ASSESSMENT BY INDUSTRY AND cGanga TEAM

Sampling at industrial outlet



RESULTS OF THE ANALYSIS CARRIED OUT BY THE INDUSTRY ARE COMPARABLE TO THOSE DONE BY TEAM CGANGA AND SUGGESTS THAT LABORATORIES ESTABLISHED BY MOST INDUSTRIES AS PER THE CHARTER (CPCB, 2015) HAVE THE CAPACITY TO ANALYSE VARIOUS EFFLUENT QUALITY PARAMETERS.

Meerut (Cluster 2 A), Muzaffarnagar (Cluster 2 B) and other Cluster (Clusters 3-10) at industrial outlets are presented in Figures 16, 17, 18 and 19, respectively. It should be noted that the effluent quality discharge norms as per the Charter (CPCB, 2015) for PPIs of agro and waste paper industries for BOD, COD, TSS and TDS are 20, 200, 30, 1800 mg/L and 20, 150, 30, 1600 mg/L, respectively (Table 5).

The midline in the box plots represents median values of all 36 samples taken for a particular industry. For Cluster 1, the range of BOD values was observed to be between 8–26 mg/L, with a median ~15 mg/L. In general, all industries with some exceptions were within the BOD norms of the Charter (CPCB, 2015). The range of COD values was observed to be between 60–182 mg/L with median ~118 mg/L. The median value of TSS was ~20 mg/L for all industries. These values were well within the Charter norms (CPCB, 2015). The range of TDS values was observed to be between 450-1980 mg/L. 13% of the

FIGURE-16

MEDIAN AND RANGE OF PARAMETER VALUES AT THE OUTLET OF INDUSTRIES IN CLUSTER 1 (KASHIPUR)

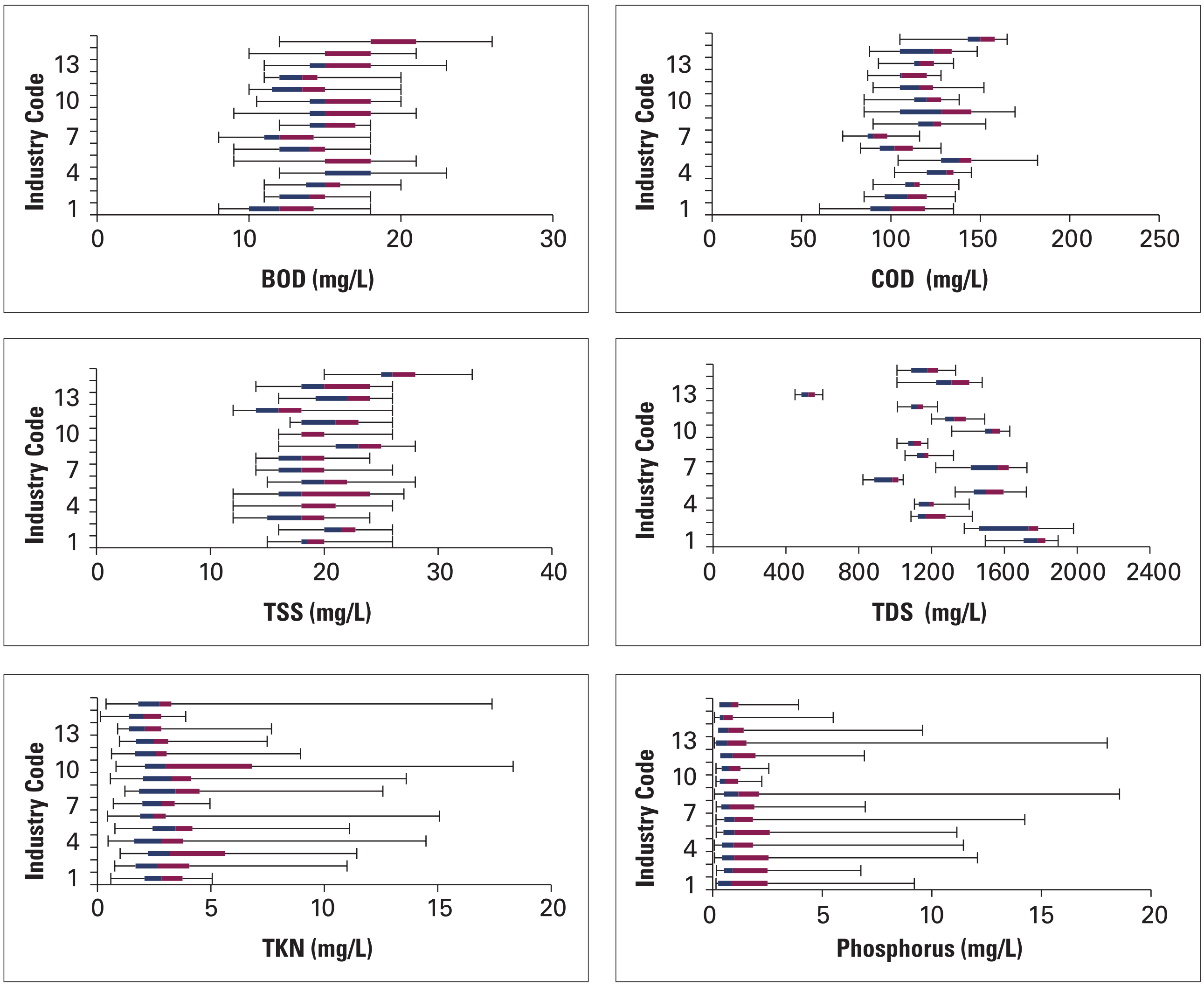
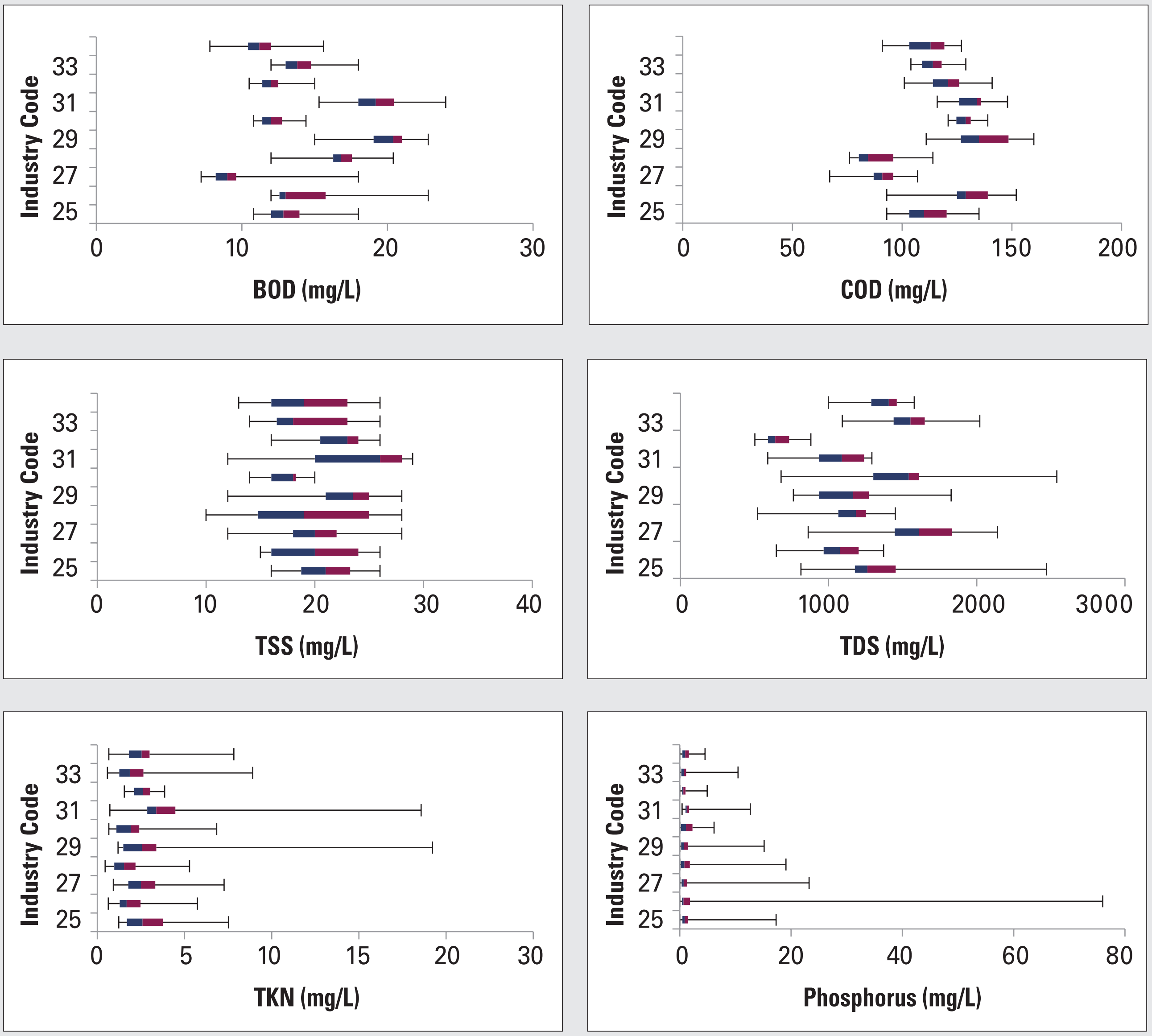


FIGURE-17

MEDIAN AND RANGE OF PARAMETER VALUES AT THE OUTLET OF INDUSTRIES IN CLUSTER 2 A (MEERUT)



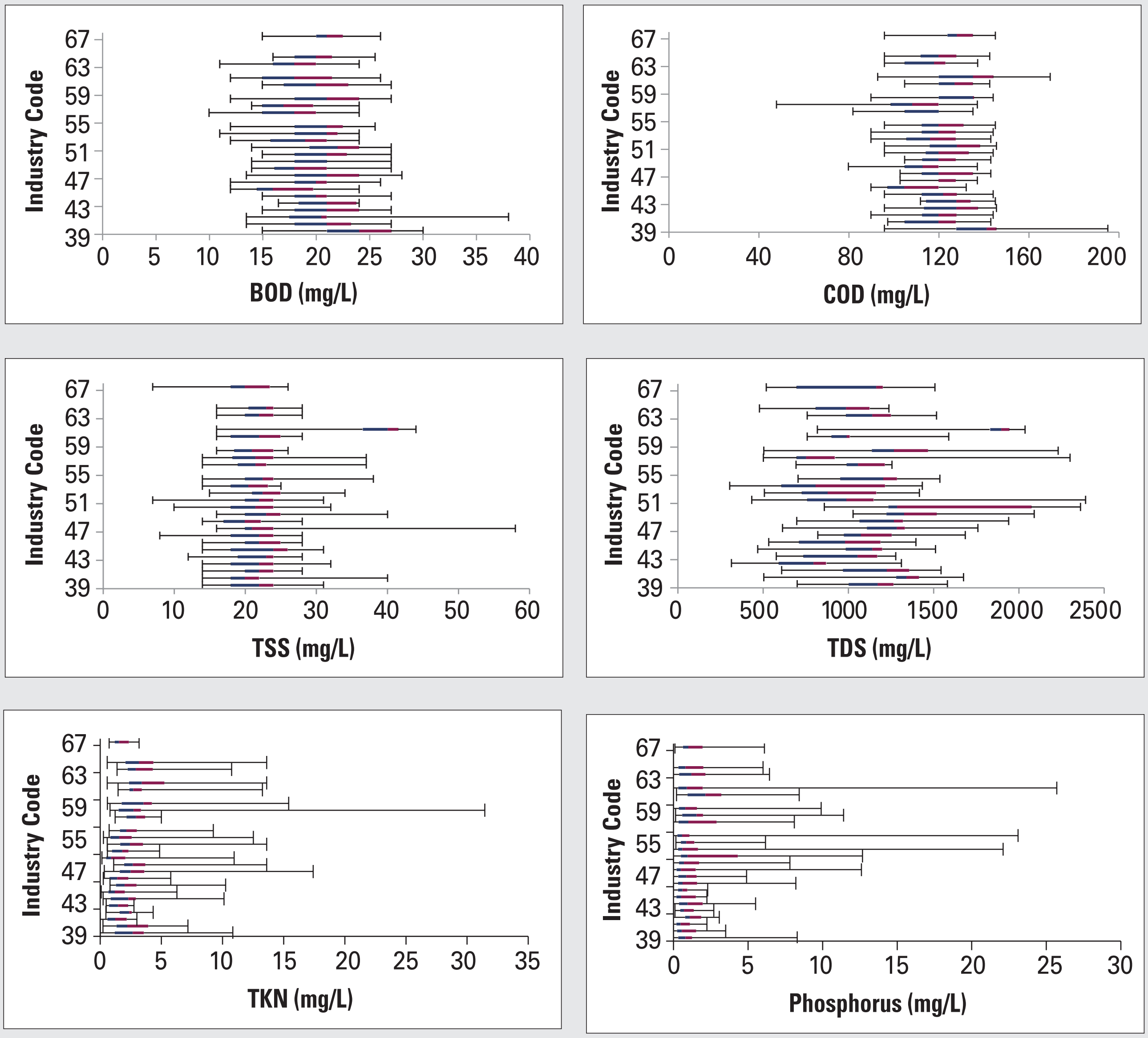
industries were found to exceed the TDS norms in Cluster 1. The median values of TKN and phosphorus were ~2.8 mg/L and ~0.8 mg/L respectively.

Phosphorus discharge norms were not mentioned in the Charter (CPCB, 2015). However, as per EPA water quality criteria, the permissible phosphate discharged into lakes and reservoirs is <0.05 mg/L. In surface waters, total phosphorus should be 0.01-0.03 mg/L. The phosphorus discharge norms were violated several times as per EPA guidelines.

For Cluster 2 A (Meerut), the range of BOD values was observed to be between 7.2-24 mg/L. Average median value of BOD was observed to be ~14 mg/L. In case of Cluster 2 B (Muzaffarnagar), the BOD range was 10-38 mg/L, while the

FIGURE-18

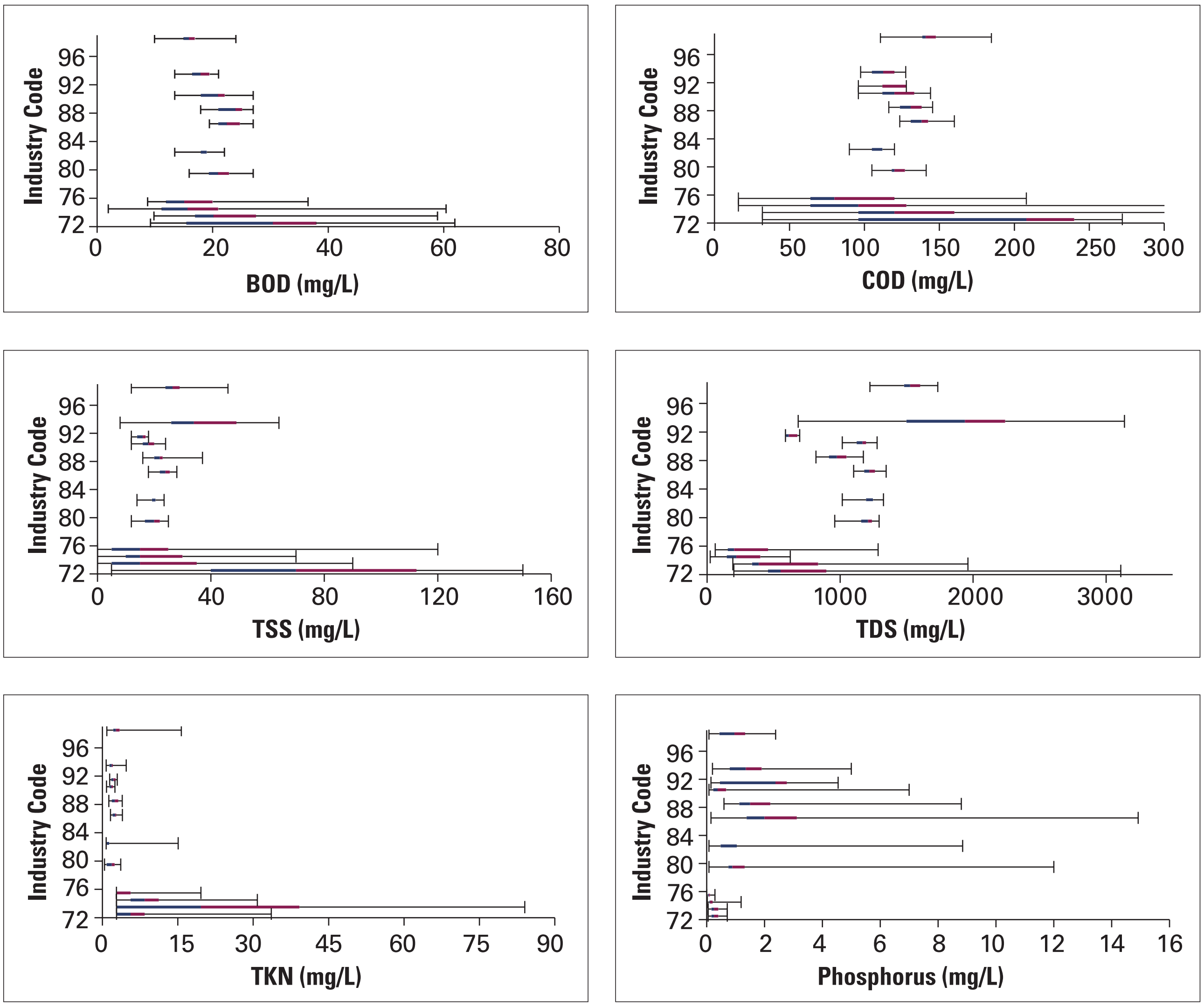
MEDIAN AND RANGE OF PARAMETER VALUES AT THE OUTLET OF INDUSTRIES IN CLUSTER 2 B (MUZAFFARNAGAR)



average median value was 20 mg/L. Most of the industries in Muzaffarnagar exceed the BOD norms of 20 mg/L. The range of COD values for Meerut and Muzaffarnagar cluster was observed to be between 67-160 mg/L and 48–195 mg/L with an average median value of ~115 and ~122 mg/L, respectively. The range of TSS in Meerut cluster was 10-29 mg/L. The TSS range increases in Muzaffarnagar cluster and was between 7-58 mg/L. The median values of TSS for Meerut and Muzaffarnagar cluster were ~20 and ~22 mg/L, respectively for all industries. The range of TDS values were observed to be between ~300 to ~2500 mg/L with a median value of ~1200 mg/L for both Meerut and Muzaffarnagar clusters. Overall, COD values were well within the range; however, TSS and TDS limit of 30 mg/L and 1800 mg/L, respectively were often

FIGURE-19

MEDIAN AND RANGE OF PARAMETER VALUES AT THE OUTLET OF INDUSTRIES IN CLUSTER 3-10



exceeded by industries. The TKN values for Meerut cluster was between 0.3 to 19.22 mg/L and the median was ~2.2 mg/L. In Muzaffarnagar cluster, the range increased and is between 0.08 to 31.45 mg/L, while the median was ~2.2 mg/L.

