Benchmarking the Water Resources & Developing Siting Criteria for Establishment of Industrial Areas and Water Intensive Units

A REPORT

Submitted to the

Rajasthan State Pollution Control Board, Jaipur

(FINAL REPORT)

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रक्षये प्रकृतिं पांतु लोकाः

National Institute of Ecology

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PREFACE

Rajasthan, the largest state of India, is a water-starved state, with most of its area being hyper-arid to semi-arid. The state depends greatly for its development upon water imported from river basins in neighbouring and other states. Much of agriculture is still rain-fed but there is growing emphasis on groundwater abstraction. Three major users of water- humans (for domestic use & sanitation), agriculture and industry compete for the limited groundwater resources. According to the latest data, more than 80% of the groundwater sources are already over-exploited.

Thus, there is growing realisation of the need for reducing water consumption in all the three sectors. However, all the three sectors pollute water in various ways. Agriculture is not only a major user of water but also a polluter - both directly and indirectly – but without a potential for recycling or reuse because its 'wastewater', contaminated with agrochemicals moves below ground and hence, cannot be intercepted. In the domestic sector and several industries, 80 to 90% of the water used is returned as wastewater. But, the domestic and industrial wastewaters can be intercepted at source, treated, recycled and reused in many ways to reduce the pressure on surface and ground waters. Rajasthan State has already adopted a policy for recycling and reuse of domestic wastewaters.

Although the industries together are estimated to use only 6-7% of total available water resources, there are several water-intensive industries which account for 85-90% of all the water abstracted by the industries. Incidentally, most of these industries are also located in water deficient areas and thereby compete with the domestic and agricultural needs of water. Further, most of the industrial areas in Rajasthan have either no perennial streams and surface water bodies or only ephemeral or seasonal streams. This situation severely aggravates the problems caused by pollution.

It is in this context that this study, commissioned by the Rajasthan State Pollution Control Board, analyses the water use efficiency in the water-intensive industries such as the textiles, breweries and distilleries, chemicals & fertilizers, dairy (milk processing) and thermal power. Criteria and guidelines for siting of new industrial areas and water intensive units, together with the expansion of existing ones, are suggested. This study is based entirely on secondary data available with the State Pollution Control Board and readily available from representative industries and other sources, and the discussions with the staff of representative industries. The role and contribution of various departments/agencies for implementation of the suggested criteria and guidelines are identified and a framework for developing a state policy on the recycling and reuse of wastewater in the industries is proposed. The study also highlights the need for detailed data on the use of water resources in different industries in relation to the processes and production. Finally, a wide range of recommendations are made for better water management in the industries through reduced abstraction, recycling and reuse of wastewater, better monitoring and appropriate changes in industrial and water-related policies.

Jaipur
10 September 2020 BRIJ GOPAL, M.S. RATHORE, R. DALWANI

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We were greatly benefitted by the discussions with the officers of various industries who spared their precious time to discuss various aspects concerning their industries. We are sincerely thankful to all of them. We heartily thank the representatives of various Government Departments and a wide range of industries, too many to be named individually, who actively participated in the discussions at the Stakeholder Workshop organised by us jointly with the RSPCB, and benefitted us with their useful suggestions.

We thank all the supporting staff of the State Pollution Control Board, and the team of our researchers for their willing cooperation, support and hard work in compiling the data on industries in the State. Their continued work and support during the difficult period since the lockdown due to CoVid-19 pandemic is deeply appreciated.

Contents

EXECUTIVE SUMMARY

BACKGROUND

Rajasthan is the largest state of India, accounting for 10.4% of the land area. It hosts about 6% of the country's human population. However, it is a water-starved state, as its average annual rainfall is only 550 mm, less than half of the Indian average. Most of its area are hyper-arid to semi-arid, with rainfall being as low as 100 mm in its western part. All of the rivers in the State are seasonal and carry very little water. There are only a few medium sized reservoirs, and the surface water is inadequate to meet even the basic human needs. The state depends greatly upon the import of about 40% of its water requirement from external sources for its development. Much of agriculture is still rain-fed but there is growing emphasis on groundwater abstraction. Thus, all the three major users of water- the humans (for domestic use & sanitation), agriculture and industry compete for the limited groundwater resources. According to the latest data, more than 80% of the groundwater sources are already over-exploited. The large population of livestock and the rural populations, particularly in the western arid Rajasthan suffer the most from water scarcity while the industries in these areas continue to exploit the ground water from deep aquifers.

Thus, there is growing realisation of the need for reducing water consumption, and recycling and reuse of wastewater after appropriate treatment. All three sectors pollute water in various ways. Agriculture is not only a major user of water but also a polluter - both directly and indirectly – but without a potential for recycling or reuse of its own wastes. The 'wastewater' produced by agriculture cannot be intercepted and diverted for treatment. Therefore, while the domestic and industrial sectors can, and are required to, treat their wastewaters for recycling and reuse, the agriculture has the major option of only reducing water consumption and use the treated wastewaters from other two sectors in order to reduce groundwater abstraction. The State has already adopted a policy for recycling and reuse of domestic wastewaters.

Although the industries together are estimated to use only 6-7% of total available water resources, there are several water-intensive industries which account for 85-90% of all the water abstracted by the industries. Incidentally, most of these industries are also located in water deficient areas and thereby compete with the domestic and agricultural use. Further, these industrial areas have either no perennial streams and surface water bodies or only ephemeral or seasonal streams. This situation severely aggravates the pollutional impacts of wastewater generated by the industries in these areas.

The Rajasthan State Pollution Control Board recognised the highly critical problem of water availability in most parts of the State of Rajasthan, and that many kinds of industries required very high volumes of water which results in an equally acute problem of pollution caused by industrial wastewaters. Therefore, the State Pollution Control Board decided to commission the present study to examine the potential for reducing the use of water in the water-industries and issues related to the siting of new industries in the state vis-à-vis water availability, as well as the policy concerning recycling and reuse of effluents.

OBJECTIVES

The objectives of the study were:

- Benchmarking the use of water resources in the water-intensive industries,
- To develop criteria and guidelines for siting of industrial areas & locating water intensive units,
- To review the State and national policies, guidelines and rules related to water and waste water,
- To examine the competitive uses of available water resources, and
- To suggest a policy framework for the recycling and reuse of industrial effluents.

METHODOLOGY AND LIMITATIONS

This study is based entirely on secondary data in the applications for Consent to Operate, available with the State Pollution Control Board, and that readily available from other government sources. Efforts were made to validate the data with field survey and interaction with representative industries.

The study is also limited by the non-availability of required time series data on actual production, and the actual water use, over any time period due to reluctance of industries to share the required data. Conducting extensive surveys of industries across the scales and districts was constrained on account of limited time and resources.

PHYSIOGRAPGY AND CLIMATE OF RAJASTHAN

Rainfall is the ultimate source of water and the groundwater varies with the geological and physical conditions. Therefore, it is important to understand the physiography and climatic conditions which determine the spatial distribution of water across the state.

Physiographically, the state is divided into four regions: (a) Aravalli hill ranges, (b) Eastern plains, (c) Western Sandy Plain and Sand Dunes, and (d) Vindhyan Scarpland and the Deccan Plateau,

Climate of Rajasthan

The climate in Rajasthan is subtropical monsoonal but experiences very high variability of rainfall. The total annual rainfall ranges from less than 100 mm in the far west to nearly 1000 mm in the southeastern parts. The normal annual rainfall of Rajasthan is 549 mm. Based on the annual rainfall, we can distinguish three hydrologic zones:

(1) All of the Arid to Semi-Arid area west of Aravallis with a mean annual rainfall of less than 250 mm only. The area is almost completely devoid of any natural surface water sources (except the seasonal river Luni). It includes the districts of Hanumangarh, Churu, Sri Ganganagar, Jhunjhunu, Nagaur, Sikar, Jodhpur, Pali, Jalore, Sirohi, Barmer and Jaisalmer;

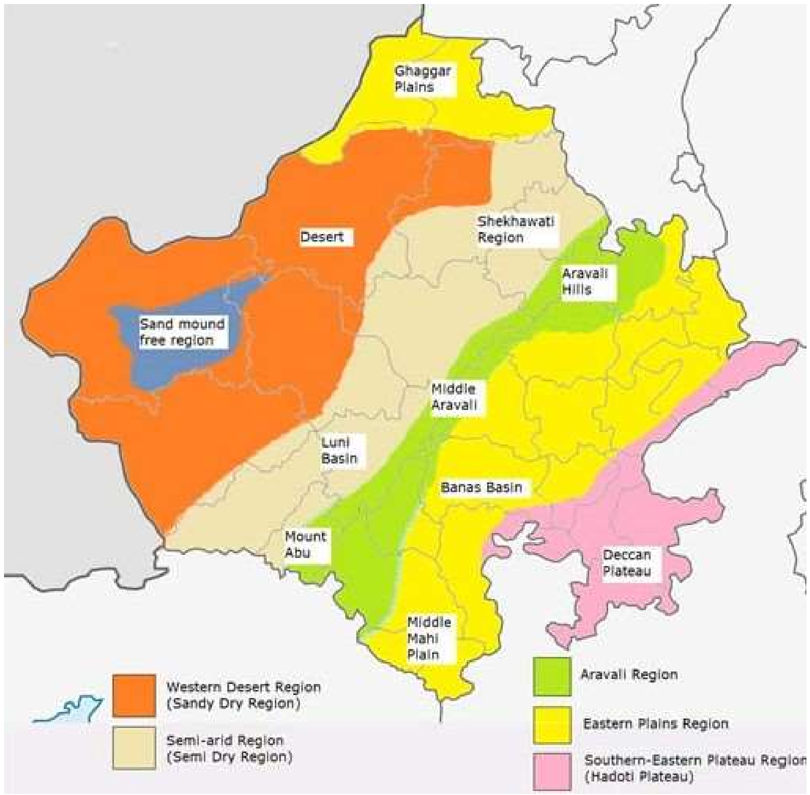


Figure 1. Physiographic divisions of Rajasthan

(2) The central Sub-humid to Humid Zone east of the Aravallis, with annual rainfall between 250 and 700 mm. It includes the districts of Alwar, Bharatpur, Jaipur, Dausa, Ajmer, Sawai Madhopur, Karauli and Dholpur. As the rainfall increases from west to the east, the zone may be subdivided into two parts with rainfall from 250 to 500 mm, and from 500 to 700 mm; and

(3) The South-Eastern Rajasthan with rainfall more than 700 mm. It includes the district of Kota, Baran, Bundi, Banswara, Dungarpur, Rajsamand, Jhalawar, Bhilwara, Chittor and Udaipur.

Pattern of Annual Rainfall distribution across the state of Rajasthan

Based on the climate, soils and other characteristics relevant to agriculture, five main agroclimatic zones are recognised in Rajasthan: Western Plain, Transitional Plain, Eastern Plain, Southern Plain and the Southeastern Plain (= Hadauti Plateau). These are further divided into sub-zones..

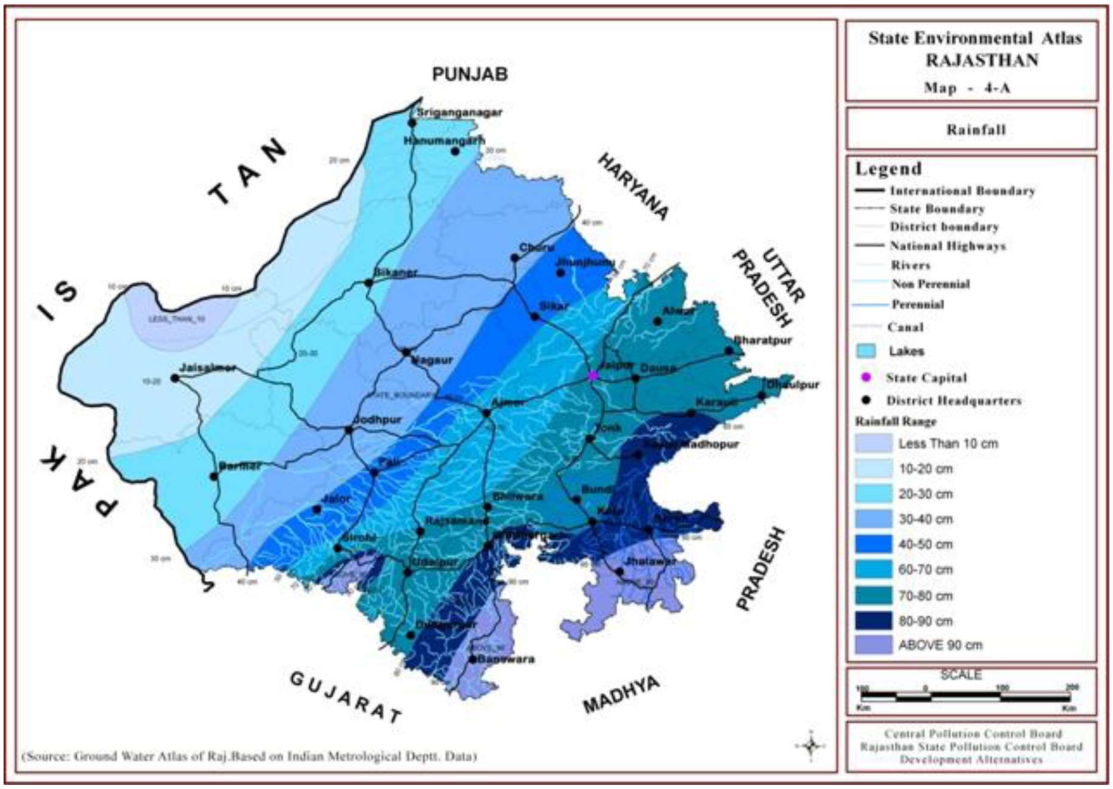


Figure 2. Variation in annual rainfall within Rajasthan

Figure 3. Agroclimatic zones of Rajasthan

WATER RESOURCES IN RAJASTHAN

Rajasthan has very few water resources. Most of the rivers except Chambal and Mahi are seasonal. All the rivers which originate within the state, carry their flows outside the state into U.P. or Gujarat. Chambal originates in M.P., passes through Rajasthan and carries the flow of its tributaries into R. Yamuna in U.P. There is no natural freshwater lake The only natural lakes are the salt lakes which are also seasonal and depend upon the monsoon rains. However, many reservoirs have been constructed on most of the seasonal and ephemeral streams to intercept their monsoon season flows for irrigation and domestic supplies.

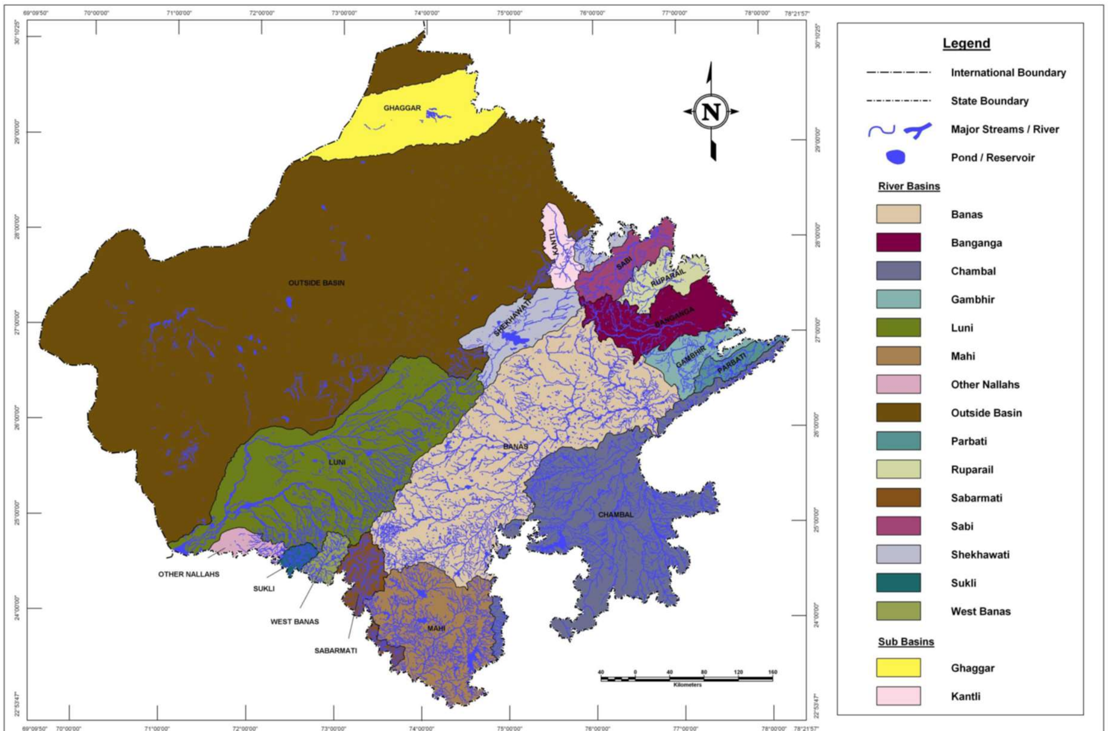


Fig. 2 : River Basin Map of Rajasthan

The estimates for the total surface and groundwater resources in Rajasthan show that the state depends heavily (about 35% of total water and 45% of the surface water) on the imported water (from outside the state) for its development needs. The latest available data show that more than 80% of the groundwater blocks are over-exploited, some to the extent of 300%. Only about 15% of the blocks were in the safe limit in 2017. About half of the total groundwater is nearly saline, and in many areas it has high fluoride, chloride, nitrate and iron levels, besides it generally high TDS concentration, making it unsuitable for drinking.

Agriculture water demand is around 85% of total water utilized in the state and of that 60% is met from groundwater. Although drinking water for livestock has been accorded high priority in the State Water Policy, the livestock suffer the most in the arid and semi-arid region in the absence of surface water bodies. Industries are often a powerful competitor for water against other priority users.

Groundwater

According to the latest (2017) data available from the Groundwater Board. 63.3% of the blocks (183 out of 295) were over-exploited (withdrawal exceeding the annual recharge) whereas another 62 blocks were in critical or semi-critical state. Only 45 blocks (15.4%) were within safe limit (withdrawal less than 70% of annual recharge).

Table 1. Total Surface and Ground water resources in Rajasthan

Item	Availability (BCM)	% of Total Water	% of Surface Water	Utilization (BCM)	% utilization
Surface Water a. Internal Water	21.71	42.6	54.8	11.29 (31.6%)	52
b. External Water	17.88	35.1	45.2	12.66 (35.4%)	70.8
Total Surface Water (a+b)	**39.59**	**77.7**	**100**	**23.95**	**69.3**
Ground Water	11.36 *	22.3		11.771** (32.9)	104 **
Grand Total	**50.95**	**100**		**35.721 (100.0)**	**70.1**

*The Vision 2045 document of the Govt of Rajasthan reports only 10.09 BCM as utilizable

** According to the 2017 assessment of CGWB (Dynamic Water Resources of India), the available GW is 11.99 BCM and actual utilisation is 16,77 BCM (i.e. 140% exploitation)

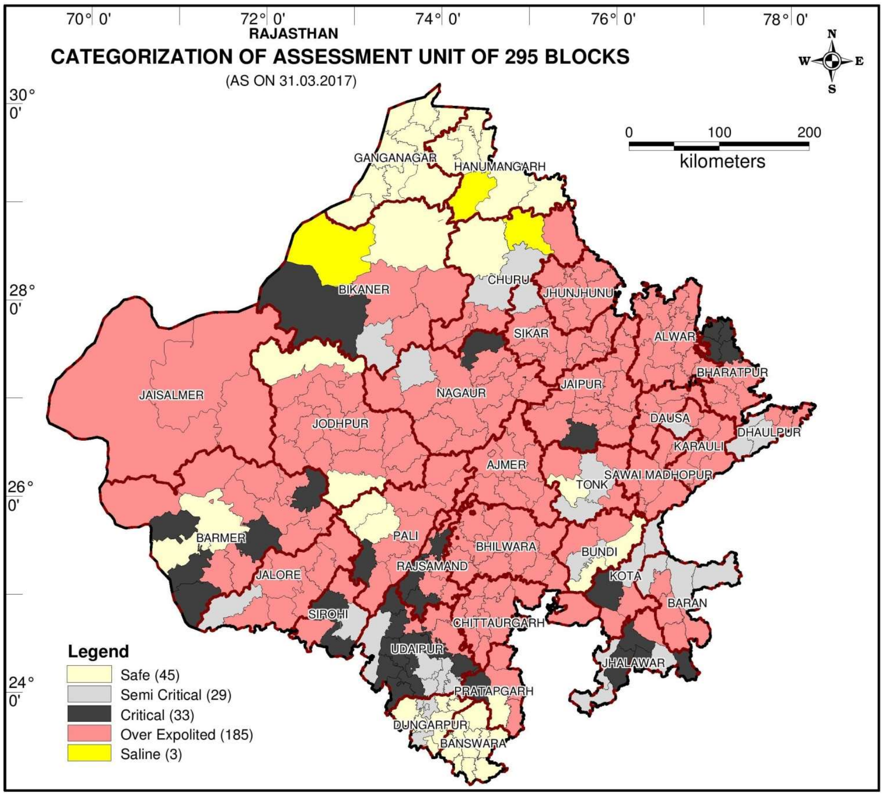


Figure 5. Groundwater map of Rajasthan (2017)

STATUS OF INDUSTRIES

Rajasthan has been known since centuries for its marble, stone and textiles, besides Sambhar salt. Modern industries started in 1938 with the first cement plant in Sirohi. Rajasthan is dominated by small scale industries which have grown almost exponentially in recent years. There were only 17892 industrial units (MSME) until 1974-75. Their number rose from 17,892 units in 1974-75 to 397,054 by 2013-14, and 760,487 during 2018-19. During 2019-2020, 146,472 new units were registered in the State. Thus, small scale industries form the backbone of industrial growth in Rajasthan. Jaipur, Bhilwara, Udaipur, Churu and Ganganagar are major districts which account for 70% of the industrial output. The establishment of RIICO and several policy initiatives of the government have promoted rapid industrial development.

Currently, following are the major industries:

Cement: There are 24 major cement plants. The state is rich in cement grade limestone (17% of India's total) and gypsum.

Mining: The State being highly rich in nearly 80 kinds of minerals, mining is a major industry. There are estimated 560 mines, the second highest number in the country.

Automobiles and their parts: large number of units, concentrated in Alwar, Bhiwadi, Neemrana, Pathredi and Jaipur

Textiles: The most dominant industry in the State which leads in polyester viscose yarn and synthetic textiles. The cotton textile industry is concentrated in Pali, Jodhpur, Balotra, Sanganer, and Bagru

IT and ITeS: Rapidly developing IT industry

Agro-based industries utilised the major crops of coarse grains, oilseeds and spices

They include the breweries, distilleries and beverages.

Dairy industry (milk processing) is spread all over the state.

Chemical industries, mostly fertilisers, pesticides, caustic soda and pharmaceuticals: located mostly in Jaipur, Kota, Udaipur and Bhilwara

Steel re-rolling and Stainless steel industries, mostly in Alwar, Jodhpur and Jaipur

Ceramics and Glass: Abundant supply of various types of clay, felspar and quartz has spawned more than 500 units of ceramic and glass industry in Jaipur, Bikaner, Abu Road and Bhiwadi

Salt making is a centuries old industry at Sambhar Salt lake (Jaipur & Nagaur).

Marble, Slate and Sandstone related industries account for about 90% of India's production.

Energy: All forms of energy (solar, wind, thermal and nuclear) are produced in Rajasthan which is now an energy-surplus state.

Industrial Areas

According to the latest data on the websites of RIICO and Industries Department, currently, there were 320 Industrial areas (IAs) in 20 districts which were set up before the EIA notification 2006 and hence did not require Environmental Clearance. There were 353 industrial areas open for allotment of plots to industries, 10 areas were upcoming, and 34 raw land banks were yet to be developed.

The data show that Jaipur, Alwar, Jodhpur, Ajmer districts had >25 IAs each. Kota, Sikar, Ganganagar, Pali, Bhilwara and Bikaner districts had 14 to 20 IAs each, Sirohi and Udaipur had 12 and 11 IAs respectively. Bhilwara and Udaipur districts had fewer IAs but more large industries. Alwar (including Bhiwadi) also has relatively few (29) IAs but has the largest concentration of large and medium industries. Jaipur has largest number of IAs but only few large industries.

Water Intensive Industries

Industries are categorised by the government on the basis of their size, determined by the investment (and now turnover). For the purpose of environmental regulation, solely from the viewpoint of air and water pollution, the industries are classified as red, orange, green and white. There is no specific definition or criteria available for categorising an industry as water-intensive. Water-Intensive is a relative term; it is nearly impossible to define it in terms of absolute water use. ***Water use may be consumptive***, i.e. it is consumed in the process or production and cannot be recovered even as wastewater***, or may be non-consumptive***, i.e., a very large volume of water is required for a process or activity but almost all or most of it is returned as wastewater.

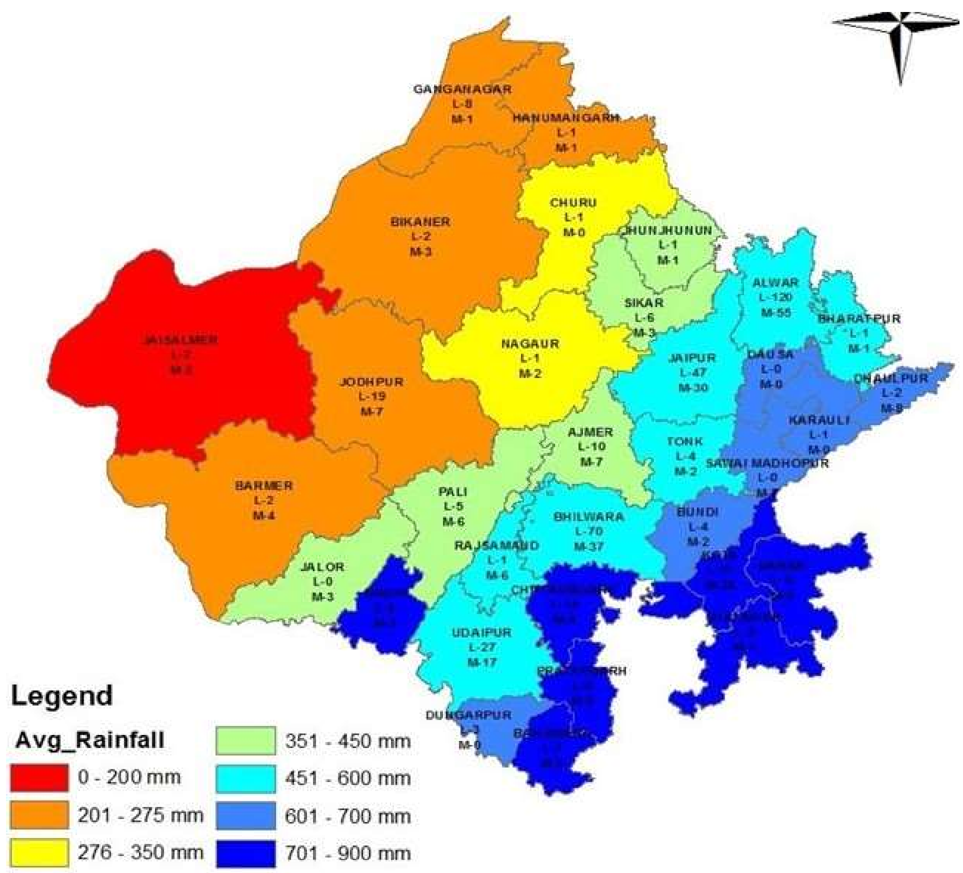
The CGWB has listed the following as water-intensive industries in its Guidelines (2015):

Packaged Drinking water
Mineral water plant
Tannery
Distillery
Brewery
Soft drink
Paper & pulp
Fertilizer
Textile Dyeing
Textile Printing
Textile Spinning
Sugar
Dairy Product
Water park & Amusement center

It is noteworthy that drinking water packaging is considered water-intensive but salt making and thermal power generation are not included.

The data (Table and maps below) show that a significantly large proportion of large and medium scale industries, including the water intensive industries are located in the semi-arid districts of Rajasthan and just east of the Aravalis in areas with less than 500 mm annual rainfall.

District-wise number of industries
Source: Brief Industrial Profiles of Districts,2016-17, Carried out by MSME-Development Institute.



Distribution of Large & Medium Industries in relation to Rainfall

Table 2. Status of Large and Medium Industries in Rajasthan up to March 2017
(extracted from District Industry Profiles)

District (IAs)	District	Large	Medium	Kinds (major)	Kinds (small)
Ajmer (26)	Ajmer	10	7	cement	dairy
Alwar+ Bhiwadi*	Alwar+ Bhiwadi	15 + 105	8 + 47	Brewery, distillery, chemical, pharma, paper, leather, textile. Ceramics, sanitaryware	
Baran (4)	Baran	7	0	Thermal power	
Banswara (6)	Banswara	5	0	Synthetic Textile, cement, distillery	
Barmer (4)	Barmer	2	4	Thermal power	textile, leather
Bharatpur (8)	Bharatpur	1	1	--	
Bhilwara (13+1)	Bhilwara	70	37	Synthetic textiles, cotton, wool fabrics/yarn	Cotton, wool, jute, paper, leather
Bikaner (12 +1)	Bikaner	2	3	--	dairy
Bundi (6)	Bundi	4	2	Cement	--
Chittorgarh (7)	Chittorgarh	14	4	Cement, thermal power, chemicals	synthetic yarn, fertilizer
Churu (8+1)	Churu	1	0	--	--
Dausa (6)	Dausa	0	0	--	--
Dholpur (6)	Dholpur	2	8	Thermal Power, dairy	dairy
Dungarpur (3)	Dungarpur	3	0	Synthetic textile	232 textiles
Ganganagar (14+1)	Ganganagar	8	1	Thermal power	sugar
Hanumangarh (8)	Hanumangarh	1	1	--	Cotton yarn, dairy
Jaipur (R+U) (48)	Jaipur (R+U)	27+20	16+14	Cement, beverage, chemical, tannery	Textile, salt
Jaisalmer (4+2)	Jaisalmer	2	2	--	--
Jalor (4)	Jalore	0	3	--	dairy

Jhalawar (10)	Jhalawar	2	1	Textile	textile
Jhunjhunu (6)	Jhunjhunu	1	1	Copper, chemicals	
Jodhpur+Phalodi (25+3)	Jodhpur +Phalodi	19 + 0	7 + 0	Textile,	
Karauli (4)	Karauli	1	0	--	--
Kota (19)	Kota	11	38	Thermal power	
Nagaur (7)	Nagaur	1	2	Cement	chemical
Pali (14)	Pali	5	6	Textile, cement	Textile
Pratapgarh (1)	Pratapgarh	0	0	--	--
Rajsamand (2)	Rajsamand	1	6	--	--
Sawai Madhopur (3)	Sawai Madhopur	0	7	--	--
Sikar (14)	Sikar	6	3	Cement, synth yarn, dairy	cement
Sirohi (12)	Sirohi	8	3	Cement, synthetic yarn	
Tonk (6)	Tonk	4	2	--	Beverage, cotton yarn
Udaipur (11)	Udaipur	27	17	Synthetic textile, fertilizer, pesticide	--

BENCHMARKING OF WATER USE IN INDUSTRIES

Benchmarking is a process for improving performance of any organization by identifying, understanding & adopting outstanding practices and processes inside or outside the organization. Basically, it means learning from others.

Benchmarking is used to measure performance using a specific indicator resulting in a metric of performance that is then compared to others. It is also referred to as "best practices" which may be adopted or adapted by others. Benchmarking starts with the identification of the best unit in an industry where similar processes exist.

Benchmarking is a tool to determine the efficiency of various user sectors, and for improving water use efficiency through development of appropriate programs and policies based on a comparative analysis of water consumption patterns in various industries. Water has received considerable attention for benchmarking in various industries in many countries but very little so far in India. Depending upon the availability of actual data, benchmarking can be done at

(a) plant level;
(b) process-block level (i.e., grouping certain process steps into one block); and
(c) process-step level.

The water use efficiency for the purpose of benchmarking is the ratio of the amount of water abstracted to the quantity of products (individually or collectively) manufactured over a unit time period (day, month or year). If the industry is able to recycle/reuse wastewater at each process step or before discharge for treatment in the ETP, its water abstraction will decline (considering the same amount of material processed and products manufactured), and hence water use efficiency will increase.

Benchmarking at the plant level requires data on the daily inputs (water, raw materials, energy, etc.) and outputs (finished products) for at least one year to account for the seasonal and day-to-day variability. In our study, we have reloed on the data submitted by the industries in their applications for seeking consent to establish and operate, and approved by the State Pollution Control Board. Data on the amounts of raw materials and/or finished products were not available. Time-series data for the groundwater abstraction and wastewater discharge are of no consequence for benchmarking.

The industries for which water use data were analysed are:

Textiles (Cotton & Synthetic); Dairy; Thermal Power; Brewery; Fertilizers; Cement;

The water use efficiency in various kinds of industries varies greatly depending upon their size and investment in water-saving technologies, and for recycling and reuse. A brief summary of the ranges of water abstraction & used per unit production by different industries is presented in Table below.

RANGE OF WATER ABSTRACTED AND USED BY VARIOUS INDUSTRIES

TEXTILES

Water use in textile industries varies greatly depending upon the material (yarn or fabric, cotton, synthetic or woollen, and its quality), the processes and the products in different units. The average amount of water abstracted per ton of textile processed in various industries in different districts is summarised below.

The values reported from India and other countries also vary greatly – from 120 KL/ton to more than 300 KL/ton in cotton textile industry. The Environment Protection Rules 1986 [Schedule-VI (Part-B)] permit high volumes of effluents from synthetic textiles (120 m^3/ton for nylon & polyester and 150 m^3/ton for viscose rayon), implying thereby the possibility of still higher amount of water being abstracted.

District	Products	Gross Water use KL/ton
Alwar		**10.29**
	Synthetic Yarn	5.26
	Cotton Yarn	24.67
	Dyed Finished Fabric	6.8-21.05
	Mechanized Laundry	5.90
	Suiting Cloth (Weaving)	1.00
	Hosiery	27.27
	Textile Dyeing &Printing	0.42
Banswara		**92.3**
	Fabric Processing /Dying	122.8
	Denim Fabric	172.22
	Cotton Spun Yarn/ Synthetic Blended Yarn/Synthetic Blended Fabric	2.73
	Dyeing Fibre Yarn	40.61
Barmer		**62.14**
	Dyed, Washed, Bleached, Padded Cloth /Fabric	87.63
	Dyed, Printing and Finished Cloth	37.13
	Dyeing of Cloth	35.58
	Dyeing and Printing Cloth	22.18
	Finished Fabric	56.55
	Dyed Washing, Mercerizing, Finishing Cloth	74.12
	Printed and Washed Cloth	12.88
Bhilwara		**268.38**
	Processing of Synthetic Fabric	480.63
	Sized Yarn	9.93
	Denim Fabric	5.6
	Surgical Cotton	11.88
	Woollens Yarn / Tops	18.11
Chittorgarh	Dyeing &Weaving of Cloth	**80.56**
Dholpur	Carpets Durries, Bathmats &home furnishing (Per Piece)	17.52
Jaipur		**138.54**
	Dyed Woollen Yarn	16.0 to 30.0
	Sewing Thread	14.0
	Napkin Face towels	26.0
	Carpet Weaving & Processing	116.67 to 147.93
	Coated Textile Fabric	58.67
	Cotton Fabric Cloth	62.50 to 481.48
	Dye & Printed Cloth	252.62
	Made-up & Garments	140.66
	Printing Dyeing Fabric	28.83 to 250.00
Jhalawar	Blended Synthetic Yarn Dyed	4.53
Jodhpur	Printed Cloth	258.84
Pali		**65.25**

	Bleach Dyed and Printed cloth	74.62
	Cotton Cloth/ Fabric	85.65 to 117.42
	Desized Dyed Printed & Finished Cloth	76.33
	Dyed Printed Cloth	76.5
	Dyed, Mercerized Printed Cloth	66.67 to 190
	Dyed, Finished Cloth	48.73
	Finished Cloth	28.15
	Mercerized Bleached Desized; Washing Printing and Finishing	51.55
	Printed Cloth	85.54
	Synthetic Fabric Processing	243.11
	Washed & Finished Cloth	22.8
	Cotton Blended Yarn/Fabric	21.85
Sirohi	Blended Synthetic Yarn Dyed, Blended Synthetic Yarn Gray	54.22
Udaipur		**3.66**
	Synthetic Polyester & Viscose	0.06
	Cotton Sewing Thread	0.25
	Synthetic Fibre Dyeing	10.65

MILK PROCESSING

The values of water consumption in milk processing units across the state differ by a wide range depending upon the number, kind and amounts of various milk products, some of which like butter, ghee and cheese (paneer/cottage cheese) require large amounts of water for CIP. There is also considerable variation between various industrial units in the number and kinds of products manufactured there. Water is also often used, after appropriate treatment, for making reconstituted milk. Accordingly the volume of water used by different units varies considerably

Overall, the water consumption ranges from 0.07 KL to more than 7.0 KL per ton of production.