In the Other Clusters, the range of BOD, COD, TSS and TDS were 2-61.9 mg/L, 16-352 mg/L, 5.0-950 mg/L and 24.0-3137 mg/L, respectively. For Other Clusters, the industries of Roorkee were found to exceed the prescribed limits of BOD, COD, TSS and TDS, a maximum number of times. The values of TKN were also found higher (0.4-117.6 mg/L) as compared to other industries of Cluster 3-10.

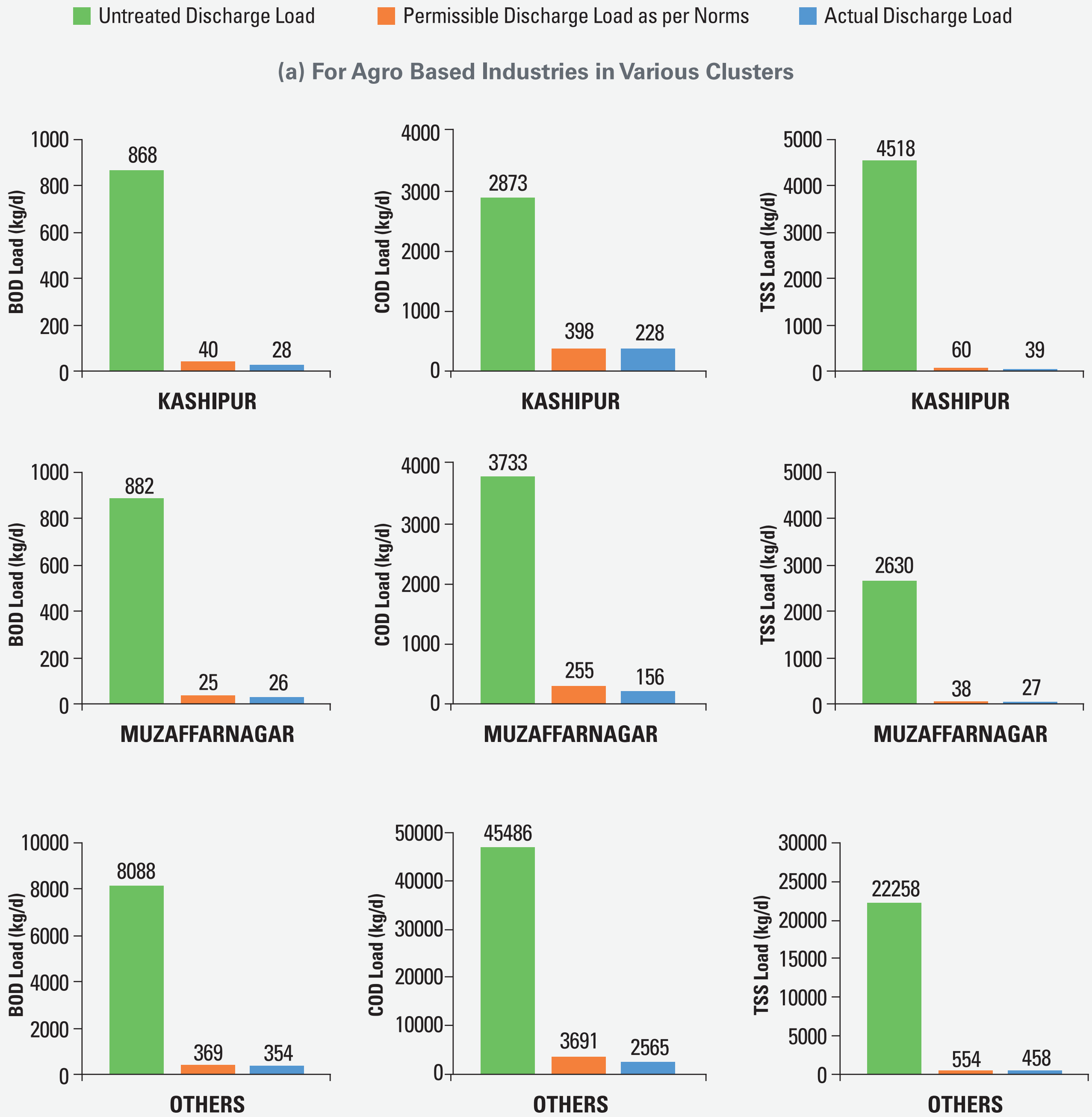
7.2. POLLUTION LOAD

Figure 20 presents average pollution load of BOD, COD and TSS from two categories, namely (a) agro based and

(b) waste paper recycle based PPIs of Uttarakhand and Uttar Pradesh under three different conditions, viz
(i) discharge of untreated effluents,
(ii) discharge of effluents after treatment as per the Charter (CPCB, 2015) norms, and (iii) discharge of treated effluents as per the survey conducted by Team cGanga. It can be noticed that implementation of measures for pollution control in PPIs as per the Charter (CPCB, 2015) has resulted in substantial reduction in organic load in terms of BOD and COD as well as suspended solids in the receiving water bodies. However, it is important to examine if this has improved the condition of the water bodies in the vicinity of PPIs as per the intent of any pollution control strategy. This aspect has been studied extensively by Team cGanga, and is presented in following sections of the report.

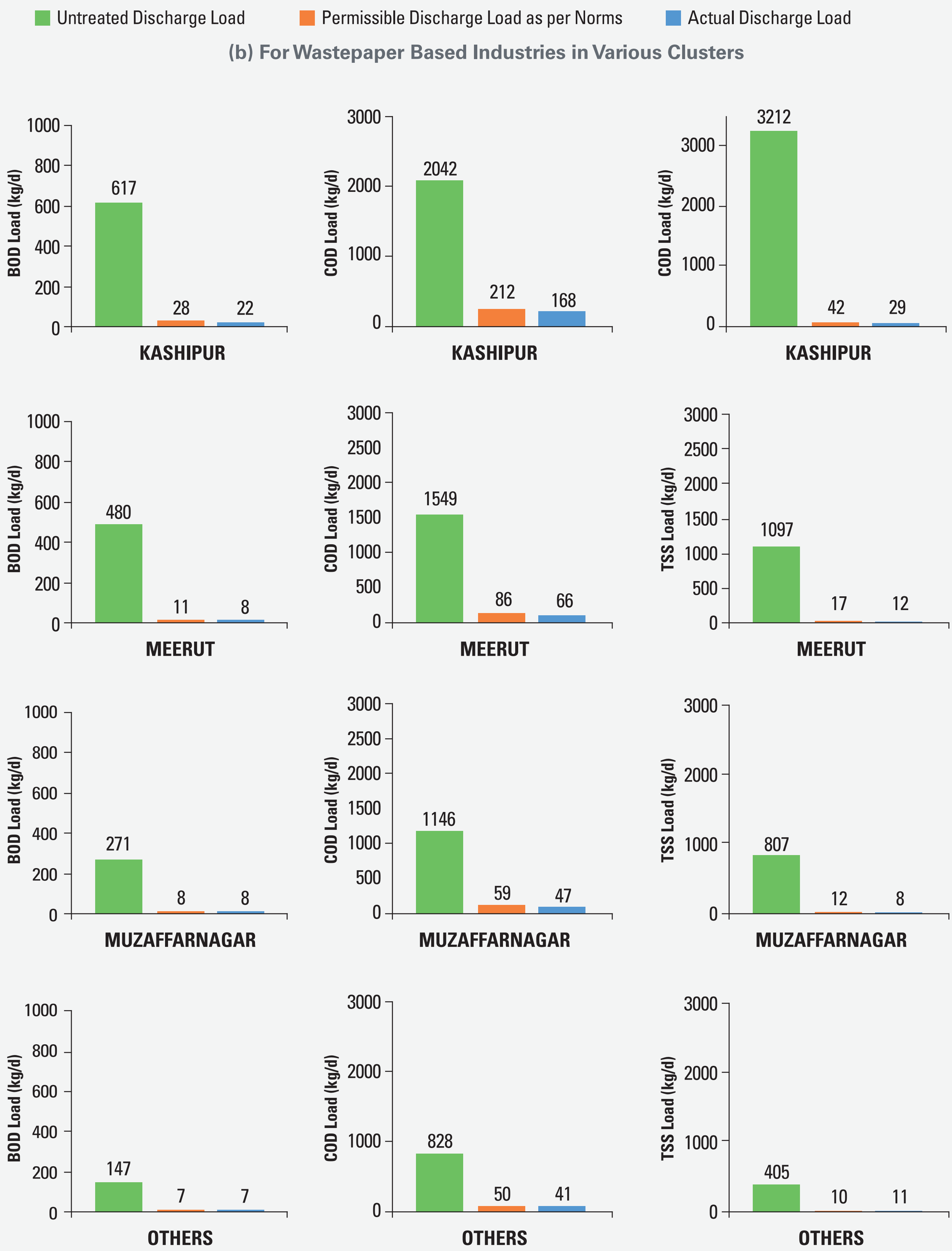
FIGURE-20

AVERAGE POLLUTION LOAD OF BOD, COD AND TSS



IT CAN BE NOTICED THAT IMPLEMENTATION OF MEASURES FOR POLLUTION CONTROL IN PPIs AS PER THE CHARTER (CPCB, 2015) HAS RESULTED IN SUBSTANTIAL REDUCTION IN ORGANIC LOAD IN TERMS OF BOD AND COD AS WELL AS SUSPENDED SOLIDS IN THE RECEIVING WATER BODIES.

FROM PPIs OF UTTARAKHAND AND UTTAR PRADESH



(b) For Wastepaper Based Industries in Various Clusters

CONDITION OF DRAINS RECEIVING TREATED EFFLUENTS POST IMPLEMENTATION OF THE CHARTER

The effluent quality at PPI's outlet was by and large found to be within the norms specified in the Charter (CPCB, 2015). But it is important to understand that the ultimate concern is to improve the condition of adjoining drains in which treated effluents are being discharged. Therefore, a survey was conducted to assess the physical condition of the drains as well as water quality parameters of the drains where the industrial discharge is released. The industrial outlet is integral part of industry where as drains are not, so a true picture of the effluent could only be assessed by assessing the water quality at the upstream and the downstream of industrial outlet in the drain.

Sampling from a particular industry was done at three locations. The first

FIGURE-21

SCHEMATIC REPRESENTATION OF LOCATION OF SOME PULP AND PAPER INDUSTRIES IN MEERUT SUB-CLUSTER ON THE BANKS OF RIVER KALI

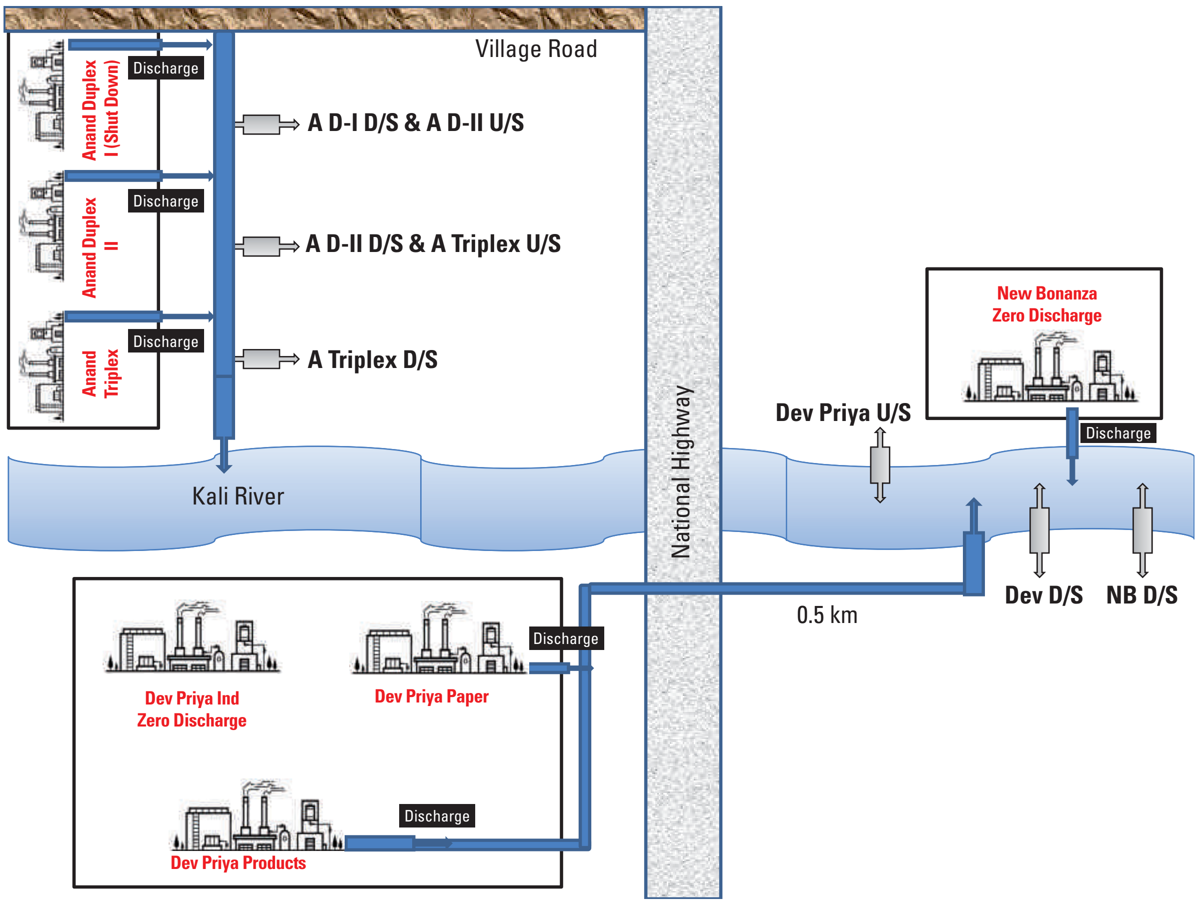
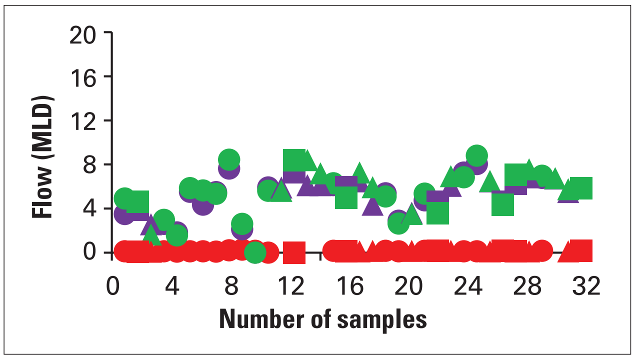


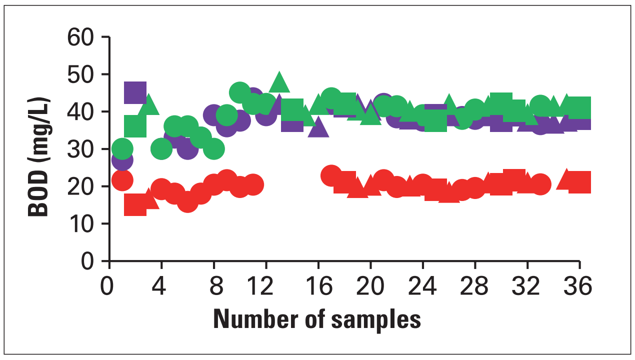
FIGURE-22

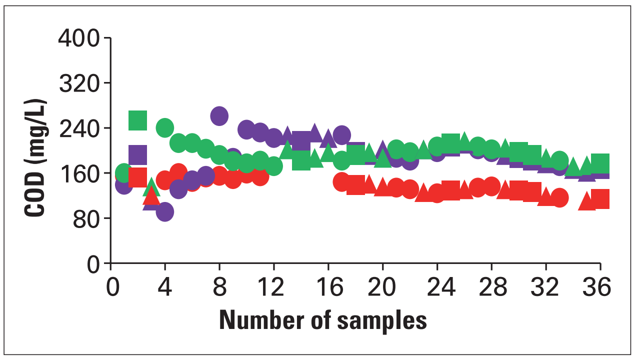
DRAIN WATER QUALITY AND THE CONDITION OF DRAIN IN THE VICINITY OF EFFLUENT DISCHARGE

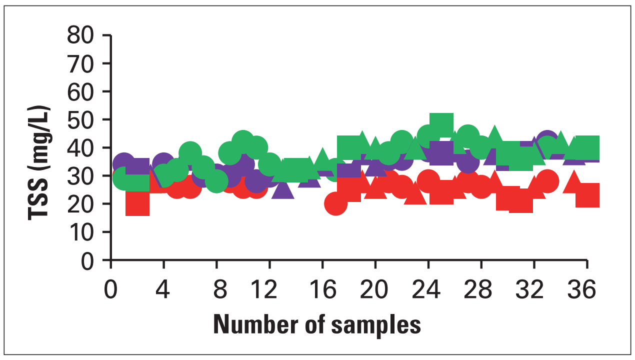
Sampling at drains

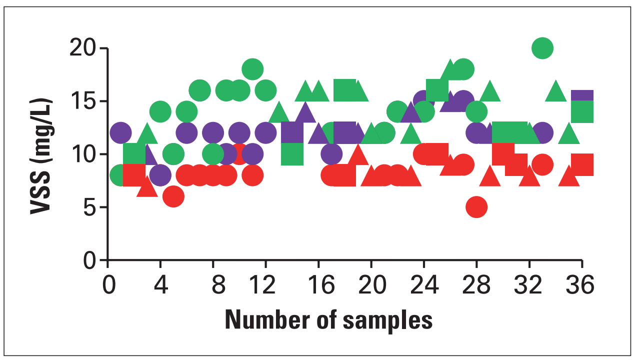
● Outlet (6 am - 2 pm)	▲ Outlet (2 pm - 10 pm)	■ Outlet (10 pm - 6 am)
● Upstream (6 am - 2 pm)	▲ Upstream (2 pm - 10 pm)	■ Upstream (10 pm - 6 am)
● Downstream (6 am - 2 pm)	▲ Downstream (2 pm - 10 pm)	■ Downstream (10 pm - 6 am)











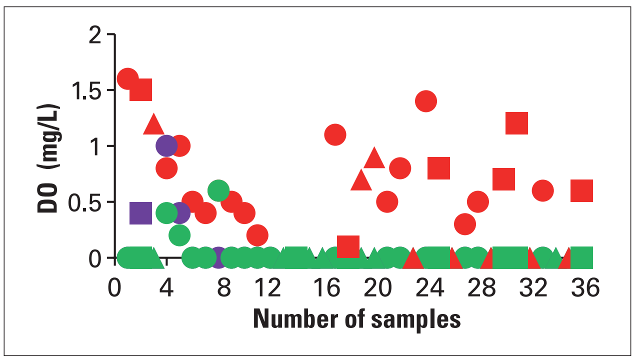


TABLE-6

SUMMARY OF DRAIN WATER QUALITY FOR KASHIPUR (CLUSTER 1)

Industry Code		Flow (MLD)	DO (mg/L)	BOD (mg/L)	COD (mg/L)	TSS (mg/L)	VSS (mg/L)
1	Upstream	4.8 ± 6.3	0.3 ± 0.5	40.8 ± 6.6	163 ± 21	36.9 ± 4	13.8 ± 3.7
1	Downstream	10.1 ± 7.7	2.9 ± .99	25.2 ± 4.2	138 ± 16.4	28.5 ± 2.6	10.1 ± 2.07
2	Upstream	8.9 ± 7.2	1.1 ± 0.4	26.2 ± 6.7	133 ± 12	28.8 ± 6.4	10.7 ± 3.6
2	Downstream	12.4 ± 8.4	1.5 ± 0.9	21.6 ± 3.6	115 ± 12.2	27.5 ± 2.3	10.3 ± 2.3
3	Upstream	9.0 ± 6.7	0.2 ± 0.3	51.5 ± 14.4	286 ± 77.9	53.6 ± 10.3	23.6 ± 8.2
3	Downstream	15 ± 6.2	0.4 ± 0.5	31.8 ± 3.9	189 ± 43.5	37.9 ± 3.7	13.1 ± 2.4
4	Upstream	14.4 ± 6.5	0.3 ± 0.5	31.9 ± 3.9	190 ± 43	37.9 ± 3.8	13.9 ± 4.7
4	Downstream	17.0 ± 6.9	0.7 ± 1.0	24.6 ± 2.7	142 ± 11.9	28.6 ± 3.5	10.7 ± 3.9
5	Upstream	2.3 ± 1.8	0.6 ± 0.6	16.5 ± 4.1	67.6 ± 9.9	20.1 ± 6.5	7.2 ± 3.0
5	Downstream	3.6 ± 2.3	1.3 ± 1.0	26.9 ± 5.2	148 ± 11.8	30.3 ± 5.0	10.8 ± 2.4
6	Upstream	6.2 ±5.0	1.1 ± 0.8	28.6 ± 4.5	418 ± 405	31.9 ± 3.8	11.9 ± 2.9
6	Downstream	8.1 ± 5.1	1.8 ± 1.1	22.3 ± 3.3	116 ± 11.1	26.9 ± 2.6	10.0 ± 2.4
7	Upstream	8.1 ± 5.4	0.9 ± 0.8	25.2 ± 2.8	132 ± 8.9	30.9 ± 3.9	11.7 ± 3.4
7	Downstream	10.3 ± 5.2	2.4 ± 1.3	19.6 ± 4.4	114 ± 8.6	24.5 ± 2.2	8.9 ± 1.3
8	Upstream	4.1 ± 2.4	0.5 ± 1.0	32.6 ± 3.9	147 ± 4.6	36.8 ± 5.3	14.3 ± 3.4
8	Downstream	5.7 ± 2.7	0.2 ± 0.5	28.8 ± 3.8	158 ± 21	39.2 ± 7.3	15.0 ± 5.4
9	Upstream	-	-	-	-	-	-
9	Downstream	2.4 ± 1.3	1.2 ± 0.7	31.3 ± 4.8	158 ± 19.1	38.9 ± 4.3	14.1 ± 2.7
10	Upstream	1.2 ± 2.3	1.4 ± 1.7	24.6 ± 3.2	141 ± 7.2	28.5 ± 2.7	10.2 ± 1.4
10	Downstream	2.3 ± 2.4	1.7 ± 0.7	25.5 ± 4.0	145 ± 15.8	27.9 ± 3.0	9.9 ± 1.9
11	Upstream	0.6 ± 0.8	0.6 ± 0.9	10.6 ± 2.3	66.5 ± 15.8	12.1 ± 3.1	4.4 ± 1.27
11	Downstream	2.0 ± 1.2	1.0 ± 0.8	20.6 ± 3.4	133 ± 10.4	25.5 ± 2.3	9.6 ± 1.2
12	Upstream	-	-	-	-	-	-
12	Downstream	3.5 ± 1.1	1.4 ± 0.9	22.3 ± 4.3	131 ± 20.7	24.2 ± 4.7	9.7 ± 2.7
13	Upstream	1.3 ± 1.5	0.1 ± 0.3	39.6 ± 6.0	231 ± 45.3	43.0 ± 3.1	15.9 ± 2.7
13	Downstream	2.2 ± 1.8	0.4 ± 0.6	28.7 ± 4.3	157 ± 19.0	32.9 ± 5.5	11.8 ± 3.2
14	Upstream	0.6 ± 0.7	0.3 ± 0.4	34.8 ± 15.2	156 ± 56.8	33.9 ± 11.8	12.5 ± 4.9
14	Downstream	1.0 ± 0.7	0.8 ± 1.1	47.2 ± 15.1	249 ± 77.3	50.2 ± 10.9	19.5 ± 6.7
15	Upstream	0.5 ± 1.0	0.1 ± 0.1	14.2 ± 10.0	108 ± 66.5	16.3 ± 11.9	5.6 ± 4.3
15	Downstream	1.0 ± 1.4	0.2 ± 0.4	32.8 ± 3.9	169 ± 7.5	34.0 ± 4.7	12.0 ± 1.9

is effluent from outlet of the industry, second is drain water sample just upstream of the drain in which the industrial effluent is discharged, and the third is just downstream of the drain immediately after the discharge point/outlet point. As an illustration, a schematic representation of river Kali and location of 7 industries in Meerut sub-cluster discharging effluents into the drains/river has been depicted in Figure 21.

8.1. COMPARISON OF UPSTREAM AND DOWNSTREAM WATER QUALITY OF DRAINS WITH INDUSTRIAL EFFLUENT

Variation in six important water quality parameters was observed at the upstream and downstream location of the discharge points in the drain/river. These parameters were Flow, BOD, COD, TSS, VSS and DO. Figure 22 presents an illustration of variation of these parameters obtained from industry outlet, and the upstream and downstream locations of the drain. Images at the top of the figure gives an idea of the physical condition of the drain in the vicinity of the effluent discharge point. Similar figures for all the industries covered during the survey have been presented in a separate volume that reports cluster wise and industry wise information.

From the graphs presented in Figure 22, it could be observed that the particular industry is discharging effluents well within the norms. However, the water quality parameters for the upstream part of the drain were much inferior than the industrial effluent i.e., the industrial effluent is diluting the upstream flow of the drain. This scenario differs from one location to the other. Tables 6, 7, 8 and 9 present a summary of water quality parameters at upstream and downstream ends of drains in Kashipur (Cluster 1), Meerut (Cluster 2 A), Muzaffarnagar (Cluster 2 B) and other clusters (Cluster 3-10), respectively. Detailed drain water quality for various clusters has been presented in a separate volume that reports cluster wise and industry wise information.

Data presented in Tables 6 to 9 reveal that dissolved oxygen concentrations in all the drains are less than 4 mg/L. Most of the samples from Kashipur cluster (except two industries, DO values: 2.9 and 2.4 mg/L), all from Meerut (except one industry, DO value: 2.8 mg/L) and all from Muzzafarnagar cluster were found to have DO values less than 2.0 mg/L. BOD, COD and VSS values in most drains are high reflecting poor status as a water body. This may be due to several reasons including (i) malpractices within the industry, (ii) occasional bypass of ETP leading to release of untreated effluent/ sludge, (iii) non inclusion of nitrogen and phosphorus as parameters in the Charter (CPCB, 2015) protocol leaving scope for eutrophication, thereby partially or fully nullifying the effectiveness of ETPs, and (iv) entry of wastes originating from other sources/activities. It is important that significant efforts made by PPIs are not nullified and an appropriate strategy is formulated to carryout additional efforts to ensure that condition of the recipient water bodies is improved and PPIs are protected from the ill effects of other wastes and polluting activities.

TABLE-7

SUMMARY OF DRAIN WATER QUALITY IN CLUSTER 2 A (MEERUT)

Industry Code		Flow (MLD)	DO (mg/L)	BOD (mg/L)	COD (mg/L)	TSS (mg/L)	VSS (mg/L)
25	Upstream	0.0 ±0.0	0.1 ± 0.2	23.5 ± 5.6	136 ± 27.8	31.9 ± 5.9	12.4 ± 2.6
25	Downstream	0.0 ±0.0	0.0 ±0.0	36.0 ± 7.6	203 ± 31.9	35.1 ± 5.8	13.5 ± 2.5
26	Upstream	1.81±1.18	0.0 ± 0.0	21.2 ± 4.1	137 ± 14.9	29.3 ± 4.4	11.9 ± 2.4
26	Downstream	0.0 ± 0.0	0.1 ± 0.1	23.4 ± 5.8	148 ± 32.1	31.9 ± 5.8	12.5 ± 2.4
27	Upstream	-	0.5 ± 0.6	33.8 ± 7.2	135 ± 19.4	38.8 ± 3.3	14.1 ± 2.2
27	Downstream	1.3 ± 1.0	0.2 ± 0.3	39.3 ± 9.2	189 ± 39.4	36.0 ± 3.9	15.1 ± 2.0
28	Upstream	2.4 ± 1.6	0.1 ± 0.2	38.2 ± 5.8	157 ± 34.3	33.0 ± 4.6	11.9 ± 2.2
28	Downstream	2.5 ± 1.6	0.0 ± 0.0	43.7 ± 6.0	213 ± 17.3	35.2 ± 5.9	14.1 ± 2.5
29	Upstream	5.1 ± 2.1	0.3 ± 0.2	31.8 ± 3.0	170 ± 30.2	30.7 ± 3.5	11.3 ± 1.6
29	Downstream	3.7 ± 1.4	0.0 ± 0.1	90.8 ± 7.9	139 ± 14.6	29.1 ± 4.2	9.5 ± 1.8
30	Upstream	22.6 ± 12.0	2.8±2.2	38.8 ±3.8	192 ± 30.3	36.0 ± 3.5	12.8 ± 2.5
30	Downstream	23.5 ±11.9	0.1 ±0.3	51.4 ± 4.9	225 ± 29.5	35.8± 5.1	13.9 ±2.9
31	Upstream	0.9± 0.7	0.1 ± 0.1	38.3 ± 5.6	164 ± 22.3	36.9 ± 2.4	13.0 ± 1.7
31	Downstream	1.8±0.9	0.0 ± 0.1	38.7 ± 4.9	203 ± 30.2	36.8± 3.9	13.1 ± 2.4
32	Upstream	-	-	-	-	-	-
32	Downstream	0.9± 0.7	0.1 ±0.2	38.2 ±5.9	163 ± 22.3	37.0 ± 2.3	13.0 ± 1.6
33	Upstream	3.0 ± 1.3	0.1 ± 0.3	37.0 ± 4.1	210 ± 35.8	30.6 ± 3.4	10.8 ± 1.9
33	Downstream	5.1 ± 1.5	0.0 ±0.1	38.0 ± 3.9	218 ± 47.9	34.9± 4.1	12.5± 2.1
34	Upstream	3.1 ± 1.2	0.1± 0.3	37.2± 3.5	211 ± 32.7	30.8 ± 3.3	10.9 ± 2.0
34	Downstream	5.2 ± 1.4	0.0 ± 0.1	38.1 ± 2.8	213 ± 42.3	35.1 ± 4.0	12.7± 1.9

TABLE-8

SUMMARY OF DRAIN WATER QUALITY IN CLUSTER 2 B (MUZAFFARNAGAR)