THERMAL POWER

The data om water use by thermal power plants based on different kind of fuels are summarised below. These values are very high, largely because of the type of cooling system employed by the units. Recently, the MOEF&CC and Central Electricity Authority have mandated the coal-based thermal power units to switch over to circulating cooling towers and restricted the water used for cooling to only 3 KL/MWH.

Fuel-wise Water Requirement (KL/MWH) in Thermal Power Industry

Fuel for Power	Gross Water use	Net Water use	Range of Production (MW)	Range of Gross Water use (KLD)	Number of Industries
					56
Biomass	64.64	63.55	4.8 to 20	4.58 to 218.40	17
Coal	269.41	54.56	1.3 to 2800	0.0 to 4801.30	23
Coal+ LDO, HDO	79.33	83.44	125 to 1320	63 to 108.29	6
Natural gas	12.25	9.97	110 to 1000	0 to 45.15	5
Natural uranium	84.42	44.42	220 to 1400	0.80 to 153.60	5

BREWERIES AND DISTILLERIES

There are only a few breweries and distilleries whereas some are only bottling units. Internationally, 4 KL/KL of beer is considered acceptable requirement though higher amounts are common. Distilleries require larger amounts of water because of the distillation process. The industries in Rajasthan have somewhat higher consumption though one of the famous brand beer industry claimed to have reduced its requirement to 2.5 KL/KL beer.

District wise Water Requirement (KL/KL) in Breweries Industry

District	Product (KL)	Gross Water use	Net Water	Range of Production (KL)	Range of Gross Water use	No. of Industries
Alwar		4.44	4.04			
	Beer	4.74	4.22	150 to 346	2.24 to 9.66	4
	Bottling of Scotch Whisky/IMFL	0.43	0.31	30	0.43	1
	Grain Neutral spirit Production	8.87	8.79	95.76	8.87	1
Banswara	Bottling of country liquor and IMFL	362.5	325	0.8	362.5	1
Jaipur	Beer	4.86	4.56	241.94	4.86	1

Kota	Beer	1.45	1.25	684.93	1.45	1
	Bottling of Country Liquor	0.0	0.0	26400	0.0	1
Sirohi	Wine & Jam	8.27	8.27	362.67	8.27	1
Ganganagar	Rectified Sprit	10.33	9.17	30.0	10.33	1

FERTILIZER AND CHEMICALS

Rajasthan has India's two large urea manufacturing units and a few others producing Single Super Phosphate (SSPs), NPK and other fertilizers. The urea industry in Rajasthan has been rated among the best in the country with 4.55 LK/ton water use, although there is a large scope for further reduction. The SSPs use relatively less water as compared to urea.

District wise Water Requirement in Fertilizer Industry

District	Product in Ton	Gross Water use KL	Net Water KL	Range of Production (Ton)	Range of Gross Water use (KLD)	Number of Industries
Rajasthan State		**0.48**	**0.43**			**7**
Bhilwara	SSP	0.04	0.04	200	0.04	1
Chittorgarh	GSSP	0.11	0.11	350.0 to 1056.7	0.06 to 0.19	3
Kota		1.87	1.71			3
	GSSP	0.26	0.28	500.0 to 800.0	0.04 to 0.49	2
	Urea	5.07	4.55	1900.0	5.07	1

Various chemical industries use water in the process or as an ingredient in the product, but primarily as a coolant in most manufacturing processes, for generating steam for various important tasks, and for domestic use including cleaning and sanitation. Since these industries manufacture a large variety of products in different amounts, and often one compound is the base or raw material for other compound or group of compounds, it is nearly impossible to assess the water use efficiency of various categories of chemical industries. The pharmaceutical industry presents a far more complex situation because they require water of very high purity, and often produce small amounts of ultra pure water through distillation and other processes which consumes huge quantities of water.

CEMENT INDUSTRY

Based on the reported ground water abstraction and the installed production capacity, the cement industries exhibit large variation – from 0.02 KL/ton to 0.54 KL/ton of cement. These values are nearly similar to those reported elsewhere (Selvaranan et al. 2017) but do not reflect the actual water consumption of the cement industry because they often use rainwater accumulated in their mine pits, and also have captive coal-based power plants. The industries using a wet process use more water than those with the dry process. Large amounts of water are still abstracted by some for dust suppression and green belt development around their units.

CURRENT WATER-RELATED POLICIES

All policies, Acts and Rules & regulations related to water, wastewater, groundwater, and industries at both the national and state level, have been reviewed as part of the Study. Major observations are the following:

1. The National and State policies on water do highlight the importance of IWRM but an integrated view is missing in the rules, regulations, and action plans.
2. Despite an acknowledgement of spatial variability in precipitation, location specificity of water availability and use pattern are not considered in any of the documents and therefore, implementation of policy fails to deliver desired results.
3. Different sectoral policies and governance system fail to capture the diversity in availability of water (rainfall, surface and ground water, quality), its usage pattern, and emerging issues over space and time (climate change, climate variability, water conflicts). To make it more explicit the geographical features, such as Deserts, hills, plain, canal command areas, tribal areas, agro-climatic zones, river basins, etc. are not differentiated/ considered while providing policy prescriptions.
4. Industrial Policy makes no mention of water using industries or polluting industries. No direction is given for location of industries based on water availability, regional inequalities, unemployment (regional) status, etc. Rather the approach is to increase the number of MSME's in the state.
5. The incentives (Subsidies and Tax exemptions) to different types of industries do not differentiate between water efficient industries and water-intensive industries.
6. The industrial policy does not consider the relationship between type of industry, nature of pollution and suitability or unsuitability for a particular region in the State.
7. Industries are also located in and around the urban areas; the conflicts with water demand of urban areas finds no mention in the policy.
8. The State Govt has taken lead in formulating a policy on recycling and reuse of domestic sewage. Treated sewage is proposed to be used both in agriculture and industries. However, the issue of location of STPs in relation to agricultural and industrial areas as well as the type of industries has apparently been not considered.
9. While rainwater harvesting has been made mandatory, there is practically no emphasis on reducing water consumption and implementing recycle-reuse of industrial wastewaters.

CRITERIA FOR SITING NEW INDUSTRIAL AREAS/UNITS

Industrial activity in India can be traced back to pre-British period but soon after India's independence, the industries were brought under the control of the central government with the enactment of the Industries (Development and Regulation) Act, 1951, with the objective to promote industrial growth. There were no regulations whatsoever for the industries until 1974 when the Water (Prevention and Control of Pollution) Act was passed by the Parliament, and gradually the States adopted it.

While environmental pollution caused by the industries of various kinds has attractyed the attention of the Government and the regulator (CPCB) through a plethora of acts, rules, regulations and notifications, no specific criteria were prescribed for location of Industrial Estates/industries. In Rajasthan, the RIICO has however identified IAs where industries requiring Environmental Clearance in category A or B can be allotted land.

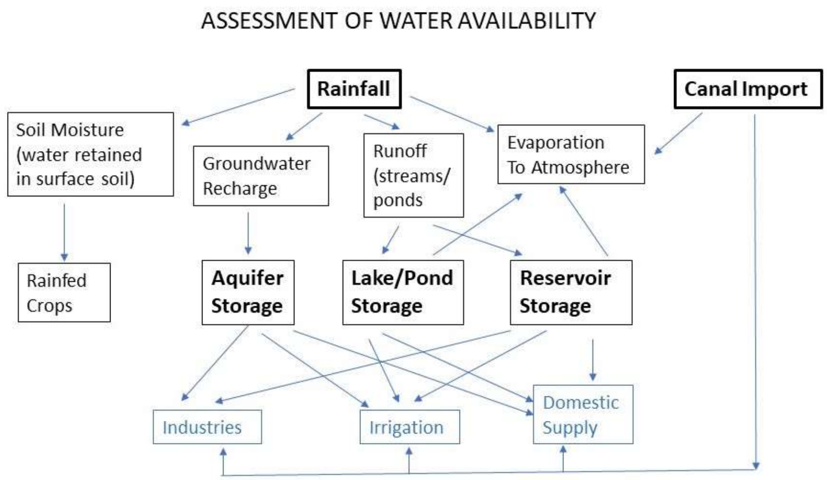
Article 17(1)(n) of the Water Act 1974 concerning the Functions of the Boards, requires them "to advise the State Government with respect to the location of any industry the carrying on of which is likely to pollute a stream or well", the locations/sites of industries were not determined or regulated by the Pollution Control Boards. The CPCB has made efforts over years towards classifying industries according to their air, water and soil pollution potential and preparation of Zoning Atlases for Siting of Industries based on environmental pollution indices. However, the programme was left to be completed and implemented by the States. In Rajasthan the State Pollution Control Board worked on the zoning atlas for the districts of Udaipur and Rajsamand, Kota and Baran, Sirohi and Bhilwara, and Alwar until around 2009, but these were not finalised and published, and hence, not implemented.

The MOEF (2010) published a Technical EIA Guidance Manual for Industrial Estates that included an annexure on the "Identification of Suitable Sites and Industries". This followed the CPCB's Zoning Atlas framework in general, with minor changes.

It has never been thought necessary to consider water as a resource input in the industries (and even for siting settlements/townships). Despite extreme spatial variability in the available water resources in the country, and particularly Rajasthan, no attention has ever been paid to the hydrologic constraints as well as those imposed by geology and hydrogeology Apparently, it has been assumed that wherever surface water resources are not available, the ground water shall be available and can be used freely.

It is therefore proposed that the availability of water should be taken into account as a primary factor in considering the location of any industry. The availability itself should be determined by the totality of the water resources (surface+ground+waste) and after meeting the basic needs of humans, livestock, environment, and agriculture in accordance with the priorities laid out in the State Water Policy, and in consonance with the national laws related to water.

The Hon'ble NGT has already placed certain restrictions on the withdrawal of groundwater from the critical and overexploited blocks. RIICO has mentioned on their website that "Allotment of land to Water Intensive Industries shall be subject to "CGWA Guidelines/ Criteria for evaluation of proposals/requests for ground water abstraction (With effect from 16.11.2015)". We propose that the groundwater withdrawal should be based on the water budget of each block in the district. The total withdrawal by all the existing industries should not exceed the annual recharge potential of the particular block.



CRITERIA FOR EXPANSION AND RENEWAL OF EXISTING INDUSTRIES

While the new industries and industrial areas can be located suitably according to the water availability, some steps are also required to regulate the water use by the existing industries. Their expansion and renewal should be allowed only after taking into account the overall water availability. No new industry may be approved for setting up in the water stressed areas such as the notified blocks with over-exploited groundwater. Further, cumulative impact of large number of industries should be assessed while considering water availability for approving new industries.

The water saving technologies/processes and Reuse & Recycling of water may be made **mandatory** for the expansion and renewal of consent to operate for the water intensive industries. Each industry may be required to provide with an Action Plan for reducing the dependence on ground water and to achieve benchmarks over a specified period, say 3 years.

The industries willing to invest in water-saving technologies/processes and for recycling and re-use of their own wastewater or from other industries or treated domestic sewage can continue their operations within the limits of already permitted withdrawal of surface or ground water.

RECOMMENDATIONS

Following recommendations are made for the siting of Industrial areas and industries with emphasis on the availability of water in those areas, and for increasing the efficiency of water use through appropriate interventions within the industry, and recycling and reuse of wastewater, with the overall objective of reducing the surface and groundwater abstraction. Suggestions are made for implementation by the Government of Rajasthan through its concerned departments and organisations including the State Pollution Control Board. The roles of various departments and organisations are indicated against the recommendations.

Siting of New Industrial Areas / Industrial Units	**Dept responsible for action**
Sites for all new industrial estates or units should be selected by according highest consideration to the overall (net) water availability in that specific area, taking into account both the surface and groundwater, the existing consumption by all sectors (domestic, agriculture, existing industries) and their projected demand over the next 20-25 years. The changes in water availability resulting from climate change should also be factored in.	Dept of Industries; RIICO WRD/CGWB
The Industrial Zoning exercise undertaken in the past should be revived and the water availability in each village/block should be included as the most important parameter in the zoning process.	RIICO; RSPCB
All those areas which have very low water availability (rain, surface water or groundwater), including the over-exploited blocks notified by the Central Ground Water Board, should be identified as prohibited areas for setting up any new industry that requires significant amounts of water for industrial process.	RIICO; RSPCB
Consent to Establish / Consent to Operate	
Cumulative water requirement of already approved/setup industries should be taken into account before granting approval (consent to establish and consent to operate) for new industries requiring any amount of water for use in processes (other than domestic use).	RSPCB
Achievement of the objective of reduction in water use (in terms of abstraction) and meeting the desired standards for effluents may supersede the technological restrictions.	RSPCB
The Application Forms for obtaining Consent to Establish/Consent to Operate should be suitably modified to require information on the specific water use in different processes and on the proposed quantum of each product, as well as the steps proposed to be taken for recycling/reuse of wastewater.	RSPCB
Existing Industrial Areas/Industrial Units	
Further expansion of existing industries should be prohibited in areas identified for their low water availability. In areas where water consumption has already reached the limits of safe sustainable availability, industries may be required to relocate or change to another kind. (mention areas highly or medium stressed)	RSPCB

Reduction in Water Consumption/Withdrawal	
All efforts should be directed at reducing water consumption at every stage / in each process in the existing industrial units.	Industries; CII etc
Adoption of all measures which help in reducing the overall consumption of water should be promoted and incentivized. These may include a change in the nature and quality of inputs, processes, and machinery.	Dept of Industries; RSPCB
Various regulations, rules and procedures should be amended to facilitate and promote the adoption of latest technologies. Industries should be at liberty to choose the technology that they deem appropriate for saving water and energy directly and/or through recycling and reuse, and reducing the discharge of wastewater.	CPCB
Monitoring Water Use	
Monitoring of water abstraction, use and wastewater generation at each process step should be mandatory and the meters installed for the purpose should be connected to dataloggers, accessible to the regulatory institutions. Rectification of any malfunctioning of the meters should be responsibility of the industry.	CGWB; PHED; RIICO; RSPCB; Industries
Daily, monthly, and seasonal variation in production should be reported and must be reflected clearly in the water consumption and wastewater generation.	Industries
Rainwater Harvesting	
Rainwater harvesting that is currently mandatory in all industries should be linked with the use of water in that industry. All industries should be required to store the harvested rainwater appropriately, and use it in their respective units, thereby effectively reducing the withdrawal of ground water or surface water. The amounts of water harvested and used within the industry should be made reportable and verifiable.	CGWB; WRD;
Accordingly, the current policy of rainwater harvesting that mandates groundwater recharge through specifically designed recharge structures should be changed and communicated for implementation at the earliest. This will help avoiding the exemptions from recharge to be granted to the industries in those areas where the water table is quite high and hence, recharge wells cannot be installed.	CGWB
Rainwater harvesting requirement should also be set according to the actual rainfall in various districts and the potential for harvesting it (instead of as a percentage of water consumed by the industry).	CGWB

Recycling and Reuse of Wastewater (Industrial Effluents)	
All technological measures for resource recovery, recycling and reuse of wastewater should be encouraged, actively promoted (or made mandatory) and incentivized. The wastewater can be used within the same industrial unit or another industry.	RSPCB; PHED; Industries Dept
Industrial effluents from some sectors may be appropriate, without or after treatment, for reuse in agriculture, horticulture or silviculture. Such reuse should be promoted in nearby fields especially in view of the availability of the industrial effluents throughout the year, and their use in agriculture will reduce groundwater abstraction for irrigation in the dry season.	RSPCB; CPCB; Agriculture Dept;
Industries should be required to stop discharging any effluent (i.e., zero liquid discharge) even after treatment on land or into a surface water body or into the ground water.	CPCB, RSPCB;
Industrial sectors where total ZLD may not be feasible should be identified based on the nature and quality of their effluents.	CPCB, RSPCB;
Changes in EIA Process	
The availability of adequate water within the area where the industry is proposed to be set up should be included as a determining factor in the EIA process by MOEFCC/SEIAA. The proponent should declare in the proposal that the site lies or does not lie in a block notified by the CGWA or the block with critical or semi-critical state of groundwater. Further it should be the responsibility of the proponent to inform the current committed use/withdrawal of water by the existing industries, settlements (domestic use) and agriculture within the block.	MOEF-CC; SEIAA; SECA
In order to promote the reuse of industrial wastewater in agriculture or another industry, the EIA process may include a pre-project tie-up with farmers/industry within the specified area (block), in order to ensure that the wastewater meets the standards required by the recipient.	Agriculture Dept; Industries Dept; RSPCB
Changes in Policies	
Industrial policy may be modified to consider water availability (and its projection over the next 50 years) as the prime factor in granting	Dept of Industries;

approval to establishment of new industrial areas and industrial units which require water beyond the carrying capacity of the area.	Central/State Groundwater Board
Appropriate institutional arrangements should be made to ensure intersectoral cooperation for implementing the policies in letter and spirit	All concerned Deptts of the State Government
Education and Awareness	
Industrial workers should be involved in the management of water and wastes within the industry. Education and awareness programmes should be organized regularly to sensitize them about the importance of water consumption and impacts of wastewater in an integrated manner. Awareness and education programs are also required among the farmers and other stakeholders who may use the industrial effluents. Strict quality control measures will also be required.	RIICO; Industries Dept; RSPCB; NGOs; Industry Associations
Promotion of Water Conservation in the Industries	
The industries should be encouraged to participate in an annual or biennial rating of their performance with respect to water use and wastewater (quantum and quality). Such rating exercise may be used exclusively for a new 'ecolabelling' of the products of water-intensive industries	RSPCB, NGOs, and Industry Associations
Further Studies	
Industry-wise detailed studies are required for collection and analysis of data related to water use in each process of all kinds on industries. This should account for the daily and seasonal variability, efficiencies of various processes and machinery, the nature of waste stream from each process and its recycling / reuse potential, various inputs and energy linkages, product quality and socio-economic considerations. Such a detailed study requires that the industries maintain a log of water abstracted, received from RIICO or through any other source, water consumed in every process on a daily basis, the amount and quality of waste generated in each process, amount of wastewater reused/ treated or disposed, or sent to the ETP/ CETP, and the fate of the water coming out of the CETP/ETP.	RSPCB; Universities, IITs and other Research institutions; NGOs, Industries throughout the State RSPCB asks the industries to maintain a log and

	report the data every month.
Studies required on the detailed mapping of groundwater and its quality along with changes over time in the industrial areas. Investigations on the likely impacts of industrial water use in agriculture, on soils and vegetation, and on groundwater, for all kinds of water-intensive industries. Field level studies to investigate the potential and efficacy of nature-based solutions to treatment of industrial wastewaters, including the recovery of resources wherever feasible.	RSPCB; Groundwater Dept, Universities, IITs and other Research institutions; NGOs,

POLICY FRAMEWORK FOR

RECYCLING AND REUSE OF INDUSTRIAL WASTEWATER

A Draft is submitted of a Policy Frame work for the recycling and reuse of industrial wastewaters. It may be discussed further to include certain administrative and operational aspects such as financing, pricing, penalties, institutional mechanism, etc.

Chapter 1.
INTRODUCTION

1.1 Water: A Crucial Resource for Development

WATER is the most important naturally occurring substance which is essential for the very existence of life on the Earth. Water influences also all the non-living components of the Earth's environment and many physical and chemical processes depend upon water. Whereas all living organisms use water for their biological needs, humans have learned to use water for a large diversity of activities - from food production (agriculture and aquaculture) through domestic use and sanitation to industrial production and energy generation, as well as various forms of recreation. Though water occurs in great abundance, as it covers nearly three-fourths of the Earth's surface, only a tiny fraction of the total water that occurs on land - flowing in rivers, lying in lakes and ponds, or in belowground aquifers - is of direct use to the humans. However, the water resources are highly unevenly distributed – both spatially and temporally. In India, both spatial and temporal variability, which stretch between extremes, are governed largely by the monsoonal climate in conjunction with the topographic features. Most of the country receives about 80% of its rain during the four months of southwest monsoon (June to September). The western parts of the country receive the lowest amount of rainfall over a still shorter period, with western Rajasthan receiving an annual rainfall of less than 100 mm, over a few days only.

Rapid increase in human population, together with the growing pace of urbanization, industrialization, and intensive agriculture, has resulted in ever-increasing demand on limited surface and ground water resources. Rainfed agriculture accounts for about 60% of total land area under cultivation. Despite numerous large, medium and small reservoirs constructed for storing monsoonal runoffs for irrigation through an extensive canal system, only about 35% of the irrigated land receives canal irrigation (Statistical Year Book India 2018) whereas about 65% of irrigated area depends upon ground water. Most of the domestic water supplies as well as industrial water requirements are met by abstraction of groundwater.

Human use of water is closely linked with its quality. Up to 80% or even more of the water used by humans for domestic and industrial purposes is returned as ‘waste water’ which is either discharged into the rivers, streams, lakes, etc., or disposed of on the land. Water used in agriculture for irrigation moves through the soil and carries with it the wide range of agrochemicals (fertilizers, pesticides, etc.) into the ground water or surface water bodies. The waste waters cause various kinds of problems for both humans and other life.

The traditional system of abstracting water from rivers, lakes or aquifers for various human uses and returning the wastewater (along with the urban stormwater) back to surface waters is no more sustainable because the surface waters have lost their ability and capacity to assimilate wastes, to support biodiversity, and provide other benefits to humans, due to overloading with wastes and excessive alteration of the natural flows.

1.2 Need for Water Resources Management

Water availability has become an increasingly critical issue for human survival and development. Many areas have run out of water even for the basic needs of humans. Climate change, that is now real and already happening, is further increasing the spatial and temporal variability and situation is projected to become severe in the next few decades. Water management calls for a multipronged approach and major paradigm shift. As early as 1977, during the United Nations Conference on Water, an integrated water resources management (IWRM) approach was recommended to incorporate the multiple competing uses of water. After nearly a quarter century of discussions at several international conferences, the concept of IWRM was properly defined in 2002 by the Global Water Partnership (GWP) as "*a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*." During the past two decades, the concept and its implementation have been discussed extensively in all countries, and it has gained increasingly greater support from water resource managers as well as decision makers, despite many criticisms. The IWRM approach is now advocated in India also by the Ministry of Water Resources (now the Jal shakti Ministry) (National Water Policy 2012, Central Water Commission 2016).

The management of water resources is currently receiving greatest attention in the context of sustainable development and protection of natural ecosystems. The 17 Sustainable Development Goals (SDGs) set by the United Nations for 2030, focus significantly on water

Targets in SDG 6

6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion of untreated waste water and substantially increasing recycling and safe reuse globally.
6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reduce the number of people suffering from water scarcity.
6.6 By 2030, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes.

as seven of these goals depend directly or indirectly upon water. Now, high priority is being accorded in India to the issues of sanitation (providing toilets to make India Open Defecation-Free) and drinking water supply to every household (Nal se Jal scheme under Jal Jeevan Mission). Steps are being taken to ensure irrigation for crops particularly in drought prone areas and during the years of deficit monsoonal rains. Repair, Renovation and Restoration (RRR) of Water Bodies directly linked to agriculture constitutes an important scheme of the Ministry of Water Resources (now Jal Shakti) for ensuring storage of rainfall and runoff for irrigation. The Scheme has now been integrated with the Pradhan Mantri Krishi Sinchai Yojna (PMKSY). Considerably large efforts are being made to reduce the pollution of surface waters (rivers and lakes) by emphasizing upon the diversion and treatment of both domestic and industrial wastewaters.

1.3 Emerging Focus on Recycling and Reuse of Wastewater

While these efforts are being made to improve supplies to meet the growing and competing demands on water, the need for better demand management through reduction, recycling and reuse of water/wastewater has emerged very strongly with a sense of urgency. It is widely felt, and innovations are being tried globally, that there is a great scope for reducing water consumption in all sectors – agriculture, domestic and industrial – through adoption of various available technologies, approaches, and regulations. At the same time, a realisation has emerged that the wastewater needs to be considered as a resource which should be recycled and reused.

Some of the targets of the SDGs' Goal 6 on Water and Sanitation, that are expected to be achieved by 2030, are directly concerned with the recycling and safe reuse of wastewater (Target 6.3), increasing water-use efficiency across all sectors and ensuring sustainable withdrawals and supply of freshwater (Target 6.4), and protection and restoration of aquatic ecosystems (Target 6.6).

The World Water Development Report of the UN-Water (2017) states in its conclusion that:

*"In a world where demands for freshwater are ever growing, and where limited water resources are increasingly stressed by over-abstraction, pollution and climate change, neglecting the opportunities arising from **improved wastewater management** is nothing less than unthinkable."*

In India, wastewater recycling and reuse have been discussed at many forums and various Government institutions such as the Planning Commission, Ministry of Urban Development, National Mission on Sustainable Habitat, Ministry of Water Resources, River Development & Ganga rejuvenation, the National Water Mission, the draft National Water Framework Law, and the Ministry of Environment, Forests & Climate Change, have recognised the need to include it in wastewater management programs and mentioned in their respective policy frameworks.

The National Water Framework Bill, 2016, Chapter III, Clause 9, states that:

"(1) The appropriate Government shall make all efforts for appropriate treatment of wastewater and its gainful utilisation, and

(2) The appropriate Government shall evolve and implement economic models that promote sustainability of recycle-reduce-and-reuse of water resources, while ensuring adherence to principles of equity".

The Report of the Mihir Shah Committee on Restructuring the CWC and CGWB (2016) also emphasised the need for recycling and reuse of both domestic and industrial wastewaters in the industrial and power sectors.

However, practically very little has been done to formulate a clearly defined national policy and provide detailed guidance on the subject, except that the Ministry of Urban Development has developed certain guidelines for the recycling and reuse of domestic wastewater and included them in the Manual on Sewerage and Sewage Treatment Systems (CPHEEO 2013). Recently, the Rajasthan State government became the first state in India to prepare a State Sewerage and Waste Water Policy in 2016. The Ministry of Environment and Forests (now MOEF-CC) also issued directions and guidelines for the recycling and reuse of wastewaters. In 2018, the Government of Gujarat adopted a Policy for Reuse of Treated Wastewater (only domestic sewage). [These developments have been discussed further in the Chapter on Policies and Laws.]

1.4 Origin of This Study

Therefore, recognising the highly critical problem of water availability in most parts of the State of Rajasthan, and the very high consumption of water in many kinds of industries, accompanied by an equally acute problem of pollution caused by industrial wastewaters, the Rajasthan State Pollution Control Board decided to commission the present study (vide their call for expression of interest (e.o.i.); reference No.: F(l2)/PSC-18/RPCB /153 of 29 May 2018).

1.5 Scope of The Study

The study focuses on the potential for reduction in the abstraction of ground and/or surface water for use in the water intensive industries that can be achieved by (i) improving water use efficiency within the industries, and/or (ii) by recycling and reuse of the wastewater. The study is set in the specific context of the Rajasthan State where the availability of water resources is highly variable due to the physiographic and eco-climatic characteristics of different regions. Therefore, the study also focuses on the siting of industrial areas and water-intensive industries in different ecoclimatic zones of the State.

Any policy or regulation concerning the water use and location of industries has to take into account the existing relevant national and state policies and laws, and in relation to other sectors. Hence, the study reviews briefly the national and state policies, rules and regulations concerning water and wastewater, especially in relation to their relevance and application to industries.

Then the study summarises the status of both the surface and ground water resources in different physiographic and climatic zones, and the competing demands on water for human population, agriculture, and economic development.

The study examines the current state of industries in the state, their distribution in various districts and the kinds of water-intensive industries in different eco-climatic zones. In order to suggest benchmarks for water use, the study analyses the secondary data on water abstraction and use, and wastewater generation and treatment, available from the State Pollution Control Board and other sources, for the current water use efficiency. Efforts were made to validate the data with field survey and interaction with a few representative industries in different districts. The study discusses the potential for improving water use efficiency in various kinds of industries, and highlights the need for monitoring of water use at process level for setting up benchmarks for water use in water-intensive industries.

The study reviews the efforts made by the Central Pollution control Board, the Ministry of Environment & Forests, and the Rajasthan State Pollution Control Board towards environmental planning and zoning for industries with respect to pollution levels and impacts. The study suggests criteria and guidelines, for developing industrial areas & locating water intensive units, that lay emphasis on the availability of water resources in different ecoclimatic zones, after meeting the needs of sectors of high priority in accordance with the State Water Policy and existing laws and regulations.

Lastly, the study provides a framework for a state policy for recycling and reuse of industrial wastewater, to be integrated with the State policy on the reuse of sewage. The role and responsibilities of various departments/agencies for implementing the policy and guidelines are also discussed.

1.6 Limitations of This Study

This study is based entirely on secondary data in the applications for Consent to Operate, available with the State Pollution Control Board, and that readily available from other government sources. Efforts were made to validate the data with field survey and interaction with representative industries.

The benchmarking of water resources use in the industries can be further improved and periodically updated after requiring the industries to maintain records of daily utilization of water in different major processes, daily use of raw material and daily production of various products, and the amount of wastewater generated from each process.

GIS-BASED MAPPING OF WATER-RELATED DATA

The following GOS-based maps of the Rajasthan state have been prepared and placed at the end of the Report. The Ground Water Board has increased the groundwater assessment blocks to 295 by splitting and redefining the boundaries of many earlier blocks. However, their exact boundaries are not yet available with geographic coordinates for mapping on a GIS platform. The list of 295 blocks and their groundwater status has been included in this Report.

1 Administrative-Districts & Tehsil boundaries
2 Physical- Physiography
3 Drainage- Rivers
4 River Basin boundaries
5 Lakes, reservoirs, water bodies
6 Annual Temperature - Maximum & Minimum
7 Annual rainfall distribution
8 Imported water- canal system
9 Groundwater levels -Pre-monsoon
10 Groundwater levels- Post-monsoon
11 Hydrogeology
12 Geology
13 Population Distribution
14 Agriculture - rainfed/irrigated
15 Protected areas/forests
16 Industries – Location of major and minor industries

Chapter 2.
WATER MANAGEMENT: LAWS AND POLICIES

2.1 Water in India's Constitution

There are many stakeholders in the water resources who not only compete for the limited available resources of a region but whose use of water causes serious problems for, and hence conflicts with, other users. Therefore, in order to discuss the use of water by various users, including the industries, and its regulation, it is necessary to understand all water-related laws and policies of the nation.

Laws and policies related to water in India are governed by article 246 of the Constitution which defines the power of the union and state governments to make laws with respect to various matters as detailed in Schedule VII. Water is listed under Entry 17 in List II -State List of the Schedule VII, as under:

17. Water, that is to say, water supplies, irrigation and canals, drainage and embankments, water storage and water power subject to the provisions of entry 56 of List I.

Entry 56 in List I read:

56. Regulation and development of inter-State rivers and river valleys to the extent to which such regulation and development under the control of the Union is declared by Parliament by law to be expedient in the public interest.

Further, Article 262 {Adjudication of disputes relating to waters of inter-State rivers or river valleys} provides that,

1. Parliament may by law provide for the adjudication of any dispute or complaint with respect to the use, distribution or control of the waters of, or in, any inter-State river or river valley.

2. Notwithstanding anything in this Constitution, Parliament may by law provide that neither the Supreme Court nor any other court shall exercise jurisdiction in respect of any such dispute or complaint as is referred to in clause (1).

In the context of siting of industries, it is also important to note that land is also a state subject. Entry 18 in List II referring to land reads as under:

18. Land, that is to say, rights in or over land, land tenures including the relation of landlord and tenant, and the collection of rents; transfer and alienation of agricultural land; land improvement and agricultural loans; colonization.

The recent 1992 amendments to the Constitution regarding Panchayats and Municipalities introduced the power of the State Governments and legislatures to devolve functions to such bodies, so as to make them evolve as local self-governing institutions. The Eighth Schedule (Part IX) dealing with Panchayats, lists "Minor irrigation, Water management and Watershed development", "drinking water" and "maintenance of community assets". The Twelfth Schedule (Part IX A) dealing with municipalities, lists "water supply of domestic, industrial and commercial purposes".

The Union Government enacted under Article 262 and Entry 56 of List I, the Inter-State Water Disputes Act, 1956 (amended up to 1980) and the River Boards Act, 1956.

2.2 The Environment Protection Act 1986

According to the definitions provided in the Act,
(a) "environment" includes water, air and land and the inter- relationship which exists among and between water, air and land, and human beings, other living creatures, plants, micro-organism and property;

The Environment Protection Act 1986 is perceived as an umbrella for all necessary actions. It provides that, "(1) Subject to the provisions of this Act, the Central Government, shall have the power to take all such measures as it deems necessary or expedient for the purpose of protecting ans improving the quality of the environment and preventing controlling and abating environmental pollution" (Section 3(1)). Section 25 confers powers upon the Central Government to notify Rules on a wide range of matters related to environmental pollution. However, the Act emphasizes upon the 'quality of the environment' and does not consider the issues related to the quantitative aspects such as the volume of water that directly or indirectly affect the quality.

Section 3(2)(v) provides for **(v) restriction of areas in which any industries, operations or processes or class of industries, operations or processes shall not be carried out or shall be carried out subject to certain safeguards**;

Within the bounds of the above-noted constitutional framework, the Union Government has provided guidance to the State in the form of national policies and framework laws, and also made several Acts, Rules and Regulations on various water and environment related subjects. Like other states, Rajasthan has also implemented many of these laws, rules and regulations.

Besides, the State has also formulated several of its own policies, enacted state-specific legislation, and framed rules and regulations concerning water, land, industries, and related matters in its jurisdiction. These policies, laws, rules and regulations are reviewed briefly in the following pages from a viewpoint of their relevance, concern and application to address the issues of water use efficiency and recycling and reuse, particularly in the industrial sector in Rajasthan.

2.3 National Water Policy 2012

Statements in the Document	Comments and Observations
Section 3: Water usage	Section 3.1 does not include industries which are a major user of water, and likely to require significantly more water with their growth and possible shift from agriculture to industry and service sector and from rural to urban areas. In case of industries, the virtual water use (water in production of raw materials) is also an important and major consideration.
Section 6: Demand Management and Water Use Efficiency	Section 6.1 deals with benchmarks, water footprint and water audit only at 'project' and basin level. Section 6.2 however requires industries' water footprint to be included in the EIA of the industrial projects. Section 6.3 requires recycling and reuse to be a general norm. Yet, the water saving (sections 6.5, 6.6) focuses only upon the agriculture sector. Section 6.7 calls for involvement of users in monitoring of water use pattern, and should be applied to industries.
Section 7. Water Pricing	This Section makes no mention of water pricing for industrial use.