Industry Code		Flow (MLD)	DO (mg/L)	BOD (mg/L)	COD (mg/L)	TSS (mg/L)	VSS (mg/L)
39	Upstream	5.6±4.5	0.8±1.1	31.3±9.8	141.7±19.1	61.2±82.1	31.4±63.2
39	Downstream	7.3±5.6	1.3±1.7	43.4±14.0	166.0±25.5	49.9±43.4	19.5±21.8
40	Upstream	-	-	-	-	-	-
40	Downstream	1.9±0.7	0.8 ±1.31	31.3 ±9.75	141.6 ± 19.1	61.2 ± 82.1	31.4 ± 63.2
41	Upstream	-	-	-	-	-	-
41	Downstream	1.5 ± 0.6	0.8 ± 1.3	31.9 ± 9.4	141.9 ± 18.8	62.6 ± 82.8	31.8 ± 63.2
42	Upstream	-	-	-	-	-	-
42	Downstream	3.2 ± 1.4	0.8±0.7	52.8 ± 8.9	186.7 ± 25.7	36.8 ± 9.5	13.1 ± 4.7
43	Upstream	-	-	-	-	-	-
43	Downstream	3.0 ± 1.2	0.8± 0.7	53.5± 9.3	189.0 ±27.9	36.4 ± 10.8	13.2± 5.2
44	Upstream	8.3 ± 3.5	1.9± 0.7	29.3± 5.0	135.4 ± 8.7	38.5 ± 7.2	13.9 ± 5.7
44	Downstream	10.2 ±4.3	1.7 ± 0.5	25.4 ±4.7	125.5 ± 11.7	39.3± 6.7	14.6 ± 4.8
45	Upstream	8.3 ± 3.5	1.9± 0.7	29.3± 5.0	135.4 ± 8.7	38.5 ± 7.2	13.9 ± 5.7
45	Downstream	10.2 ±4.3	1.7 ± 0.5	25.4 ±4.7	125.6 ± 11.7	39.3± 6.7	14.6 ± 4.8
46	Upstream	7.2 ±3.1	1.6 ± 0.7	32.0 ± 9.5	140.4± 16.4	43.0 ± 15.8	15.9 ± 9.9
46	Downstream	7.9 ± 2.8	1.9 ± 0.7	29.5 ± 5.0	136.2 ± 9.3	40.3 ± 11.2	16.2 ± 12.0
47	Upstream	3.2± 1.4	1.6 ± 1.1	53.9 ± 9.7	186.7 ± 25.7	36.8 ± 9.5	13.1 ± 4.7
47	Downstream	7.9 ± 3.9	2.0 ± 1.2	32.0 ± 9.3	140.4 ± 16.0	43.0 ± 15.6	15.9 ± 9.8
48	Upstream	-	-	-	-	-	-
48	Downstream	1.2 ± 1.9	0.1 ± 0.2	29.3 ± 6.2	133.8 ± 12.0	45.0 ± 27.5	19.4 ± 18.0
49	Upstream	-	-	-	-	-	-
49	Downstream	3.8 ± 5.7	0.3 ± 0.4	27.5± 5.6	130.6±10.9	38.6±7.2	14.5 ±4.0
50	Upstream	9.7 ± 3.4	1.7± 0.8	25.6 ± 4.8	125.3 ± 13.2	41.0 ± 9.6	16.4± 9.5
50	Downstream	11.7± 3.3	1.3 ± 0.9	32.4 ± 8.8	142.8 ± 16.7	57.8 ± 66.7	24.4 ± 38.4
51	Upstream	11.3 ±2.7	1.1 ± 1.1	32.4 ±8.8	142.8 ± 16.7	57.8 ± 66.7	24.4 ± 38.4
51	Downstream	14.5 ±2.7	1.4 ± 1.3	30.3 ± 5.6	137.5 ± 11.1	41.6± 12.7	15.1 ±6.5
52	Upstream	8.3 ± 3.5	1.7 ± 0.8	25.4 ± 4.6	123.7± 11.7	41.2 ± 9.8	16.5 ± 9.8
52	Downstream	10.6 ±3.6	1.3 ± 0.9	32.9 ±9.8	143.1 ± 18.1	58.4 ±67.6	25.0 ± 39.3
53	Upstream	16.6 ±7.3	1.6 ± 1.5	30.2 ± 5.7	137.1 ± 11.1	41.7± 12.8	15.2 ± 6.7
53	Downstream	16.6± 4.0	1.0 ± 1.5	29.2 ± 7.3	134.9 ± 13.9	40.7 ± 12.4	15.5 ± 10.7
54	Upstream	4.0 ± 2.7	0.5 ± 1.2	38.9 ± 5.5	129.7± 17.3	25.8± 65.0	8.9 ± 23.1
54	Downstream	5.6± 3.2	0.5 ± 1.0	19.3 ± 5.8	87.6 ± 11.8	29.6± 11.8	9.5 ±3.3
56	Upstream	19.1± 1.7	0±0	191.3 ± 15.3	1809 ± 118	35.2 ± 4.0	12.7 ± 2.3
56	Downstream	13.8 ±7.6	0.4 ± 0.8	151.9 ± 15.9	938.7 ± 77.3	41.4 ± 8.3	14.8± 4.5
57	Upstream	21.0 ±2.5	0.1 ± 0.4	153.6 ± 15.7	935.5 ± 78.6	41.4 ± 8.8	14.5± 4.1
57	Downstream	19.7 ±7.2	0±0	117.9 ± 22.2	629.3 ± 41.0	38.3 ± 5.6	12.5 ± 2.4
58	Upstream	24.4 ±9.2	0.2 ± 0.5	81.2 ± 9.1	348.5 ± 34.6	35.9±3.8	12.6 ± 1.9
58	Downstream	26.1± 9.5	0.2 ± 0.5	61.0 ± 7.2	205.1 ± 37.6	43.0 ± 9.7	15.0 ± 3.7
60	Upstream	20.6 ± 1.8	0.1 ±0.2	153.1 ± 17.1	946.1 ± 66.5	41.8± 8.7	14.2 ± 4.1
60	Downstream	20.0± 6.2	0±0	117.9 ± 22.2	629.3 ± 41.0	38.3 ± 5.6	12.6 ± 2.6
61	Upstream	5.4 ± 5.3	1.1± 1.4	71.3 ± 9.7	293.3 ± 78.9	35.6 ± 6.0	12.8 ± 4.4
61	Downstream	5.7± 5.7	1.3 ± 1.5	53.5 ± 10.2	176.2 ±61.1	43.5 ± 11.3	16.4 ± 6.6
63	Upstream	47.9± 9.5	0±0	132.5 ± 25.1	647.6 ± 59.7	36.4 ± 5.4	12.2 ± 2.2
63	Downstream	52.5±12.0	0±0	81.7 ±9.9	376.3 ± 44.6	40.4 ± 6.2	14.9 ±3.3
64	Upstream	16.3± 4.4	0.02± 0.1	154.9 ± 28.3	884± 75.0	34.4 ± 4.8	12.0 ± 2.3
64	Downstream	17.6± 3.8	0±0	83.7± 27.7	596.7 ± 49.8	41.0 ± 8.2	14.9 ± 3.7
67	Upstream	11.4 ±3.0	1.2 ± 1.2	33.6 ±9.0	146.0 ± 16.2	61.0 ±73.1	26.4 ± 42.2
67	Downstream	14.6± 3.0	1.5± 1.4	31.3 ±5.5	139.8 ± 10.2	40.8± 12.1	14.9± 6.5

TABLE-9

SUMMARY OF DRAIN WATER QUALITY IN CLUSTER 3-10

Industry Code		Flow (MLD)	DO (mg/L)	BOD (mg/L)	COD (mg/L)	TSS (mg/L)	VSS (mg/L)
CLUSTER 3: ROORKEE							
72	Upstream	0±0	0.8 ± 0.9	65.3 ± 76.6	357 ± 467	149 ± 144	93.2 ± 71.8
72	Downstream	0.4 ± 0.1	1.3 ± 0.9	61.0 ± 31.7	342 ± 168	172 ± 301	93.3 ± 86.8
73	Upstream	0±0	0±0	521 ± 223	3164 ± 1340	351 ± 205	205 ± 94.4
73	Downstream	0±0	0±0	432 ± 184	2747 ± 1245	1343 ± 1032	459 ± 319
74	Upstream	0±0	1.3 ± 1.5	90.6 ± 145	507 ± 879	68.5 ± 94.9	60.7 ± 89.5
74	Downstream	0±0	0.9 ± 1.1	79.5 ± 72.3	468.6 ± 452	82.8 ± 86.5	58.1 ± 50.2
75	Upstream	0.1 ± 0.1	0.23±0.65	187 ± 125.5	1123 ± 714	124 ± 85.0	127 ± 123
75	Downstream	1.2 ± 2.1	0.3 ± 0.5	153 ± 112	990 ± 646	138 ± 146	140 ± 175
CLUSTER 4: SITAPUR/KANPUR							
79	Upstream	-	0.6±1.2	321 ± 375	1168±1380	32.5±2.6	11.4±1.9
79	Downstream	-	1.3±1.8	435± 361	1706±1564	35.5±3.5	13.0 ±1.4
82	Upstream	9.2±9.1	3.1±0.8	18.9±2.5	115 ±10.0	20.8±2.9	7.2±1.3
82	Downstream	12.8±5.9	2.7±1.4	22.9±2.0	130 ±8.4	41.2±5.6	14.5±4.2
CLUSTER 6: FAIJABAD/KHALILABAD/BASTI							
86	Upstream	-	-	-	-	-	-
86	Downstream	3.8±0.7	2.9±0.2	28.3±3.8	147 ±9.6	12.2±2.1	12.2±2.1
87	Upstream	-	-	-	-	-	-
87	Downstream	3.8 ± 0.7	2.9 ± 0.2	28.3 ± 3.8	147 ± 9.6	12.2 ± 2.1	12.2 ± 2.1
88	Upstream	225 ± 13.6	3.7 ± 0.2	5.7 ± 1.9	48.8 ± 12.5	33.9 ± 2.9	12.3 ± 1.4
88	Downstream	334 ± 21.9	3.8 ± 0.3	12.3 ± 1.5	80.1 ± 12.2	42.3 ± 3.2	15.6 ± 2.1
90	Upstream	124 ± 16.0	3.5 ± 0.3	5.6 ± 2.1	49.3 ± 12.9	33.6 ± 2.5	12.6 ± 2.9
90	Downstream	129 ± 24.3	3.5 ± 0.4	11.9 ± 1.5	83.2 ± 11.4	37.3 ± 4.0	13.9 ± 2.9
CLUSTER 7: DEORIA							
91	Upstream	16.5 ± 2.5	3.5 ± 0.5	8.9 ± 1.5	75.3 ± 7.9	30.1 ± 5.1	10.7 ±2.2
91	Downstream	17.9± 2.3	3.5± 0.3	11.0 ± 1.3	80.5 ± 6.5	33.8 ± 6.0	12.0 ±2.9
CLUSTER 8: VARANASI							
93	Upstream	-	3.4 ± 0.4	25.2 ± 4.9	130 ± 9.2	81.6 ± 39.8	39.6 ± 24.8
93	Downstream	0.3 ± 0.1	3.4 ± 0.8	21.1 ± 2.8	124 ± 7.5	53.3 ± 29.9	20.2 ± 13.5
CLUSTER 10: UDDHAM SINGH NAGAR EXCEPT KASHIPUR							
98	Upstream	296± 75.5	3.6 ± 0.7	2.8± 1.2	14.5 ± 2.2	55.8 ± 16.8	58.4 ±24.7
98	Downstream	344± 27.2	3.6 ± 0.7	3.7 ± 1.4	24.4± 4.6	17.9 ± 7.3	49.3 ± 24.3

It is plausible that regular monitoring of the industrial outlet and the upstream/downstream location of the drain may not guide in diagnosing and addressing the issue of poor drain quality. To overcome this problem a thorough brainstorming was done at various levels including Scientific Advisory Committee (SAC) of cGanga to identify a solution to monitor, check and stop the untreated flow of wastes from any source or activity at any point of time. An outline of such a strategy is presented for consideration later in this report.

GROUNDWATER ANALYSIS

Groundwater being an important source of water in rural areas, it is important to assess the impact of discharge of industrial effluents in surface water bodies on ground water quality in the vicinity. Along with water pollution, soil pollution is equally or rather more significant in contributing to the degrading quality of land ecosystem of surrounding river. To assess the impact of PPIs on the groundwater, sampling was done in villages surrounding the targeted industries with the objective to understand the effect of industrial pollution on groundwater.

Roughly three villages were selected in the surrounding of every industry. Some villages were common to multiple industries. The number of villages sampled in Kashipur (Cluster 1), Meerut (Cluster 2 A), Muzaffarnagar (Cluster 2 B) and Clusters 3-10 were 34, 32, 24 and 47, respectively. Ground water sampling was done from 2 types of sources namely, hand pumps (including India Mark handpumps) and tube wells. The reason for obtaining two different samples from various places surrounding the industry was to estimate the water quality at different strata of the water table.

9.1. VARIATION OF GROUNDWATER PARAMETERS

Figures 23 and 24 present information on some groundwater parameters, namely pH, TDS, Alkalinity, Hardness, Sulphates, Ammonical Nitrogen, Total Kjeldahl Nitrogen, Chlorides and Phosphorus. The acceptable and maximum permissible limits of these parameters in the groundwater have been indicated in these figures. Acceptable limit is the one that could be tolerated in the absence of any other sources whereas permissible limit is the one which should not be exceeded in any circumstances. The lower and upper limit in graphs represents acceptable and permissible limits, respectively.

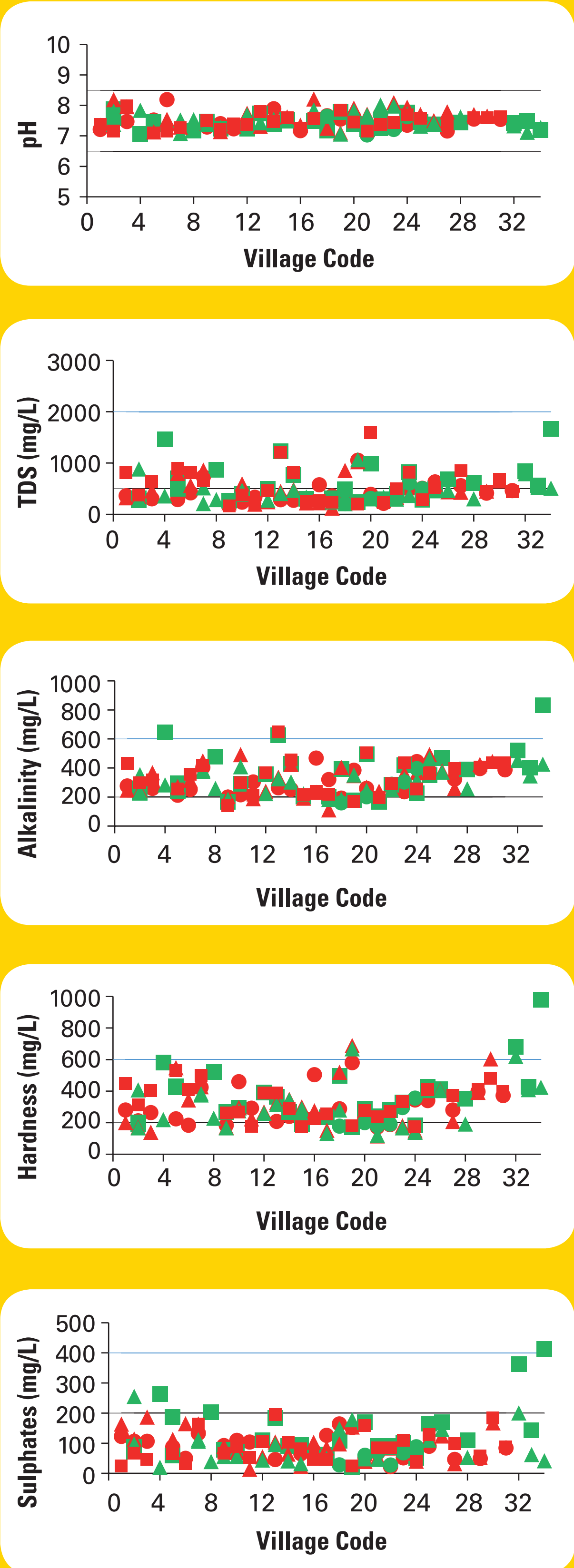
Relatively higher values of TDS, Nitrogen and Phosphorus in groundwater are a matter of concern and this could possibly be due to discharge of industrial effluents as well as agricultural practices. A detailed investigation on contribution of various sources is warranted. Particularly, monitoring of Nitrogen and Phosphorus in effluents of PPIs should be included in the monitoring protocol as these nutrients lead to eutrophication in surface water bodies.

TO ASSESS THE IMPACT OF PPIs ON THE GROUNDWATER, SAMPLING WAS DONE IN VILLAGES SURROUNDING THE TARGETED INDUSTRIES WITH THE OBJECTIVE TO UNDERSTAND THE EFFECT OF INDUSTRIAL POLLUTION ON GROUNDWATER.

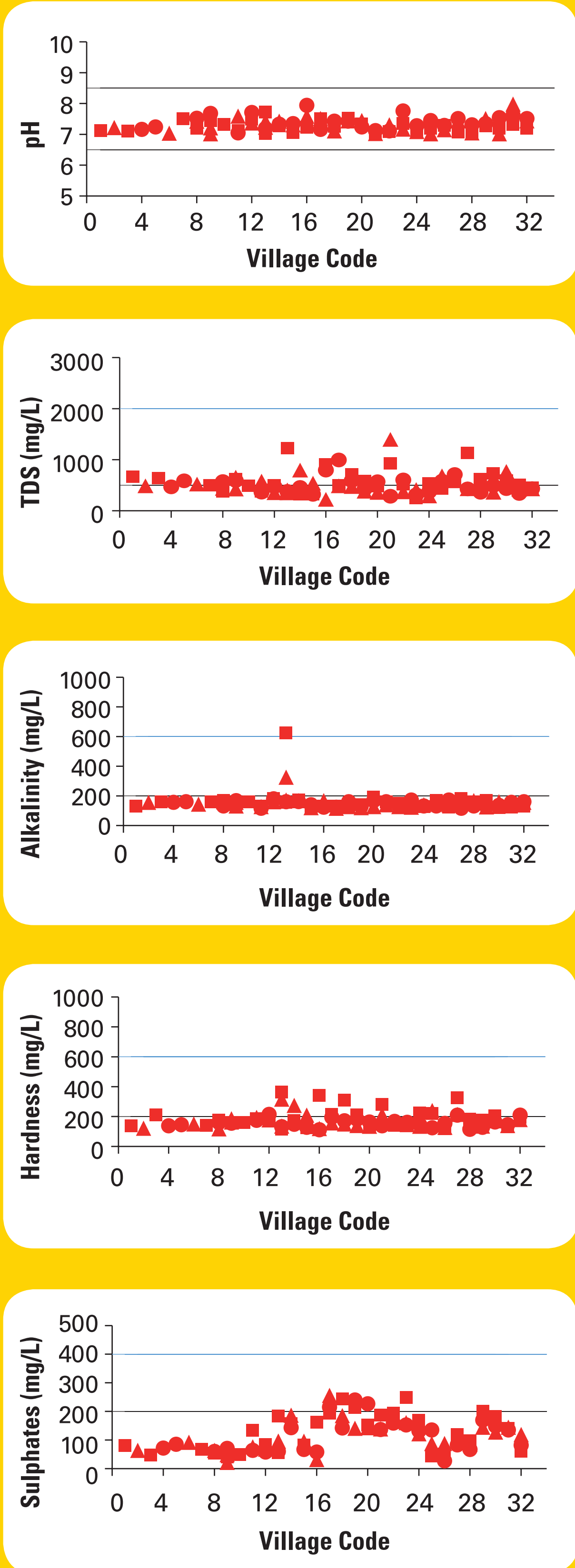
FIGURE-23

REPRESENTATION OF INFORMATION ON GROUNDWATER QUALITY IN THE VICINITY OF PPIs IN CLUSTER 1 (KASHIPUR) AND CLUSTER 2 A (MEERUT)