Overall, it can be inferred from the National Water Policy 2012 that industrial water demand, use and pollution do not find importance in the document, despite a growing focus on industries for economic development and their significant demand for water and impact of the quality of water resources.

2.4 The Water (Prevention & Control of Pollution) Act, 1974 (Amended 1988)

The Act passed by the Parliament under Article 252 of the constitution, and adopted by the State of Rajasthan, among other States, provides for the prevention and control water pollution (both surface and Groundwater) from domestic or industrial sources. The State Boards were established under the Act and implement the provision of the Act in the respective States.

Statements in the Document	Comments and Observations
Section 17. Function of the State Boards. (a) To plan a comprehensive programme for the prevention, control or abatement of pollution of streams and wells	We are not aware of a state-specific comprehensive Plan/ Program for the prevention, control or abatement of pollution of streams and wells prepared by the RSPCB, if any, and also of specific methods developed for the treatment of waste-waters in the State.

in the state and to secure the execution thereof. *(h)* To evolve economical and reliable methods of treatment of sewage and trade effluents, (n) *To advice the State Government with respect to the location of any industry the carrying on which is likely to pollute a stream or well.*	 The present exercise of developing criteria for siting of industrial areas and water-intensive units in Rajasthan, is an important step in the discharge of function envisaged in section 17(n).

2.5 Water (Prevention and Control of Pollution) Cess Act, 1977 (Amended up to 1992)

Statements in the Document	Comments and Observations
Article 3. Levy and Collection of Cess Article 4. Affixing of Meters Article 6. Assessment of Cess Article 7. Rebate Schedule I.	Empowers the SPCBs to levy a cess on local authorities supplying water to consumers and on consumption of water for certain specified industries. While providing financial resources to the SPCBs, the levy has the potential to promote water conservation by reducing abstraction/ consumption. The amount of water abstracted has to be metered and only permitted amounts can be abstracted. The provision of 25% rebate promotes the treatment of wastewaters by the users, especially industries. Schedule I lists most of the water-intensive industries (without specifying their water demands).

2.6 Draft Water Framework Bill 2016

Section 16c of Water Security Plans lists, "restrictions on setting up of water intensive industries in water stressed areas"

Section 22b on water pricing recommended full economic pricing for water used in industries and commerce besides commercial agriculture;

Section 18. deals in detail with the conservation, protection and management of Groundwater as a common heritage, and emphasizes the role of Panchayat Raj institutions.

Section 25 deals with Industrial Water Management and is reproduced below:

(1) All industrial units shall make every possible attempt to reduce their water footprint over time.

(2) All companies using large volumes of water (beyond a limit to be specified by the Appropriate Government) shall be required to transparently state their water footprint in their Annual Reports, including information, such as, water utilization per unit produce, effluent discharge details, rain water harvested, water reuse details and fresh water consumption.

They shall also include the outline of a plan to reduce their water footprint over time and a statement of where they have reached every year in the attainment of these goals.

(3) Industries with high intensity of water use should not be located in regions prone to water stress or in drought prone regions.

(4) Industries in water short regions shall be allowed to either withdraw only the make up water or have an obligation to return treated effluent to a specified standard back to the hydrologic system.

(5) Pricing of water for industry shall include efficiency costs and capital charges.

(6) Incentives shall be implemented to encourage recovery of industrial pollutants including recycling and reuse that are otherwise capital intensive.

(7) There shall be prohibitive penalties to discourage profligate use, with denial of water supply services beyond a threshold, as may be prescribed by the appropriate government.

2.7 NGT Orders dated 3.1.2019 and 11.9.2019 concerning CGWA

NGT's order Summary	Comments & Observations
The main object for the constitution of the Board as an Authority is the urgent need for regulating the indiscriminate boring and withdrawal of underground water in the country. The NGT order dealt in detail with the grievance of illegal drawal of ground water by hotels, industries and builders for commercial purposes, in light of the requirements of a NOC from the Board by the industries in safe and OCS areas. The NOC was linked to rain water harvesting/ground water recharge measures and NOCs were denied in over exploited areas. CGWA had also prescribed limits of groundwater withdrawal for various industries in OCS blocks. Till 2015, existing industries were not required to seek any NOC. The Order pointed out that for monitoring and supervision of notified area, CGWA has empowered district level authorities of State Government under Section 4 of the Environment (Protection) Act, 1986. The NGT ordered that ***water intensive industries should only be permitted in safe, semi-critical and critical area, and should not be allowed to establish new industries in overexploited area.***	The NGT orders are fine for new industries but what about those industries already drawing lots of water and making the area over exploited. Presently there is no provision to stop them. The industrial units should be directed to adopt State of the Art technologies, use of surface water, treated waste water and reduce specific water consumption, thereby ground water demand is substantially in three years' period. The industries also be encouraged to create facilities for storage of excess storm water and adequate measures such as groundwater recharge as well as restoration of lakes /ponds in the vicinity of the industry. There is no check on injection of pollutants in the ground water in the impugned notification. There is no provision with regard to check on water quality and its remediation, if there is contamination. The water conservation fee virtually gives license to harness ground water to any extent even in OCS areas. The so-called regulation is illusory and conditions are incapable of meaningful monitoring, as shown by past experience also.

Vide its order dated 15.04.2015, the NGT had asked for fresh guidelines. Draft guidelines issued on 16.11.2015 required all existing industries who have not obtained NOC, to apply to CGWA.	The most important problem with the CGWA regulation, not addressed by the NGT, is the cumulative withdrawal of groundwater. The restrictions imposed by the CGWA consider the volume of water drawal by individual units in a block, and not the total drawal by all the industries together in a particular block. There is no restriction on the number and kind of industries in a block.

2.8 Rajasthan State Water Policy – 2010

The Rajasthan State Water Policy is one of the most progressive water policies in the country. The prominent feature of the policy is the declaration that the state is neither the owner of water resources nor the manager, state acts as facilitator and people are owner and manager. That sets the tone for water sector reforms in the State. State is committed to IWRM principle of water resource management and advocates community management of water resources.

However, from the viewpoint of water use in industries and their siting in the State, industry and its water related issues do not find serious concern in the state policy despite the fact that water is scarce in Rajasthan and there are industries which cause serious threat to water resources and their quality. Textile industry is well known for its excessive water use and pollution in the state. In the list of water allocation priority, industry finds seventh place, i.e., the lowest priority. Yet in the dry western Rajasthan, groundwater abstraction by the industries is only next to that for agriculture, whereas the absence of surface water sources affects the livestock most that are accorded second priority. The IWRM would in practice mean that the surface and groundwater are considered together.

Section 5.3 specifically deals with Municipal and Industrial water conservation. It mentions that the reuse of treated sewage water will be promoted for use in industry. The water intensive industries will be required to recycle their water. A rolling programme for water auditing will be undertaken for all the industries large or small to compile a register of industrial water usage. It is further mentioned that the audit will include the quantified water usage, the potential for water recycling and conservation, and actual and potential pollution associated with each site. The potential for the reuse of industrial effluents in agriculture finds no place here.

Section 5.5 deals with groundwater. Groundwater is major source of water supply to most of the industries in Rajasthan. The section 5.5.5 mentions that for efficient use of groundwater, aquifer-based management system will be developed. There is no clarity on who and which agency of the state will do it? So far in the State there is no aquifer-based planning of groundwater. The state government presently lacks institutional mechanism to regulate, implement and monitor the plans once in place. In its absence, industries are drawing groundwater excessively resulting in over-exploitation. Dry wells/tube wells are often used for dumping the industrial waste water.

Section 7 on Environmental Management makes no mention of industries.

Section 8 on Water Pricing s is the only section addressing demand side management of water resources in the state. But industrial water use and pricing do not find any mention in it except that differential rates be charged for agriculture, industrial, commercial and municipal purpose. In all cases, the highest rate will be a strong disincentive for profligate water usage. There is no mention of the basis on which the differential prices will be fixed and, it is also not clear if differential pricing of water will be considered within the industry sector; i.e. for water intensive industries such as textile, distilleries, breweries, thermal power, etc., and less water-using industries.

As there is little scope for creating additional employment in agriculture sector, the role of industries in generating additional employment in the state is recognized by the planners and policy makers. Because Rajasthan is a water deficient state, industries that demand less water need to be considered for establishment.

The policy covers aspects of water quality and pollution. It also includes quantification of water pollution and its abatement by proper treatment of sewage and industrial effluents before discharge into natural streams or groundwater recharge and the reuse of wastewater.

The Legal Enablement section informs that the state intends to have Comprehensive Water Law as part of water sector reforms in the state. It is mentioned that legal framework will be developed to preserve the existing water bodies from pollution but industrial pollution which is emerging as a major threat in many rivers and other water bodies in the State, finds no specific mention.

2.9 Rajasthan State Environment Policy 2010

Chapter 1. Preamble

It traces the development trajectory of the State, and recognises that the environmental policy must weave in with the State-specific issues in key sectors.

It notes that significant growth was achieved in the industrial sector, particularly mines and mineral based industries. Also, large industries were setup in most of the districts of Rajasthan. But the basic objective of the industrial sector was to minimize regional imbalances within the State in infrastructure and employment.

It recognizes the advantages of increased abstraction of surface and groundwater for irrigation in 1980s as well as the consequences of rapid groundwater depletion in 1990s.

Chapter 2. Key Environmental Challenges

At the outset, the policy identifies the challenge of water scarcity, increasing demand of various sectors, depletion of groundwater, degradation of water bodies and the pollution.

Chapter 4. Strategies and Actions

4.1.1 Water Resources in Rajasthan

- The document points out conflicting sectoral policy objectives as a big challenge in meeting the water demand and efficient allo-cation of water resources. The facts/data about water resources and their use pattern on page 10 are incorrect.
- Except River Chambal as perennial river, and River Jojari in Jodhpur and River Bandi in Pali (both falling in the Luni River Basin) affected by industrial activity, no mention is made of other River Basins in the State where the major industries are located.
- The section on water use efficiency makes no mention of water use in industries

The *section on suggested strategies* refers to the industries under water supply augmentation. It mentions rainwater harvesting, storm-water harvesting, recycling and reuse of waste waters, and again states: Waste water recycle and reuse shall be promoted in all sectors; the re-use of treated sewage effluent shall be promoted, with appropriate levels of treatment applying to municipal usage, industrial usage, other horticultural usage, beneficial surface discharge (e.g. for irrigation) and recharge of groundwater. Water intensive industries shall be required to recycle their water.

Rajasthan Environment Mission and Climate Change Agenda for Rajasthan

Issues related to water are again discussed in these two chapters but the strategies for reducing groundwater abstraction or increasing water use efficiency, especially in the industrial sector remain neglected.

2.10 State Sewerage and Waste Water Policy- 2016

- The policy document lists 19 core principles. - 5.1 (Second para) 'All local bodies will make City Sanitation Plan (CSP) for a period of 30 years'… - Section 5.5 Pricing of treated water	This policy document is more a guideline document to initiate establishment of sewerage and waste water treatment plants in Rajasthan. - As regards utilization of treated waste water in agriculture and industry, it will largely depend on the willingness of the users and location of STP/CETP *vis a vis* agricultural land and industries, particularly in case of urban areas. The quality of treated wastewater shall be another important factor. - The Policy does not consider the industrial wastewater and its potential for use in agriculture. - On one side state ensures highly subsidized water supply to the industry and agriculture, then pricing of treated water is not an issue rather supply of treated water to both agriculture and industry is a bigger issue. - Item 5.5 deals with pricing of treated water. If the safe drinking water is highly subsidized how the state will fix the price of treated water.

2.11 Rajasthan Urban Water Supply Policy – 2018

Summary	Comments & Observations
- The policy provides framework for addressing legal, regulatory, institutional, administrative, environmental issues and challenges faced by urban water sector. There are 185 Urban Local Bodies in the state. - The policy is intended to provide all households with a piped water connection. - It is proposed that conjunctive water use and progressively greater use of recycled water for non-consumptive usage. Promotion of rainwater harvesting is advocated. - Section 1.3 to 1.15, At the policy level it is intended to provide the following; i) All households with a piped water connection. ii) O&M cost to be recovered from users iii) Conjunctive water use and progressively iv) greater use of recycled water for non-consumptive usage. v) Rainwater harvesting recommended. vi) Water service provided through PPP mode.	- The policy treats all towns/cities at par, irrespective of their geographical location and availability of water resources. The State can be divided into three/ four distinct regions and city/towns falling under them can have differential policy. - The introduction in the document does not mention the constraints in urban water supply. Only after these are identified on the supply, demand and management side, the policy steps can address them. - Presently groundwater is the major source of drinking water to rural and urban population, as 70% towns depend fully on groundwater supply, and that too for a very small duration, and even once in 2-3 days. 1. There is no clarity between the items to be covered in Urban Water policy given the overarching State Water Policy or why a separate urban water policy is needed. 2. The existing water bodies were neglected in most urban areas in the state consequently either they vanished, have been encroached, or put to other use. If that is the status of water bodies then conservation of rivers should be the first priority for their sustenance. 3. PPP model of water resource management is mentioned at many places but there is no clarity on the purpose, such as for augmenting water supply, for billing services, water distribution, improving distribution efficiency, or awareness building, etc. 4. Water demand of industries located in and around urban areas finds no mention. 5. Objective 6 deals with user participation, the issue is whether there is any tested model of user participation in the country that to be adopted or we have to evolve one. 6. Objective 7- Institutional issues; It refers to involvement of ULBs in urban water management. As per 74th Constitutional Amendment Act urban water supply is to be handed over to ULBs with autonomous role. However, at ground level PHED takes all the decisions.

Chapter 7 deals with Water Management and Source Sustainability.	Presently none of the urban township is self-sustainable in water resources. Only few urban areas have surface water supply and those sources also fails to maintain sustainable water supply. Most of the urban water bodies have ceased to exist or have very lean flows, and the groundwater is already over exploited. - The increasing size of urban areas and increasing water demand for diverse activities is posing new threats for managing sustainable water supply. - The issue of quality water supply and addressing pollution is a challenging task.

2.12 Rajasthan Water Resource Vision 2045

Water Resource Vision 2045 has been prepared to highlight the short term (up to 2015) and long term (up to 2045) thrust areas and action plan which are pre-requisites for successful implementation of the State Water Policy and Plan.

- The surface water utilization has to be increased by 60% from present utilization of about 10 BCM,
- Distribution system efficiency has to be increased to 74% from present estimated efficiency of 54%,
- Average on-farm irrigation efficiency has to be significantly increased to about 70% from present estimated efficiency of below 27%.

2.13 Industrial Policy of Rajasthan 2018

- The state industrial policy 2018 says that a special Textile Complex with the requisite infrastructure facilities like a common effluent treatment plant, warehousing, a training Centre, etc. would be developed by RIICO. Also following thrust sectors for growth have been identified after the analysis of State's inherent strength, growth potential of various sectors and their long term sustainability.	In the objectives there is no mention of water security as a concern area of industries. Also, inter regional equity and environmental concerns are missing. A new concept of Integrated Industrial Development is mentioned, that need more clarity. - So far, the State had Industrial Policy made in 1996, 1998, 2016, 2018 and 2019 (draft) and none of these policies has dealt with 'Water Resources' as input in industries did not find area of concern. Rather, in all these policy documents water supply for RIICO Industrial Areas and other industrial sites, was to be ensured by the government. There was no mention of Water Intensive Industries or Water Polluting Industries and their location

	according to availability of water. The possible reasons for oversighting this aspect may the following: (a). It might have been assumed that total industrial water demand in the state is negligible compared to other sectoral usage. (b). All industries are not high water demanding only few types are there and they were not on the priority list of State/RIICO. (c) Water shortage was not that severe in 1980's and 90's to the extent that industries be classifies on that basis. (d) Employment and economic growth seem to be the major priority objective of industrialization in the State. - The policy does not pay desired attention to: (i) regional inequality in the state as income generating capacity of different regions such as, western desert region, hilly and tribal region and water abundant eastern region is visibly different. This regional inequality mainly reflected in terms of contribution in the state GDP and employment generated could have been addressed by location of industries in different parts of the state; (ii) The environmental consequences of siting of industries in different regions might be different. But no mention is made of relationship between type of industry, nature of pollution and suitability or unsuitability for a particular region. Because of this neglect some of the environmental consequences are visible in the state.

2.14 Rajasthan Industrial and Investment Promotion Policy 2010

- The policy lists critical components for setting up industries in Rajasthan and those are; land, infrastructure, skill pool, policy environment, investor experience, etc. - MSME industries	- There is no mention of secure water supply for industries in Rajasthan. - In the objective section no mention is made of water saving or less water using industries as priority to generate growth and employment in the State. - Encouraging MSME is one of the objectives, but already MSME industries are large in number and are less monitored

- Chapter 3 - It is mentioned that to enhance the competitiveness of enterprises in Rajasthan RIICO services to include effluent treatment plants, providing quality access network of roads, uninterrupted power availability, adequate water, high speed data transfer connectivity, etc. Also, it is proposed to establish Specialized New Industrial Parks. - 3.6 Water availability for Investment Projects	for their water use and pollution. These industries are 90 percent located outside the Industrial Estates created by the RIICO. - Thrust areas: In the given list two areas listed at item (iii) Mining and Mineral processing and (vi) Textiles and Apparel industries, are matter of concern as both falls under water intensive category of industries. How far these are justified without any consideration for water availability.
- 3.6.1- In the new dam/projects 10% water would be reserved for industrial and service sector.	- No mention in policy on River Basins in the state, availability of water, and based on that location of industries.
- 3.6.2- Industries in the state would be encouraged to reduce, reuse, recycle water. For setting up of treatment plants benefits from existing schemes will be extended. 3.6.3- Feasibility of sourcing water from reliable and perennial sources would be explored.	- The Section 3.6 in this document exclusively deals with water availability for investment projects but the proposed supply source shall be new dams. - Presently there is no scope of constructing new dams in the State as the economic and technically viable sites have already been exhausted. - Secondly, the location of dam site may not match with location of industry site. - Thirdly, in the existing large and medium size dams, there is already provision of allocation/ reservation of 10% water for domestic supply. Because of high variation in the annual rainfall the dams are not filled to their built capacity. The position of minor dams, existing in large numbers, is worse as they are hardly filled every year and even if filled water lasts only for few months. Therefore, this policy statement of ensuring sustainable source of water supply for industries is not a viable proposition.
Siting of Industries - Chapter 5: Availability of Land, 5.4- Creating Land Bank … being the largest state in India with large tract of waste and less fertile land… - … 5.4.2- Efforts will be made to identify and utilize government waste lands in different parts of the state for employment generating industrial and investment activities…	**Siting of Industries** Unfortunately, there is no such land that can be called or classified as 'waste land'. The so called waste lands in Rajasthan are the source of livelihood for the poor, source of fodder for large number of livestock in the state and above all they are the source of drinking water for human and livestock population. These lands are

- Section 3.6.3 –Water projects on PPP mode will be taken up for major industrial and investment regions. - Chapter 7: Thrust areas, in the given list two areas listed at (iii) Mining and Mineral processing and (vi) Textiles and Apparel industries	the catchment areas of traditional water bodies that helps in groundwater recharge. If these lands are used for industrial estates, most of the traditional sources of water shall be lost.

2.15 Rajasthan Mineral Policy-2015

The Rural Water Supply Scheme of GOI will be extended to the mining areas to meet the drinking water requirement of small and medium size mines.

Use of mines after closure for groundwater recharge

Mining is presently seen as source of revenue and employment but nowhere in the policy document the negative impact of mining on environment and more specifically on water resources by disturbing the geohydrology (drainage system) in most of the River Basins in the State is covered.

2.16 Investment Environment and Opportunities in Food Processing- Rajasthan

The document provides factual account of type of food item produced in different agro-climatic regions of Rajasthan, existing food producing units and their location, scope for new industries with different type of food products.

The major gap in this report is water aspects. Any agricultural commodity need water for production and water availability is unevenly distributed across the state, Also, 60 percent areas are Semi-Arid and Arid. Yet no mention is made of water availability for siting of food processing industries. Also, mention has to be made of climate variability and status of field and horticultural crop production and sustainable input supply to food processing industries.

2.17 Rajasthan Investment Promotion Scheme- 2014

The document deals with the facilities and subsidies provided by the state government to promote industries in Rajasthan.

Section 10.7.3, page 25 deals with Textile industries (water intensive industries) there is mention of capital subsidy on zero liquid discharge based treatment plant. This subsidy is also extended to Agro-processing and Bio- technology sector.

The incentives (Subsidies and Tax exemptions) to different types of industries is addressed in the document. Surprisingly no mention is made of subsidy and tax exemption/rebate to industries using less water or efficiently and conserving water. However, capital subsidy on zero liquid discharge based treatment plant is proposed only in case of Textile, Agro-processing and bio-technology sector industries.

2.18 Rajasthan MSME Policy 2015

The policy is meant for providing all kinds of support to MSME industries in the state. All those concessions that attracts entrepreneurs to set up industries in Rajasthan are proposed. The policy's concern about water and environment is mentioned at only two places:

I. Section 3 – Approach and Strategy, Item 14, 'Provide adoption of practices for environmental protection and water and energy conservation.'
II. Section 16 – Support for Environment Conservation, Item (I), … 'the State Government shall provide 50% of the capital cost for establishment of Common Effluent Treatment Plant (CETP) by Industry Associations/ SPV in industrial areas/ clusters, as per applicable laws, subject to the following conditions:' …

There is no mention of water using industries or polluting industries. Also, no direction is given for location of industries based on water availability, regional inequalities, unemployment (regional) status, etc. The state approach is only to increase the number of MSME's in the state.

2.19 Summary of Review of Policies, Laws/Acts, and Regulations

10. The National and State policies on water do highlight the importance of IWRM but an integrated view is missing in the rules, regulations, and action plans.

11. Despite an acknowledgement of spatial variability in precipitation, location specificity of water availability and use pattern are not considered in any of the documents and therefore, implementation of policy fails to deliver desired results.

12. Different sectoral policies and governance system fail to capture the diversity in availability of water (rainfall, surface and ground water, quality), its usage pattern, and emerging issues over space and time (climate change, climate variability, water conflicts). To make it more explicit the geographical features, such as Deserts, hills, plain, canal command areas, tribal areas, agro-climatic zones, river basins, etc. are not differentiated/ considered while providing policy prescriptions.

13. Industrial Policy makes no mention of water using industries or polluting industries. No direction is given for location of industries based on water availability, regional inequalities, unemployment (regional) status, etc. Rather the approach is to increase the number of MSME's in the state.

14. The incentives (Subsidies and Tax exemptions) to different types of industries do not differentiate between water efficient industries and water-intensive industries.

15. The industrial policy does not consider the relationship between type of industry, nature of pollution and suitability or unsuitability for a particular region in the State.

16. Industries are also located in and around the urban areas; the conflicts with water demand of urban areas finds no mention in the policy.

17. The State Govt has taken lead in formulating a policy on recycling and reuse of domestic sewage. Treated sewage is proposed to be used both in agriculture and industries. However, the issue of location of STPs in relation to agricultural and industrial areas as well as the type of industries has apparently been not considered.

18. While rainwater harvesting has been made mandatory, there is practically no emphasis on reducing water consumption and implementing recycle-reuse of industrial wastewaters.

Chapter 3.
WATER RESOURCES OF RAJASTHAN

The State of Rajasthan, in the north-western part of India, shares its border on the west and northwest with Pakistan, and is surrounded by the states of Punjab, Haryana and Uttar Pradesh on the north and northeast. Madhya Pradesh on east to southeast, and Gujarat on the southwest. The state lies between 23º03' to 30º12' N latitudes and 69º30' to 78º17' E longitudes, and covers a total area of 342,239 sq km. Administratively, it is divided into 33 districts, with the State Capital in Jaipur (Jaipur district). Its total human population is about 70 million (of which 75% is rural), and the state supports more than 11% of India's total livestock population.

3.1 Physiographic Features

The State is generally divided into four main physiographic regions (Figure 3.1):

(a) Aravalli hill ranges

(b) Eastern plains

(c) Western Sandy Plain and Sand Dunes, and

(d) Vindhyan Scarpland and the Deccan Plateau

The Aravalli hill ranges, which include some of the world's geologically oldest formations, are a series of discontinuous hills, oriented in southwest to northeast direction. These hills range from about 600 m to more than 900 m in elevation, with the highest peak (Gurushikhar) being 1722 m near Mount Abu.

The Aravalli hill ranges divide Rajasthan into two: (1) The Eastern Plain which gradually slopes towards the north in the north, towards the east in the eastern side and towards the south in the southern part; and (2) the vast Sandy Plains and Sand Dunes (on the western side) which form a part of the Thar Desert. These plains are often sub-divided into (a) Sandy Arid Plain on the western side, (b) Semi-arid Transitional Plain – a southwest sloping terrain between the plain and the western foothills of Aravalli ranges, and (c) the Ghaggar Plain in the northwest, that includes the former floodplains.

The Vindhyan scarp land (from Chittorgarh to Dholpur and Sawai Madhopur districts) and the Deccan Plateau (with elevation up to 500 m in parts of Kota, Jhalawar, Banswara and Chittorgarh districts), also known as Hadoti Plateau, lie on the south east of the Eastern Plains. The area also includes the ravines along the Chambal river and its tributaries.

The altitude varies even within these physiographic zones, from less than 50 m to more than 900 meters above mean sea level (Figure 3.2).

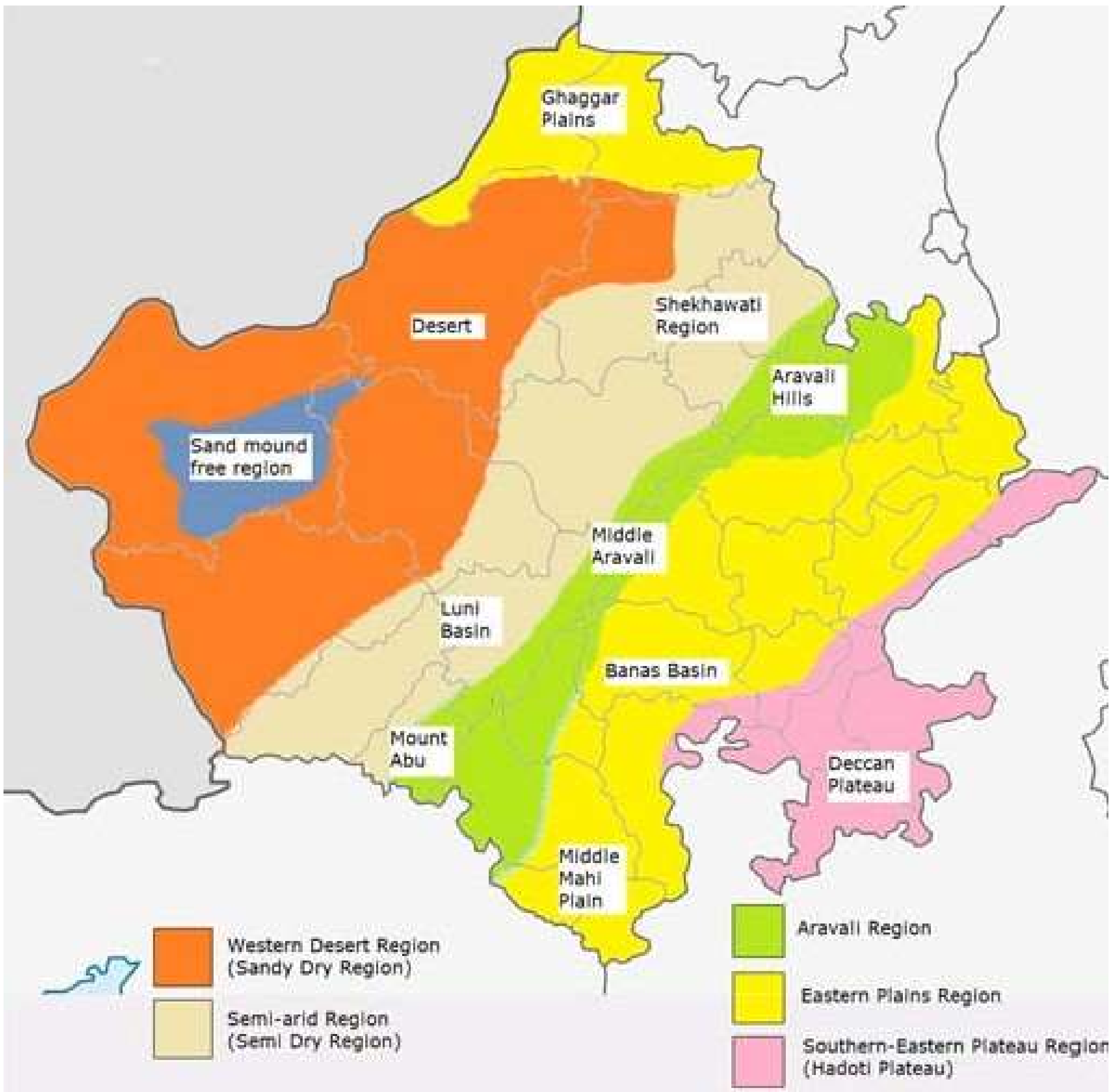


Figure 3.1: Physiographic Regions of Rajasthan

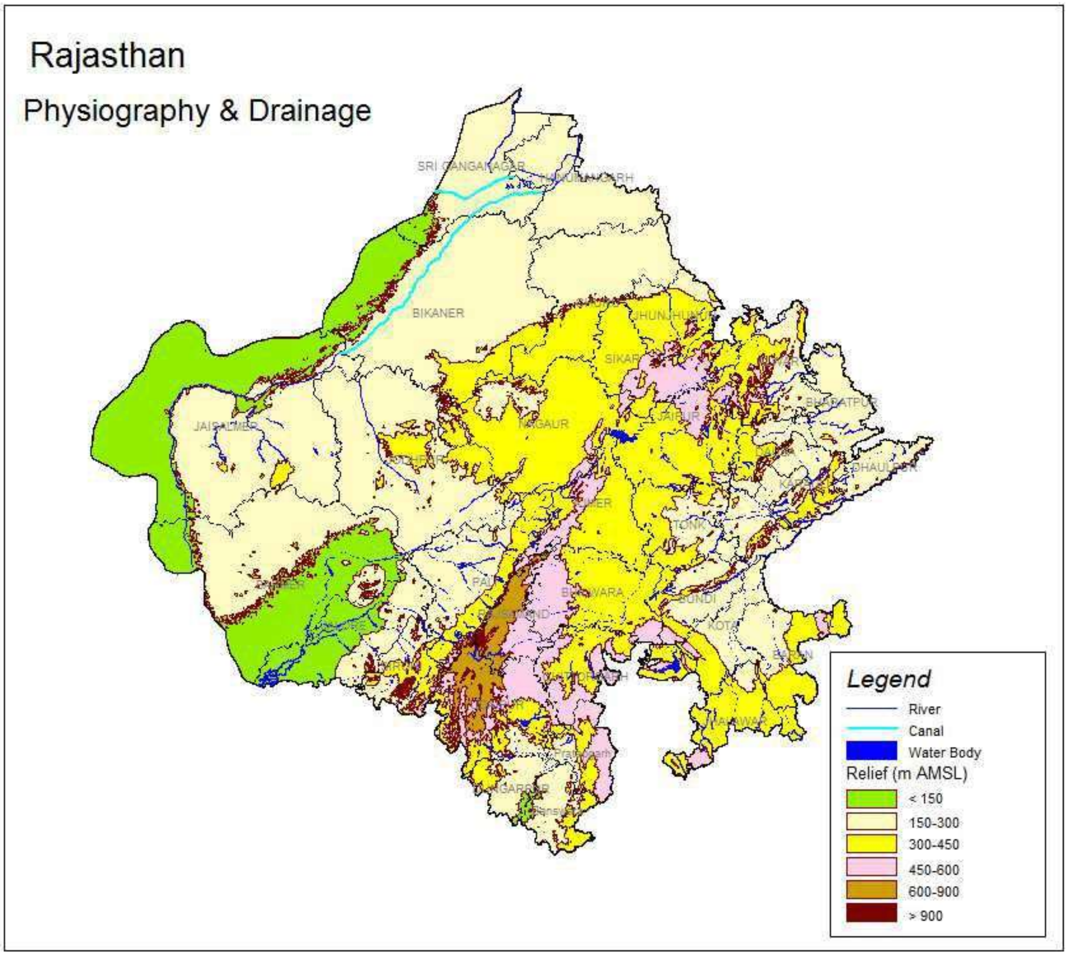


Figure 3.2: Altitudinal variations within the state of Rajasthan
Source: Report on Dynamic Ground Water Resources of Rajasthan (As On 31st March, 2013)

3.2 Climate

The climate in Rajasthan is subtropical monsoonal but experiences very high variability of rainfall. The total annual rainfall ranges from less than 100 mm in the far west to nearly 1000 mm in the southeastern parts (Figure 3.3). The normal annual rainfall of Rajasthan is 549 mm.

The Aravalli hill ranges have a direct bearing on the climate as they do not intercept the southwest monsoon winds from the Arabian Sea, and the monsoon progressing from the east towards the west of India is gradually depleted of its moisture by the time it arrives over western Rajasthan. Thus, the region lying west of the Aravallis receives very little rain. However, several seasonal rivers originate in the Aravalli ranges.

Based on the distribution of the annual rainfall, Rajasthan can be divided into three hydrologic zones:

(1) The Arid to Semi-Arid zone west of Aravallis with a mean annual rainfall of less than 250 mm only. The area is almost completely devoid of any natural surface water sources (except the seasonal river Luni). It includes the districts of Hanumangarh, Churu, Sri Ganganagar, Jhunjhunu, Nagaur, Sikar, Jodhpur, Pali, Jalore, Sirohi, Barmer and Jaisalmer;

(2) The central Sub-humid to Humid Zone east of the Aravallis, with annual rainfall between 250 and 700 mm. It includes the districts of Alwar, Bharatpur, Jaipur, Dausa, Ajmer, Sawai Madhopur, Karauli and Dholpur. As the rainfall increases from west to the east, the zone may be subdivided into two parts with rainfall from 250 to 500 mm, and from 500 to 700 mm; and

(3) The South-Eastern Rajasthan with rainfall more than 700 mm. It includes the district of Kota, Baran, Bundi, Banswara, Dungarpur, Rajsamand, Jhalawar, Bhilwara, Chittor and Udaipur.

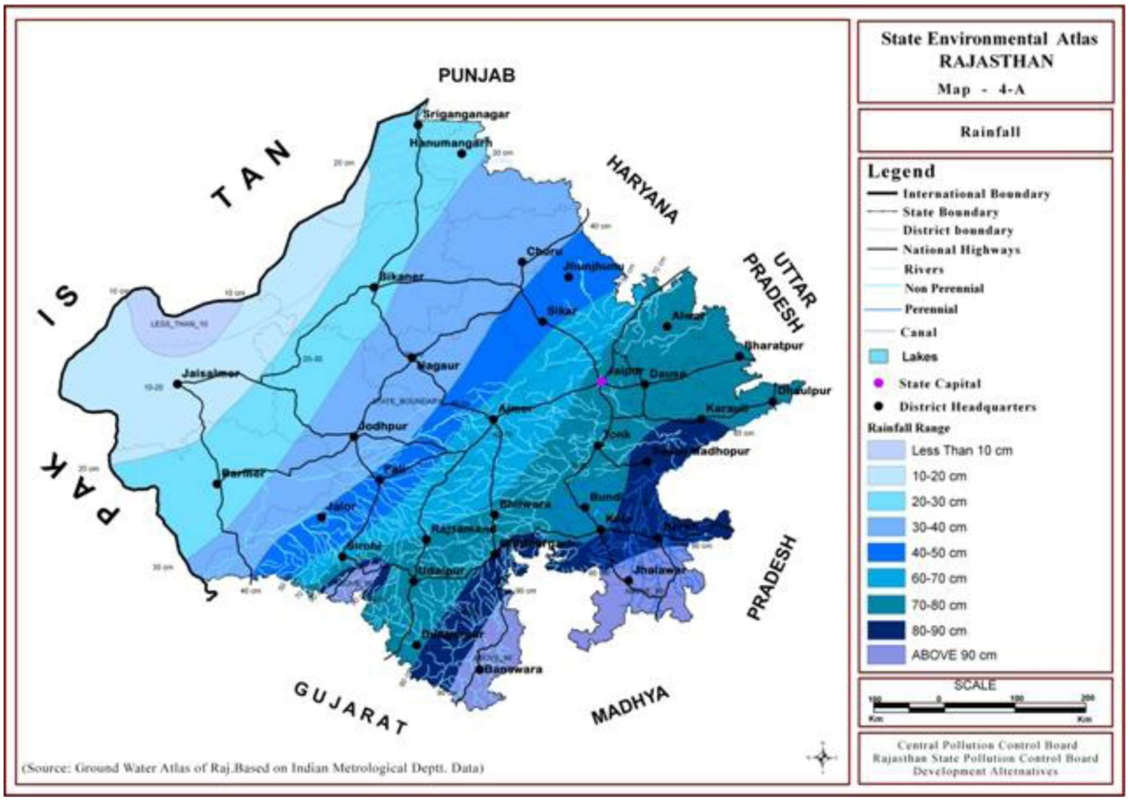


Figure 3.3: Variation in total annual rainfall in the State of Rajasthan

Source- Ground Water Atlas of Rajasthan based on Indian Metrological Department data.

Figure 3.4 shows the rainfall pattern in Rajasthan since 1901 up to 2018. The figure shows that rainfall variability is high and it is difficult to assess yearly quantum of rainwater available for planning water based economic activities. Out of 100 years, 50 years are drought years. To understand the trend in rainfall in the state, five-year and seven year moving averages were calculated and the patterns are shown in Figures 3.5 and 3.6. The figures provide cyclical pattern in the annual rainfall and long-term pattern. Despite difference in the average rainfall in the three rainfall zones discussed above the variability is high in all the zones. The pattern of rainfall over the same period, and the trends with 5-yr and 7-yr moving average, in the three rainfall zones are shown in Figures 3.7 to 3.15.

Figure 3.4: Rainfall Pattern in Rajasthan during 1901 to 2018

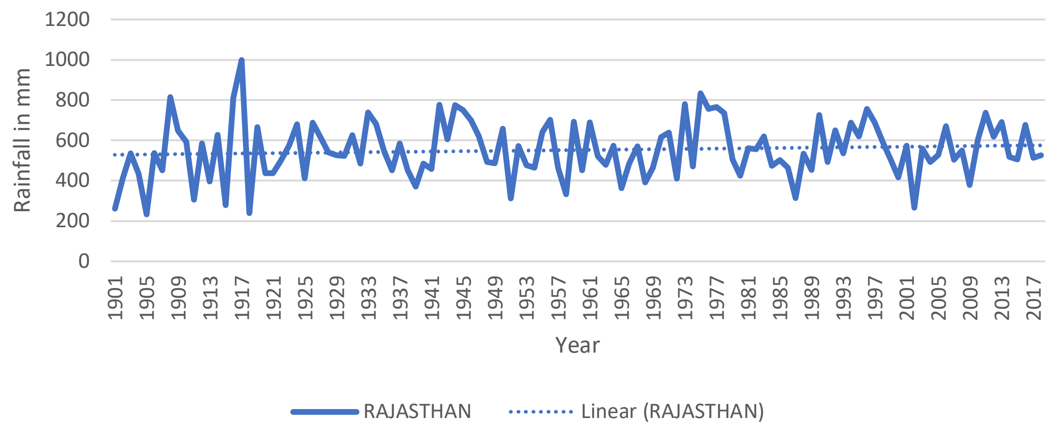


Figure 3.5: Five Year Moving AverageRainfall Pattern in Rajasthan

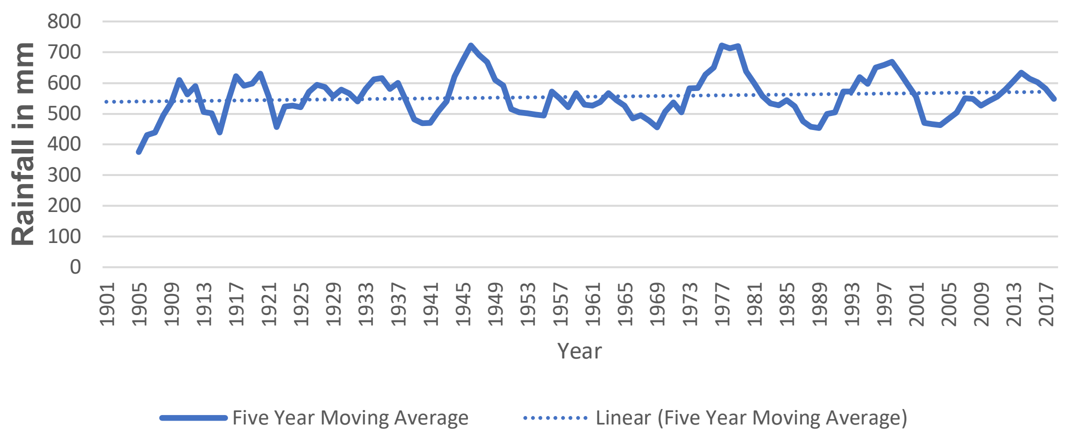


Figure 3.6: Seven Year Moving Average Rainfall Pattern in Rajasthan

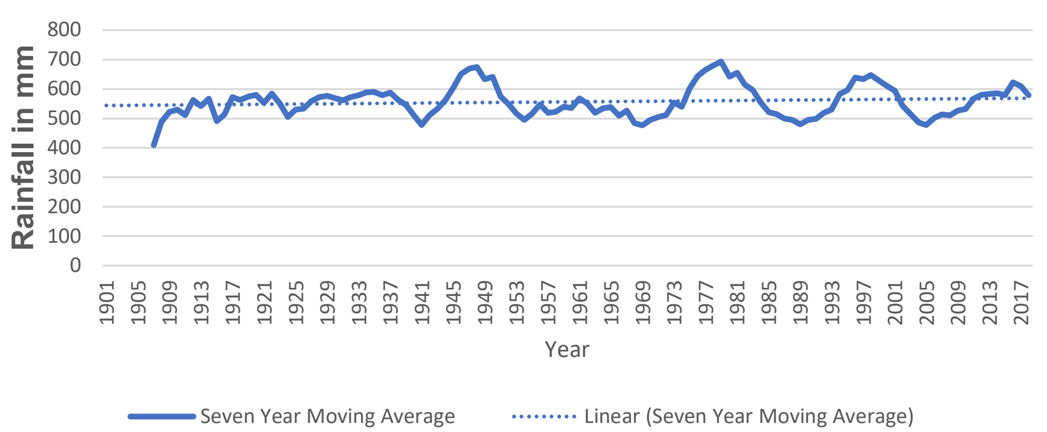


Figure 3.7: Rainfall Pattern in Western Zone of Rajasthan during 1901 to 2018

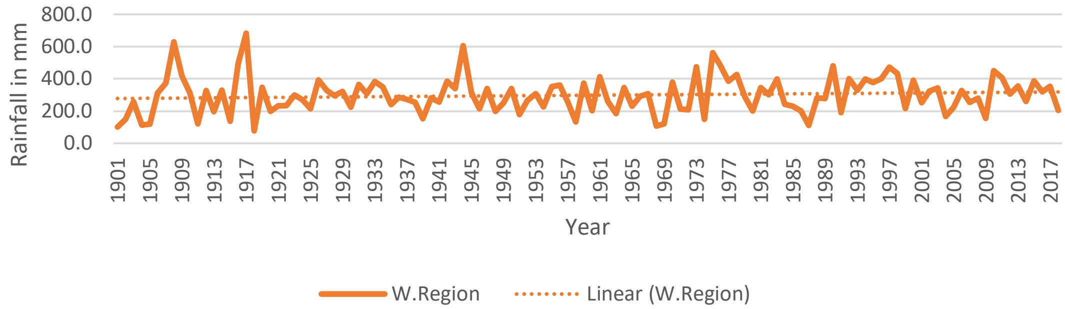


Figure 3.8: Five Year Moving Average Trend of Rainfall in Western Zone of Rajasthan

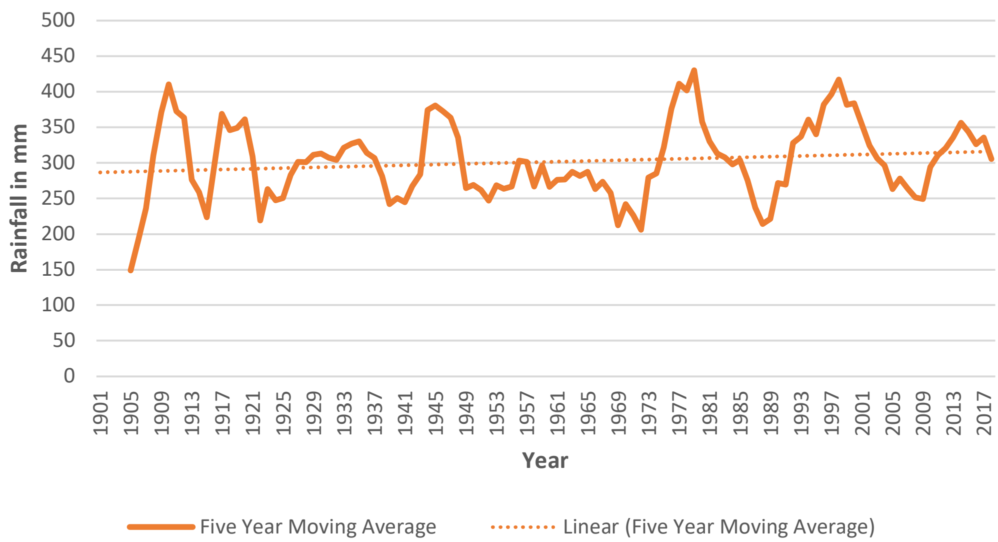


Figure 3.9: Seven Year Moving Trend of Average Rainfall in Western Zone of Rajasthan

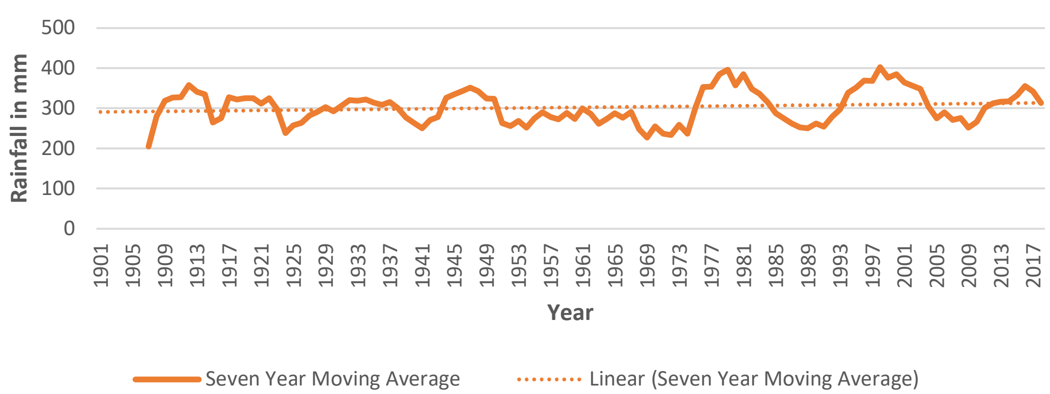


Figure 3.10: Rainfall Pattern in North-East Zone of Rajasthan during 1901 to 2018

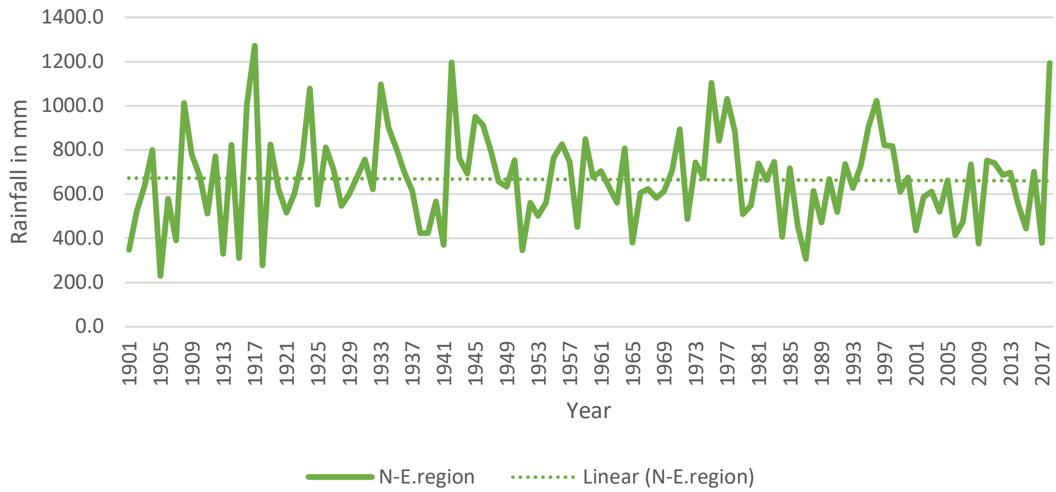


Figure 3.11: Five Year Moving Average Trend of Rainfall in North Eastern Zone of Rajasthan

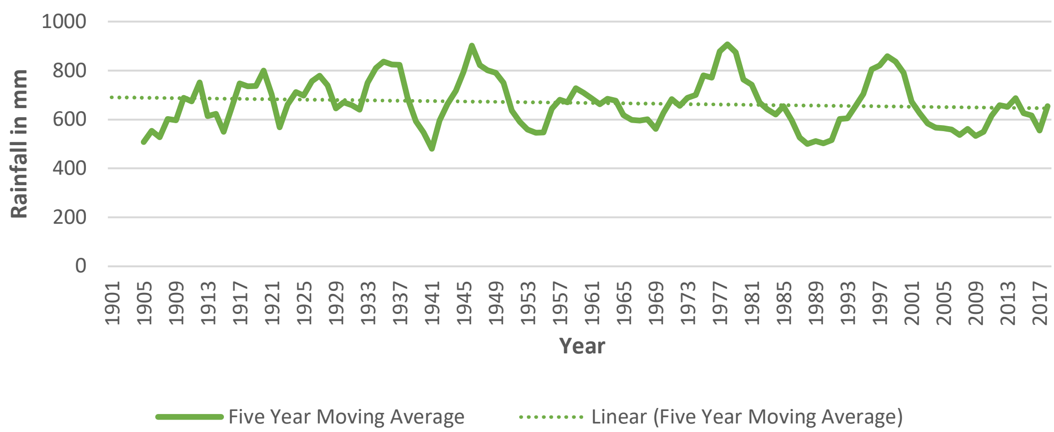


Figure 3.12: Seven Year Moving Average Trend of Rainfall in North Eastern Zone of Rajasthan

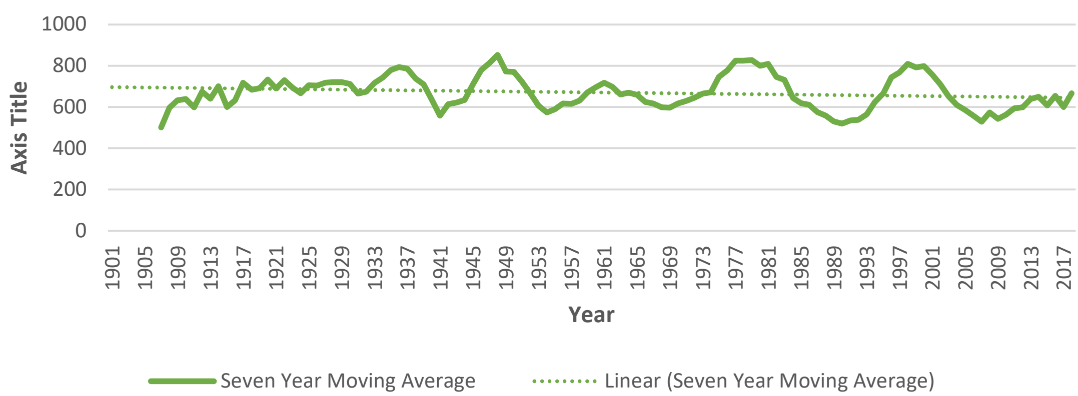


Figure 3.13: Rainfall Pattern in Southern Zone of Rajasthan during 1901 to 2018

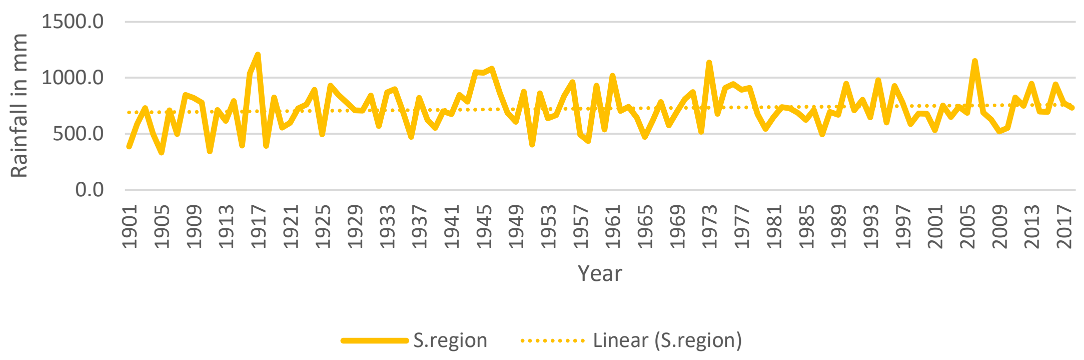


Figure 3.14: Five Year Moving Average Trend of Rainfall in Southern Zone of Rajasthan

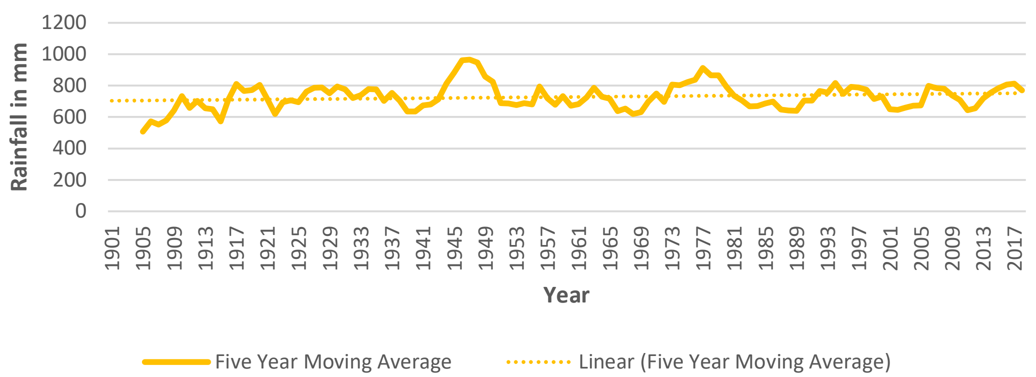
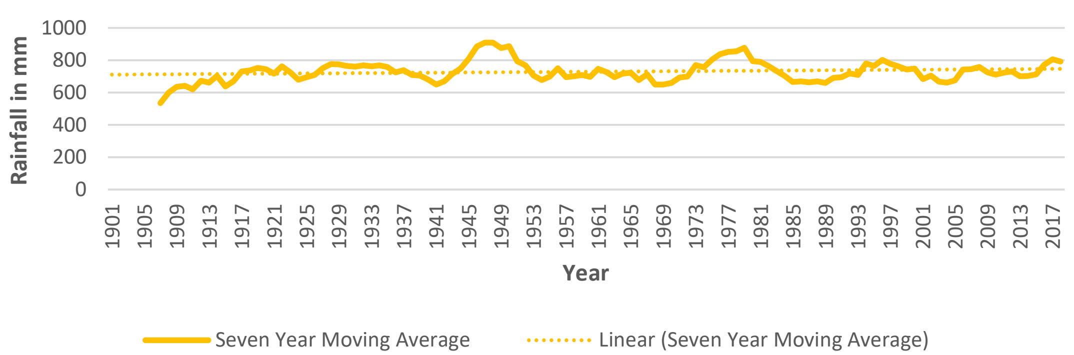


Figure 3.15: Seven Year Moving Average Trend of Rainfall in Southern Zone of Rajasthan



3.3 Agroclimatic Zones

Following Agroclimatic zones are recognised in Rajasthan, based on the climate, soils and other characteristics relevant to agriculture. These are shown in Figure 3.16.

Code ACZ Name	**Area (km^2)**	
Ia. Arid Western Plain	**45578**	Rainfall: 200-370 mm Region: Barmer and parts of Jodhpur Temperature: 8.0-40.0 °C
Ib. Irrigated North-Western Plain	**20621**	Rainfall: 100-350 mm Region: Shri Ganganagar Temperature: 4.0-42.0 °C
Ic. Hyper Arid Irrigated Western Plain Partially	**77002**	Rainfall: 100-350 mm Region: Bikaner, Jaisalmer and Churu Temperature: 4.5-42.0 °C
IIa. Transitional Plain of Inland Drainage	**37055**	Rainfall: 300-500 mm Region: Nagaur, Sikar, Jhunjhunu and part of Churu Temperature: 5.0-40.0 °C
IIb. Transitional Plain of Luni Basin	**31657**	Rainfall: 300-500 mm Region: Jalore, Pali, Parts of Sirohi and Jodhpur Temperature: 4.5-40.0 °C
IIIa. Semi Arid Eastern Plain (mostly Banas river basin)	**29513**	Rainfall: 500-700 mm Region: Jaipur, Ajmer, Dausa, Tonk Temperature: 8.5-41.0 °C
IIIb. Flood Prone Eastern Plain	**24432**	Rainfall: 500-700 mm Region: Alwar, Bharatpur, Dholpur, Karoli, and parts of Sawai Madhopur Temperature: 8.0-40.0 °C
IVa. Sub-humid Southern Plain and Aravali Hills	**37563**	Rainfall: 500-900 mm Region: Bhilwara, Sirohi, Udaipur, Chittor Temperature: 8.0-39.0 °C
IVb Humid Southern Plain	11979	Rainfall: 500-1100 mm Region: Banswara, Dungarpur, parts of Udaipur and Chittor Temperature: 7.0-39.0 °C
V Humid South-Eastern Plain (Hadauti Plateau)	26864	Rainfall: 650-1000 mm Region: Kota, Jhalawar, Bundi, Baran and Parts of Sawai Madhopur Temperature: 10.0-43.0 °C
Total Area	**342264**	

Figure 3.16: Agro-climatic Zones of Rajasthan
Source- www.Krishi.Rajasthan.gov.in

3.4 Total Water Resources of Rajasthan

According to TAHAL Study on Planning of Water Resources of Rajasthan, July 2014, the River basin wise estimated total internal surface water resources of Rajasthan are estimated at 25.39 BCM (20.95 BCM at 50% dependability and 14.82 BCM at 75% dependability) of which about 16.05 BCM are considered economically exploitable (at 50% dependability). The renewable groundwater resource (fresh, dynamic component) is estimated at 10.614 BCM per year whereas the static reserve of fresh and saline groundwater reserves is reported to be 32.9 BCM and 29.7 BCM respectively. Further, the state of Rajasthan has been about 17.11 BCM water from rivers outside the State, as its share in interstate rivers. According to the 2017 Report of the CGWB, the total groundwater abstraction in Rajasthan has reached 15.71 BCM.

According to 'Water in Rajasthan Report' of the expert committee on Integrated Development and Management of Water Resource, Jaipur (June-2003), the total surface (Internal and External) and groundwater water availability and utilization in Rajasthan is shown in Table 3.1. Table 3.2 provides more details on the sources and share of external water.

Table 3.1: Total Surface and Ground Water Resources in Rajasthan.

Item	Availability (BCM)	% of Total Water	% of Surface Water	Utilization (BCM) & %	Utilization %
Surface Water a. Internal Water	21.71	42.6	54.8	11.29 (31.6%)	52
b. External Water	17.88	35.1	45.2	12.66 (35.4%)	70.8
Total Surface Water (a+b)	**39.59**	**77.7**	**100**	**23.95**	**69.3**
Ground Water	11.36 *	22.3		11.771** (32.9)	104 **
Grand Total	**50.95**	**100**		**35.721 (100.0)**	**70.1**

Source: *The Vision 2045 document of the Govt of Rajasthan reports only 10.09 BCM as utilizable
** According to the 2017 assessment of CGWB (Dynamic Water Resources of India), the available GW is 11.99 BCM and actual utilisation is 16,77 BCM (i.e. 140% exploitation)

3.5 Surface Water Resources

Rajasthan is among the driest states of India and has very few water resources. Most of the rivers are seasonal and there is no natural freshwater lake. River Chambal and Mahi are the only perennial rivers in the State. The only natural lakes are the salt lakes which are also seasonal and depend upon the monsoon rains. However, many reservoirs have been constructed on most of the seasonal and ephemeral streams to intercept their monsoon season flows for irrigation and domestic supplies. The surface water resources available in the state are shown in Table 2. The total surface water available is 39.59 BCM (based on 50% dependability) of that 21.71BCM is from internal sources and 17.88 BCM (45%) is from inter-state transfers. The status of surface water utilization is also shown in Table 3.2. Of the total surface water available in the state only 69.87% is utilized, while in case of groundwater the availability is 11.15 BCM and utilization is 11.83 BCM, i.e. over utilization.

Table 3.2: Status of Surface Water Resources in Rajasthan

(In Billion Cubic Meters (BCM)

Water Sources	Availability, BCM & (%)	Utilization
Surface water (50% dependability)		
A. Internal	21.71* (42.79)	11.29 (28.76)
B. Inter State		
1. From Rabi Beas-Sutlej Water	13.71 (27.02)	13.71* (34.92)
2. Chambal	1.97 (3.88)	1.97 (5.02)
Mahi	0.46 (0.91)	0.46 (1.17)
Sub Total	**37.85 (74.60)**	**27.43 (69.87)**
3. Narmada	0.62 (1.22)	-
4. Yamuna	1.12 (2.21)	-
Total	**39.59 (78.03)**	**27.43 (69.87)**
Ground water	11.15 (21.97)	11.83 (30.13)
Grand Total	50.74 (100.0)	39.26 (100.0)

3.6 External Water Resources

Rajasthan state depends a lot on water imported through canals from neighbouring states under different inter-state agreements (Figure 3.17). The Gang Canal, brings 1369 MCM water from the Ravi-Beas-Sutlej basins in the erstwhile Punjab state to Bikaner under a 1920 agreement between the erstwhile rulers of Bikaner State and Punjab. Further agreements for sharing water made after independence of the country, between Rajasthan, Punjab and Haryana, provide 1739 MCM of Sutlej water, and 10,608 MCM of Ravi-Beas water through the Bhakra, Sidhmukh-Nohar and Indira Gandhi Nahar Project. These waters are utilised in the western Rajasthan (Outside Basin), along with the water in the Ghaggar basin.

Rajasthan utilises 1,119 MCM water in Ruparail and Banganga Basin (through Gurgaon Canal and Bharatpur Feeder) as its share in Yamuna basin. Water is also proposed to be obtained from the Yamuna basin for use in Banganga basin and in Churu and Jhunjhunu Districts of the Outside Basin.

Rajasthan receives 454 Mm^3 (against 1,920 MCM agreed in 1966) from the Mahi basin; 1973 MCM as Rajasthan's share in Chambal river up to Kota Barrage; and 617 MCM from Narmada basin through the Narmada Canal for use in Luni basin and Jalore

Thus, Rajasthan imports a total of 17879 MCM water from outside its boundaries, besides about 489 MCM flow in Ghaggar.

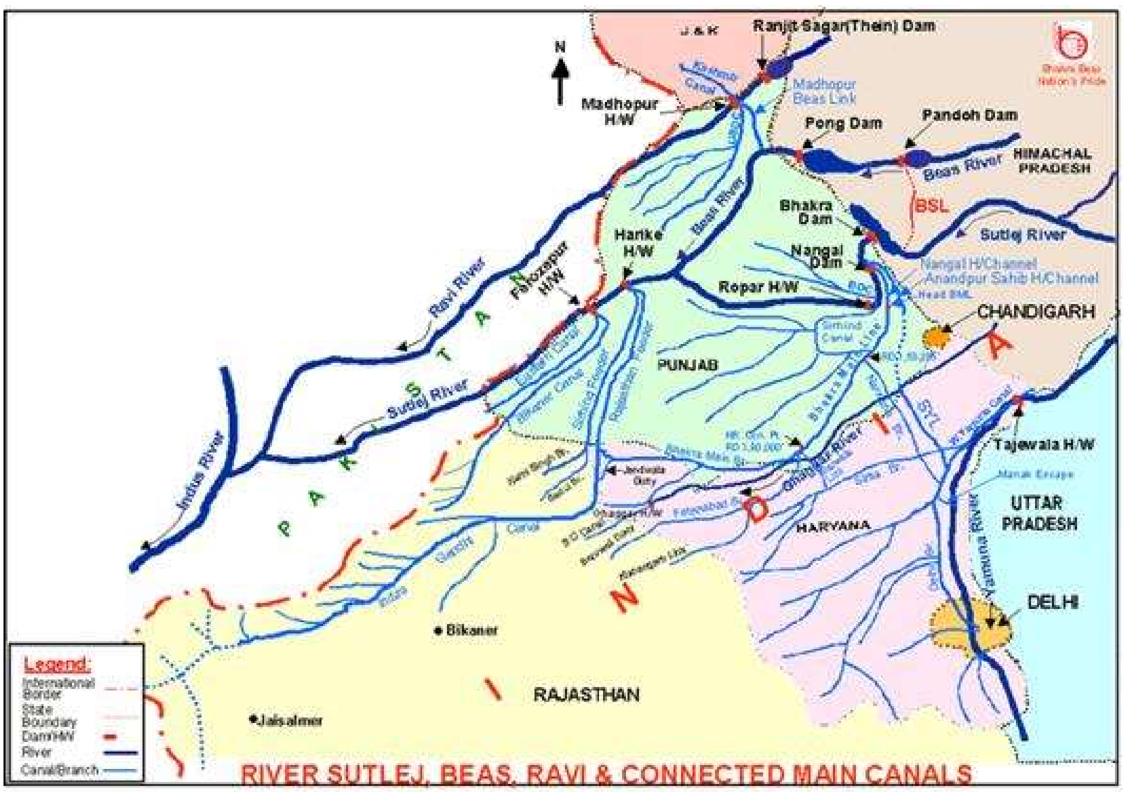


Figure 3.17: Canal System in the Western Rajasthan

3.7 Rivers and River Basins

Many rivers originate and pass through the State of Rajasthan. These may be grouped into three categories:

a. The rivers which flow towards the Arabian Sea. These include Luni, Mahi, Sabarmati and their tributaries.
b. The rivers of the Ganga river basin, contributing their discharge to the Bay of Bengal. They include mainly the river Chambal and its tributaries, besides several smaller streams.
c. The rivers of inland drainage (endorheic) i.e., which arise and end up within the Rajasthan. These are the rivers feeding the Sambhar Salt lakes and a few ephemeral streams (including Ghaggar) in Western Rajasthan.

Although some reports recognise 15 river basins within Rajasthan, these are actually sub-basins or the headwater regions of a river basin. Following are the major basins or sub basins which are shown in Figure 3.18.

3.7.1 Luni Basin

Luni is one of the major rivers flowing through Rajasthan. It originates near Pushkar as two streams which join at Govindgarh. It flows for about 495 km in a south-westerly direction in Rajasthan and then disappears in the marshy land of Rann of Kutch. The river basin extends over parts of Ajmer, Barmer, Jalore, Jodhpur, Nagaur, Pali, Rajsamand, Sirohi and Udaipur districts. The total catchment area of the basin is 37,363 sq. km. Luni River Basin lies to the west of the Aravali hills and forms part of the mid-west alluvial plain. The eastern part of the basin is an alluvial plain that is bound further east by hills of the Aravalli ranges. River Luni carries fresh water only its upper reaches but gradually turns increasingly saline downstream. The main tributaries of Luni are Sukri, Rediya, Mithri, Bandi, Khari, Jawai, Guhiya and Sagi, and Jojari. The mean annual rainfall over the Luni Basin is 320 mm. There are two major dams (Sardar Samand and Jawai dam), nine medium and 344 minor irrigation projects in the Luni Basin besides many smaller irrigation systems constructed and operated by Panchayat Samitis.

3.7.2 Chambal Basin

River Chambal, the largest tributary of R. Yamuna, originates in Vindhyan ranges of Madhya Pradesh (MP), flows through Rajasthan and Uttar Pradesh (UP) before meeting Yamuna near village Bhareh (Chakarnagar block, Dist Etawah). After flowing for 320 km generally northwards from its source near Mhow (Indore), the river enters a deep gorge in Rajasthan at Chourasigarh, extending over 96 km up to Kota. The river then flows for about 252 km forming the boundary between MP and Rajasthan. Thereafter, the river forms the boundary between MP and UP for about 117 km, flows in UP for about 40 km before joining Yamuna.

About 58% of the catchment of Chambal i.e., about 79,400 sq. km lies in Rajasthan, making it the largest and most important river in the State. Its major tributary is Banas and is often considered as a separate basin in the state. Other tributaries include Mej, Kali Sindh and Parvati. Chambal basin (excluding that of Banas) extends over most parts of parts of Chittorgarh, Bhilwara, Bundi, Sawai Madhopur, Tonk, Jhalawar, Kota, Baran and Dholpur districts.

3.7.3 Banas Sub-basin

Banas (or East Banas) is a major tributary of the River Chambal with a catchment area (45,833 square km). It originates from the Aravalli ranges near village Pindwara in District Sirohi, and flows north-eastwards for 513 km through Rajsamand, Udaipur, Bhilwara, Chittorgarh, Ajmer, Bundi, Jaipur, Tonk, Dausa and Sawai Madhopur districts before its confluence with R. Chambal near village Rameshwar in Khandar Block in Sawai Madhopur district. Its tributaries include Kothari river which passes through Bhilwara, and Berach river which flows through Udaipur and Chittorgarh.

3.7.4 West Banas

West Banas also originates from Aravalli hills and flows in a southwest direction through villages in Sirohi district for about 78 km before entering Banaskantha district in Gujarat. Its basin consists of mainly hills covered with forests up to Mount Abu. Of its total catchment area of 8,674 km^2, 3,269 km^2 lies in Rajasthan. Its major tributaries in Rajasthan are Sipu (better known as Sukli) and Balaram. Dhanari dam near Swaroopganj is the major dam on this river. Sukli River (Sipu) originates in the hills near Mera village southwest of Sirohi. It flows in a southwest direction, parallel to Mount Abu hill ranges, for about 45 km up to Khera village in Sirohi District, and meets West Banas River near Davas village in Gujarat State. Several drains (Udwaria, Tokra, Nagani, Dabari, Sillinadi, Butri and Mandar) flow into Sukli River. It is often considered to be a separate basin in Rajasthan. The total catchment of Sukli Basin covers an area of 990 km^2 within three Blocks (Abu Road, Reodhar and Sirohi) of Sirohi district.