CLUSTER 1 (KASHIPUR)



CLUSTER 2 A (MEERUT)

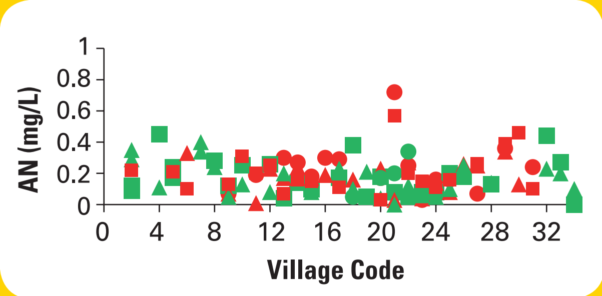


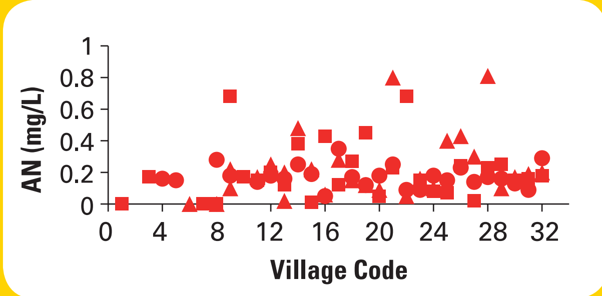
GROUNDWATER SAMPLING

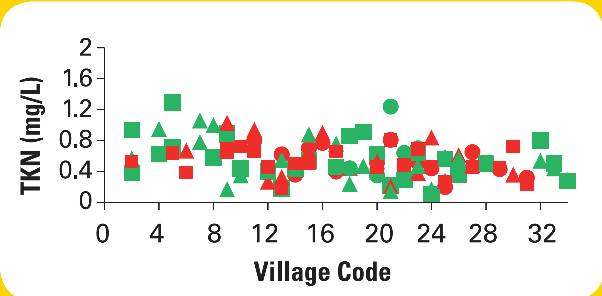
Tubewell (July) | Indiamark (July) | Handpump (July)
Tubewell (August) | Indiamark (August) | Handpump (August)

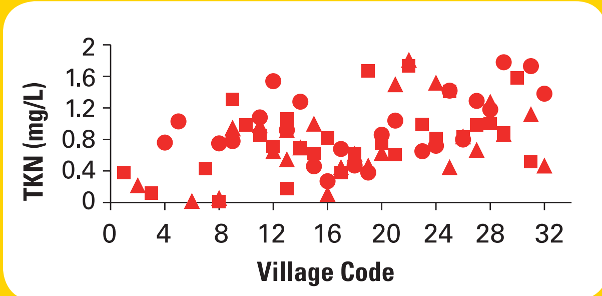
CLUSTER 1 (KASHIPUR)

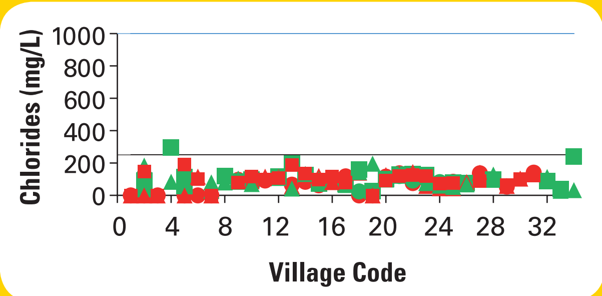
CLUSTER 2 A (MEERUT)

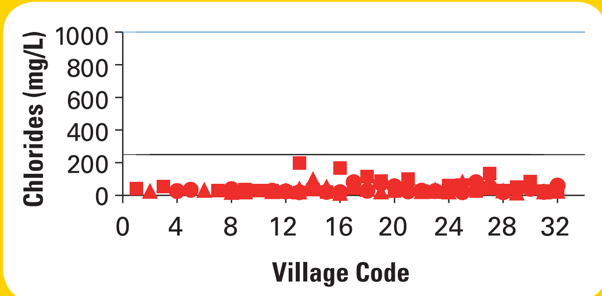


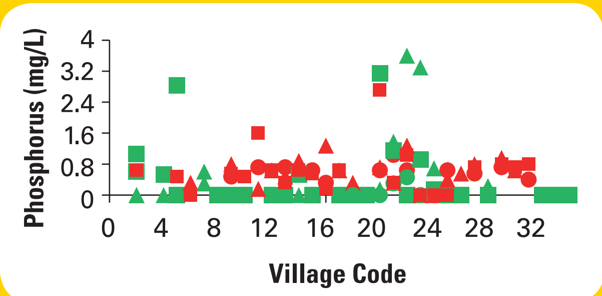


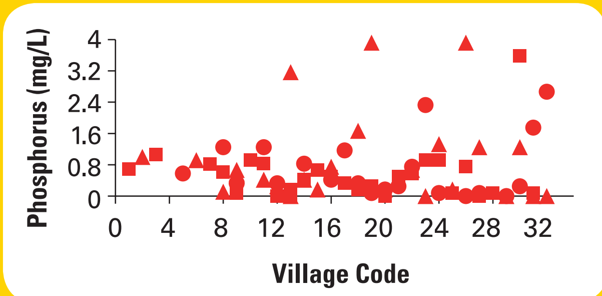










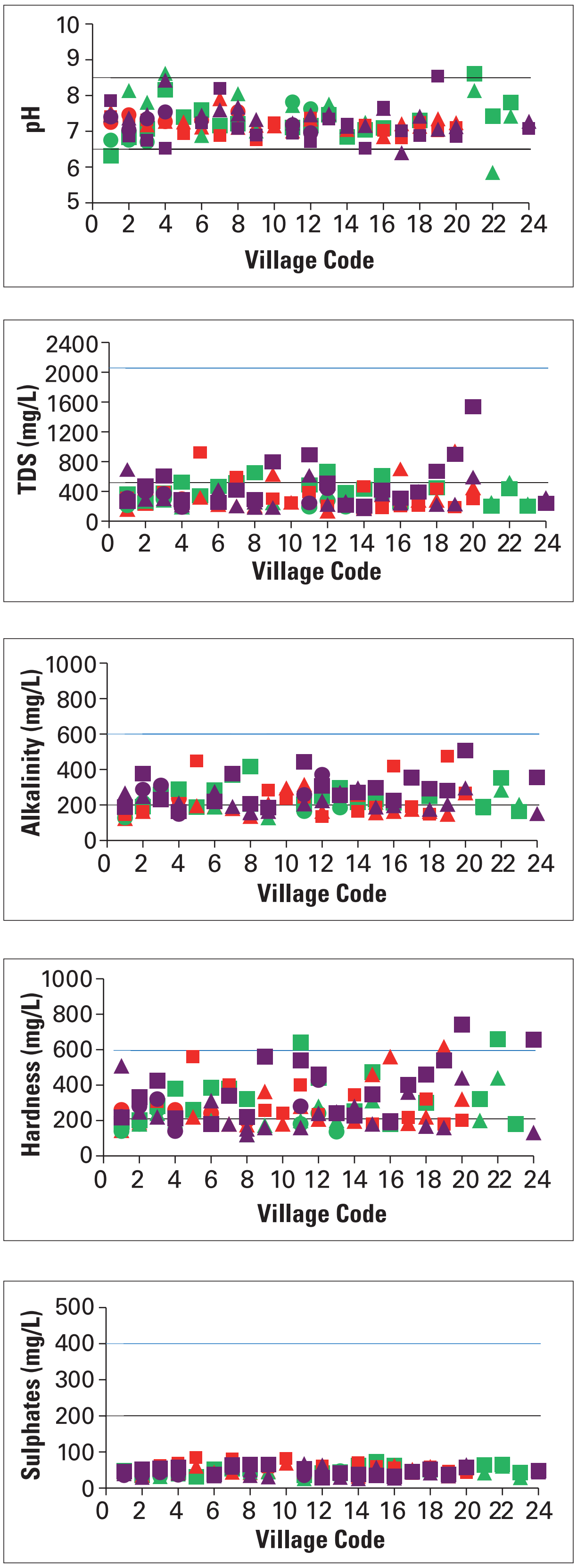


GROUND WATER SAMPLING WAS DONE FROM 2 TYPES OF SOURCES NAMELY, HAND PUMPS (INCLUDING INDIA MARK HANDPUMPS) AND TUBE WELLS. THE REASON FOR OBTAINING TWO DIFFERENT SAMPLES FROM VARIOUS PLACES SURROUNDING THE INDUSTRY WAS TO ESTIMATE THE WATER QUALITY AT DIFFERENT STRATA OF THE WATER TABLE.

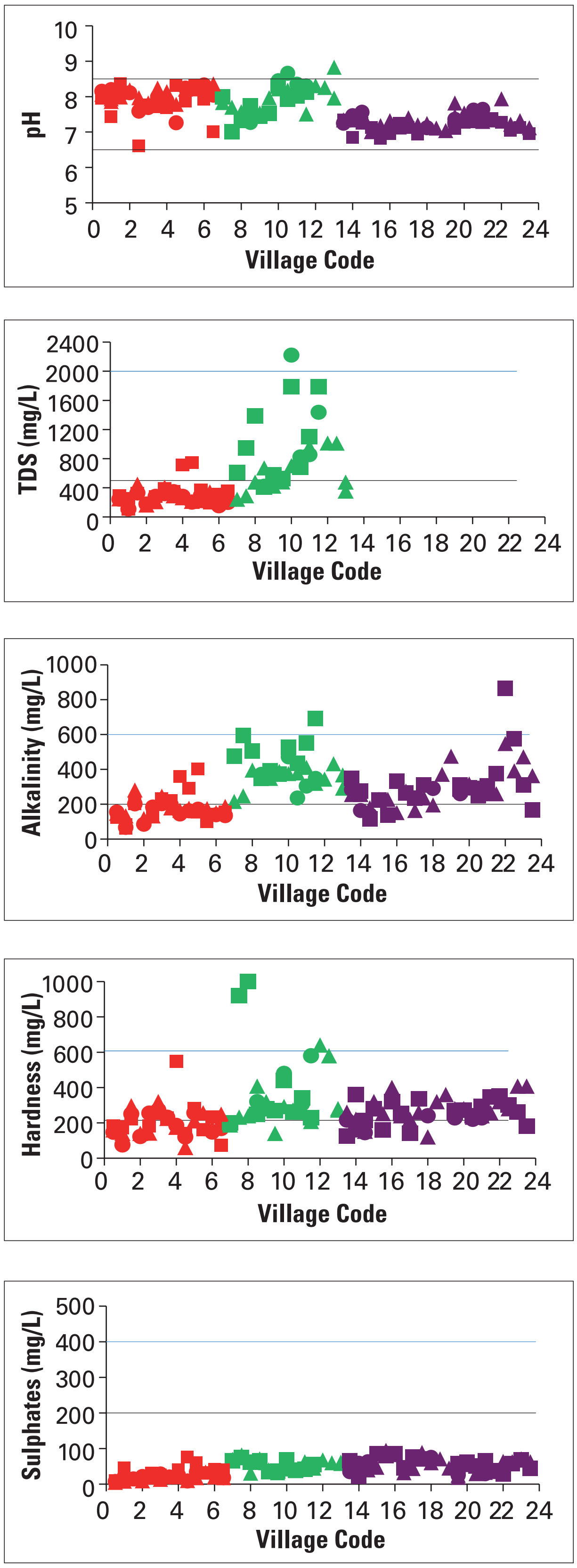
FIGURE-24

REPRESENTATION OF INFORMATION ON GROUNDWATER QUALITY IN THE VICINITY OF PPIs IN CLUSTER 2 B (MUZAFFARNAGAR) AND CLUSTERS 3-10

CLUSTER 2 B (MUZAFFARNAGAR)



CLUSTER 3-10

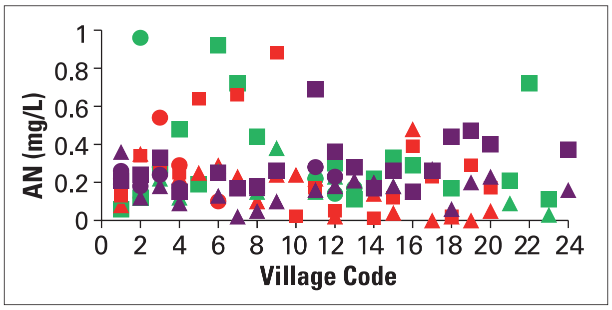


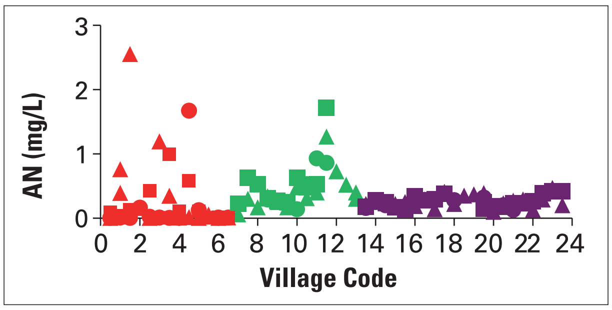
Groundwater sampling

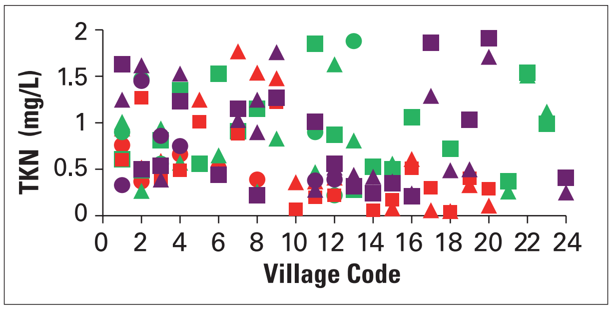
- Tubewell (October)
- Tubewell (December)
- Tubewell (January)
- Indiamark (October)
- Indiamark (December)
- Indiamark (January)
- Handpump (October)
- Handpump (December)
- Handpump (January)

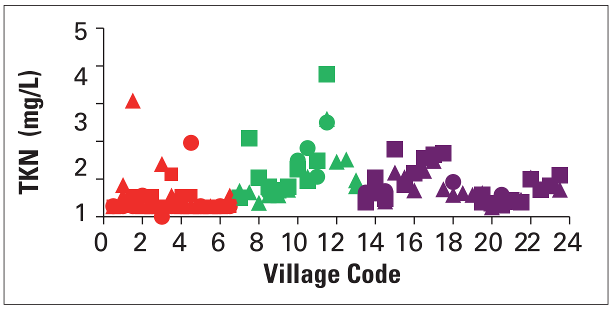
CLUSTER 2 B (MUZAFFARNAGAR)

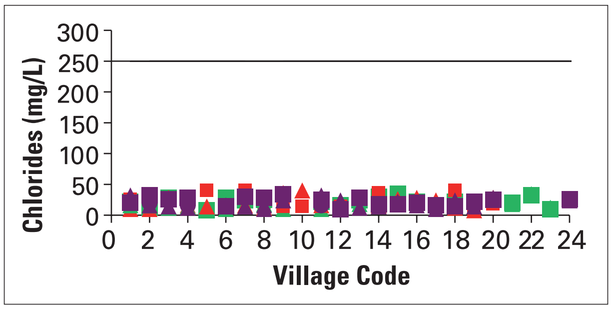
CLUSTER 3-10

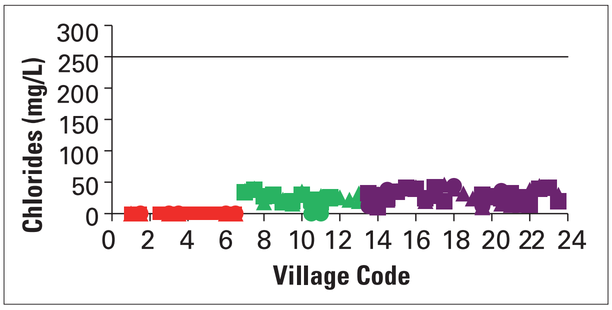


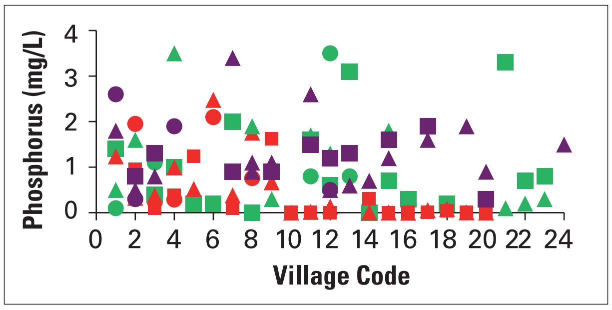


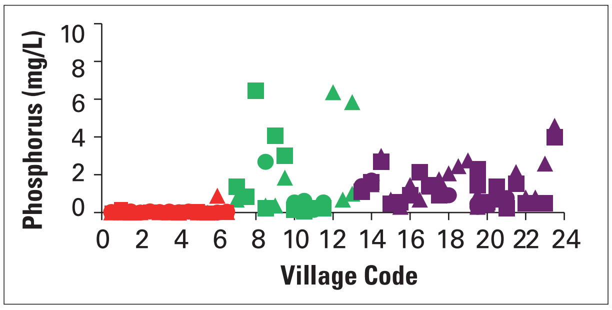












A DETAILED INVESTIGATION ON CONTRIBUTION OF VARIOUS SOURCES IS WARRANTED. PARTICULARLY, MONITORING OF NITROGEN AND PHOSPHORUS IN EFFLUENTS OF PPIs SHOULD BE INCLUDED IN THE MONITORING PROTOCOL AS THESE NUTRIENTS LEAD TO EUTROPHICATION IN SURFACE WATER BODIES.

EFFICACY OF REAL-TIME MONITORING

At each industry, real-time monitoring sensors were installed for measuring five effluent parameters namely Flow, pH, BOD, COD and TSS. Figure 25 shows a sample correlation graph of an industry for flow, BOD, COD and TSS parameters.

It could be easily observed that most online values do not even come close to the actual analytical results for most of the parameters. Ideally, the values should come closer to 45-degree line in Figure 25. Similarly, such plots were made for every industry, and the correlation values were found to be very poor; combining all the industries cluster-wise will definitely have a poor correlation. Cluster-wise graphs for all the four parameters have also been plotted to analyze the overall scenario of all PPIs in a cluster. Figure 26, Figure 27, Figure 28 and Figure 29 show the combined graphs of online and offline measurements for Kashipur (Cluster 1), Meerut (Cluster 2 A), Muzaffarnagar (Cluster 2 B) and Other Clusters (Cluster 3-10), respectively. It should be noted that effluent discharge measurements for industries which were non-operational or operational with zero liquid discharge (ZLD) were not done.

This data raises questions on the accuracy and reproducibility of online monitoring sensors. The reasons could be attributed to (i) the state-of-the-art of most water quality sensors, (ii) governance issues, and (iii) motivation for the industries to gather real time information. Except pH and EC, presently available sensors for other water quality parameters do not generate accurate and reproducible information.

Independent validation of the claims by the suppliers and regulating agencies on the performance of the sensors by technical experts and an appropriate governance mechanism for those sensors whose validity has been established (e.g. Flow, pH and EC) is a prerequisite to enforce real time/ online monitoring for regulatory purposes. Thus, insistence on online monitoring of water/ effluent quality in the charter appears to be unrealistic, does not yield value for money and puts unnecessary financial burden on the industries.

AT EACH INDUSTRY, REAL-TIME MONITORING SENSORS WERE INSTALLED FOR MEASURING FIVE EFFLUENT PARAMETERS NAMELY FLOW, pH, BOD, COD AND TSS. FIGURE 25 SHOWS A SAMPLE CORRELATION GRAPH OF AN INDUSTRY FOR FLOW, BOD, COD AND TSS PARAMETERS.

FIGURE-25

VALIDATION PLOTS FOR REAL-TIME MONITORING PARAMETERS (ONLINE AND OFFLINE)

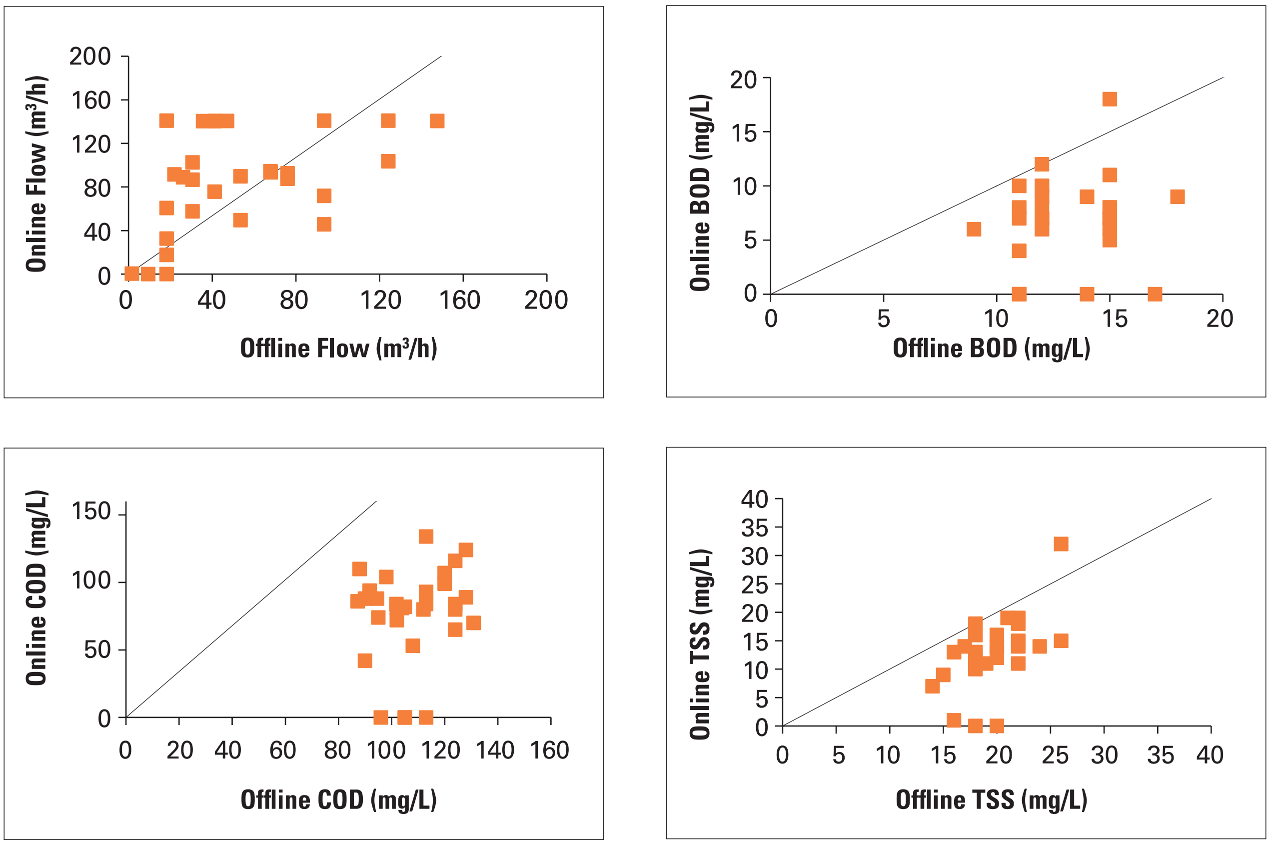


FIGURE-26

COMBINED VALIDATION PLOTS FOR REAL-TIME MONITORING PARAMETERS (ONLINE AND OFFLINE) FOR KASHIPUR (CLUSTER 1)

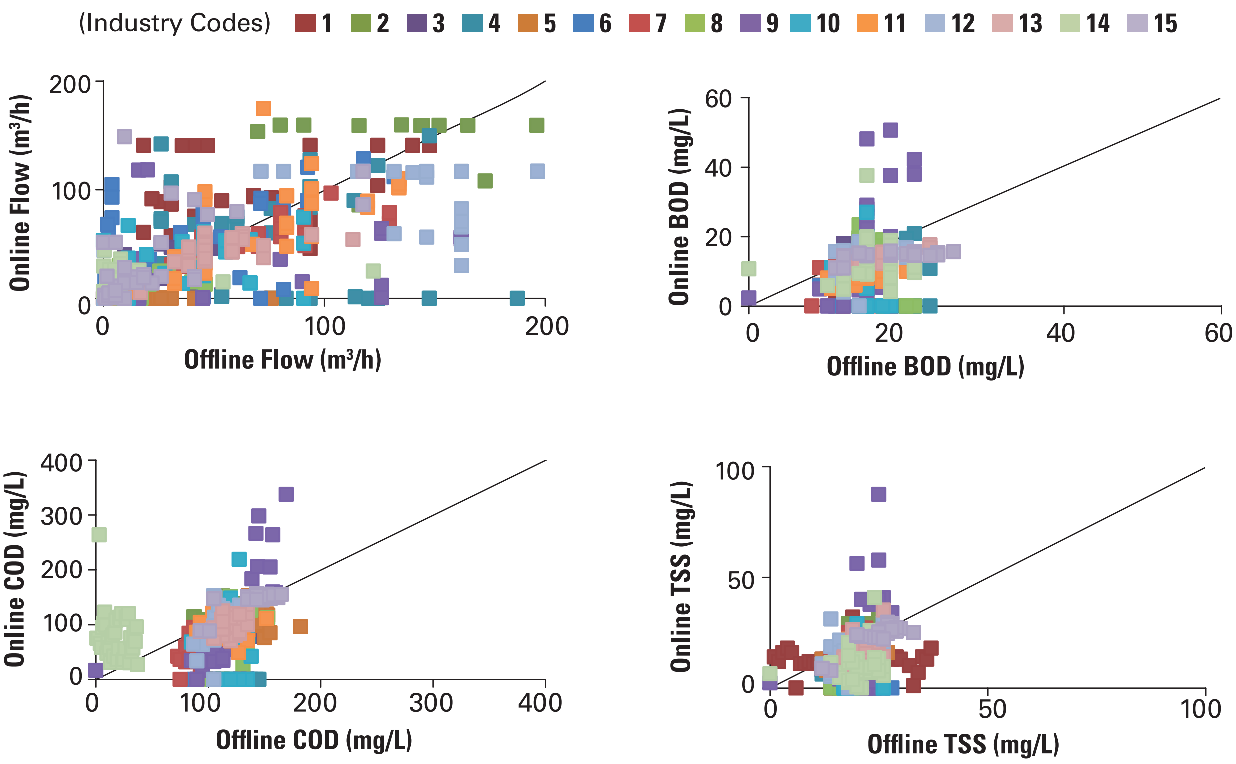


FIGURE-27

COMBINED REAL-TIME MONITORING PARAMETERS ONLINE AND OFFLINE FOR MEERUT (CLUSTER 2 A)

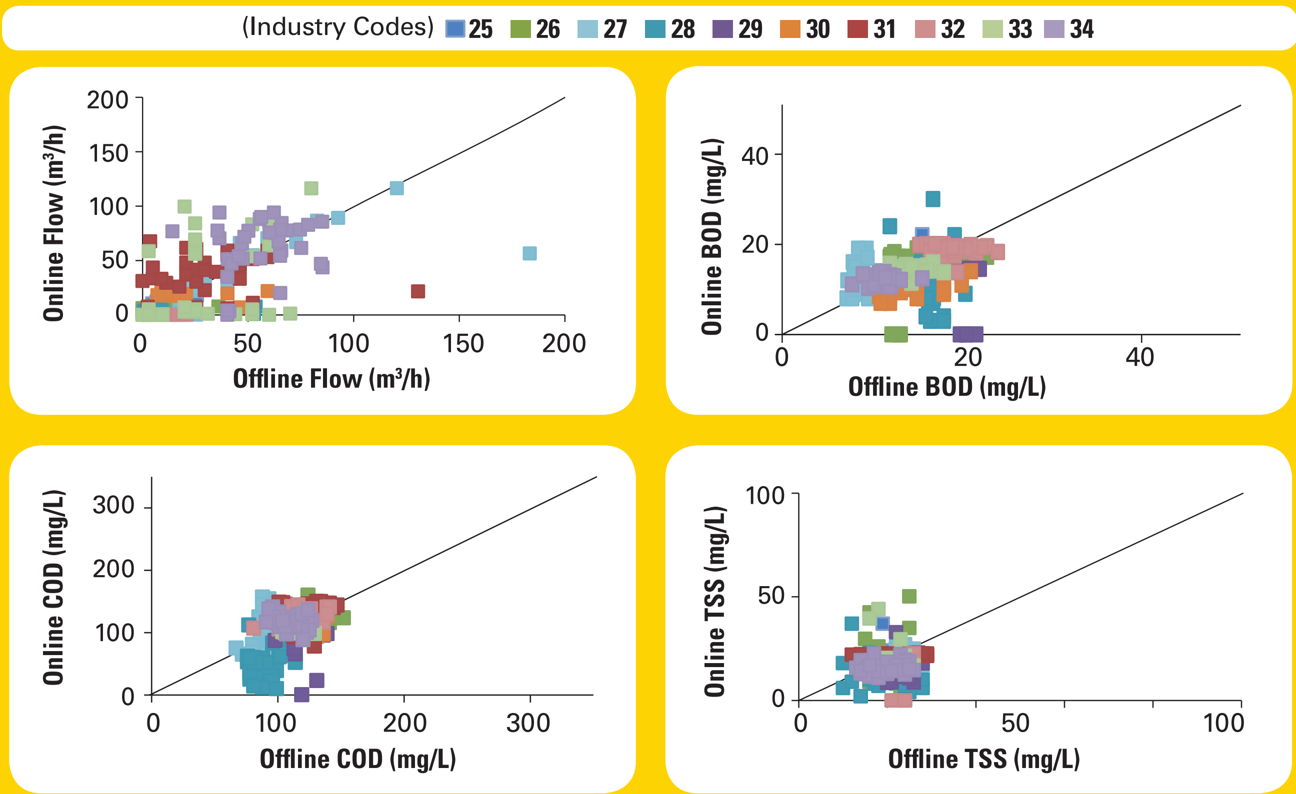


FIGURE-29

COMBINED REAL-TIME MONITORING PARAMETERS ONLINE AND OFFLINE FOR OTHER CLUSTERS (CLUSTER 3-10)

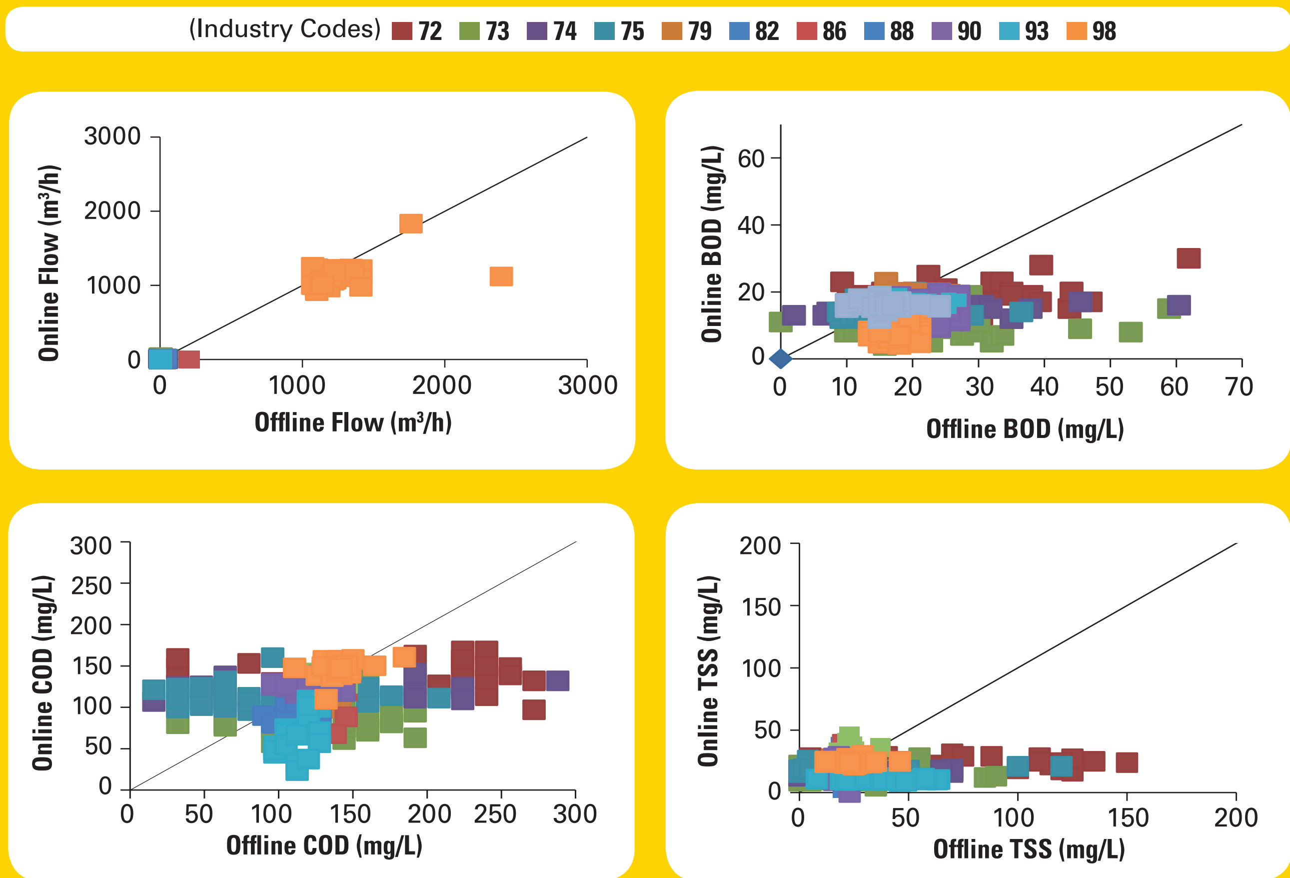
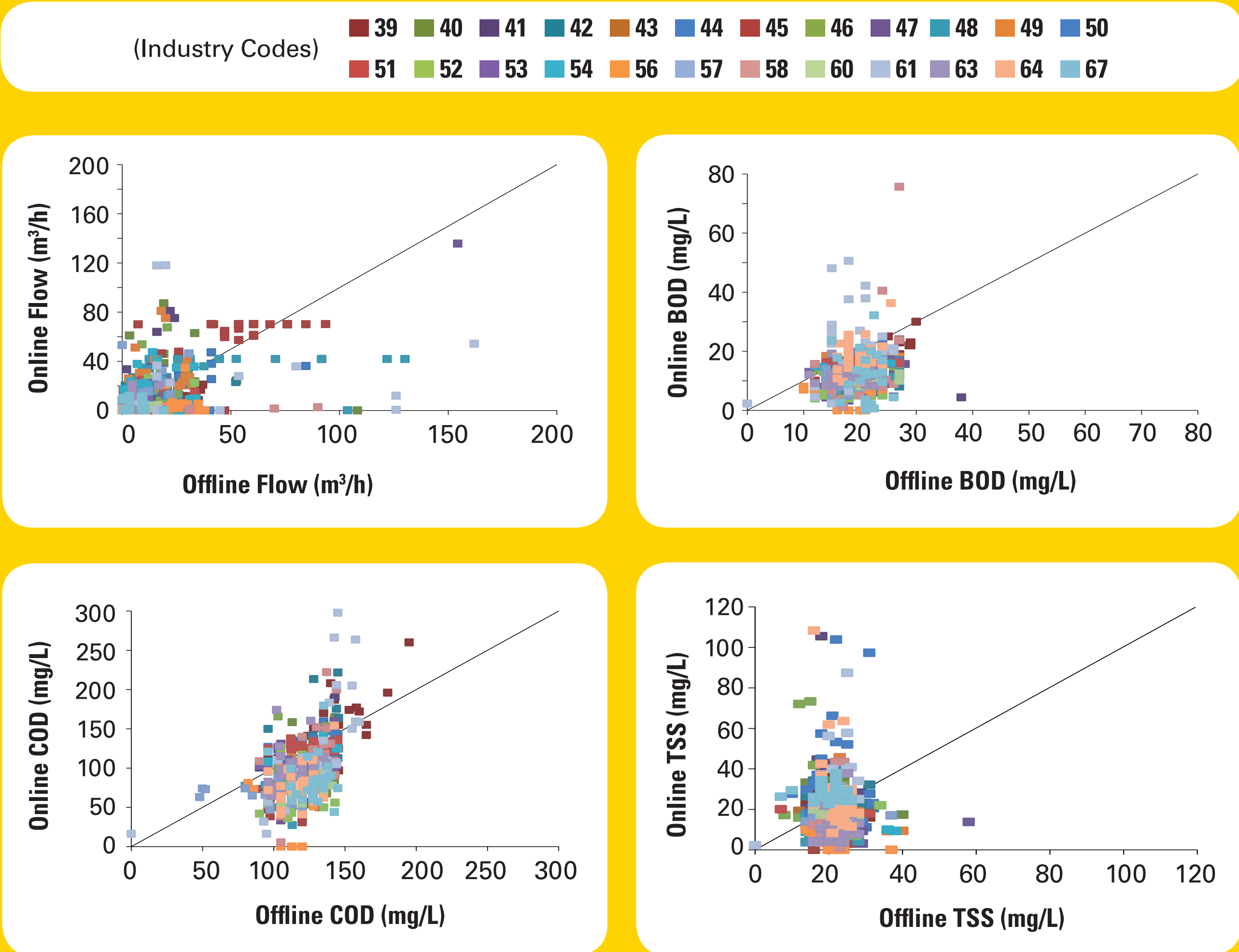