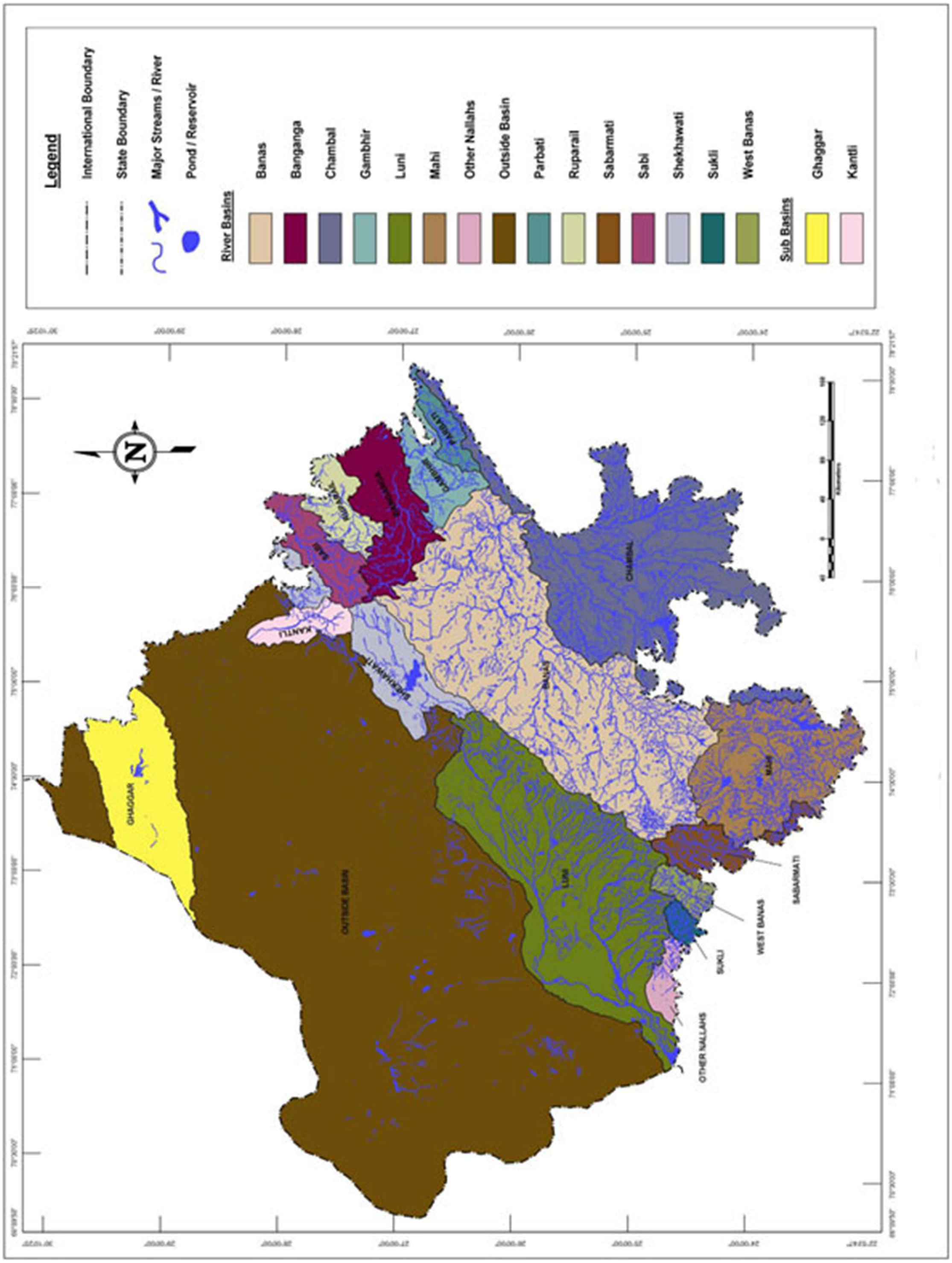


Figure 3.18: River Basin Map of Rajasthan

3.7.5 Sabarmati

Sabarmati originates from Aravalli hills near village Tepur in Udaipur district of Rajasthan. The river flows for 371 km southwards in Gujarat before discharging into the Gulf of Khambhat on the Arabian Sea. During its 48 km flow in Rajasthan its tributaries are Sei and Wakal. The catchment area in Rajasthan is 4,164 km^2 extends over parts of Udaipur, Sirohi, Pali and Dungarpur districts.

3.7.6 Mahi River

Mahi basin is bound on the North and the North-West by the Aravalli Hills, on the East by the ridge separating it from the Chambal basin, on the South by Vindhyas and on the West by the Gulf of Cambay. In Rajasthan, the basin consists of hills, forests and eroded terrain. The river traverses 174 km and makes a 'U' shaped loop in Rajasthan before entering Gujarat.

3.7.7 Sabi or Sahibi Basin (Sub-basin of River Yamuna)

Sabi (also called Sahibi), an ephemeral river, originates from the eastern slopes of the hills in Sikar district. It flows southeast to enter Jaipur district and then turns northeast near Shahpura. After flowing for 157 km in Rajasthan, it enters Haryana and then joins the River Yamuna in Delhi. In Delhi stretch, the river receives lots of wastewater and domestic sewage, and has turned into a drain – known now as Najafgarh drain.

Its main tributaries are: River Dohan which originates near Neem Ka Thana in Alwar district; and River Sota (or Sota nala) that also rises in Sikar and flows through Jaipur before meeting the Sahibi river on its left bank near Behror (Alwar district). Another former tributary, River Krishnavati flows through Patan in Dausa district and Mothooka in Alwar district, before disappearing in Mahendragarh district in Haryana.

3.7.8 Gambhir (Sub-basin of River Yamuna)

River Gambhir, an ephemeral river, originates in the hills near Karauli. It flows northwards up to Kanjoli village (Toda Bhim), then northeast up to village Mertha of Roopbas Block, before entering Uttar Pradesh. The river again enters Rajasthan near Catchapaura village in Dhoulpur District and forms the boundary between UP and Rajasthan. It then enters Mainpuri District in UP to finally join River Yamuna (Groundwater Resources Dept, Jaipur, 2013). The river length within Rajasthan is 288 km. Its basin, lying between those of Banganga and Parbati rivers, covers an area of 4,693 km^2 within Karauli and Bharatpur districts.

3.7.9 Parbati (Tributary of Gambhir)

Parbati river rises in the hills near village Chhawar in Karauli District, flows towards northeast for 123 km before joining River Gambhir near Kharaghar village in Dhaulpur District. Its basin covers an area of 1,887 km^2 in Dholpur, Karauli and Bharatpur Districts, and lies adjacent to the State of Uttar Pradesh

3.7.10 Ruparail (Inland Drainage)

River Ruparail, also known as Barah, rises in the Udainath hills of Thanagazi Reserved Forest (RF), Alwar District. After flowing northwards through the hills, it turns to eastwards and disappears in Bharatpur District near Kusalpur. The total basin area of the 104 km long river is 3809 km^2, between the Sabi and Banganga river basins.

3.7.11 Banganga (Inland Drainage)

Banganga river originates in Aravali hills near Bairath (Viratnagar) north of Jaipur and drains inland. Its basin extends over parts of Alwar, Jaipur, Dausa, Sawai Madhopur and Bharatpur districts. The total catchment area of the basin is 8,878 km^2. Along its 240 km length, it meets a few ephemeral tributaries - Gumti Nalla and Suri River its right bank, and Sanwan and Palasan Rivers on its left bank.

3.7.12 Ghaggar (within Outside Basin)

Ghaggar is a seasonal river which originates in the Shivalik hills of Himachal Pradesh and flows through Punjab and Haryana, enters Rajasthan in Hanumangarh district. It leaves Rajasthan in Sri Ganganagar district and enters Pakistan near Fort Abbas City where is called Hakra. Based on recent archaeological evidence dating back to pre-Harappan period, Ghaggar is believed to be the mythological river Saraswati. The basin area of Ghaggar within Rajasthan 9,853 km^2 (about 30% of the total). The Northern Ghaggar canal and the Southern Ghaggar canal from the Ottu barrage constructed in 1896-97 near the border with Haryana irrigate the fields in Rajasthan. Ghaggar basin partly overlaps the command area of Indira Gandhi Canal and Bhakhra Canal. Supplies to some of Bhakhra and Indira Gandhi canals come from Ghaggar whenever there is surplus water in it.

3.7.13 Shekhawati Basin (Inland Drainage Systems)

In north-eastern part of Rajasthan, west of the Sahibi river basin and north of the Luni river basin, flow two ephemeral rivers: Kantli and Mendha, both arising at nearly the same area in Sikar district. Whereas Kantli flows north and northeast for about 134 km before it disappears in the sandy plain near Naurangpura, River Mendha flows south-southwest and disappears in Lake Sambhar – an endorheic saline lake. The basins of these two rivers together are known as Shekhawati Basin and cover a total area of 9,750 km^2. Small parts of Dohan and Krishnavati rivers (see Sahibi river) also lie within this basin.

3.7.14 Jalore Drains

Many drains, including Baragaon Nadi and Sukal River, originating from the western slopes of Jaswantpura hills, Silar hills and adjacent areas in Jalore district are often treated together as a separate basin, covering an area of 1900 km^2 and carrying their flow into Gujarat.

3.7.15 Outside Basin

The vast desert area lying to the west of Aravalli ranges and beyond the Luni basin has no natural drainage (except the Ghaggar described above) and is usually referred to as outside basin. The area is part of the Great Indian Desert and slopes gently westwards. Its approx. 1,65,842 km^2 area (including Ghaggar sub basin), cover the entire districts of Ganganagar, Hanumangarh, Churu, Bikaner, Jaisalmer and Nagaur, and most parts of the districts of Barmer, Jodhpur, Sikar and some parts of Jhunjhunu, besides very small areas of Jalore and Ajmer districts.

Basin-wise surface and groundwater resources in Rajasthan are shown in Table 3. The total surface water (including external surface water) available in the State is 44,610.64 MCM, and the dynamic and static fresh groundwater is 10613.84 MCM and 32,914.18 MCM respectively.

Table 3.3: Basin-wise Mean Annual Water Resources (MCM) of Rajasthan (Year 2010)

S.N.	Basin	Internal surface water	External water	Dynamic Fresh GW	Static Fresh GW
1	Shekhawati	562.85	-	433.35	1,196.66
2	Ruparail	641.38	19.39	302.18	472.79
3	Banganga	754.83	33.77	525.76	813.57
4	Gambhir	700.89	-	428.21	478.18
5	Parbati	427.18	-	128.50	103.69
6	Sabi	348.09	-	429.89	698.56
7	Banas	5097.26	-	2282.73	1,808.90
8	Chambal	8702.14	3387.00	1999.54	953.39
9	Mahi	3720.25	699.62	604.88	108.82
10	Sabarmati	732.52	-	62.98	11.81
11	Luni	2269.92	715.42	1493.18	10,884.72
12	West Banas	222.14	-	69.63	7.44
13	Sukli	137.61	-	51.68	6.06
14	Nallahs Jalore	51.42	171.75	115.29	705.82
15	Ghaggar	19.59	2587.41*	239.44	484.6
16	Outside Basin	990.60	11617.66	1446.61	14,179.17
	State Total	**25378.62**	**19232.02**	**10613.84**	**32,914.18**

- Including 489.07 Mm^3 of Ghaggar flood water

3.8 Lakes, Reservoirs and Human-Made Water Bodies

As noted earlier, Rajasthan has no natural lakes except Lake Sambhar and a few smaller salt lakes. However, there has been a tradition of constructing small and large water bodies for harvesting the rainwater (e.g., tankas, Nadi, Talab) and by intercepting the flow of various small seasonal/ ephemeral streams. Groundwater was also exploited through beautifully constructed stepwells/ Bawris. In recent times several large dams have also been constructed to create large reservoirs such as those on River Chambal. Important reservoirs and other human-made lakes are listed in Annexure II and shown in Figure 3.19.

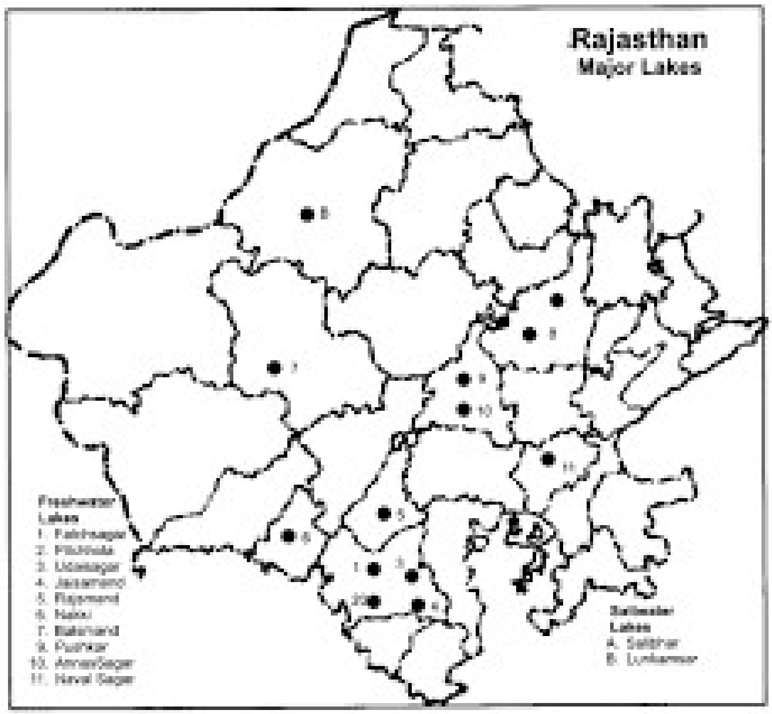


Figure 3.19: Human-made lakes in Rajasthan

3.9 Groundwater Resources

Hydrogeologically, more than 50 percent area of the State in the west-central, south-eastern and southern parts is occupied by hard rocks and confined aquifers. Only certain areas with weathered mantle, joints and fractured sedimentary rocks allow for accumulation of ground water in pockets. Alluvial aquifers are also restricted in occurrence. The hydrogeology varies greatly between and within the river basins (Figure 3.20), and the occurrence of groundwater is further affected by the annual rainfall, topography and drainage pattern. It is for this reason that most times drilling of tubewells is futile exercise, money goes waste and no groundwater is found. According to the Ground Water Yearbook 2017, the amount of water infiltrating through the soil mass to contribute to ground water storage is only 5% to 7% in areas underlain by hard rocks and 10% to 15% in alluvial areas. Some 19 such aquifers have been identified in the state. The total renewable ground water resource has been estimated at 11.56 BCM. However, most of the areas (201 blocks out of 249 blocks) have been exploited well beyond their annual recharge, and majority of the blocks have fallen into critical (9 blocks), semi-critical (28 blocks) or overexploited category (Rajasthan GW report 2013). Further, the ground water in most of the districts is affected by varying levels of salinity (except Sri Ganganagar and Hanumangarh). Among various river basins, most are overexploited except Mahi and Ghaggar river basins.

Corresponding to the relatively low rainfall, the groundwater availability in Rajasthan is also poor and it has been declining rapidly in recent years (Groundwater Yearbook 2017). Only in the eastern parts of Rajasthan, the groundwater level rises after the monsoon season, thanks to many streams flowing here. In large parts of the State, groundwater has declined to critically low levels and several dark zones have developed. Further, the groundwater quality suffers from geogenic pollution as large parts of the state has high concentration of fluorides, salts and nitrates making the groundwater unfit for domestic supplies and even for agriculture and some industries.

The total static ground water resources occurring below the lowest fluctuating levels of ground water in all the river basins taken together are estimated at 32,914.18 Mm^3 for fresh water and 29,725.51 Mm^3 for saline water.

Table 3.4 and Figures 3.21 and 3.22 show the annual groundwater resources available and changes over time, water balance and stage of groundwater development. The groundwater showed positive balance till 1998 and afterwards because of drilling technology number of tubewells increased fast and the trend of over exploitation of groundwater started. Presently the stage of groundwater extraction has reached to 140 percent and in few blocks it is more than 350 percent consequently groundwater balance has reached minus 4780 MCM. Table 3.5 further confirms the grim picture of groundwater in the State. Since 90 percent of drinking water and more than 60 percent of irrigation water and more than 90 percent of industrial water comes from groundwater the sustainability of groundwater supply and drinking water security is an area of serious concern. In order to change the status of groundwater there has to be serious efforts in increasing recharge and reduce abstraction. In the absence of Groundwater Act in the state there is little hope to check the groundwater abstraction, even the CGWB notifications have failed to check the depleting groundwater. This will seriously affect the future of industries in the state.

Table 3.4: Ground Water Resources in Rajasthan State

Year	**Annual Ground Water Resources**			Stage of GW Extraction (%)	Number of Over Exploited blocks / Total Blocks
	Recharge (mcm)	Draft (mcm)	Balance (mcm)		
1984	13790	4927	+ 8863	35.73	12/237
1990	10801	5821	+ 4981	53.89	44/237
1995	11028	6494	+ 4535	58.88	60/237
1998	12602	12019	+ 583	95.37	41/237
2001	11159	11635	- 476	**104.26**	86/237
2004	10383	12991	- 2609	**125.13**	140/237
2007	10563	14570	- 4007	**132.09**	166/239
2011	10829	14843	- 4014	**137.93**	172/243
2013	11257	15706	- 4449	**139.52**	201/248
2017#	11990	16770	- 4780	**139.88**	250/292+3*

* Due to Saline Blocks assessment not carried out. Notified Blocks as on date: 35

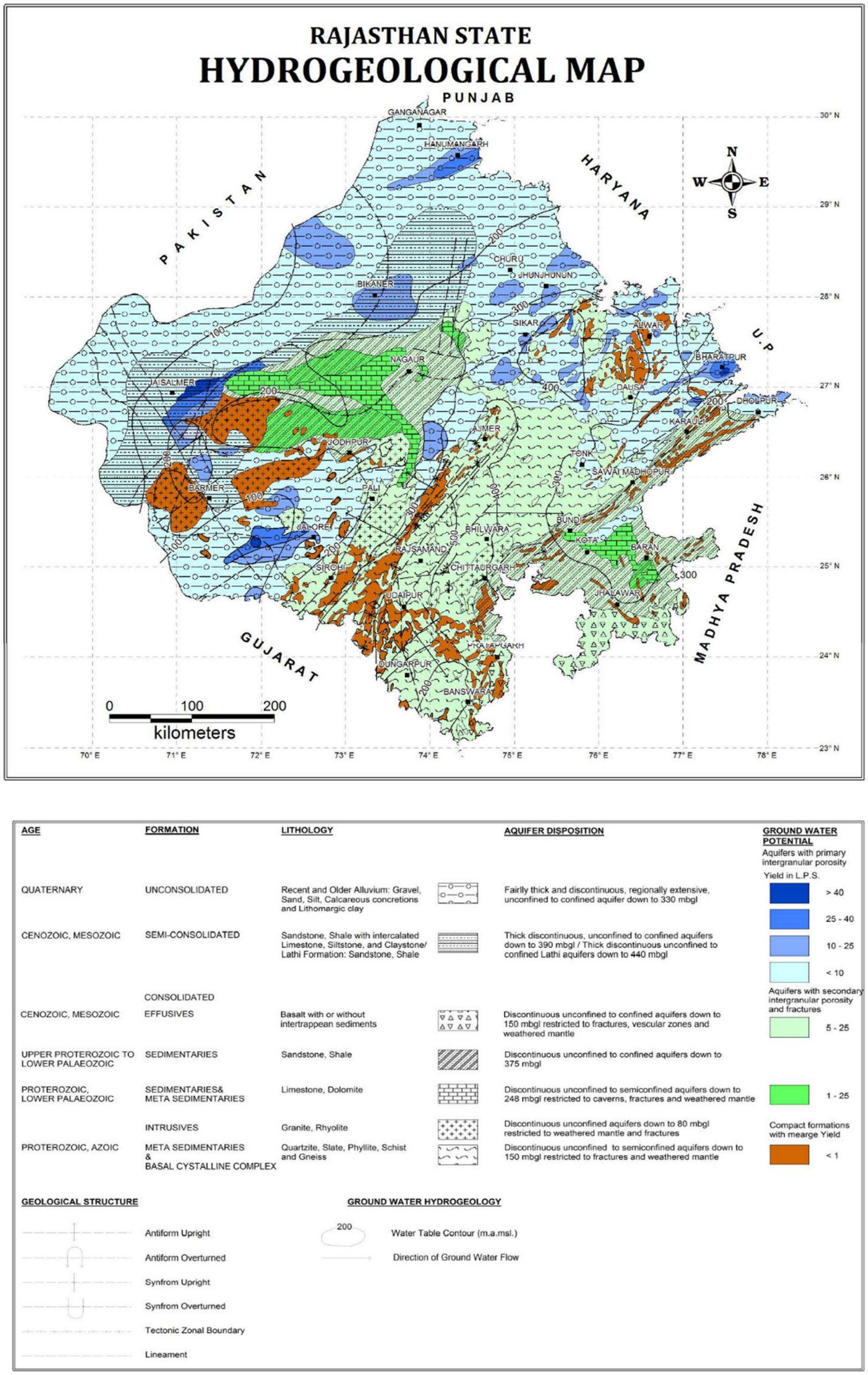


Figure 3.20: Hydrogeology of Rajasthan

Source: Rajasthan State Ground Water Year Book 2016-2017.

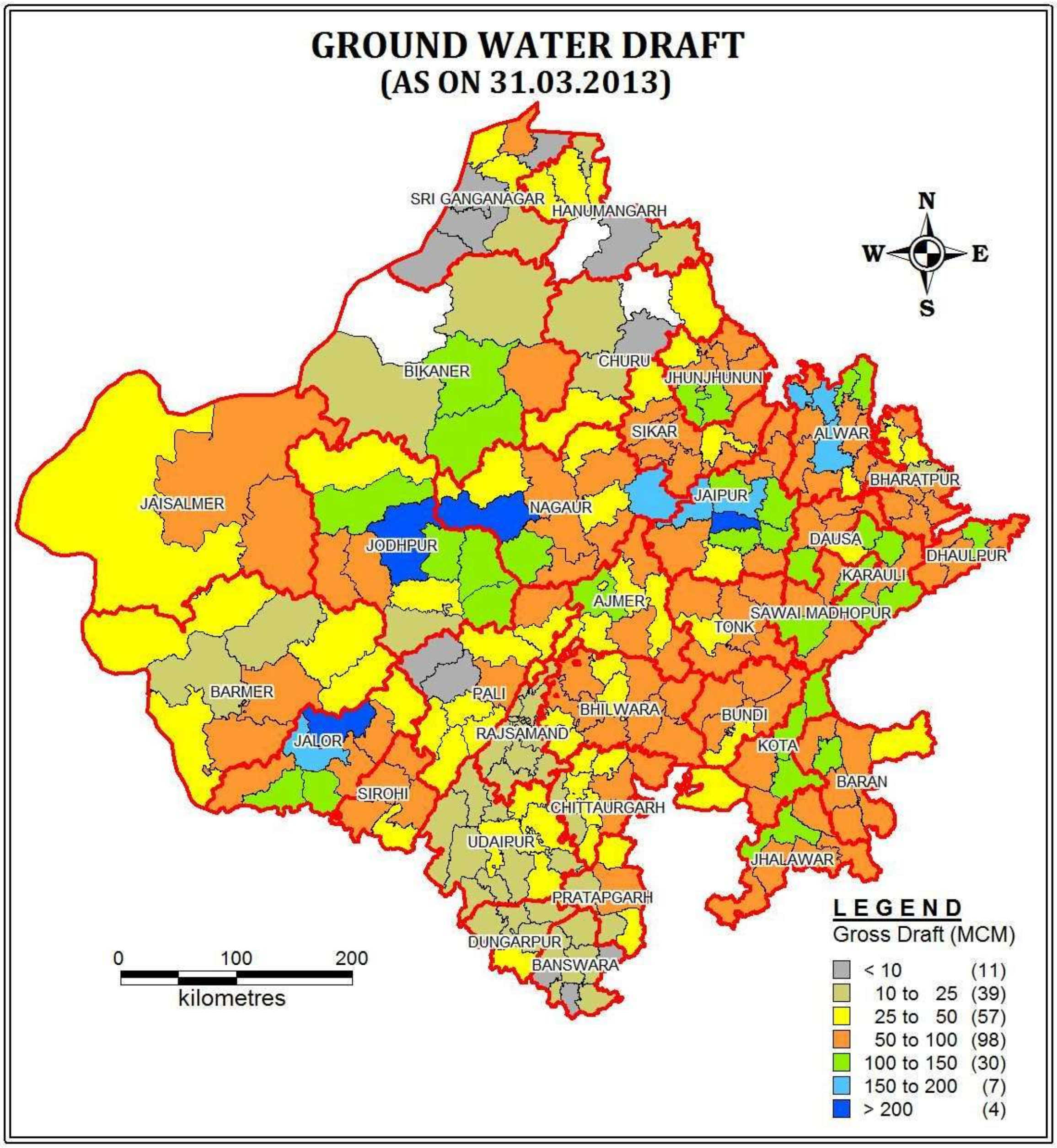


Figure 3.21: groundwater draft in Rajasthan

Source: Report on Dynamic Ground Water Resources of Rajasthan (As on 31st March, 2013)

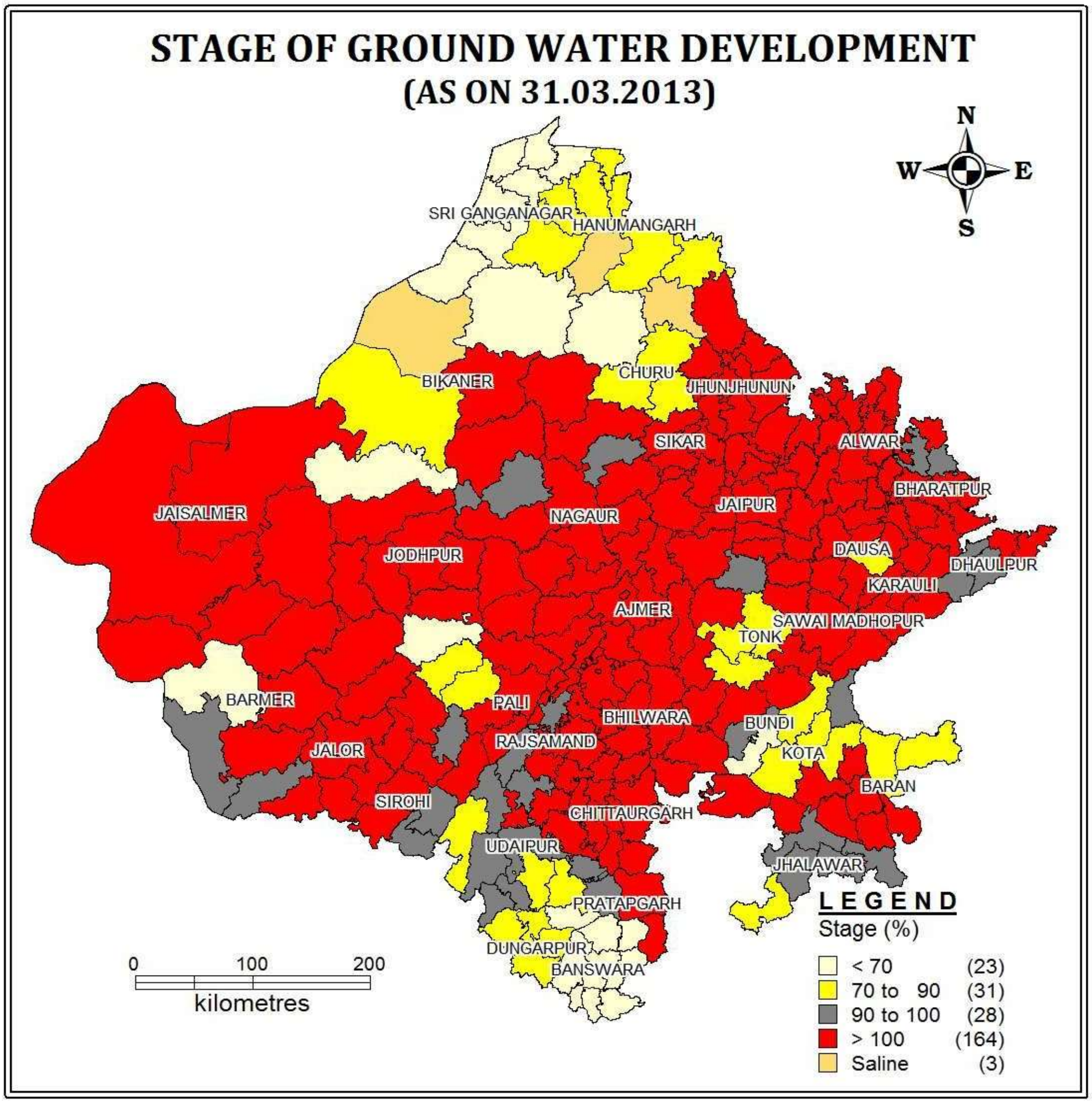


Figure 3.22: Stage of Ground Water Development in Rajasthan

Source: Report on Dynamic Ground Water Resources of Rajasthan (As on 31st March, 2013)

The changing status of groundwater in Rajasthan is shown in Table 3.5 and Figure 3.23. Out of the 292 assessed blocks, 185 blocks were categorized as 'Over-exploited', 33 as 'Critical', 29 as 'Semi-critical', 45 blocks as 'Safe' and 3 as 'Saline'.

Table 3.5: Changing Status of groundwater in Rajasthan (1984-2017)

Category	1984	1988	2001	2004	2009	2011	2013	2017
Over Exploited (>100%)	22 (9.3)	41 (17.0)	86 (36.0)	140 (59.3)	164 (69.5)	172 (71.35)	164 (66.94)	185 (63.35)
Critical (90 to 100%)	6 (2.5)	26 (11.0)	80 (34.0)	50 (21.2)	34 (14.4)	24 (9.97)	9 (3.67)	33 (11.31)
Semi critical (70 to 90%)	27 (11.5)	34 (14.0)	21 (9.0)	14 (5.9)	8 (3.4)	20 (8.30)	28 (11.43)	29 (9.93)
Safe (70%)	181 (76.7)	135 (57.0)	49 (21.0)	32 (13.6)	30 (12.7)	25 (10.38)	44 (17.96)	45 (15.41)

Source: Ground Water Department and Central Ground Water Department, Report of the Group on the Estimation of Ground Water Resources of Rajasthan (as on 1.1.2001), April 2002, 2004, 2009, 2011, 2013, 2017.

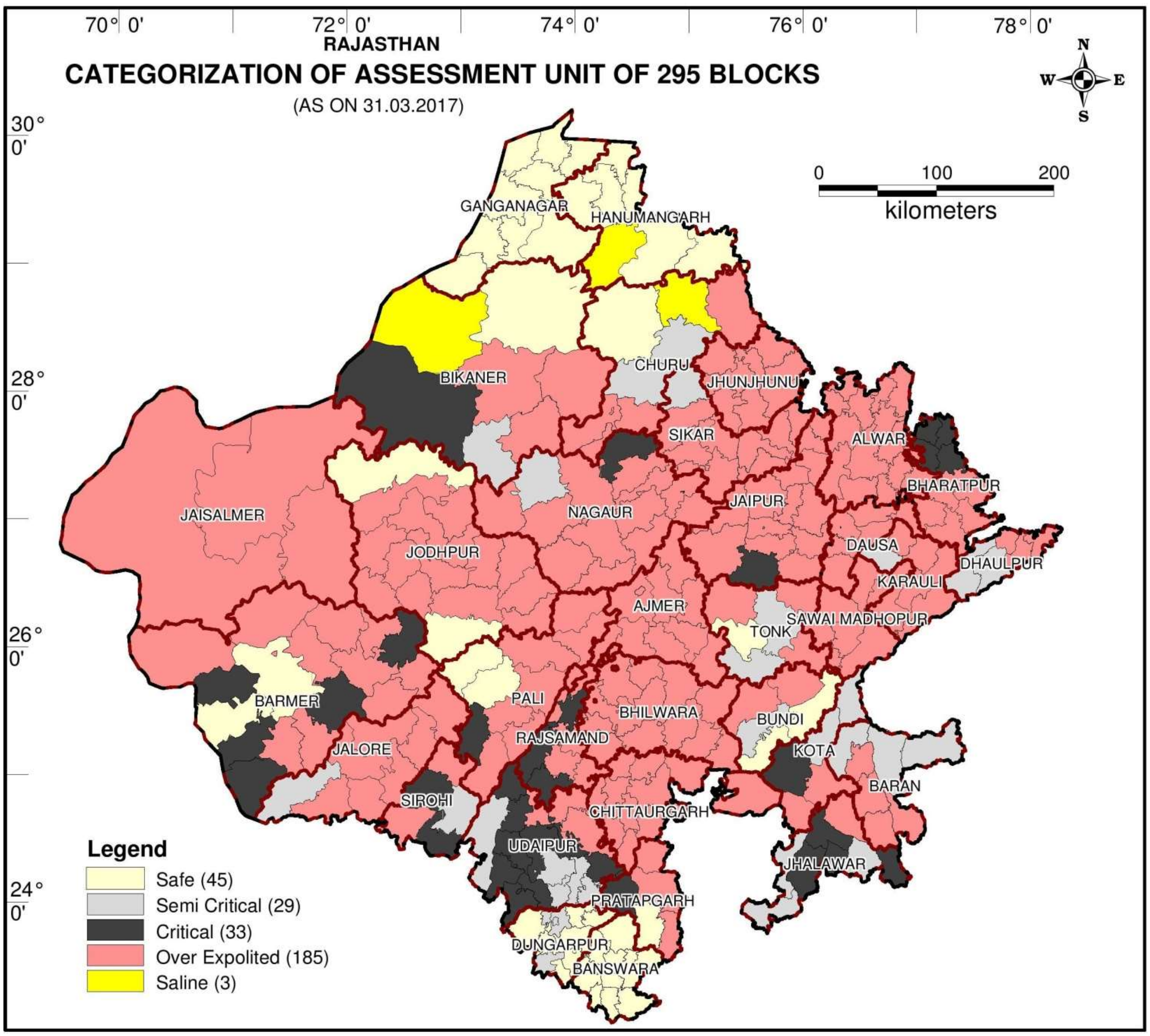


Figure 3.23: Categorization of Assessment Units for groundwater in Rajasthan.

Source: Report on Dynamic Ground Water Resources of Rajasthan (As on 31st March, 2013)

The groundwater use pattern is shown in Table 3.6. Groundwater use in Irrigation was 91.8 percent in 1998 has slightly come down to 88.6 percent in 2017 while the share of domestic and industrial use of groundwater has increased from 8.2 percent in 1998 to 11.4 percent in 2017. There is no separate figure of groundwater use in industry is available with CGWB or SGWD.

Table 3.6: Ground Water Estimation in Rajasthan

(Figures in MCM)

Item	**YEAR**						
	1998	**2001**	**2004**	**2009**	**2011**	**2013**	**2017**
Gross/Net groundwater recharge	12602	11159	10382.6	11862.2	11911.4	11260.0	11990
Groundwater Draft (1) Irrigation (2) Domestic & Industrial	 11036 983	 10454 1181	 11599.0 1392.2	 12864.9 1654.4	 13133.2 1709.8	 13790.0 1920.0	 14850 1920
Gross draft (1) + (2)	12019	11635	12991.2	14519.2	14843.0	15710.0	16770
Groundwater balance	583	(-)476	(-)2608.6	(-)2657.0	(-)2931.6	- 4450.0	- 4780.0
Stage of groundwater Development in percent	69.1	104.3	125.13	135	137	140	140

Source: Ground Water Department and Central Ground Water Department, Report of the Group on the Estimation of Ground Water Resources of Rajasthan 9as on 1.1.2001), April 2002, 2004, 2009, 2011, 2013.

Basin wise availability of static groundwater resources is shown in Table 3.7. It also shows the groundwater availability in terms of quality as, fresh and saline in each basin. Overall, at state level the fresh groundwater available is 32,914.18 MCM and saline groundwater is 29,725.51. The quantum of saline groundwater is as high as 90.3 percent of fresh water and it is mostly in the western part of Rajasthan. It shows that from location of industry point of view the western Rajasthan covering more than 50 percent of total area of the state there is little scope for industries not using saline water. If located in that area then extra cost of removing salinity from water. The other option is supply of IGNP and Narmada canal water for industries. But rest of Rajasthan is suitable for location of low water consuming industries. There are other impurities also in groundwater, such as, Fluorides, Nitrate, Chloride, Iron, TDS and Arsenic. From human health point of view these impurities are important but for industries salinity is the only constraining impurity in the groundwater and is discussed in the subsequent section.