FIGURE-28

COMBINED REAL-TIME MONITORING PARAMETERS ONLINE AND OFFLINE FOR MUZAFFARNAGAR (CLUSTER 2 B)



MALPRACTICES

Apart from poorly correlated real-time sensors (refer: Section 10), there are few other major malpractices which need to be brought in focus. These malpractices are being carried on by different industries from time to time or only occasionally. However, their effect on the overall ecosystem or management practices could be lethal or prohibitory. It is very significant to know the lacuna in the system before building a strong deterrent policy. The main aim of listing these few malpractices is to ascertain that in the near future robust technologies and management practices should be implemented to curb such incidents from occurring. The major malpractices observed in the pulp and industries are briefly described as follows.

11.1. POOR MAINTENANCE OF RECORDS: Poor/ scanty and scattered records of water consumption, discharge or power consumption are maintained by most industries. This makes extremely difficult for monitoring agencies to determine how much water extraction, discharges and pollution loads are occurring from the industry.

11.2. ILLEGITIMATE DISCHARGE OF WASTE/ SLUDGE: Unregulated and untreated industrial discharge into drains occurs during night hours (Figure 30). Online monitors are bypassed by some of the industries many times.

11.3. ILLEGAL OPERATION: Some of the industries continue production during odd hours despite being served closure notices by regulating agencies (Figure 31).

11.4. USE OF ENVIRONMENTALLY HAZARDOUS BOILER FUEL: Using plastics as a boiler fuel releases dioxins and furans formed by reaction of chlorine and hydrocarbons at high temperature. These compounds have known side effects like cancer, impotence, asthma and myriad of other allergies. This not only pollutes the atmosphere but also has potential to cause deadly diseases in localities in and around the industries. Evidence of use of plastic in the boiler as a fuel is shown in Figure 32.

THE MAIN AIM OF LISTING THESE FEW MALPRACTICES IS TO ASCERTAIN THAT IN THE NEAR FUTURE ROBUST TECHNOLOGIES AND MANAGEMENT PRACTICES SHOULD BE IMPLEMENTED TO CURB SUCH INCIDENTS FROM OCCURRING.

FIGURE-30

UN-RECORDED INDUSTRIAL DISCHARGES AT NIGHT

FIGURE-31

UN-AUTHORIZED INDUSTRIAL OPERATIONS

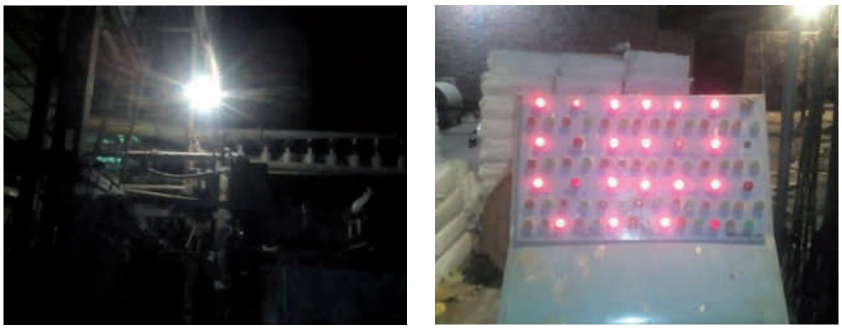


FIGURE-32

USE OF PLASTIC AS A BOILER FUEL

FIGURE-33

EVIDENCE OF AN OPERATIONAL INDUSTRY WITH NON-FUNCTIONAL ETP

11.5. ILLEGAL USE OF WATER METERS: Two or more bore wells were found to be connected to a common water meter. This leads to incorrect measurement of water used in the industry.

11.6. NON-OPERATIONAL ETPs: Some industrial units claim Zero Liquid Discharge without ETP or non-operational ETP. Apart from that, few industries which don't hold ZLD status legally but claim to be on ZLD, have taken liberty for not maintaining any records. Few others, have ETPs but they were non-functional (Figure 33).

11.7. FLOW METERS PLACED AT NON-APPROACHABLE PLACES: In some of the industrial units flow meters are placed in non-approachable places making it ineffective (Figure 34).

11.8. DISPOSAL OF SLUDGE IN THE DRAIN: Some of the industries were found to discharge sludge through different routes to drains directly (Figure 35).

11.9. HESITATION IN SHARING DATA: Industries hesitate to share data related to paper production and captive power generation, if any. It is quite possible that the industries having an authority of say 100 t/d production can produce higher quantities, leading to higher effluent discharge. Since electrical consumption can be linked to paper production capacity, non-sharing of data on captive power generation leads to inaccurate assessment of water consumption.

11.10. MULTIPLE DISCHARGE POINTS: Multiple discharge points were observed for different operations or sub-processes (i.e., at V notch, treated water has been discharged but in between V Notch and subsequent drains, untreated water/ water containing sludge or fiber has been reported (Figure 36).

11.11. TAMPERING OF ONLINE METERS: In a few industries, online monitors were sample-fed or tampered, hence their readings for outlet discharge do not change with time. The meter reading presented in Figure 37, was the same for different days and different times.

FIGURE-34

NON-APPROACHABLE INSTALLATIONS OF FLOW-METERS

FIGURE-35

BYPASS SLUDGE TO DRAINS

FIGURE-36

MULTIPLE EFFLUENT DISCHARGE POINTS

FIGURE-37

METER READINGS REMAIN UNCHANGED

ASSESSMENT OF IMPACT OF PPIs ON LOCAL RESIDENTS AND THE ENVIRONMENT

In order to analyze the social impact and prevailing conditions among the local residents near the PPIs, a questionnaire was designed. The questionnaire is considered to be a research instrument for scientifically collating information from various stakeholders. The survey was done in villages near or adjoining the PPIs. Some villages were common to two or more industries. A total of 58 villages, 231 families and 1,844 persons were sampled during the questionnaire survey. A brief summary of responses obtained from the local residents near the industries is presented in Tables 10 and 11. The survey response has been categorized into socioeconomic conditions, impact on human and domestic animals' health, impact on agriculture, impact on the environment, and recommendations from households.

12.1. SOCIO-ECONOMIC CONDITIONS OF HOUSEHOLD

In socio-economic conditions family size, number of educated members, location and source of drinking water were considered. The numbers of families sampled during the surveys were 48, 23, 69, 39, 18 and 34 with 7-10 persons/ family in Kashipur, Meerut, Muzaffarnagar, Faizabad/ Khalilabad/ Basti, Deoria and Varanasi/ Allahabad regions, respectively (Tables 10 and 11). Almost all families have drinking water sources in the vicinity of 0-100 m, which comprise of hand pumps including India Mark pumps or submersible pumps. In Kashipur (Cluster 1) and Deoria region (Cluster 7), the major industry is the pulp and paper industry while in other Clusters, some other industries may have equally contributed towards environmental pollution. Hence, while surveying, the questions were made clear and specific that the impact only due to pulp and paper industries is captured.

12.2. IMPACT OF PPIs ON HUMAN AND DOMESTIC ANIMALS' HEALTH

On an average, more than 61% of the population perceive to face problem due to PPIs on the health of their own or their domestic animals. A maximum of 94% families in Deoria to a minimum of 8% families in Faizabad/ Khalilabad/ Basti perceive pollution due to PPIs. Drinking water seems to be a major problem in the areas of Kashipur and Meerut where >80% of the population reported low aesthetic values of drinking water. Secondary problems due to PPIs were respiratory, eye problems, skin problems and smoke-related diseases. More than 84% families reported high smoke related issues in all clusters except in Faizabad/ Khalilabad/ Basti cluster, where people don't face any problem due to smoke. In Kashipur and Deoria, people reported diseases in animals due

ON AN AVERAGE, MORE THAN 61% OF THE POPULATION PERCEIVE TO FACE PROBLEM DUE TO PPIs ON THE HEALTH OF THEIR OWN OR THEIR DOMESTIC ANIMALS. A MAXIMUM OF 94% FAMILIES IN DEORIA TO A MINIMUM OF 8% FAMILIES IN FAIZABAD/ KHALILABAD/ BASTI PERCEIVE POLLUTION DUE TO PPIs.

TABLE-10

QUESTIONNAIRE SURVEY REPORT (CLUSTER 1 AND CLUSTER 2)

		KASHIPUR (CLUSTER 1)	MEERUT (CLUSTER 2 A)	MUZAFFARNAGAR (CLUSTER 2 B)
	Number of families surveyed	48	23	69
	Average number of persons per family	7	7	8
	% of members receiving formal school education	51%	84%	61%
GENERAL STATUS	**DRINKING WATER SOURCE** Hand pump (HP)	100%	52%	56%
	Gov. HP (India Mark)	-	-	17%
	Submersible pump	-	48%	25%
	Distance travelled for collecting drinking water (meter)	0 - 15	0 - 15	0 – 100
INDUSTRIES	Nearby industries in that area	Paper	Paper, sugar, salt, thread, chemical, glass/ bottle, cardboard, balloon, alcohol, holder, fiber, inverter/battery	Paper, iron/steel, chemical, brick, sugar, battery, alcohol
	% families recognizing pollution as a concern	79%	74%	84%
IMPACT OF PPIs ON HUMAN & ANIMAL HEALTH	% families facing problems due to PPIs	77%	65%	77%
	Dirty drinking water	81%	81%	54%
	Eye problem	13%	43%	23%
	Respiratory problem due to smoke	54%	40%	43%
	Health and other adverse effects of smoke	85%	96%	84%
	Other problems	Smoke, sewage and plastic dumping on land	Skin problem, diseases, ash	Smoke, skin problem, ash, new diseases emerge
	% families stating their domestic animals to be adversely affected by PPIs	63%	43%	36%
IMPACT OF PPIs ON AGRICULTURE	% families reporting productivity loss	23%	26%	35%
	% families reporting solid waste dumping on land	77%	61%	58%
	% families using water discharged by PPIs in agriculture	0%	0%	0%
IMPACT OF PPIs ON ENVIRONMENT	% families reporting black fume discharge by PPIs	73%	91%	87%
	% families reporting no improvement in industrial effluent discharge	98%	100%	100%
	% families not satisfied by water quality of drains in the vicinity	75%	61%	72%
RECOMMENDATIONS	Clean the drain and factory outlet water	50%	65%	39%
	Close the factory	10%	17%	3%
	Don't know	40%	18%	58%

IT IS INTERESTING TO NOTE THAT ALMOST ALL INDUSTRIES CLAIM TO TREAT THEIR EFFLUENT EITHER AT SECONDARY TREATMENT STAGE OR TERTIARY TREATMENT STAGE; STILL, THE DISCHARGED WATER IS NOT CONSIDERED APPROPRIATE FOR IRRIGATION PURPOSES EXCEPT IN FAIZABAD/ KHALILABAD / BASTI CLUSTER WHERE VILLAGERS USE THE EFFLUENT FOR IRRIGATION.

to sludge and wastewater discharge by the PPIs to be 63% and 78%, respectively.

12.3. IMPACT OF PPIs ON AGRICULTURE

Less than 35% of the families have reported reduced productivity due to solid waste from PPIs being dumped on agricultural land. Overall, 77%, 61%, 58% and 72% of families raised issues of solid waste dumping on agricultural as well as non-agricultural land in Kashipur, Meerut, Muzaffarnagar and Deoria, respectively.

It is interesting to note that almost all industries claim to treat their effluent either at secondary treatment stage or tertiary treatment stage; still, the discharged water is not considered appropriate for irrigation purposes except in Faizabad/ Khalilabad / Basti cluster where villagers use the effluent for irrigation.

12.4. IMPACT OF PPIs ON ENVIRONMENT

Black fumes were reported to be emitted by PPIs mostly in Cluster 1 and Cluster 2 regions, while Kashipur, Meerut, Muzaffarnagar and Deoria have a larger number of families unsatisfied with their nearby drain conditions. Apart from Faizabad/ Khalilabad/ Basti cluster, a majority of the population in other clusters feel that there is no improvement in drain water quality from the past.

12.5. RECOMMENDATIONS FROM HOUSEHOLDS

There were mainly two recommendations suggested by localities to improve their local and personal conditions: (1) to clean their drains and industrial outlets, and (2) close the industry. 50%, 65% and 39% of the people from Kashipur, Meerut and Muzaffarnagar respectively were in favor of cleaning the local drains. Rest of the population was not sure about how the conditions of water, land and air could be improved.

It should be noted that although questionnaire survey is a tool to capture peoples' perception, the answers of every individual is affected by the level of their understanding of the question, their personal thoughts, their biasness/ seriousness towards a particular topic or sometimes projecting it as a bigger picture to drag more attention from government bodies.

TABLE-11

QUESTIONNAIRE SURVEY REPORT (CLUSTER 6-9)

		FAIZABAD/ KHALILABAD/ BASTI (CLUSTER 6)	DEORIA (CLUSTER 7)	VARANASI, ALLAHABAD (CLUSTER 8, 9)
	Number of families surveyed	39	18	34
	Average number of persons per family	8	7	10
	% of members receiving formal school education	72%	85%	53%
GENERAL STATUS	**DRINKING WATER SOURCE** Hand pump (HP)	54%	11%	44%
	Gov. HP (India Mark)	22%	11%	18%
	Submersible pump	8%	78%	26%
	Distance travelled for collecting drinking water (meter)	0–100	0–5	0–50
INDUSTRIES	Nearby industries in that area	Paper, Carton, Cement pipe	Paper	Paper, poultry, biscuit, pipe, rice, thread, syringe, transformer, cement, oil, coal
	% families recognizing pollution as a concern	3%	100%	65%
IMPACT OF PPIs ON HUMAN & ANIMAL HEALTH	% families facing problems due to PPIs	8%	94%	47%
	Dirty drinking water	0%	54%	18%
	Eye problem	0%	0%	0%
	Respiratory problem due to smoke	0%	22%	24%
	Health and other adverse effects of smoke	0%	96%	84%
	Other problems	Chaff, dust	Skin problem, diseases, ash	Smoke, ash, air pollution
	% families stating their domestic animals to be adversely affected by PPIs	0%	78%	3%
IMPACT OF PPIs ON AGRICULTURE	% families reporting productivity loss	3%	28%	0%
	% families reporting solid waste dumping on land	0%	72%	0%
	% families using water discharged by PPIs in agriculture	21%	0%	-
IMPACT OF PPIs ON ENVIRONMENT	% families reporting black fume discharge by PPIs	0%	0%	21%
	% families reporting no improvement in industrial effluent discharge	18%	100%	71%
	% families not satisfied by water quality of drains in the vicinity	10%	94%	41%
RECOMMENDATIONS	Clean the drain and factory outlet water	39%	89%	38%
	Close the factory	0%	11%	-
	Don't know	Proper supervision and its improvement in terms of quality	-	62%

EFFECTIVENESS OF CPCB CHARTER 2015

9

STATES IDENTIFIED BY CPCB HAVING PPIs

During 2012-13, CPCB identified 9 states in the Ganga River Basin having PPIs. They were Uttarakhand, Uttar Pradesh, Haryana, NCT of Delhi, Madhya Pradesh, Chhattisgarh, Bihar, Jharkhand and West Bengal. CPCB implemented a Charter which envisaged the up-gradation of the status of PPIs in terms of process technology, practices, environmental performance, reduction in freshwater consumption, wastewater generation and compliance to environmental norms. The Charter proposed few strategies and activities which need to be followed by various stakeholders. Eight key stakeholders {PPIs, PPI Associations, Educational Institutes (IITs, NEERI etc.), CPPRI, SPCBs/ PCCs, CPCB, MoEF and NMCG} were identified.

The major strategy and activities mentioned in the Charter have been listed in Table 12. Based on cGanga's visit to these PPIs, some conclusions were drawn towards effective implementation of the Charter in terms of its policy, implementation, and effectiveness on the ground.

The study by cGanga is based on field surveys, questionnaire surveys, drone surveys and water sampling report in the PPIs and surrounding areas.

TABLE-12

EFFECTIVENESS OF CHARTER FOR WATER RECYCLING AND POLLUTION PREVENTION IN PULP AND PAPER INDUSTRIES

	Good	Satisfactory	Not Satisfactory
Policy Implementation Effectiveness			

01

STRATEGY
Reduce water consumption

OBSERVATION
Most of the PPIs have treatment units till tertiary level which increases water recycling, therefore reduced water consumption. Recently most PPIs changed to ZLD, which supports reduced water consumption

02

STRATEGY
Up gradation of ETP till tertiary treatment step is mandatory

OBSERVATION
Effluent treatment on site, reduced pollution, reduced freshwater uptake. Nice step by CPCB, but not all PPIs are following.

08

STRATEGY
Self-Assessment: Preparation of report of existing water consumption - section wise, reuse/ recycle practices; Preparation of work plan to achieve fresh water requirement targets

09

OBSERVATION
Log books for effluent water quality, ETP electricity consumption, ETP chemical dosing, etc., were maintained by most of the PPIs

STRATEGY
Self-Monitoring & Reporting: ETP performance monitoring by individual Mills and maintenance of Log Book as per the prescribed format

10

STRATEGY
Organization of training programs on process technology, best practices, ETP operation & maintenance, Sample analysis etc.

OBSERVATION
No such kind of activities were organized by most of the industries

11

STRATEGY
Strengthening of Environmental Cell and Laboratory in Industry to ensure improved Environmental Compliance

11A

STRATEGY
pH Estimation

11B

STRATEGY
TSS Estimation

11C

STRATEGY
COD Estimation

03

STRATEGY
Strict metering of water used and wastewater generated is recommended

OBSERVATION
Meters were installed in every industry. However, meters were not calibrated or they were tampered or the sensors technology was defective leading to meter readings far from the manual observations

04

STRATEGY
Third party involvement is recommended for planning, assessment, design and monitoring implementation of Charter

OBSERVATION
This step was made to have transparency and legitimate data records. The authority thereby is willing to understand both pros and cons of the Charter implementation by allowing third party to give disinclined results

05

STRATEGY
Installation of sealed flow meter and running hours meter on bore wells and inlet pipe line of different process section i.e. pulp mill, paper machine, boiler etc.

OBSERVATION
Section-wise meters were not installed. Although most of the industries have meters at inlet (borewells) and outlet

06

STRATEGY
Color coding of pipe lines carrying recycled process water and fresh process water

07

OBSERVATION
Log books were maintained by most of the PPIs

STRATEGY
Maintenance of log book to record daily water drawl from bore well and water consumption unit wise after installation of meter

11I

STRATEGY
SAR (Sodium Absorption Ratio) Estimation

11H

STRATEGY
AOX (Absorbable Organic Halides) Estimation

11G

STRATEGY
BOD Estimation

11F

STRATEGY
Color Estimation

11E

STRATEGY
MLSS/MLVSS Estimation

11D

STRATEGY
TDS Estimation

STRATEGY FOR IMPROVING THE STATUS OF WATER BODIES

The main aim of this study was to analyze pollution load from pulp and paper industries in Ganga River Basin as well as assessing the impact of Charter "Water Recycling and Pollution Prevention in Pulp and Paper Industries" (CPCB, 2015). Further industries, as well as regulatory agencies, have claimed that implementation of the Charter has resulted in substantial reduction in pollution load. Despite this, the water quality of drains remains poor and sometimes even comparable to that in sewers.

The current survey report highlights that most of the drains already had a considerable pollution load on the upstream, and is further burdened by pollution being discharged by the cluster of PPIs at the downstream end. The pollution in the river is aggravated to such an extent that its natural assimilative capacity is exhausted. The question arises that, in-spite of the stringent norms laid by the Charter, if the condition of drains still failed to improve, then should the norms be made more stringent or other alternative strategy should be formulated?

Secondly, as per the Charter, real-time sensors were required to be set up by industries for monitoring following five parameters – Flow, pH, BOD, COD and TSS. A comparison of real-time monitoring and water quality analysis by Team cGanga shows no correlation between the two sets of data. Poor correlation raises doubt regarding the validity of online monitoring sensors. If the values denoted by the sensors are not indicative of the actual water quality parameters, then the important question to be addressed is: whether the functioning of real-time sensor is at all worth the financial investment and data analysis time?

Thirdly, the Charter imposes norms on BOD and COD of effluents. But there are no limits for some of the parameters such as on nitrogen and phosphorus. These critical

01

THE BIGGER OBJECTIVE OF CREATING MORE WATER BODIES WHICH WILL BE PRIVATELY OPERATED AND MAINTAINED WILL BE FULFILLED.

02

SAVINGS THE COST, ENERGY, MANPOWER AND TIME FOR REGULAR MONITORING OF EACH AND EVERY INDUSTRY.

03

BETTER AWB CONDITION WILL ATTRACT CHANCES OF LOCAL PARTICIPATION IN EFFLUENT MONITORING.

04

DEGRADED AWB CONDITION WOULD CALL FOR 'POLLUTER PAYS' PRINCIPLE TO ALL THE DISCHARGING INDUSTRIES. THIS COULD BE A PRACTICAL WAY TO INITIATE THE IMPLEMENTATION OF PPP.

water quality parameters go unchecked. Nitrogen and phosphorus in water bodies are responsible for eutrophication in rivers and streams, leading to an increased growth of flora and aquatic plants like water hyacinth. The removal of these aquatic plants is costly and no one is willing to take responsibility for cleaning the water bodies. The ideal solution is to prevent the entry of such nutrients into water bodies, thereby controlling excess aquatic plant growth.

Fourthly, drinking water from handpumps and tubewells in nearby villages exceeds the acceptable concentrations of parameters such as TDS, Hardness, Alkalinity, Sulfates, Chlorides and Ammonical Nitrogen. This could be due to pollution either from point or non-point sources. The solution could only be proper management practices and treatment of wastewater locally before discharging it into the riverine system to avoid further nutrient agglomerations above and below the ground.

The ideal solution to above stated problems and many other smaller issues is to prevent the effluent being discharged to the drains.
Rather the effluent should be diverted and discharged into a separate **Adjoining Water Body (AWB)** before discharging effluent into drains. The condition of the AWB itself will be an indicator or checkpoint of whether the effluent from the industries is meeting the norms or not. If the condition of AWB is well maintained by respective industries then there is no need to invest on the experimentation of several parameters, put online sensors and do periodic survey industry-wise. This AWB can function as an oxidation pond or lagoon, where the effluents will be treated with time. This water can then be reused for irrigation or gardening purposes. The condition of the AWB could be monitored by visual aid or by looking at a few identified biological indicators in and around it. Such a system will lead to multiple benefits such as:

05

EVEN A COMMON PERSON WOULD BE ABLE TO PREDICT OR CONCLUDE WHETHER INDUSTRIES ARE MEETING THE NORMS OR NOT, BY LOOKING AT THE AWB BIO-DIVERSITY. HENCE, THERE WILL BE NO NEED FOR TECHNICAL EXPERTISE AND REGULAR IN-SITU MONITORING.

06

THE OVERALL PROCESS IS HIGHLY SIMPLIFIED AND EASILY MONITORED.

07

EFFLUENT DATA FROM A PARTICULAR INDUSTRY COULD BE ALTERED OR MANIPULATED, HOWEVER IT WOULD BE RATHER DIFFICULT TO MANIPULATE THE COMMUNITY EFFLUENT DATA VALUES FROM THE AWB OUTLET, MAKING THE SYSTEM SIMPLE, ROBUST AND QUICKLY IMPLEMENTABLE.

08

INDUSTRIES WILL SELF-WILLINGLY GO FOR ZLD POLICY OR PROPER ETP FUNCTIONING.

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LIST OF THE INDUSTRIES

INDUSTRY CODE	
1	M/s Naini Tissues Ltd.
2	M/s Naini Papers Ltd.
3	M/s Sidharth Papers Pvt. Ltd., Unit I
4	M/s Sidharth Papers Pvt. Ltd., Unit II
5	M/s Vishvakarma Paper & Boards Ltd.
6	M/s Prolific Papers Pvt. Ltd.
7	M/s Bahl Paper Mills Ltd.
8	M/s Banwari Paper Mills Ltd.
9	M/s Multiwal Duplex Pvt. Ltd.
10	M/s Katyayini Paper Mills Pvt. Ltd.
11	M/s Sahota Paper Ltd.
12	M/s Cheema Papers Ltd.
13	M/s Fibremarx Papers Pvt. Ltd.
14	M/s Uday Paper Mill/ Rajlakshmi Paper & Board Pvt. Ltd.
15	M/s Vishwanath Paper & Board Ltd.
16	M/s BR Paper Pvt. Ltd.
17	M/s Siddheshwari Paper Udyog Ltd.
18	M/s PSB Papers Ltd.
19	M/s Shree Shyam Pulp & Board Mills Ltd., Unit I
20	M/s Shree Shyam Pulp & Board Mills Ltd., Unit II
21	M/s Multiwal Pulp & Board Mills Pvt. Ltd.
22	M/s Devrishi Papers Pvt. Ltd.
23	M/s Goraya Sraw Board Mills Pvt. Ltd.
24	M/s Balaji Paper
25	M/s Janki Newsprint Ltd.
26	M/s Kanav Papers Pvt. Ltd.
27	M/s Sangal Papers Ltd.
28	M/s Sardhana Papers Pvt Ltd.
29	M/s New Bonanza India Ltd.
30	M/s Anand Tissue Ltd. / Shri Venktesh Papers Ltd.
31	M/s Anand Triplex Board Ltd.
32	M/s Anand Duplex Ltd. Unit II
33	M/s Dev Priyag Paper Mill Pvt. Ltd.
34	M/s Dev Priya Products Pvt. Ltd.
35	M/s Anand Duplex Ltd. Unit I
36	M/s Dev Star/ Star Kraft Papers Pvt. Ltd.

INDUSTRY CODE	
37	M/s Dev Priya Industries Pvt. Ltd.
38	M/s Paswara Papers Ltd.
39	M/s Parijat Paper Mills Ltd.
40	M/s Bindlas Duplux Ltd., Unit I
41	M/s Bindlas Duplux Ltd., Unit II
42	M/s Tehri Pulp & Paper Ltd., Unit I
43	M/s Tehri Pulp & Paper Ltd., Unit II
44	M/s Shree Bhageshwari Papers Pvt Ltd., Unit I
45	M/s Shree Bhageshwari Papers Pvt Ltd., Unit II
46	M/s Tirupati Balaji Fibres Ltd.
47	M/s Bindals Papers Mills Ltd.
48	M/s Shakumbhari Paper Mills Ltd.
49	M/s Agarwal Duplex Board Mills Ltd.
50	M/s Meenu Paper Mills Ltd.
51	M/s Silvertoan Papers Ltd. Unit I
52	M/s Silverton Pulp & Papers Pvt. Ltd.
53	M/s Garg Duplex & Paper Mills Pvt. Ltd.
54	M/s Shree Sidhbali Paper Mills Ltd.
55	M/s NS Papers Ltd.
56	M/s Mahalaxmi Craft & Tissues Pvt. Ltd.
57	M/s Siddheshwari Industries Pvt. Ltd.
58	M/s KK Duplex & Paper Mills Pvt. Ltd.
59	M/s Orient Board & Paper Mills Pvt. Ltd.
60	M/s Shakti Krafts & Tissues
61	M/s Suyash Kraft & Paper Ltd.
62	M/s Aristocraft Papers Pvt. Ltd.
63	M/s DLS Papers Pvt. Ltd.
64	M/s Disha Industries Ltd.
65	M/s Galaxy Papers Pvt. Ltd.
66	M/s Prime Pulp & Paper Pvt. Ltd.
67	M/s Silvertoan Paper Ltd., Unit II
68	M/s Shalimar Paper Mills Pvt. Ltd.
69	M/s Arihant Pulp and Papers Pvt. Ltd.
70	M/s Seeta Paper Mills Ltd.
71	M/s Taj Paper Pvt. Ltd.
72	M/s Sagar Paper Mills Pvt. Ltd.

INDUSTRY CODE	
73	M/s Aroma craft and Tissues Pvt. Ltd.
74	M/s Uttranchal Pulp & Paper Mills (P) Ltd, Village –Mundet
75	M/s Sagar Pulp & Paper Mills Ltd.
76	M/s Gangotri Paper Mills Pvt. Ltd.
77	M/s JMJ Paper Products Pvt. Ltd.
78	M/s Anandeshwar Industries Pvt. Ltd.
79	M/s Mahadev Pulp Product Pvt. Ltd.
80	M/s Shri Nageshwar Paper Ltd.
81	M/s RD Papers Ltd.
82	M/s Hari Om Industries Ltd.
83	M/s Bajaj Kagaj Ltd.
84	M/s JB Daruka Paper Ltd.
85	M/s Shree Bhawani Paper Mills Ltd.
86	M/s Yash Papers Ltd., Unit II
87	M/s Yash Papers Ltd., Unit I
88	M/s Suyash Paper Mills
89	M/s Rayana Paper Boards Industries Ltd., Unit- I
90	M/s Rayana Paper Boards Industries Ltd., Unit- II
91	M/s Deoria Paper Mills Ltd.
92	M/s Shri Krishna Straw Board Industries Pvt. Ltd.
93	M/s Ganga Pulp and Papers Pvt. Ltd.
94	M/s Newal Calcutta Pvt. Ltd.
95	M/s Devprayag Paper Mill Pvt. Ltd.
96	M/s PN Pulp & Paper Industries Pvt. Ltd.
97	M/s PN Papers Mills Pvt. Ltd.
98	M/s Century Pulp and Paper
99	M/s KM Papers Mill
100	M/s Ramaa Shyama Papers Ltd.
101	M/s Genus Paper & Boards Ltd.
102	M/s Shri Ramchander Straw Products Ltd.
103	M/s Gangeshwar Papers Pvt. Ltd.
104	M/s Maruti Papers Ltd.
105	M/s Nikita Papers Ltd.
106	M/s Lal Ji Board Industries Pvt. Ltd.
107	M/s SR Mittal Paper Mills
108	M/s Dayalji Industries Pvt. Ltd.

INDUSTRY CODE	
109	M/s Swaroop Papers Pvt. Ltd.
110	M/s Star Paper Mills Ltd.
111	M/s Chadha Papers Ltd.
112	M/s Modinagar Paper Mills Ltd.
113	M/s Ved Cellulose Ltd.
114	M/s Nav Bharat Duplex Ltd.
115	M/s Chamunda Papers Pvt. Ltd.
116	M/s Ashoka Pulp & Paper Pvt. Ltd.
117	M/s Magnum Ventures Ltd.
118	M/s Shri Ganga Paper Mills Pvt. Ltd.
119	M/s Suchi Paper Mills Ltd.
120	M/s Kawatra Papers Pvt. Ltd.
121	M/s Sandeep Paper Mills Pvt. Ltd.
122	M/s Kamakshi Papers Pvt. Ltd.
123	M/s Coral Newsprints Ltd.
124	M/s Kaushambhi Paper Mills Pvt. Ltd.
125	M/s Mohit Paper Mills Ltd.
126	M/s Rama Paper Mills Ltd.
127	M/s Shree Badri Kedar Papers Pvt. Ltd.
128	M/s Chandpur Enterprises Ltd.
129	M/s KR Pulp & Paper Ltd., Unit I
130	M/s KR Pulp & Paper Ltd., Unit II
131	M/s Khatema Fibres Ltd.

CENTRE FOR GANGA RIVER BASIN MANAGEMENT AND STUDIES