The State's water policy and 'The Rajasthan River Basin and Water Resources Planning Act 2015' advocates river basin wise management of water resources in the state. In the absence of river basin wise data on regular interval information from Tahal Consultants report for the year 2014 is given below. Basin wise stage of groundwater development is shown in Table 3.8. Except three river basins namely, Mahi, Sabarmati and Ghaggar all other basins are classified as "Over Exploited". It shows that siting of water intensive groundwater based industries have no scope in the state.

Table 3.7: Basin-wise Static Groundwater Resources of Rajasthan (Year 2010)

S.N.	Basin	Static Groundwater Resources (Mm^3)		
		Fresh	Saline	Saline as % of Fresh
1	Shekhawati	1,196.66	130.77	10.9
2	Ruparail	472.79	107.89	22.8
3	Banganga	813.57	280.35	34.5
4	Gambhir	478.18	56.82	11.9
5	Parbati	103.69	0	-
6	Sabi	698.56	13.69	1.9
7	Banas	1,808.90	90.42	5.0
8	Chambal	953.39	22.09	2.3
9	Mahi	108.82	0	-
10	Sabarmati	11.81	4.09	34.6
11	Luni	10,884.72	4,041.33	37.1
12	West Banas	7.44	0.89	11.9
13	Sukli	6.06	0	-
14	Nallahs Jalore	705.82	0	-
15	Ghaggar	484.6	1,120.90	231.3
16	Outside Basin	14,179.17	23,856.27	168.2
	State Total	**32,914.18**	**29,725.51**	**90.3**

Table 3.8: Basin-wise Stage of Groundwater Development (Year 2010)

Basin	Net Annual Availability (Mm^3)	Existing Total Draft (2010), (Mm^3)	Stage of GW Development (%)	Basin Category
1 Shekhawati	433.35	927.62	214.06	Over Exploited
2 Ruparail	302.18	482.07	159.53	Over Exploited
3 Banganga	525.76	938.08	178.42	Over Exploited
4 Gambhir	428.21	615.58	143.76	Over Exploited
5 Parbati	128.50	155.76	121.22	Over Exploited
6 Sabi	429.89	803.27	186.85	Over Exploited
7 Banas	2,282.73	3,380.23	148.08	Over Exploited
8 Chambal	1,999.54	2,236.13	111.83	Over Exploited
9 Mahi	604.88	447.37	73.96	Safe
10 Sabarmati	62.98	59.42	94.35	Critical
11 Luni	1,493.18	2,646.11	177.21	Over Exploited
12 West Banas	69.63	70.40	101.11	Over Exploited
13 Sukli	51.68	69.67	134.81	Over Exploited
14 Nallahs Jalore	115.28	221.15	191.84	Over Exploited
15 Ghaggar	239.44	128.91	53.84	Safe
16 Outside Basin	1,446.61	2,019.07	139.57	Over Exploited
State as a Whole	**10,613.84**	**15,200.86**	**143.22**	**Over Exploited**

3.9.1 Pre- and Post-Monsoon Groundwater Fluctuation

The latest (2017) report of the Rajasthan GW Dept, says that during the monsoon season of 2017, 6 districts received more rainfall than the normal, 9 districts received normal rainfall and 14 districts received deficit rainfall. The state as a whole experienced normal rainfall in 2017. The pre monsoon and post monsoon monitoring of the groundwater levels at nearly 5700 monitoring stations showed that: During the pre-monsoon season, the depth to water level ranged from 0.05 m to 167.90 m below ground level (Figure 3.24). The lowest water level was recorded in Charna Bhundwai (Ghatol block) of Banswara district, Mandal (Mandal block) of Bhilwara district and Cheekelwas (Khamnor block) of Rajsamand district. The highest water level was reported at Kharia Khangar (Pipar City block) of Jodhpur district. Thus, the water level change on an average by only 1.8 m between the pre- and post-monsoon seasons of 2017. Only in two districts the water level was less than 10 m, in 19 districts it was 10-20 m, and in 8 districts 30-50 m bgl. In 4 districts the water level was between 50 and 100 m bgl.

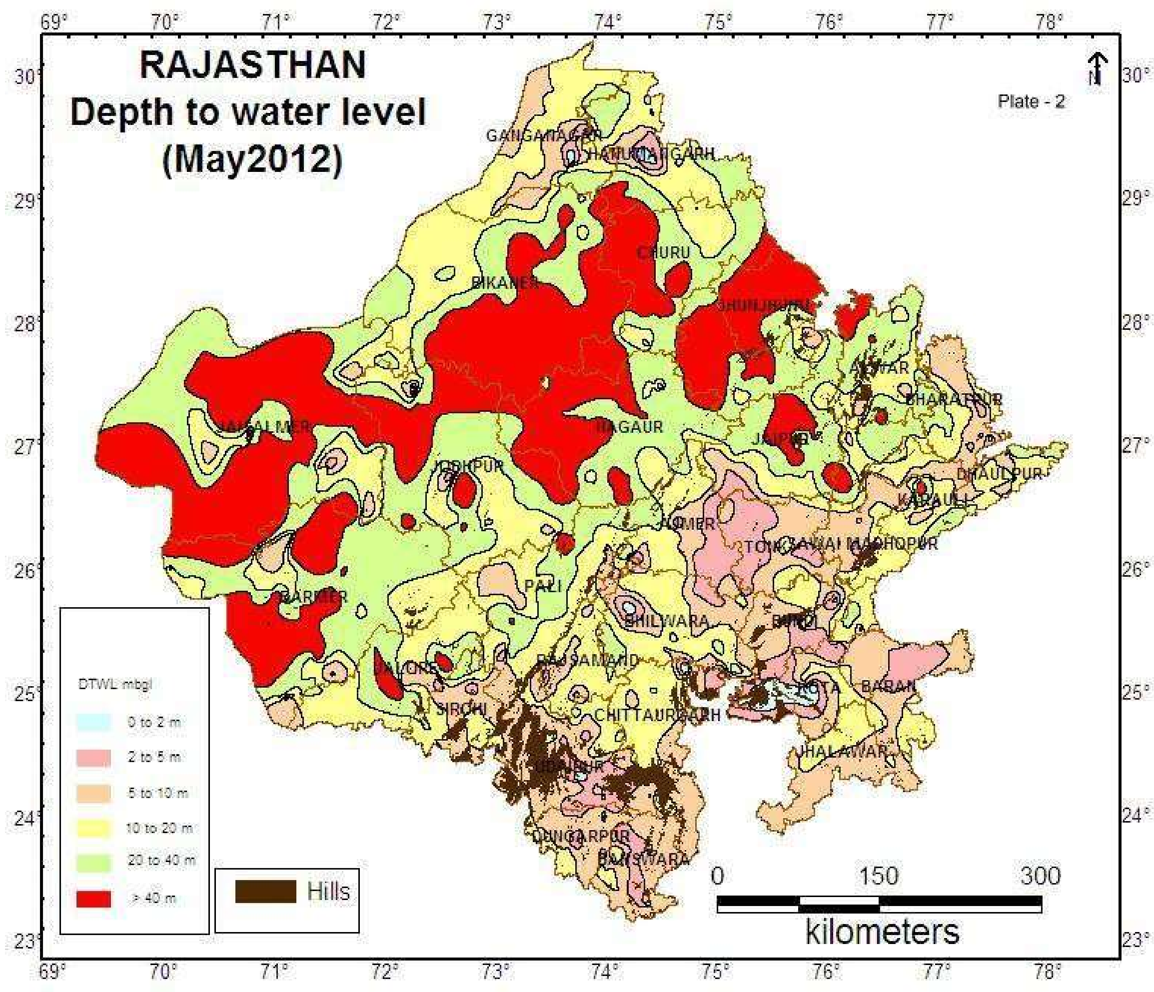


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Figure 3.24: Depth of groundwater level in Rajasthan

Source: Report on Dynamic Ground Water Resources of Rajasthan (As on 31st March, 2013)

3.9.2 Block Wise Status of Groundwater

Availability of groundwater as the important criteria for siting of water intensive industries in Rajasthan can be based on the information given in the Table 3.9. The table shows the district wise Block wise change in the status of groundwater. If new industries be located in the groundwater safe zone only, then potential blocks in entire Rajasthan are only 45 and their distribution is shown in Table 3.10. The over exploited blocks are 185 (63.4%) and covers the entire Rajasthan except four districts, i.e. Shri Ganganagar and Hanumangarh districts in the north and Banswara and Dungarpur districts in the south reported as in safe category. The second level of priority goes to 29 semi-critical blocks (9.9%) where limited withdrawal of groundwater with strong commitment of recharging and zero discharge industries can be located. The Semi Critical blocks are mostly in southern zone.

Table 3.9: District and Block-wise status of ground water development in Rajasthan.

District	Block	Category-2004	Category – 2017
AJMER	Arain	Over-exploited	Over-exploited
	Masuda	Critical	Over-exploited
	Bhinay	Over-exploited	Over-exploited
	Sarwar	-	Over-exploited
	Jawaja	Over-exploited	Over-exploited
	Silora	Over-exploited	Over-exploited
	Kekri	Critical	Over-exploited
	Pisangan	Over-exploited	Over-exploited
	Shrinagar	Over-exploited	Over-exploited
ALWAR	Thanagazi	Critical	Over-exploited
	Bansur	Over-exploited	Over-exploited
	Kishangarh	Over-exploited	Over-exploited
	Rajgarh	Over-exploited	Over-exploited
	Tijara	Over-exploited	Over-exploited
	Umrain	Over-exploited	Over-exploited
	Neemrana	Over-exploited	Over-exploited
	Laxmangarh	Over-exploited	Over-exploited
	Ramgarh	Over-exploited	Over-exploited
	Kathumar	Over-exploited	Over-exploited
	Reni	Over-exploited	Over-exploited
	Kotkasim	Over-exploited	Over-exploited
	Mandawar	Over-exploited	Over-exploited
	Behror	Over-exploited	Over-exploited
BANSWARA	Ghatol	Sami -Critical	Safe
	Arthoona	-	Safe
	Garhi	Critical	Safe
	Talwara	Sami -Critical	Safe
	Sajjangarh	Sami -Critical	Safe
	Chhoti Sarwan		Safe
	Gangartalai	-	Safe
	Banswara		Safe
	Kushalgarh	Sami -Critical	Safe
	Bagidora	Sami -Critical	Safe
	Anandpuri	Sami -Critical	Safe

BARAN	Chhabra	Safe	Over-exploited
	Atru	Over-exploited	Over-exploited
	Chhipabarod	Sami -Critical	Over-exploited
	Baran	Over-exploited	Over-exploited
	Shahbad	Safe	Semi-critical
	Anta	Critical	Semi-critical
	Kishanganj	Safe	Semi-critical
BARMER	Kalyanpur	-	Critical
	Sedwa	-	Critical
	Dhanau	-	Critical
	Ramsar	-	Critical
	Sindhary	Critical	Critical
	Baitu	Over-exploited	Over-exploited
	Gudamalani	-	Over-exploited
	Siwana	Over-exploited	Over-exploited
	Patodi	-	Over-exploited
	Samadri	-	Over-exploited
	Gadra Road	-	Over-exploited
	Balotra	Over-exploited	Over-exploited
	Dhorimana	Over-exploited	Over-exploited
	Gida	-	Over-exploited
	Shiv	Over-exploited	Over-exploited
	Barmer	Safe	Safe
	Chohtan	Critical	Safe
BHARATPUR	Nagar	Safe	Critical
	Kaman	Safe	Critical
	Deeg	Safe	Critical
	Pahari	-	Critical
	Bayana	Sami -Critical	Over-exploited
	Kumher	Safe	Over-exploited
	Rupbas	Safe	Over-exploited
	Sewar	Over-exploited	Over-exploited
	Weir	Over-exploited	Over-exploited
	Nadbai	Over-exploited	Over-exploited
BHILWARA	Banera	Over-exploited	Over-exploited
	Kotri	Sami -Critical	Over-exploited
	Hurda	Over-exploited	Over-exploited
	Shahpura	Sami -Critical	Over-exploited
	Mandal	Over-exploited	Over-exploited
	Bijoliya	-	Over-exploited
	Sahara	Sami -Critical	Over-exploited
	Jahazpur	Over-exploited	Over-exploited
	Bhilwara	-	Over-exploited
	Asind	Over-exploited	Over-exploited
	Raipur	Over-exploited	Over-exploited
	Mandalgarh	Over-exploited	Over-exploited
BIKANER	Kolayat	Safe	Critical
	Dungargarh	Critical	Over-exploited
	Bikaner	Over-exploited	Over-exploited
	Nokha	Over-exploited	Over-exploited
	Lunkaransar	Safe	Safe
	Khajuwala	Saline	Saline
	Panchoo	-	Semi-critical

BUNDI	Hindoli	Over-exploited	Over-exploited
	Nainwa	Over-exploited	Over-exploited
	Talera	Critical	Safe
	Keshorai Patan	Critical	Safe
	Bundi	-	Semi-critical
CHITTOURGARH	Bhupalsagar	Over-exploited	Over-exploited
	Rawatbhata	-	Over-exploited
	Dungla	Over-exploited	Over-exploited
	Rashmi	Over-exploited	Over-exploited
	Nimbahera	Over-exploited	Over-exploited
	Gangrar	Over-exploited	Over-exploited
	Chittaurgarh	Over-exploited	Over-exploited
	Bari Sadri	Over-exploited	Over-exploited
	Begun	Over-exploited	Over-exploited
	Kapasan	Over-exploited	Over-exploited
	Bhadesar	Over-exploited	Over-exploited
CHURU	Sujangarh	-	Over-exploited
	Bidasar	-	Over-exploited
	Rajgarh	Over-exploited	Over-exploited
	Sardarshahar	Safe	Safe
	Taranagar	-	Saline
	Ratangarh	Safe	Semi-critical
	Churu	Safe	Semi-critical
DAUSA	Dausa	Over-exploited	Over-exploited
	Sikrai	Over-exploited	Over-exploited
	Lawan	-	Over-exploited
	Mahwa	Over-exploited	Over-exploited
	Bandikui	Over-exploited	Over-exploited
	Lalsot	Over-exploited	Over-exploited
DHAULPUR	Rajakhera	Over-exploited	Over-exploited
	Saipau	-	Over-exploited
	Dhaulpur	Over-exploited	Over-exploited
	Bari	Safe	Semi-critical
	Baseri	Critical	Semi-critical
DUNGARPUR	Galiykot	-	Safe
	Jothri	-	Safe
	Sabla	-	Safe
	Aspur	Safe	Safe
	Bichhiwara	Semi -Critical	Safe
	Chikhli	-	Safe
	Sagwara	Critical	Safe
	Simalwara	Critical	Semi-critical
	Dungarpur	Semi -Critical	Semi-critical
	Dovda	-	Semi-critical
GANGANAGAR	Anoopgarh	Safe	Safe
	Vijainagar	-	Safe
	Sadulshahar	Safe	Safe
	Gharsana	-	Safe
	Raisinghnagar	Safe	Safe
	Padampur	Safe	Safe
	Karanpur	Safe	Safe
	Suratgarh	Safe	Safe

	Ganganagar	Safe	Safe
HANUMANGARH	Sangria	-	Safe
	Bhadra	Safe	Safe
	Nohar	Safe	Safe
	Tibbi	-	Safe
	Hanumangarh	Safe	Safe
	Pilibangan	-	Safe
	Rawatsar	-	Saline
JAIPUR	Phagi	Critical	Critical
	Dudu	Critical	Over-exploited
	Paota	-	Over-exploited
	Viratnaga	Over-exploited	Over-exploited
	Chaksu	Over-exploited	Over-exploited
	Jamwa Ram	Over-exploited	Over-exploited
	Amber	Over-exploited	Over-exploited
	Jalsu	-	Over-exploited
	Bassi	Over-exploited	Over-exploited
	Sanganer	Over-exploited	Over-exploited
	Kotputli	Over-exploited	Over-exploited
	Shahpura	Over-exploited	Over-exploited
	Govindgar	Over-exploited	Over-exploited
	Sambhar	Over-exploited	Over-exploited
	Jhotwara	Over-exploited	Over-exploited
JAISALMER	Sam	Safe	Over-exploited
	Jaisalmer	Over-exploited	Over-exploited
	Sankra	Over-exploited	Over-exploited
JALOR	Ahore	Over-exploited	Over-exploited
	Jalor	Over-exploited	Over-exploited
	Jaswantpura	Over-exploited	Over-exploited
	Sanchore	Over-exploited	Over-exploited
	Bhinmal	Over-exploited	Over-exploited
	Raniwara	Over-exploited	Over-exploited
	Sayla	Over-exploited	Over-exploited
	Chitalwana	-	Semi-critical
JHALAWAR	Jhalrapatan	Critical	Critical
	Pirawa	Over-exploited	Critical
	Bakani	Critical	Critical
	Manoharthana	Over-exploited	Critical
	Khanpur	Critical	Over-exploited
	Aklera	-	Semi-critical
	Bhawani Mandi	-	Semi-critical
	Dug	Critical	Semi-critical
JHUNJHUNU	Alsisar	Safe	Over-exploited
	Khetri	Over-exploited	Over-exploited
	Buhana	Over-exploited	Over-exploited
	Udaipurwati	Over-exploited	Over-exploited
	Chirawa	Over-exploited	Over-exploited
	Jhunjhunu	Over-exploited	Over-exploited
	Surajgarh	Over-exploited	Over-exploited
	Nawalgarh	Over-exploited	Over-exploited
JODHPUR	Mandor	Over-exploited	Over-exploited
	Pipar City	-	Over-exploited

	Shergarh	Critical	Over-exploited
	Phalodi	Semi- Critical	Over-exploited
	Bhopalgarh	Over-exploited	Over-exploited
	Bilara	Over-exploited	Over-exploited
	Shekhala	-	Over-exploited
	Dechu	-	Over-exploited
	Balesar	Over-exploited	Over-exploited
	Osian	Over-exploited	Over-exploited
	Baori	-	Over-exploited
	Lohawat	-	Over-exploited
	Bapini	-	Over-exploited
	Tinwari	-	Over-exploited
	Luni	Critical	Safe
	Bap	Safe	Safe
KARAULI	Mandrial	-	Over-exploited
	Sapotra	Semi -Critical	Over-exploited
	Karauli	Over-exploited	Over-exploited
	Hindaun	Over-exploited	Over-exploited
	Todabhim	Over-exploited	Over-exploited
	Nadoti	Critical	Semi-critical
KOTA	Ladpura	Over-exploited	Critical
	Sangod	Over-exploited	Over-exploited
	Khairabad	Over-exploited	Over-exploited
	Sultanpur	Semi -Critical	Semi-critical
	Itawa	Over-exploited	Semi-critical
NAGAUR	Ladnu	Semi Critical	Critical
	Didwana	Over-exploited	Over-exploited
	Jayal	Critical	Over-exploited
	Parbatsar	Over-exploited	Over-exploited
	Makrana	Over-exploited	Over-exploited
	Riyan	Over-exploited	Over-exploited
	Nawa	-	Over-exploited
	Molasar	-	Over-exploited
	Degana	Over-exploited	Over-exploited
	Khinvsar	-	Over-exploited
	Kuchaman	Over-exploited	Over-exploited
	Merta	Over-exploited	Over-exploited
	Mundwa	Over-exploited	Over-exploited
	Nagaur	Safe	Semi-critical
PALI	Sumerpur	Over-exploited	Critical
	Bali	Critical	Over-exploited
	Sojat	Over-exploited	Over-exploited
	Rani	Over-exploited	Over-exploited
	Desuri	Critical	Over-exploited
	Raipur	Critical	Over-exploited
	Jaitaran	Over-exploited	Over-exploited
	Marwar Ju	-	Over-exploited
	Rohat	Critical	Safe
	Pali	Critical	Safe
PRATAP GARH	Dhariawad	Over-exploited	Critical
	Pratapgarh	Over-exploited	Over-exploited
	Arnod	Over-exploited	Over-exploited
	Chhoti Sadri	Over-exploited	Over-exploited

	Peepalkhoont	-	Safe
RAJSAMAND	Khamnor	Over-exploited	Critical
	Deogarh	Over-exploited	Critical
	Kumbhalga	Over-exploited	Critical
	Amet	Over-exploited	Over-exploited
	Rajsamand	Critical	Over-exploited
	Bhim	Over-exploited	Over-exploited
	Railmagra	Critical	Over-exploited
SAWAI MADHOPUR	Bamanwas	Critical	Over-exploited
	Bonli	Critical	Over-exploited
	Khandar	Critical	Over-exploited
	Chauth Ka Berwada	-	Over-exploited
	Sawai Madhopur	Over-exploited	Over-exploited
	Gangapur	Over-exploited	Over-exploited
SIKAR	Lachhmangarh	Over-exploited	Over-exploited
	Patan	-	Over-exploited
	Khandela	Over-exploited	Over-exploited
	Neem Ka Thana	Over-exploited	Over-exploited
	Danta Ramgarh	Over-exploited	Over-exploited
	Dhod	Over-exploited	Over-exploited
	Piprali	Over-exploited	Over-exploited
	Sri Madhopur	Over-exploited	Over-exploited
	Fatehpur	Safe	Semi-critical
SIROHI	Sirohi	Critical	Critical
	Abu Road	Critical	Critical
	Sheoganj	Over-exploited	Over-exploited
	Reodar	Over-exploited	Over-exploited
	Pindwara	Critical	Semi-critical
TONK	Uniara	Over-exploited	Over-exploited
	Niwai	Critical	Over-exploited
	Malpura	Critical	Over-exploited
	Todaraisingh	Critical	Safe
	Tonk	Critical	Semi-critical
	Deoli	Critical	Semi-critical
UDAIPUR	Gogunda	Over-exploited	Critical
	Girwa	Over-exploited	Critical
	Jhadol	Over-exploited	Critical
	Phalasiya	-	Critical
	Rishabhdev	-	Critical
	Kurawad	-	Critical
	Lasadiya	-	Critical
	Sayara	-	Critical
	Kherwara	Critical	Critical
	Bhinder	Over-exploited	Over-exploited
	Badgaon	Over-exploited	Over-exploited
	Mavli	Over-exploited	Over-exploited
	Jallara		Semi-critical
	Salumbar	Over-exploited	Semi-critical
	Semari	-	Semi-critical
	Kotra	Critical	Semi-critical
	Sarada	Critical	Semi-critical

Source: Report on Dynamic Ground Water Resources of Rajasthan (As on 31st March, 2005,2017)

Table 3.10: Groundwater Safe Blocks Suitable for Siting of New Industries (as of 2017)

Region	District	Block	Category-2004	Category – 2017
Northern Zone	TONK	Todaraisingh	Critical	Safe
Southern Zone	BANSWARA	Ghatol	Sami -Critical	Safe
		Arthoona		Safe
		Garhi	Critical	Safe
		Talwara	Sami -Critical	Safe
		Sajjangarh	Sami -Critical	Safe
		Chhoti Sarwan		Safe
		Gangartalai		Safe
		Banswara		Safe
		Kushalgarh	Sami -Critical	Safe
		Bagidora	Sami -Critical	Safe
		Anandpuri	Sami -Critical	Safe
	BUNDI	Talera	Critical	Safe
		Keshorai Patan	Critical	Safe
	DUNGARPUR	Galiykot		Safe
		Jothri		Safe
		Sabla		Safe
		Aspur	Safe	Safe
		Bichhiwara	Semi -Critical	Safe
		Chikhli		Safe
		Sagwara	Critical	Safe
	PRATAPGARH	Peepalkhoont		Safe
Western Zone	BARMER	Barmer	Safe	Safe
		Chohtan	Critical	Safe
	BIKANER	Lunkaransar	Safe	Safe
	CHURU	Sardarshahar	Safe	Safe
	GANGANAGAR	Anoopgarh	Safe	Safe
		Vijainagar		Safe
		Sadulshahar	Safe	Safe
		Gharsana		Safe
		Raisinghnagar	Safe	Safe
		Padampur	Safe	Safe
		Karanpur	Safe	Safe
		Suratgarh	Safe	Safe
		Ganganagar	Safe	Safe
	HANUMANGARH	Sangria		Safe
		Bhadra	Safe	Safe
		Nohar	Safe	Safe
		Tibbi		Safe
		Hanumangarh	Safe	Safe
		Pilibangan		Safe
	JODHPUR	Luni	Critical	Safe
		Bap	Safe	Safe
	PALI	Rohat	Critical	Safe
		Pali	Critical	Safe

Source: Report on Dynamic Ground Water Resources of Rajasthan (As on 31st March, 2005,2017)

3.10 Water Utilization and Competing Uses

The available data show that the state of Rajasthan depends heavily upon the groundwater which is over exploited throughout the state except for a small area of Ghaggar basin (poorly developed economically) and the southeast Rajasthan (plateau area, rich in water resources). More than 90% of drinking water, almost all industrial water needs, and more than 60% of the State's irrigation water requirements are met from groundwater. The data on water consumption in these sectors were compiled for each district/river basin in the TAHAL Report (2014).

The Rajasthan State Water Policy, 2010, had identified and prioritized various competitive uses of water. These are (in the order of decreasing priority: Human drinking water, Livestock drinking water, other domestic, commercial and municipal water uses, agriculture, power generation, environment and ecological use, industrial use, non-consumptive uses (cultural, leisure & tourist uses) and others.

According to TAHAL Report, the total estimate consumption of water by all the industries together in the State was 2.97 BCM per year. The domestic supplies were estimated at 50.74 BCM. These figures do reflect the situation in different climatic zones. Industries are heavily dependent upon groundwater except in the southeast part of Rajasthan (around Kota). In western Rajasthan, which is hot and arid, there is considerable competition among different users for the groundwater resources, despite a relatively small human population in that region. Only in a small area, the agriculture receives the imported water. Industry also gets a share in this imported water that was ostensibly only for agriculture and humans. The Super Thermal Power Plant at Suratgarh draws water from Indira Gandhi Canal.

The surface water is otherwise non-existent and the ground water is often saline and polluted with fluorides. The surface water storages are inadequate to meet the needs of agriculture, and after the water, particularly in the hundreds of minor storages, is used up for agriculture, the domestic supplies suffer greatly from the lack of water despite the priority accorded to drinking water and domestic use in the State Water Policy. The livestock suffers the most. Yet, the textile industry which requires huge quantities of water and pollute the most are concentrated in western Rajasthan (Pali, Barmer, Jodhpur districts). The problems caused by this competition between the needs of humans, livestock and agriculture on one hand and the industries on the other were reflected in recent PILs in the NGT. Similarly, the water guzzling super thermal power plants are also located in the drier parts of the State. Further, even the few breweries and distilleries that consume large amounts of water are located in the drier districts.

It must be stressed that human wellbeing as well as economy depend not only on water used by the humans themselves but also on the natural processes of other life forms which need water, and especially those living in water. Hence, ***humans themselves are a competitor for water with all other living organisms***, although most of the life forms provide such large benefits without which the humans cannot survive. The rapidly falling groundwater tables have affected even the terrestrial vegetation.

This implies that humans should appropriate only as much water from the natural sources, both surface and ground water, that does not impact on the functioning of natural ecosystems and sustains the biodiversity. The Ministry of Water Resources, River Development & Ganga Rejuvenation has recognised the necessity of ensuring environmental flows in all rivers downstream of various water resources projects. Allocation of water for environmental and ecological purposes is already accorded higher priority than that for industrial use in the Rajasthan State Water Policy 2010. Thus, environmental water requirements will be paid due consideration among the competing uses.

The availability of water should take into account the surface- and ground waters together as well as the wastewater that may become usable for various purposes after some degree of treatment. A total water budget approach is required for allocation of water resources among different users who compete for the same resource. The domestic wastewater and industrial wastewater from many industries which do not use toxic chemicals could be easily treated at primary level alone and used for irrigation of a variety of crops, in horticulture and for plantations on degraded lands. These effluents will provide significant amounts of nutrients and reduce the need for fertilisers. Instead of competition between users for the same source and quality of water, mechanisms need to be developed for cooperation and collaboration between users as the waste generated by one user can be used profitably by another user.

3.11 Groundwater Quality

The groundwater, which is generally considered as safe is being contaminated by geogenic and anthropogenic pollution in the State. The groundwater quality degradation in the State is mainly due to its over-abstraction leading to mining of contaminated water from deeper aquifers and percolation of wastes from human activities. The availability of water for human use becomes further constrained by its quality due to natural geogenic factors. Groundwater in large areas of Rajasthan, are highly saline or saline-alkaline, or have high fluoride content.

Most of the industrial effluents and domestic sewage are not treated and flow directly to the dry riverbeds. This accumulated pollution load if not degraded on land gets into groundwater through leaching and pollute it. Groundwater once polluted cannot be easily rehabilitated.

The dumping of urban and industrial wastes without proper treatment is leading to its seepage in groundwater and polluting it. The CGWB, RGWD and PHED monitor the groundwater quality in the State. As per the findings of these agencies, the water quality is highly polluted. The major water quality issues of Rajasthan are related to salinity as reflected by electric conductivity values in water quality data, fluoride and nitrate (Figure 3.25 to 3.29). These pollutants are both anthropogenic and geogenic. Majority of groundwater quality related problems arise due to its contamination and over-exploitation. There is hardly any safe (from human health point of view) groundwater zone in Rajasthan but mostly suitable for industrial use.

Table 3.11 gives the details on the water quality affected villages and habitations (Dhanies) in Rajasthan. It shows that only 18.7% villages and 71.9% Dhanies get safe drinking water. Overall, only 50.45 percent villages and habitations get safe water. The water impurity wise affected areas in Rajasthan are shown in Figures 3.25 to 3.29.

Table 3.11: Quality of Ground Water in Rajasthan

Chemical Parameter	Prescribed Limit	Villages (No.)	Dhanies (No.)	Total (No.)
Fluoride	>1.5mg/l	10897 (28.76)	6496 (11.59)	17393 (18.51)
Chloride	>1000mg/l	3333 (8.80)	1338 (2.39)	4671 (4.97)
T.D.S.	>2000mg/l	6811 (17.98)	2811 (5.01)	9622 (10.24)
Nitrate	>100mg/l	9546 (25.19)	5035 (8.98)	14581 (15.52)
Iron	>1.0mg/l	232 (0.61)	62 (0.11)	294 (0.31)
Arsenic	>0.05mg/l	0	0	0
Safe		**7070 (18.66)**	**40315 (71.92)**	**47385 (50.45)**
Total		**37889 (100.00)**	**56057 (100.00)**	**93946 (100.00)**

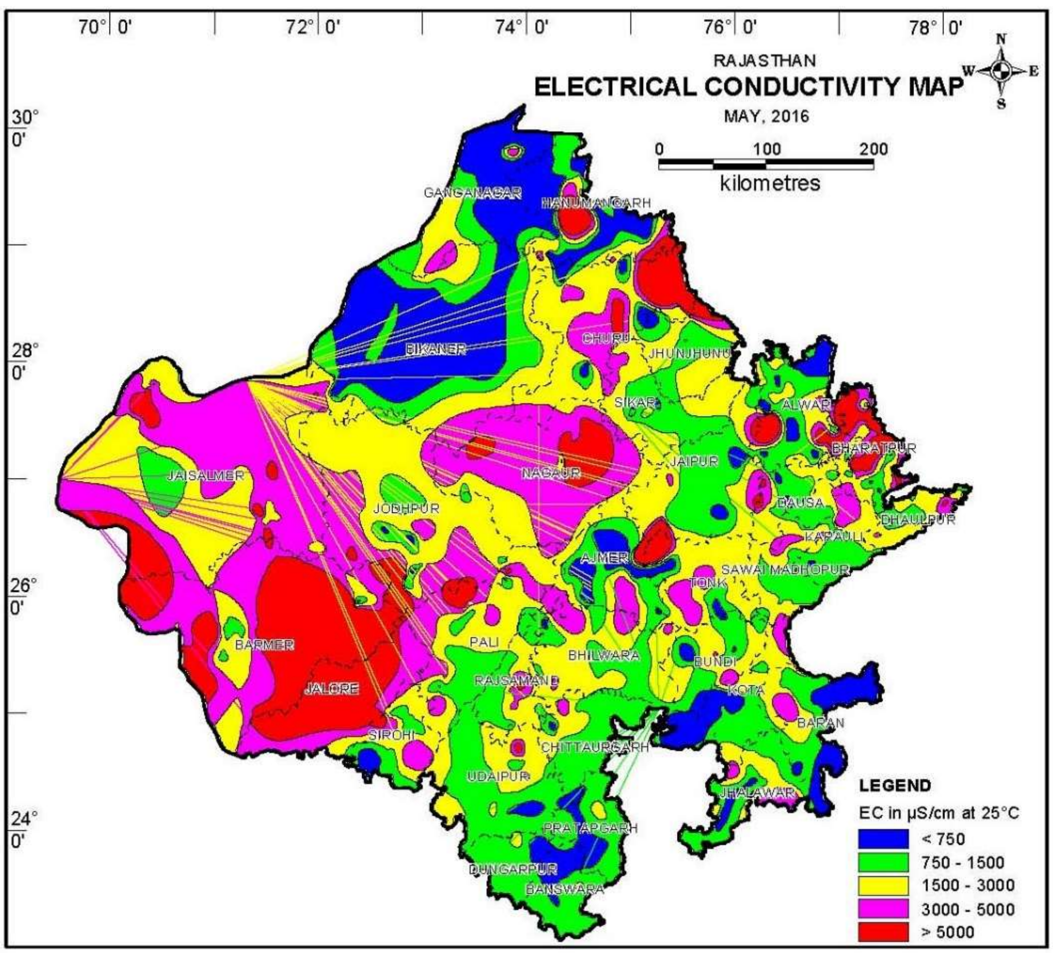


Figure 3.25: Distribution of Electrical Conductance –May 2016

Source: Ground Water Year Book 2016 – 2017

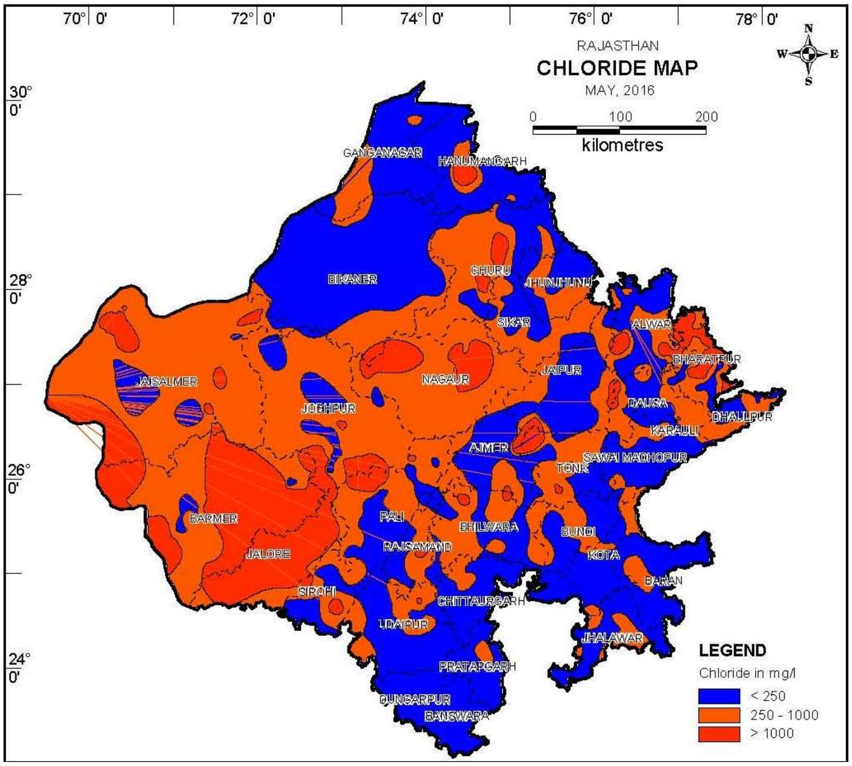


Figure 3.26: Distribution of Chloride in Rajasthan –May 2016

Source: Ground Water Year Book 2016 – 2017

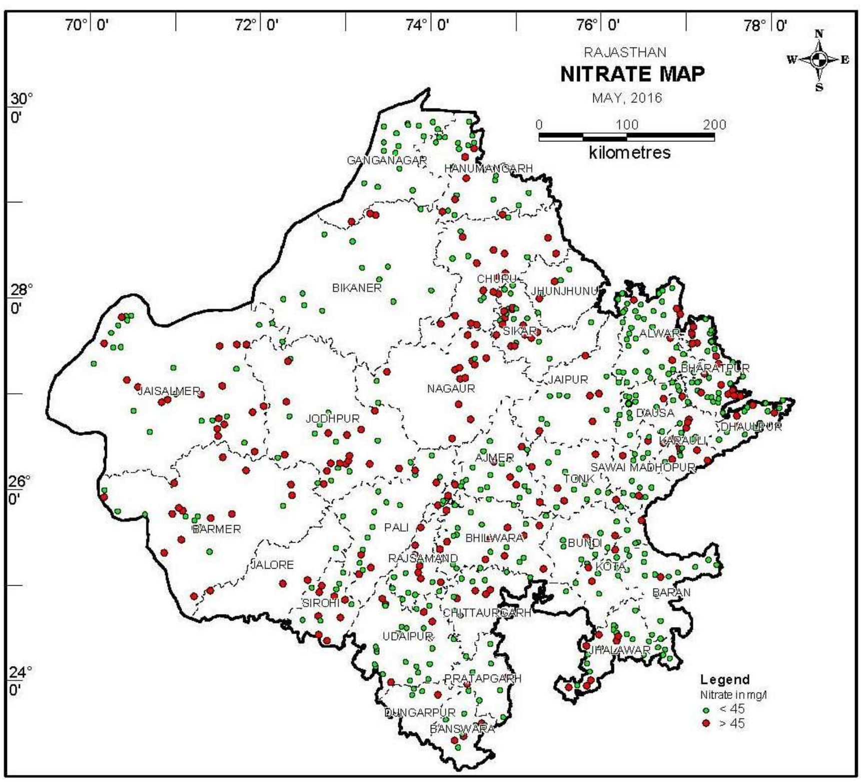


Figure 3.27: Distribution of Nitrate in Rajasthan –May 2016

Source: Ground Water Year Book 2016 – 2017

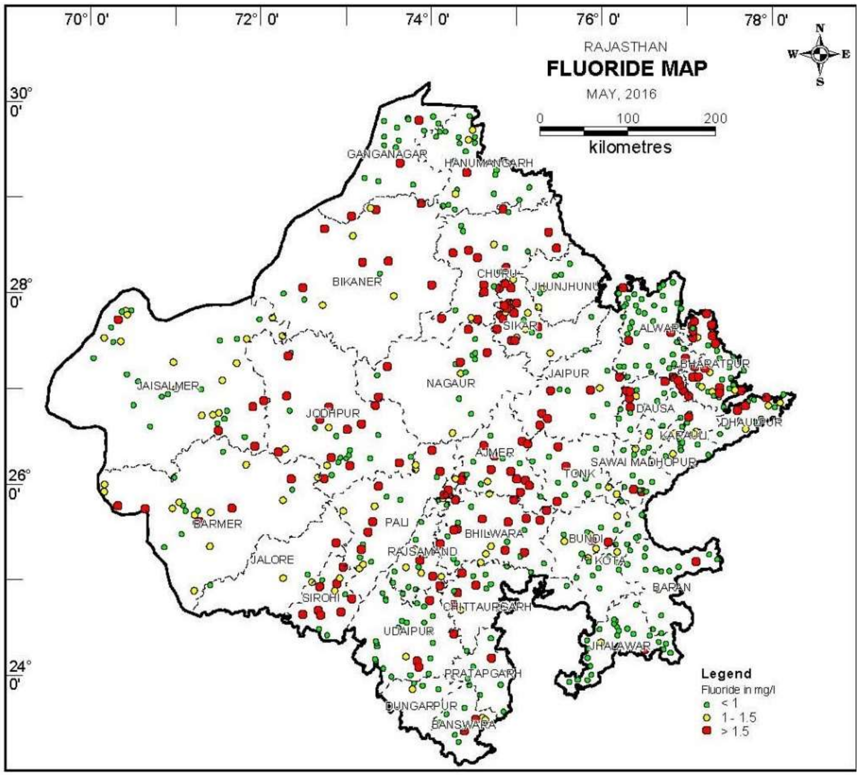


Figure 3.28: Distribution of Fluoride in Rajasthan –May 2016

Source: Ground Water Year Book 2016 – 2017

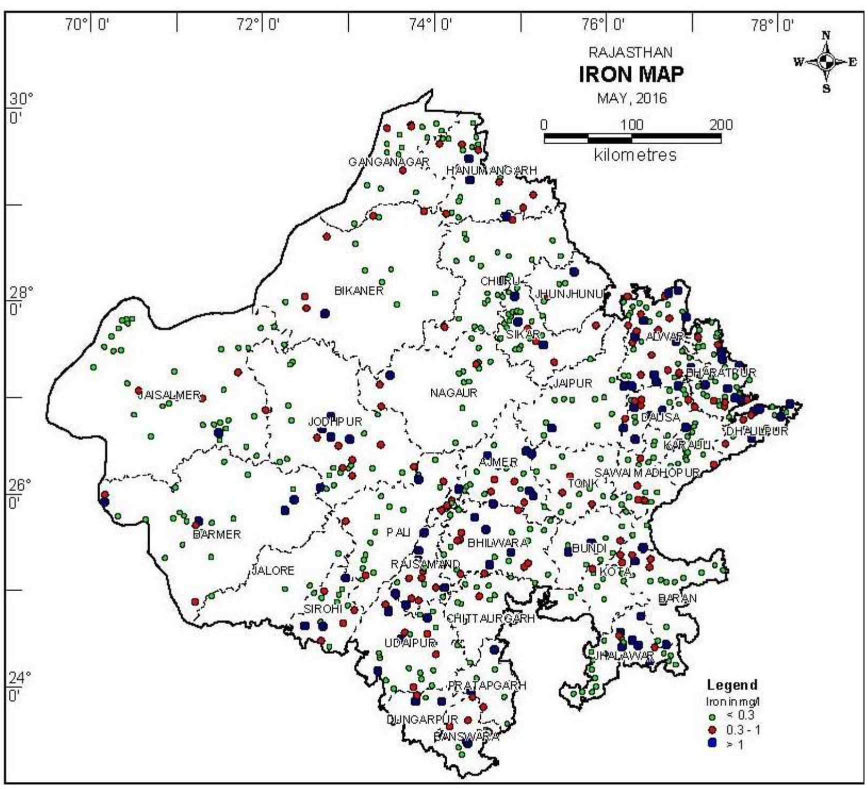


Figure 3.29: Distribution of Iron in Rajasthan –May 2016

Source: Ground Water Year Book 2016 – 2017

3.12 Wastewater Generation

Scarcity of water in the State can be addressed by reduction in water use, reducing quantity of waste water, conservation of water in all usage and recycle and reuse. Presently wastewater generation is highest in urban areas followed by industries. Wastewater generation in urban areas is assumed to be a function of water supply. In Rajasthan, piped water supply is largely restricted to urban areas. Rural population and smaller towns still depend on community wells, hand-pumps or even rivers/ponds for their drinking water needs. Estimation of wastewater quantities is difficult due to non-availability of real data on urban water supply (including lack of exact figure on unaccounted water/ distribution losses), withdrawal of groundwater through private pumps (not accounted in the estimated water supply per capita), lack of infrastructure to collect sewage and portion retained in the low lying areas in the city or percolating during its flow in unlined drains and existence of septic tanks for part of the population, etc. Here it is pertinent to mention that the wastewater from smaller towns and villages in Rajasthan is generally insignificant due to lack of proper collection system.

Data presented in Table 3.12 and Figure 3.30 show that the total volume of wastewater generated from domestic and industrial source is 1799.03 MLD (1330.31 from domestic and 468.72 from industries usage). Domestic wastewater is 76% and industrial wastewater is 24% of the total. Data for the domestic and industrial wastewater in various districts are shown in Figure 3.31. Jaipur district generates largest amount of wastewater, predominantly domestic, followed by Kota and Jodhpur. This can be attributed to the concentration of urban population in these districts. Bhilwara, Barmer, Pali, Rajsamand and Baran districts have much larger share of industrial effluents than domestic sewage, due to larger industrial activity in these districts. Information on industry-wise pollution load generation is generally not available. Reliability of the available data is questionable. The Central Pollution Control Board has adopted an approach to estimate pollution contribution from industrial sources based on industrial production (CPCB 2001).

Estimation of wastewater generation for the purpose of establishing wastewater treatment facilities, considers only urban population. Although rural population will generate wastewater, but it is assumed that the sewage will be collected/treated in septic tanks, at household level and only grey water will flow to the wastewater collection system. Moreover, sewerage systems at village level may not be feasible due to cost involved, and septic tank-based sanitation will continue to prevail. Hence, it is the urban population, which needs sewage treatment facilities. It is considered that 80% of the urban water supply will be generated as wastewater. This assumption was also adopted by CPCB in its documents (CPCB 2009). The water demand estimation based on TAHAL report for 2020, 2040 and 2060 taking urban water supply as criteria is reported in Table 3.13. It has been estimated that the sewage quantity will grow from 2300 MLD in 2020 to 3106 MLD in 2040 and 3674 MLD in 2060.

Table 3.12: Domestic and Industrial Wastewater Generation (MLD) in Rajasthan.

Districts	Domestic*	Industrial
Ajmer	**93.47**	2.99
Alwar	22.88	**28.76**
Banswara	7.03	10.26
Baran	6.14	**36.46**
Barmer	15.15	**69.63**
Bharatpur	16.18	-
Bhilwara	21.65	**91.41**
Bikaner	**69.17**	0.38
Bundi	7.44	-
Chittorgarh	14.25	4.19
Churu	31.08	0.08
Dausa	3.78	-
Dholpur	14.17	1.75
Dungarpur	-	3.23
Ganganagar	27.25	4.12
Hanumangarh	23.91	-
Jaipur	**397.31**	**52.02**
Jaisalmer	4.87	-
Jalore	3.02	0.25
Jhalawar	6.96	1.15
Jhunjhunu	12.86	8.1
Jodhpur	167.3	20.45
Karauli	9.73	-
Kota	**189.92**	**36.75**
Nagaur	20.86	-
Pali	20.04	**40.85**
Pratapgarh	-	-
Rajsamand	4.45	**28.96**
Sawai Madhopur	11.33	-
Sikar	31.29	1.4
Sirohi	2.87	1.82
Tonk	11.6	2.56
Udaipur	62.35	21.16
Total	**1,330.31**	**468.72**
Percentage	74%	26%
Grand Total (Domestic and Industrial)	**1,799.03**	

* For Class-I cities and Class-II towns only
Source: Benchmarking of Urban Water Supply Schemes of Rajasthan by SMEC, 2012 and CPCB

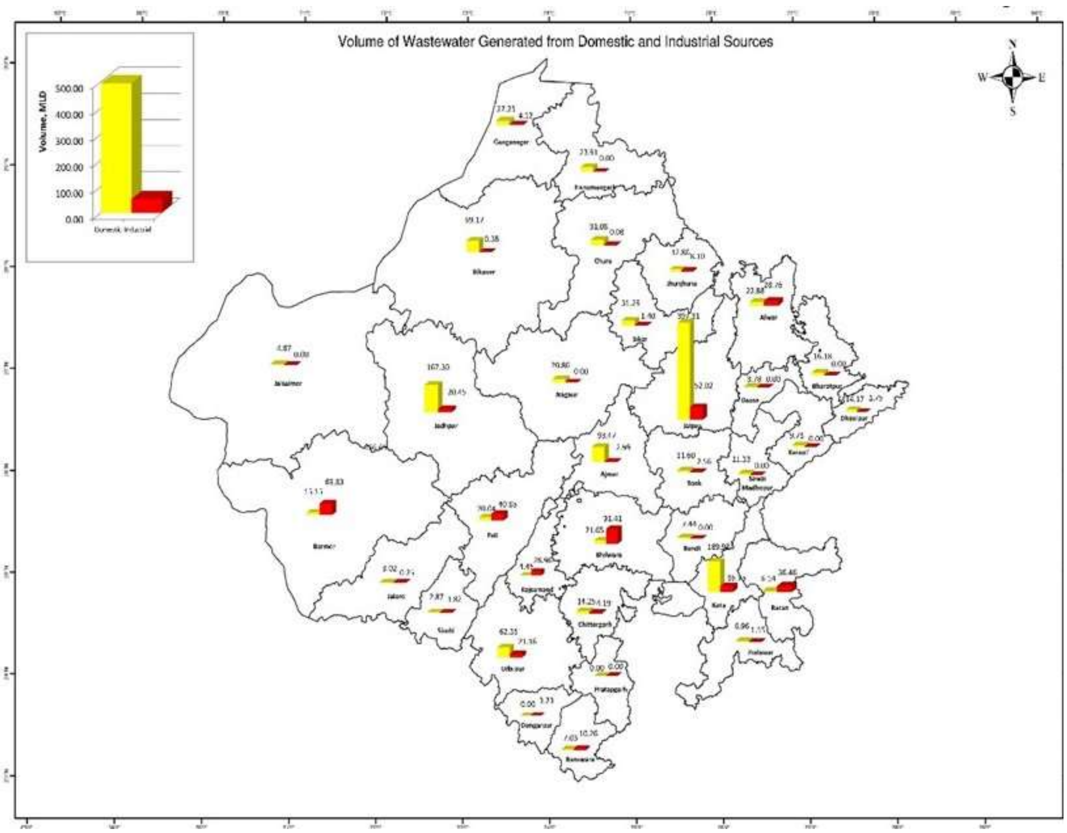


Figure 30: Volume of Wastewater Generated from Domestic and Industrial Sources

Data on projection of the volume of waste water generation and industrial effluent generation in future are reported in the Tables 3.13 and 3.14. It show that Bilwara, Jaipur, Barmer and Pali generate over 50% of the industrial wastewater in Rajasthan. While the District-wise projections of industrial effluent generation Jaipur ranks first followed by Kota, Chittor, Alwar and Udaipur. State has to plan for reuse, recycle of this resource to deal with the fast growing urban water demand.

Table 3.13: District-wise Projection of Wastewater Generation (MLD) from Urban Areas in Rajasthan.

Districts	2020	2040	2060
Ajmer	134.38	163.99	186.24
Alwar	91.44	147.51	182.33
Banswara	13.24	14.18	17.86
Baran	35.33	52.14	63.61
Barmer	20.58	23.76	30.64
Bharatpur	60.62	74.76	87.28
Bhilwara	62.62	87.63	103.06
Bikaner	111.8	145.53	170.19
Bundi	27.16	34.32	40.02

Chittorgarh	33.86	41.97	48.79
Churu	69.26	82.72	94.25
Dausa	28.1	42.5	53.04
Dholpur	34.35	49.23	59.57
Dungarpur	11.07	13.13	13.59
Ganganagar	62.27	74.5	85
Hanumangarh	41.18	47.87	54.79
Jaipur	522.85	736.99	871.54
Jaisalmer	10.08	10.61	12.21
Jalore	19.73	27.24	34.78
Jhalawar	28.82	41.05	50.74
Jhunjhunu	58.04	74.48	86.49
Jodhpur	184.02	249.93	295.23
Karauli	27.33	35.33	42.28
Kota	180.49	259	306.89
Nagaur	83.51	114.37	137.16
Pali	53.61	64.64	74.39
Pratapgarh	6.95	7.32	9.53
Rajsamand	23.96	34.89	42.1
Sawai Madhopur	32.94	42.98	50.61
Sikar	82.96	114.04	134.71
Sirohi	27.31	39.32	47.39
Tonk	39.34	50.61	60.47
Udaipur	81.16	107.38	127.45
Total	**2300.36**	**3105.91**	**3674.24**

Source: Benchmarking of Urban Water Supply Schemes of Rajasthan by SMEC, 2012 and CPCB

Table 3.14: District-wise Projections of Industrial Effluent Generation (MLD) in Rajasthan.

Districts	**2020**	**2040**	**2060**
Ajmer	14.58	22.79	35.62
Alwar	69.1	108	168.79
Banswara	21.56	33.7	52.68
Baran	1.01	1.59	2.47
Barmer	30.93	48.33	75.53
Bharatpur	3.12	4.9	7.67
Bhilwara	23.48	36.66	57.29
Bikaner	16.25	25.37	39.64
Bundi	1.12	1.73	2.71
Chittorgarh	76.66	119.75	187.12

Churu	5.42	8.47	13.21
Dausa	2.44	3.78	5.92
Dholpur	12.47	19.48	30.47
Dungarpur	5.86	9.15	14.3
Ganganagar	18.14	28.33	44.25
Hanumangarh	3.62	5.64	8.79
Jaipur	248.9	388.9	607.67
Jaisalmer	1.32	2.03	3.18
Jalore	2.14	3.34	5.21
Jhalawar	3.75	5.86	9.15
Jhunjhunu	23.21	36.25	56.66
Jodhpur	18.36	28.66	44.79
Karauli	1.81	2.79	4.38
Kota	90.27	141.07	220.44
Nagaur	7.56	11.84	18.47
Pali	12.85	20.08	31.37
Pratapgarh	0.27	0.44	0.68
Rajsamand	24.66	38.52	60.22
Sawai Madhopur	2.33	3.62	5.64
Sikar	6.63	10.38	16.25
Sirohi	17.18	26.88	42
Tonk	4.16	6.49	10.14
Udaipur	53.59	83.73	130.79
Total	**824.75**	**1288.55**	**2013.5**

Source: Benchmarking of Urban Water Supply Schemes of Rajasthan by SMEC, 2012 and CPCB

Chapter 4.

STATUS OF INDUSTRIES IN RAJASTHAN

Rajasthan has been known since centuries for its marble, stone and textiles, besides salt from Sambhar lake. First major industry set up in Rajasthan was the JK Lakshmi Cement in 1938 in Sirohi. The National Engineering Industries and the Chambal Fertilizers were started in 1950. Mewar Textile Mills – for spinning and knitting, started in 1938 in Bhilwara. The first synthetic textile unit was started in 1961 in Bhilwara. Later, JK Synthetics and Shriram Rayons were set up in Kota in 1962 and 1965 respectively. Zinc and copper mining and smelting industries were started in 1960s in Udaipur and Khetri (Jhunjhunu) respectively. The JK Cements unit was set up in Nimbahera (Chittaurgarh) in 1975. However, Rajasthan is dominated by small scale industries which have grown almost exponentially in recent years. There were only 17892 industrial units (MSME) until 1974-75. Their number rose to 397054 by 2013-14, and 760487 during 2018-19. During 2019-2020, 146,472 new units were registered in the State. Thus, small scale industries form the backbone of industrial growth in Rajasthan. Jaipur, Bhilwara, Udaipur and Ganganagar are major districts which account for 70% of the industrial output. The establishment of RIICO and several policy initiatives have promoted the rapid industrial development.

4.1 Current Status of Major Industries

Cement:

There are 24 major cement plants. The state is rich in cement grade limestone (17% of India's total) and gypsum.

Mining:

The State being highly rich in nearly 80 kinds of minerals, mining is a major industry. There are estimated 560 mines, the second highest number in the country.

Automobiles and their parts:

Large number of units are concentrated in Alwar, Bhiwadi, Neemrana, Pathredi and Jaipur

Textiles:

The most dominant industry in the State which leads in polyester viscose yarn and synthetic textiles. The cotton textile industry is concentrated in Pali, Jodhpur, Balotra, Sanganer, and Bagru.

IT and ITeS:

Rapidly developing IT industry with units in several districts

Agro-based Industries

These units utilise the major crops of coarse grains, oilseeds and spices. They include the breweries, distilleries and beverages.

Dairy Industry:

Milk Processing units are spread all over the state.

Chemical Industries:

Mostly fertilisers, pesticides, caustic soda and pharmaceuticals: located mostly in Jaipur, Kota, Udaipur and Bhilwara

Steel Re-rolling and Stainless Steel

These industries are located mostly in Alwar, Jodhpur and Jaipur

Ceramics and Glass:

Abundant supply of various types of clay, felspar and quartz has spawned more than 500 units of ceramic and glass industry in Jaipur, Bikaner, Abu Road and Bhiwadi

Salt Industry:

Salt making is a centuries old industry at Sambhar Salt lake (Jaipur & Nagaur).

Stone-based Industries:

Marble, Slate and Sandstone related industries account for about 90% of India's production.

Energy Generation:

All forms of energy (solar, wind, thermal and nuclear) are produced in Rajasthan which is now an energy-surplus state.

4.1.1 Status of 17 Categories of Industries

According to the CPCB report to the Parliamentary Standing Committee in 2016, there were 124 highly polluting 17 Category of industries. Of these, 29 are cement manufacturing units, 26 fertilizers, 10 distilleries and 37 Thermal power plants. The details of the industries are as follows:

S.No.	Industrial Category	No. of units
1	Aluminium	-
2	Cement	29
3	Chlor Alkali	2
4	Copper	1 (Closed)
5	Distillery	10
6	Dye & Dye intermediates	1
7	Fertilizer	28
8	Integrated Iron & Steel	-
9	Oil Refinery	-
10	Pesticide	5
11	Petrochemical	-
12	Pharmaceuticals	8
13	Pulp & Paper	-
14	Sugar	-
15	Tannery	-
16	Thermal Power Plant	37
17	Zinc	3
Total		**124**

4.2 Distribution of Industrial Areas and Industries in the State

According to the data available on the Official websites of RIICO and Industries Department, until the end of 2019-2020, the status of industries in Rajasthan was as summarized below:

There were 320 Industrial areas in 20 districts which were set up before the 2006 EIA notification and hence did not require Environmental Clearance. There were 353 industrial areas open for allotment of plots to industries, 10 areas were upcoming, and 34 raw land banks were yet to be developed. As on 31 March 2019, there were 390 large and 254 medium industries in the state. Their distribution across various districts, along with the number of Industrial Areas (IA) is presented in Table 4.1. The main kinds of water-intensive industries (both large and small) are also noted in the Table.

Table 4.1: Industries Status in Rajasthan up to 31 March 2019

District (IAs)	Large	Medium	Small	Water-Intensive	Kinds (small)
Ajmer (26)	10	7		Cement	Various
Alwar+ Bhiwadi*	14 + 105	3 + 47	1129	Brewery, distillery, chemical, pharma, paper, leather, textile. Ceramics, sanitaryware	Various
Baran (4)	6	2			Various
Banswara (6)	7	0			Various

Barmer (4)	2	4	2925	Thermal power	1877 textile, leather
Bharatpur (8)	1	1			Various
Bhilwara (13+1)	75	35	600	Synthetic textile, wool, cotton, fabrics/yarn	Cotton, wool, jute, paper, leather
Bikaner (12 +1)	2	2			Various
Bundi (6)	3	4			Various
Chittorgarh (7)	13	5		Cement	Various
Churu (8+1)	1	0			Various
Dausa (6)	0	0			Various
Dholpur (6)	2	9			Various
Dungarpur (3)	2	0	3712	Synthetic textile	232 textiles
Ganganagar (14+1)	7	1			Various
Hanumangarh (8)	1	1			Various
Jaipur (R+U) (48)	27+14	18+14			Various
Jaisalmer (4+2)	0	2			Various
Jalore (4)	1	2			Various
Jhalawar (10)	2	2			Various
Jhunjhunu (6)	1	0			Various
Jodhpur + Phalodi (25+3)	25 + 0	7 + 0		Textile, Steel rolling,	Various
Karauli (4)	0	2			Various
Kota (19)	10	33		Thermal power,	Various
Nagaur (7)	1	2			Various
Pali (14)	6	8			Textile
Pratapgarh (1)	0	0			Various
Rajsamand (2)	7	3			Various
Sawai Madhopur (3)	0	17			Various
Sikar (14)	6	4			Various
Sirohi (12)	8	3			Various
Tonk (6)	4	2			Various
Udaipur (11)	27	14		Cement, Zinc Smelter	Various

The data show that most of the industrial areas are in Jaipur, Alwar, Jodhpur, Ajmer districts (each with >25 IAs). Kota, Sikar, Ganganagar, Pali, Bhilwara and Bikaner districts had 14 to 20 IAs each, whereas Sirohi and Udaipur had 12 and 11 IAs respectively. Bhilwara and Udaipur districts had fewer IAs but more large industries. Alwar (including Bhiwadi) also has relatively few (29) IAs but has the largest concentration of large and medium industries. Jaipur has largest number of IAs but only few large industries.

Figure 4.1: District-wise number of industries

Source: Brief Industrial Profiles of Districts,2016-17, Carried out by MSME-Development Institute.

4.2.1 Criteria for Locating Industries/Industrial Estates

Currently, there are no criteria for location of Industrial Estates/industries in the State. The RIICO has however identified IAs where industries requiring Environmental Clearance in category A or B can be allotted land. It is noteworthy that the four new IAs for category A & B industries are being developed in Jodhpur, Bhiwadi and Jaipur (Rural). These lists are reproduced in Annex.

The distribution of larger and medium industries in different climatic zones is shown in Figure 4.2 and rainfall zones in Figure 4.3. It reveals that a significantly large proportion of large and medium scale industries, including the water intensive industries are located in the semi-arid districts of Rajasthan and just east of the Aravallis in areas with less than 500 mm annual rainfall.

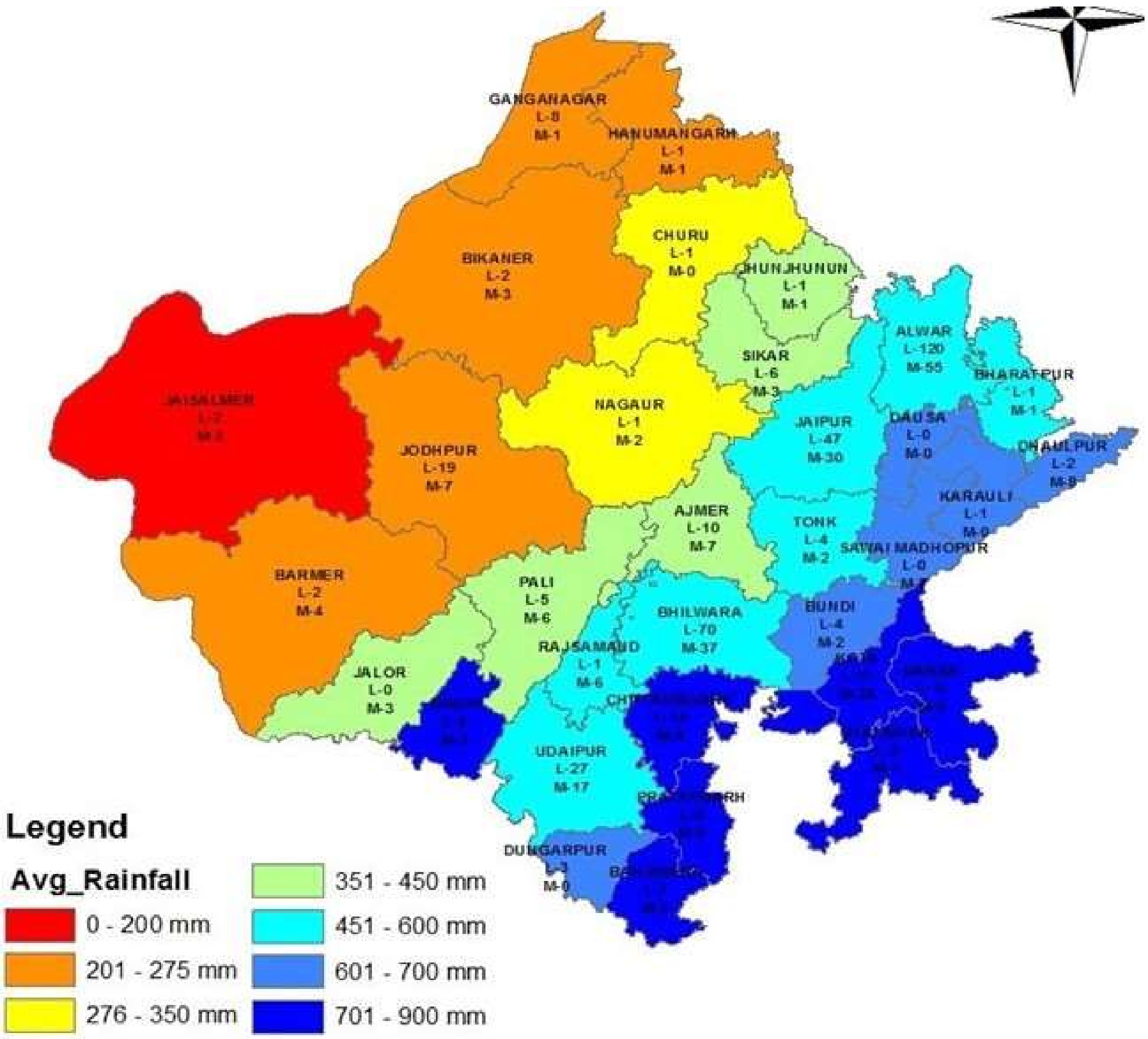


Figure 4.2: Distribution of Large & Medium Industries in relation to Rainfall

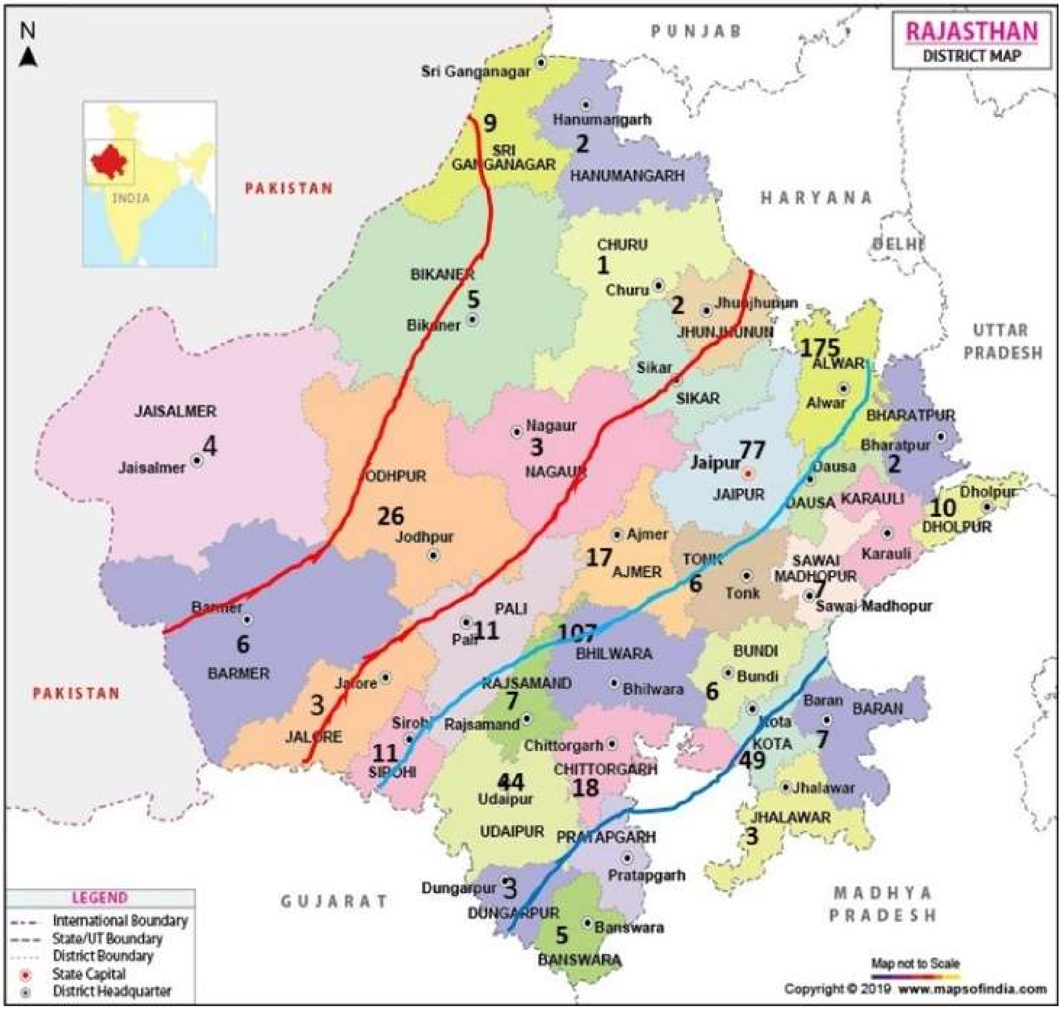


Figure 4.3. Distribution of industries in relation to five zones of rainfall.

The total annual rainfall increases from northwest to southeast of Rajasthan. Distribution of total large and medium industries presented in Figure 4.3 shows than about 350 industries are located in areas with less than 500 mm rain, whereas about 260 industries are in the areas with 500 to 800 mm rain.

4.3 Categorisation of Industries by the CPCB

However, the Central Pollution Control Board categorises industries according to their pollution potential into Red, Orange and Green categories. The Rajasthan State Pollution Control Board, in compliance of the directions issued by Central Pollution Control Board, vide their letter dated 04/06/2012, and on the recommendations of the committee constituted by the State Board notified a list of industries, projects, processes, activities, and mines in Red, Orange and Green categories, on 7 March 2013, for the purpose of consent mechanism.

In March 2016, the Ministry of Environment & Forests & Climate Change, re-categorised the industries based on the range of score of their pollution index, and recognised four categories of industries as:

Pollution Index score of 60 and above - Red category (60 industries)

Pollution Index score of 41 to 59 - Orange category (83 industries)

Pollution Index score of 21 to 40 - Green category (63 industries)

Pollution Index score incl.& up to 20 - White category (36 industries)

The categorisation also considered the use of raw materials, manufacturing process adopted and in-turn pollutants expected to be generated. The white category industries were exempted from seeking environmental clearance or 'consent to operate'. The RSPCB accordingly follows this categorisation.

The ***MOEF-CC or CPCB have not identified any criterion for distinguishing the water-intensive industries***. The only reference to them is made by the CGWB in its guidelines.

Chapter 5.

BENCHMARKING OF WATER RESOURCES IN INDUSTRIES IN RAJASTHAN

5.1 Theoretical Background

The term 'benchmarking' was first adapted to business practices by Xerox in 1979, with the aim to evaluate itself, to identify its strengths and weaknesses and adapt to constantly changing market conditions.

Benchmarking is defined as a process for improving performance of any organization by continuously identifying, understanding & adopting outstanding practices and processes inside or outside the organization. Basically, it means learning from others.

Benchmarking is the practice of comparing business processes and performance metrics to industry bests and best practices from other companies, in terms of quality, time and cost. ***Benchmarking is used to measure performance using a specific indicator (e.g., cost per unit of measure, productivity per unit of measure) resulting in a metric of performance that is then compared to others***. It is ***also referred to as "best practices***" which may be adopted or adapted by other organizations to develop plans for improvement in their performance. Benchmarking may be a one-off event, but is often treated as a continuous process.

Benchmarking ***starts with the identification of the best unit in an industry*** where similar processes exist. The results and processes of that unit are compared with those of others to learn where the improvements are required and can be made.

Many different types of benchmarking have been identified and categorised variously, depending upon individual perspectives, goals, objectives, and components of a larger system to be benchmarked. Benchmarking may be used for a Product, a Process, or a Parameter, or may be Strategic to meet competition.

5.1.1 Advantages of Benchmarking

Benchmarking has the following advantages:

- Learn from others experience & practices.

- It allows examination of present processes
- It aids change & improvement.
- It gives a chance for study & measurement of a competitor for the purposes of process or product quality improvement.
- Benchmarking often proves particularly successful when comparing processes.
- Helps the organizations to stay in the business with high performance
- Delight the customer of the organizations.
- Sharing the best practices between benchmarking partners.
- It identifies opportunities for improvement
- Provides the momentum necessary for implementing change
- Involves for looking in detail at how other organizations carry out the same or similar processes.
- The capability to use for everyone and can be applied to (almost) any company, any private organization, any public organization.

5.2 Benchmarking of Water Resources

In view of the multiple competing demands on the scarce and declining water resources, there is an urgent need to (i) control water use and (ii) promote efficiency in all water usages at all levels. Benchmarking is a tool to determine efficiency of various user sectors. Benchmarking is a useful tool for improving water efficiency through development of appropriate programs and policies based on a comparative analysis of water consumption patterns in various industries. ***Water benchmarking allows a comparison of water use efficiency of an individual unit or an entire sector of similar units against a common metric that represents "standard" or "optimal".*** Water has received considerable attention for benchmarking in different industries, including water utilities, in many countries.

5.2.1 Levels of Benchmarking

Depending upon the availability of actual data, benchmarking can be done at

(a) plant level;
(b) process-block level (i.e., grouping certain process steps into one block); and
(c) process-step level.

The flow of water in an industry from the stage of abstraction to the discharge of treated wastewater after passing through various processes is presented below in a conceptualised diagram (Figure 5.1). The wastewater generated in each process may be recycled/reused in the same or another process (with or without some treatment), or discharged into the main wastewater stream going to the ETP. The treated effluent from the ETP may also be recycled/reused suitably or discharged into a water body (river, lake or reservoir).

For the purpose of benchmarking, the ***water use efficiency is the ratio of water abstracted to the total amount of raw material processed OR the amount/quantity of products (individually or collectively).***

In some industries, such as milk processing, raw milk is processed every day into several products, and it is convenient to benchmark water use for the unit amount of raw milk. In case of dyeing and printing of textiles, there is no change in the amount of the raw material input and the finished product output, and hence, either of them may be used in the computation. In other industries such as cement and thermal power, the benchmarks are best computed on the basis of final product (cement or energy). Another relevant component is

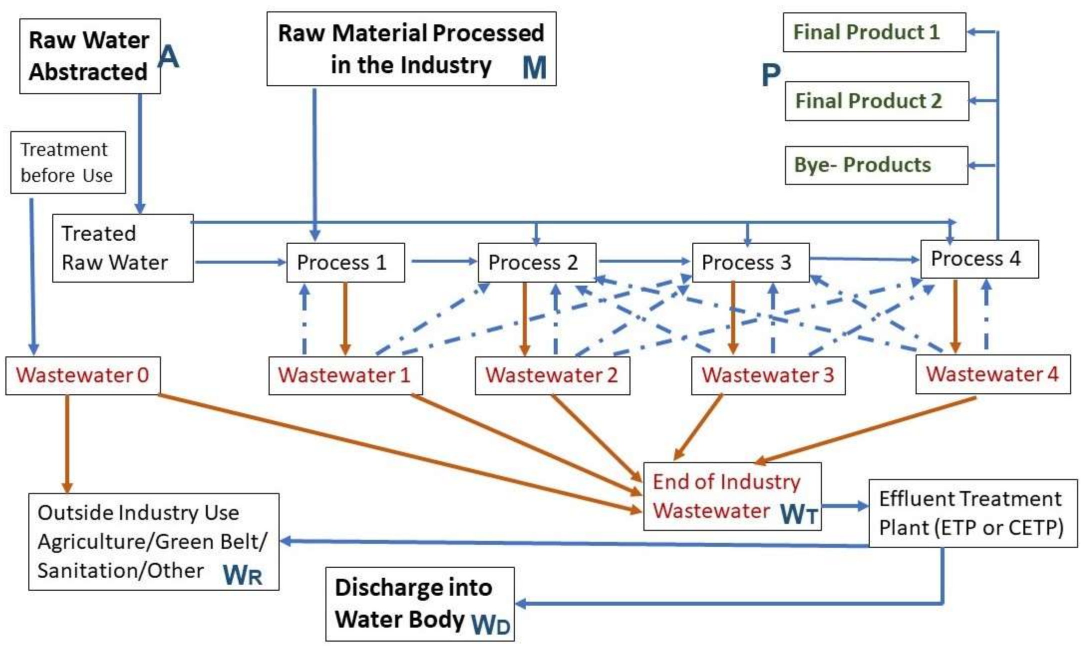


Figure 5.1: Conceptual diagram for computation of benchmarks for water use in an industry at different levels (Plant, Process Block or each Process)

Benchmark	Computation
Plant level water use efficiency (Gross)	A/M: water abstracted per unit raw material processed A/P: water abstracted per unit final product (s)
Plant level water use efficiency (Net) *	A-Wt/M: water abstracted minus the wastewater discharged per unit raw material processed A-Wt/P: water abstracted minus the wastewater discharged per unit final product (s)
Process level water use efficiency (Gross)	raw water A (before treatment) used per unit raw material processed in each process (P0 to P4)
Process level water use efficiency (Net) **	[raw water A (before treatment) used] minus [wastewater from that process recycled/reused in the same process] per unit raw material processed in each process (P0 to P4)

- If Wt =0, it is expected that all wastewater is recycled/reused within industry unit and hence, the abstraction will be reduced (or there will be greater production)

** It is expected that the reuse of wastewater in the same process will reduce water consumption in that process. The reuse of wastewater in the same process will depend on the waste characteristics and hence treatability of wastewater generated from each process separately.

Wr = wastewater returned after treatment and available for reuse elsewhere
Wd = wastewater discharged into another water body or land after treatment in an ETP. It causes pollution and may not benefit the system.

the time involved. The water abstracted, raw materials and the products manufactured may be considered over any unit of time period, from one day to one month or one year. However, this may often be difficult, if not wholly impossible, to account for water use per unit time because of the variability of time required in processing to obtain a certain final product

It is important to point out here that many reports on the water use in the various industrial products do not distinguish between the water required for the production of raw materials and the water used by specific industries; instead they club the water consumption to project very high alarming values which raise concerns for water conservation. For example, the amount of water required to produce a unit amount of grains or fruits is some times added to the amount of water used in the production of beer or alcohol, Similarly, the amount of water used in the production of cotton is added to the amounts used in making yarn and then processing the cloth. The raw material used in dairy (milk), paper & pulp, and sugar industries also are based on agricultural production. Whereas such considerations of total water use from the production of raw material to final product are important to the overall water resources management, they should not divert our attention from the goal of reducing water requirements (actual abstraction of surface and/or ground water) by specific industries at their level. Every industrial unit can be benchmarked for its water use efficiency independent of the related units contributing to the production of its goods.

5.2.2 Improving Water Use Efficiency (Benchmarks)

There are several ways in which the water use efficiency in the industries can be enhanced considerably. First and foremost, among them is the ***recycling and reuse of wastewater***. If the industry is able to recycle/reuse wastewater ***at any process step or before discharge*** for treatment in the ETP, its water abstraction will decline (considering the same amount of material processed and products manufactured), and hence, water use efficiency will increase. For example, in textile industry, the raw cloth undergoes several process steps before the final product is ready. Washing, for example, is one process carried out in several steps which together form a process block. Here, the wastewater after third or fourth washing can be used in the first wash. Similarly, in milk processing also washing requires more than two steps, and allows for some reuse. Further, in some cases the cooling water can be reused in boilers to save both water and energy.

Second method involves ***treatment of wastewater within the industrial unit*** using appropriate technologies depending upon the nature of the wastewater. Such treated water may be used in some process within the industry, depending upon the level of treatment.

The third method requires a change in the industrial processes, nature of ingredients used (such as dyes), and the technologies employed within the industry that require lesser amounts of water and/or generate lesser effluents.

Majority of the industries require that the raw water (surface water or ground water) is treated in a RO plant to lower its TDS concentration or is demineralised by other processes before use. Therefore, the increase in water use efficiency is also linked to the reuse of wastewater generated in the treatment of abstracted raw water.

Finally, in our considered view, the wastewater discharged by the industrial units for treatment in an ETP should not be considered in the estimation of the water use efficiency or benchmarks. Some industries may claim that they return 80-90% of the abstracted water after use to the ETP. This does not help in conservation of water resources or enhancing the water availability unless the industry makes it re-usable for another user (agriculture or another industry). Also, the treated wastewater that may be recycled/reused for any other purpose outside the premises of an industry should not be considered towards the efficiency or benchmarking of that industry.

5.2.3 Process-Level Benchmarking for Higher Water Use Efficiency

As mentioned earlier (section 5.2.1), the benchmarks can also be developed by considering the water use efficiency at the level of a block of processes or each process as the amount of water used for the unit amount of raw material processed through that process step (or block of processes). Benchmarking at the process-step and process-block level helps the industry identify specific areas for interventions for improvement in water use efficiency, and make comparisons for each process step or block, and rank them in order of priority. The industry will then have the option to improve water use efficiency (reduce water consumption or reuse treated water) of different processes at different times depending upon the resources and/or technology available.

It is certainly easy and simple to determine and compare the water use per unit product in the industry at plant level to continue with status-quo or business-as-usual approach. The regulators will also find these benchmarks quite easy to monitor but are unlikely to help conserve water resources – the goal of benchmarking. The process level benchmarking requires significant investment in automated monitoring of water use and wastewater generated at each process step, and installation of equipment for treating/reusing the wastewater from different process steps. However, these investments and efforts for monitoring are bound to turn into gains in the long-term for both the industry and the society at large through sustainability of water resources.

5.2.4 Examples of Water Use Benchmarks in Different Countries

Many countries and international organisations have been concerned with the problems of water scarcity, water pollution and increasing demands for water from the industries.

Considerable effort has been made to analyse the use of water in different industries, identify 'best practices' or develop benchmarks (e.g.,). Whereas significant information is available on the water consumption in different processes of various industries, it has not yet been possible to develop enforceable benchmarks either at the plant level or process level in any industry. The situation is complicated by the large variability in the scale of industries, nature of the raw materials used, the wide range of processes involved, variety of products, the accessibility of technologies, the climatic conditions and the quality of available raw water, and the socio-economic status of different countries. The published data from various countries for water use in different industries provides a very wide range of values which make it impossible to identify the 'Best' among them. A broad overview of this situation can be had from some examples for countries of the European Union (Table 5.1). More data are presented later in the following sections on some industries in Rajasthan.

Table 5.1: Water usage (Liters) per unit product in selected European Union countries (European Environment Agency 1999)

Country	L beer	L milk	kg cloth	kg paper	kg steel	kg sugar
Austria	10	5	n/d	150	15	15
Denmark	3.4	-	-	-	-	-
France	25	1-4	n/d	250-500	300-600	21-35
Ireland	8	-	-	-	4.5	-
Norway	10	1-1.5	130 (all kinds)	20	30	n/d
Spain	6-9	1-5	8-20 (wool)	250	30	3.5-5
Sweden	3-5	1.3	40-50	20	0.6-6.3	0.5
UK	6.5(2-10)	2.9	6-300	15-30	100	1.5(0.7-6L)
Depends on the type of fabric						

Source: European Environment Agency (1999) Sustainable water use in Europe: part 1—sectoral use of water, Environmental Assessment Report No.1 [http://www.eea.europa.eu/publications/binaryeenviasses01pdf/download].

5.2.5 Benchmarking of Water Resources in India

In India, with agriculture being the largest user of water, the Indian National Committee on Irrigation and Drainage issued in 2002 Guidelines for Benchmarking of Irrigation Systems in India. Similarly, water utilities have received some attention for performance benchmarking. A report on: "*Benchmarking of Urban Water Supply Schemes of Rajasthan*" was prepared in 2013 for the Public Health Engineering Department of the Government of *Rajasthan, by SMEC* International. The study focused on the performance of the water supply sector. RUIDP has also developed a framework and a toolkit (list of performance indicators) for benchmarking water supply, sewerage and slum development by Urban Local Bodies in Rajasthan (http://ruidptestserver.online/page.php?t=Toolkit). However, guidelines are not yet available for other major water users such as the industries, except that the MOEF-CC has notified norms for freshwater use in cooling towers of the thermal power plants (details discussed later). Some studies have been made on water use in some of the industries but we have not come across benchmarks for any specific industry. Within the domestic sector, the recommended allocation of water for per capita use in rural and urban areas, or even for livestock population, are desirable basic requirements but cannot be considered as benchmarks.

5.3 Water-Intensive Industries

There is no specific definition or criteria available for categorising an industry to be water-intensive. Water-Intensive is a relative term; it is nearly impossible to define it in terms of absolute water use. Water use may be consumptive, i.e. it is consumed in the process or production (e.g., breweries and beverages) and cannot be recovered even as wastewater, or may be non-consumptive, i.e., a very large volume of water is required for a process or activity (e.g., washing in textiles) but almost all or most of it is returned as wastewater. Agriculture is the single water user responsible for the 'consumption' of more than 70% of all water resources. A large amount of water applied in irrigation is returned to the atmosphere in evaporation and transpiration, and a significant amount moves through the land carrying with it the agrochemicals. This wastewater from the fields results in pollution of both surface and ground water but cannot be recovered for treatment before it reaches the water body or the aquifer. However, agriculture is not considered as an industry even when it is mechanised and practised on a large scale. Most of the water used for sanitation (flushing, washing, bathing etc) is returned as highly polluted wastewater which can be intercepted and treated for reuse.

Among the industries, following have been recognised as water intensive by the CGWB, without specifying any criteria (Table 5.2):

Table 5.2: List of Water Intensive Industries
[CGWB Guidelines/Criteria for evaluation of proposals/requests for ground water abstraction (With effect from 16/11/2015)]

Packaged Drinking water	Mineral water plant	Tannery	Distillery
Brewery	Soft drink	Paper & pulp	Fertilizer
Textile Dyeing	Textile Printing	Textile Spinning	Sugar
Dairy Product	Water park & Amusement centre		

In some of these industries such a packaged drinking water and mineral water, water is the raw material itself, and a large proportion of the water used is actually consumed by humans. Interestingly, whereas packaged drinking water industry is considered water-intensive, the salt industry based entirely on the ground water as the resource is left out. In salt industry, the saline water is simply allowed to evaporate until salt crystalizes. In other industries, water is used for industrial processes but significantly large amounts are returned as wastewater. Usually, textile printing and dyeing form part of the same industrial unit nut these have been listed separately. In cases such as Water Parks, water is used for recreation – a non-consumptive use, but is returned back to environment with some pollution load. In still other industries, water is used for cooling or heating only and most of it either evaporates or is returned to environment. However, thermal power plants which require huge amounts of water and cause thermal pollution of surface waters, are excluded from the list by the CGWB.

In the absence of any definitive guidelines for the categorisation of water-intensive industries, we restrict our studies to a few industries: textiles, breweries and distilleries, milk processing, chemicals, fertilizers and pharmaceuticals, cement, and thermal power generation.

5.3.1 Benchmarking of Water Use in Industries in Rajasthan

Benchmarking of water resources in this study is severely constrained by the availability of data. Benchmarking even at the plant level requires data on the periodic variability of inputs (water, raw materials) and outputs (final products) so that the influence of seasonality can be accounted for. In the present study, we have relied on the data submitted by the industries in their applications for seeking consent to establish and operate, and approved by the State Pollution Control Board. We approached many industries for some details of data but they did not provide the periodic data on the amounts of raw materials and/or finished products. Time-series data could be accessed only in a few industries where on-line monitoring systems have been installed for the groundwater abstraction and wastewater discharges. These data are already submitted by the industries to the State Pollution Control Board, and were of no help for benchmarking. We also personally interacted with the management of many representative industries across the State but the industries were not willing to share the actual data which admittedly is at variance with that reported to the regulators.

We wish to highlight the fact that the consent applications by the industries usually do not provide information on their water requirement justified by or related to their production and the processes they follow. The daily requirements based on the installed capacity for production cannot be related to the actual production and its seasonal (or monthly) variation. Similarly, the installed capacity of the ETPs does not reflect the actual wastewater generation from the industrial unit. Only a few large industries have set up on-line monitoring systems but the data from these systems do not help in benchmarking in the absence of figures for actual production of the goods.

Plant level benchmarking has to consider also the processes employed within each industry – from the raw material to the finished product. Often processes are split between different industrial units and it is difficult to link them together. For example, in breweries, malting is often done by different units, may be even outside the State, and then the malt is processed in another industrial unit. In textiles also, the yarn making, dyeing or mercerising are done in different units. In milk processing (dairy) plants, the milk collected from the village households is first chilled at chilling centers and then brought to the processing plants by large containers. As said earlier (section 5.2.1.1), all such units need to be benchmarked separately at their level only.

The following analysis of water use in various water-intensive industries, is confined to the assessment of the volume of water (KL) abstracted by the industry for each unit amount of production (usually a ton (=1000 kg)). A slightly lower figure is obtained if the amount of water explicitly demanded and abstracted for domestic use and green belt development within the industry is subtracted from the total volume of water withdrawal. Similarly, the volume of water recycled by the industry within the unit, will be reflected in a lower value of water use per unit of production. Thus, the benchmarks presented in this study are only indicative and require improvement based on adequate reliable data on actual withdrawal or actual consumption (use) in relation to actual production.

5.4 BENCHMARKING IN MILK PROCESSING INDUSTRY

5.4.1 About the Industry

India has the world's largest livestock population of which the bovine population alone is 304 million (more than 21% of the world's total). It includes 57.3% of the world's buffalo population and 14.7% of the cattle population. According to the Livestock Census of 2017, India had 50.42 million cross bred cattle, 142.11 million indigenous cattle and 109.85 million buffaloes. India has made great strides in milk production after independence, increasing the milk production from 17 million tonnes in 1951 to 176.3 million tonnes during 2017-18. Fourteen states contribute about 80% of the total milk production in the country, of which Rajasthan alone contributes about 11% (16934 million tonnes in 2014-15; NDDB 2016: Dairying in Rajasthan). As per 2017 data, Rajasthan had a total livestock population of 56.8 million (cattle 13.9 million, buffaloes 13.7 million. Goats & sheep 28.74 million). Whereas the crossbred cows accounted for 1.84 M tonnes of milk, the indigenous cows yielded 4.286 MT, buffaloes 8.985 MT and the goats 1.822 MT.

In Rajasthan, there are 45 milk processing unit of various capacities in both the private and government sector in practically all the districts. These units process less than one ton to 550 tons milk per day, and produce products such as shrikhand, lassi (sweet and salt), butter milk (chhachh), besides curd, cheese, butter and ghee.

List of Milk Processing Units in Rajasthan

https://www.ruralrelations.com/wp-content/uploads/2018/09/State-Wise-List-of-Dairy-Plants.pdf

1 Bhole Baba Milk Food Industries Ltd

2 Chandra Prakash & Sons

3 Gaudhan Dairy Pvt Ltd

4 Gujarat Food Products

5 Jai Shree Food Products

6 Jaipur Gow Samvardhan Samiti

7 Jaipur Zila Dugdh Utpadak Sahakari Sangh Ltd

8 Jasraj Ganeshimal

9 Krishna Dairy Products

10 Kundan Edible Products Ltd

11 Lotus Dairy Products Pvt Ltd

12 Mahesh Dairy Products Pvt Ltd

13 Mannalal Chainsukh Ghee Wale Milk Farm India Ltd

14 Narsinghdas Ramakrishna Pungaliya

15 Paliwal Sons Dairy Pvt Ltd

16 Pious Agro Pvt Ltd

17 Radhika Agro Food Products

18 Rajpurohit Dairy

19 Sangam Dairy & Food Products

20 Rajasthan Cooperative Dairy Federation LId: (Ajmer, Alwar, Banswara, Bhilwara, Bikaner, Hanumangarh Junction (Sri Ganganagar), Jaipur, Jodhpur, Kota, Pali, Raniwara (Jalore), Sardar Sahar (Churu), Sawai Madhopur, Sikar, Udaipur,

21 Shri Anu Milk Products Ltd

22 Shri Vrindavan Dairies

5.4.2 Milk Processing: Processes and Products

Most of the milk is produced in the unorganised sector by small farmers in rural areas whereas it is marketed in urban areas, usually far from the production sites. Therefore, the milk obtained from the cattle or buffaloes requires appropriate treatment for increasing its shelf life before it is consumed. Milk is also processed for manufacturing a variety of products such as cheese, butter, curd (yoghurt), milk powder, ghee etc. The processing involves procurement of milk, chilling, standardization, homogenization, pasteurization, skimming (standardised, toned and double toned milk), manufacture of various products, and packaging.

Water is used in milk processing mainly for chilling, boiling and CIP (cleaning in place). Water has also to be softened or demineralised before use, depending upon the source and quality of water available in the area. Different steps/processes in milk processing industry are shown in Figure 5.2.

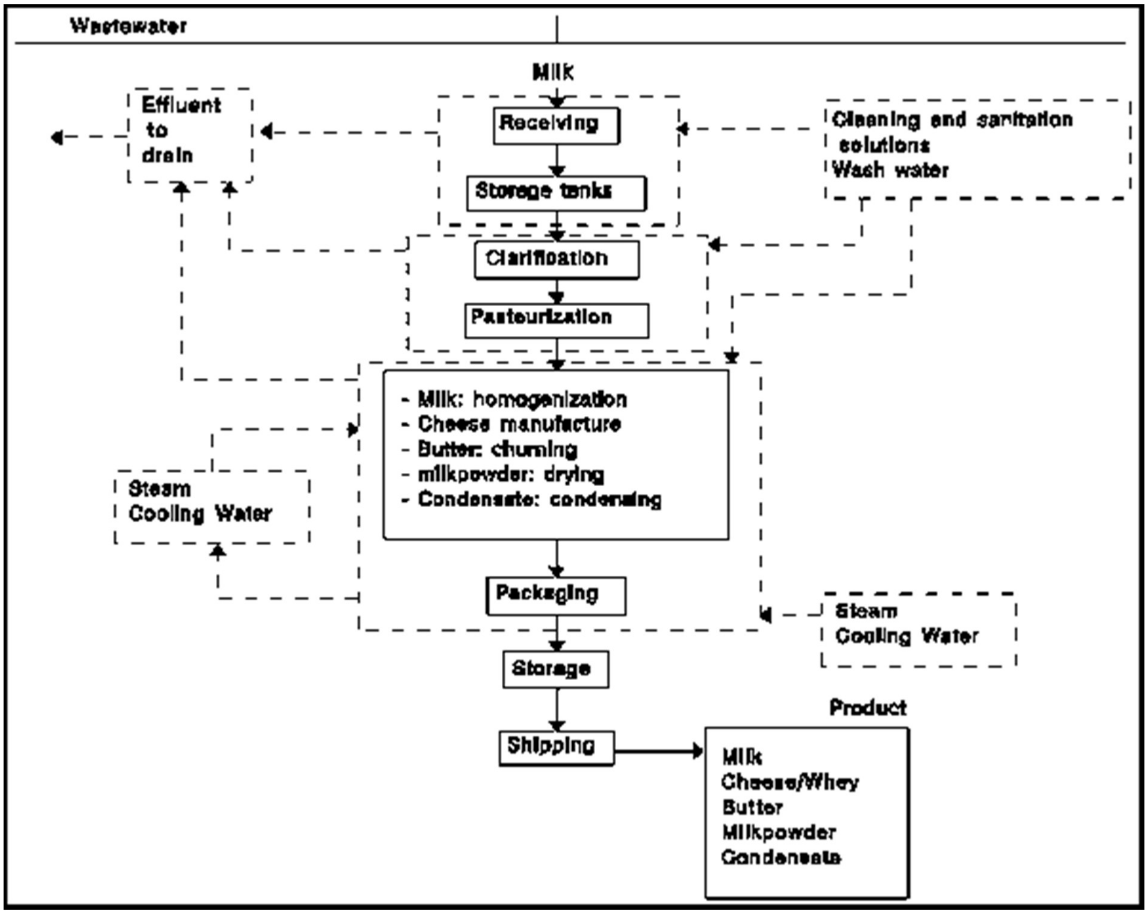


Figure 5.2: Flow chart of steps in milk processing.
(from http://www.fao.org/3/X6114E/x6114e06.htm)

In Rajasthan, water is also used as an input in the production stream for making reconstituted milk with milk powder. Demineralised water is added to the raw homogenised milk and then milk powder is mixed to meet the standard value of fat and milk solids.

5.4.3 Benchmarking of Water Use in Milk Processing

The requirement of water for boiling, chilling and CIP varies greatly according the nature of the products manufactured and the processes used. For example, the chillers may be water cooled, air cooled, or use refrigeration based on power supply (electricity or solar). Different kinds of cheese require variable amounts of water. The CIP generally uses various chemicals/ detergents or scrubbing that influence water consumption (Table 5.3).

Generally, the water use in milk processing may be calculated per unit raw milk (input) processed by the processing plant. The values will however differ by a wide range depending upon the number, kind and amounts of various milk products, some of which like butter, ghee and cheese (paneer) require large amounts of water for CIP. There is also considerable variation between various industrial units in the number and kinds of products manufactured there. And accordingly, the volume of water used by different units varies considerably. (see for example, Wojdalski et al. 2018, who analysed in detail the water consumption in four groups of industries with different processing profiles).

Table 5.3: Water used per unit product at different steps/processes in milk processing industry. (from Carawan et al. 1979)

Operation / location	Product	Water use / Product (Kg/Kg)
Total Use	Receipts	4.16
Case Washer	Fluid Product	0.27
Filling Room	Fluid Product	0.19
Cheese Room	Cottage Cheese	8.14
Cold Storage	Fluid and by-Product	0.08
Boiler	Total Product	0.19
Cooling Tower	Total Product	0.45
Receiving	Total Product	0.24
Utilities	Total Product	1.08
Clean and Sanitize	Total Product	1.39
Consumptive	Total Product	0.18
Total Use	**Total Product**	**3.57**

We analysed the data on water consumption (abstraction) by Rajasthan's milk processing units on the basis of the total production of all milk products taken together. All industries produce at least 2-3 products other than the full cream and toned milk. Some industries have not provided information even on the total amount of water used. The data are presented for the units in different districts of Rajasthan in Table 5.4. The Lotus dairy's plant near Khatu Shyamji, has a collaboration with Nestle India and the entire plant is fully mechanised for each product. Their water consumption is about 1.9 kl per ton of all products taken together. This may be considered as the baseline benchmark towards achieving greater water use efficiency. The reported low values of water use are apparently for smaller units which do not produce value added milk products. Very high water consumption in Dholpur industries cannot be explained.

Table 5.4: District-wise Water Use in Milk Processing Industry in Rajasthan

District	Gross Water use, kL per ton of Product	Net Water use kL/ton of Product	Range of Production (ton)	No. of Industries	No. of Units with no data
Rajasthan	**1.57**	**1.08**		**45**	**5**
Ajmer	1.66	1.42	96.17	1	
Alwar	0.99-7.10	0.09-1.10	50.0 to 273.0	3	1
Bharatpur	0.0	0.0	8.19		1
Bhilwara	0.07- 0.37	0.07-0.10	185.0 to 550.55	2	
Bikaner	0.10 - 0.16	0.03-0.09	136.50 to 374.53	2	
Chittorgarh	0.08 - 1.19	0.03-0.24	12.62 to 59.15	2	
Dholpur	31.68	22.19	0.30 to 123.74	7	1
Hanumangarh	0.88	0.60	175.20	1	
Jaipur	5.48	4.12	1.0 to 187.0	14	2
Jaisalmer	1.23	0.92	26.0	1	
Jalore	0.16	0.11	210.50	1	
Jodhpur	6.02	3.73	98.0	1	
Kota	1.36	1.12	154.10	1	
Pali	0.75	0.60	182.7	1	
Sikar	2.44	1.68	30.0 to 1247.65	4	
Sirohi	0.36	0.26	50.0	1	
Udaipur	2.86-3.37	2.29-2.85	52.37 to 94.82	2	

Note: Gross water use is calculated from the amount of water abstracted. The Net water use is calculated after deducting the volume of wastewater discharged from the unit. NA = Data not available

For comparison with benchmarks of water consumption in other countries, the published data for the dairy industry are reproduced in Table 5.5. More detailed analysis with water consumption in making various milk products in the U.K. is presented in Table 5.6. The data show that in the U.K. the water consumption per unit milk processed varied from 0.5 to 2.5. For cheese production value ranged from 0.5 to 18.5 (average 5.7).

In California, USA, a Benchmarking and Energy/Water-Saving Tool (BEST) (Version 1.2) had been developed (Xu et al. 2011) for the Dairy Processing Industry. The tool compares the total production energy intensity of the dairy with that of the reference-plant's energy/water use intensity, and generates estimation of technical energy/water saving potential and the associated cost savings in the dairy plant. The efficiency can be estimated at plant level, process level or process-block level depending upon the data provided. In a study, Wojdalski et al. (2013) have concluded that the indicators of water consumption per unit of the final product were correlated (at 0.820 > | r | > 0.663) with equipment profiles, the degree of process automation and employment. This view is consistent with the efficiency of the milk processing plant of Nestle near Khatu Shyamji in Rajasthan.

Table 5.5: Benchmarking of water consumption and wastewater disposal from dairy plants. (from Wojdalski et al. 2013)

Type of Plant		**Indicators of water use and Wastewater Management**		**Source**
Number of Plants (Location)	Production Profile	Range of Value	Unit	
7 (Australlia)	White and flavored only	1.05-2.21	L Water L Processed Milk	Prasad et al [24]
3 (Australlia)	Cheese and whey Products	0.64-2.90		
10 (Australlia)	Powdered Products	0.07-2.70		
Dairy Plants in Canada		1.0-5.0	L Water L Processed Milk	Wardroop Eng Inc[37]
Dairy Plants in Poland (Total)		7.0	L Water L Processed Milk	WS Atkins Int.[7]
Dairy Plants in Denmark (Total)		2.21-9.44	L Water Kg Product	Bosworth et al.[28]
8 (sweden)	Milk and dairy drinks	0.98-2.80	L Water L Processed Milk	Ws Atidns Polska[39]
3 (Denmark)		0.60-0.97		
8 (Finland)		1.20-2.90		
1 (Norway)		4.10		
1 (Poland)		0.5-0.75		
4 (sweden)	Cheese and Whey Products	2.0-2.5	L Water L Processed Milk	
5(Denmark)		1.2-1.7		
2 (Finland)		2.0-3.1		
2 (Norway)		2.5-3.8		
1 (Poland)		2.22		
7 (sweden)	Milk Powder,cheese and /or dairy drinks	1.7-4.0	L Water L Processed Milk	
3(Denmark)		0.69-1.90		
2 (Finland)		1.40-4.60		
2(Norway)		4.60-6.30		
5 (Poland)		1.80-5.30		
1 (USA)	Fluid Product	1.89	Water use/ Product kg/kg	Carawan et al.[40]
	By Product	10.5		
	Frozen Product	15.7		
	Total Product	3.57		
Dairy Plants in Poland(Total)		3.48-9.77 Average of 6.08	L Water L Processed Milk	Wojdalskl et al [41]
1 (Lithuania) Company data	Cream	3.28	L Water L Processed Milk	Davarioniene et al[42]
	Butter	3.99		
	Canned Product	7.438		
	UHT	2.7		
11 (France)	N/A	0.2-10.0	L Waste Water L Processed Milk	Vourch e al[43]

Table 5.6: Typical and optimal water use by major dairy products in U.K.
(from Ajiero and Campbell 2018)

Type of Product	Units	Water or Steam	SWC (specific water consumption) average/rang	SWC (specific water consumption) best practice
Milk - Milk Plant	$M^{3/t}$	Water	5.76 [1,2,3]	
	$M^{3/t}$	Water	0.192[1,2,3]	
Pasteurized Milk- bulk average	M^3/M^3	Water	1.6[4]	0.75[4]
Pasteurized Milk- bulk <1000 M^3/Month	$M^{3/t}$	Water	3.2[4]	
Pasteurized Milk- bulk >1000 M^3/Month	$M^{3/t}$	Water	1[4]	
Pasteurized Milk- Sachets	M^3/M^3	Water	1.7[4]	1.1[4]
Pasteurized Milk- Cartons	M^3/M^3	Water	2.2[4]	1.5[4]
Pasteurized Milk- Bottles	M^3/M^3	Water	3[4]	2[4]
Skimmed Milk	$M^{3/t}$	Water	3.6[4]	2.1[4]
Condensed Milk	M^3/M^3	Water	4.4[4]	3.5[4]
Sterilised /UHT Products	M^3/M^3	Water	3.7[a4]	2[a4]
Powdered Milk	$M^{3/t}$	Water	0.03[1,2,3]-11.8[4]	8.7[4]
	$M^{3/t}$	Steam	0.091[1.2.3]	
Blue Cheese	$M^{3/t}$	Water	11.29[1,2,3]	
	$M^{3/t}$	Steam	0.353[1,2,3]	
Cheese	$M^{3/t}$	Water	8.5[1,2,3]-23[4]	20[4]
			9.1[6]	
	$M^{3/t}$	Steam	0.25[1,2,3]	
Whey	$M^{3/t}$	Water	8.3[6]	
Ice Cream	$M^{3/t}$	Water	0.88-2.5[a4]	1.9[a4]
Yoghurt	$M^{3/t}$	Water	4.24[1,2,3]	
	$M^{3/t}$	Steam	0.135[1,2,3]	
	$M^{3/t}$	Water	10.2[a4]	6.3[a4]
Butter	$M^{3/t}$	Water	1.5[a4]-6.37[6]	1.3[a4]

[a]An additional average specific water consumption (SWC) of 0.6 is be added to account for intermediate products water use.
Adapted from [1] Harris, D [31]; [2] North Carolina Cooperative Extension Service. [44]; [3] Bartholomai, A. [8]; [4] Steffen, Robertson and Kristen Inc., Consulting Engineers, [50]; [6] Environment Agency [23] cited in ([24], p. 11).

5.4.4 Dairy Industry in Different Climatic Zones of Rajasthan

Dairy industry is distributed across all the districts in the Rajasthan. Raw milk is collected from large number of villages, often from neighbouring districts as well and processed variously. Water is abstracted locally in the processing plant but milk products are often marketed not only within Rajasthan but also outside the State. The impact of dairy on water resources in different climatic zones cannot be readily assessed though the cattle population is larger in the drier zones.

5.4.5 Suitable Performance Indicators

The most important performance indicator will be the ratio of wastewater generated to the volume of milk processed. As the water requirement for CIP varies with the nature of the product, actual amounts of each product produced every day will be required to assess the water use efficiency.

5.4.6 Potential for Reuse of Effluents

The dairy (milk processing) wastewater has a high BOD due to organic matter derived from the milk, and chemicals used in cleaning, the wastewater can be easily used in agriculture after only primary treatment. Practically most of the water can be recovered through MVR technology and recycled within the industry. The milk processing units can also recycle a significant portion of the wastewater, particularly that from chilling, cooling and boiling operations. A reduction in the use of detergents and similar chemicals used in CIP will also help in reducing the water requirement.

5.4.7 Suggested Measures for Increasing Water Use Efficiency

The measures suggested for increasing water use efficiency in Milk Industry are as follows:

- Introduction of better chilling technology and cooling systems.
- Improvement in CIP to reduce water requirement.
- Recycling of used water within the unit.

5.5 BENCHMARKING IN BREWERIES & DISTILLERIES

5.5.1 About the Industry

Beverages include: beer, distilled spirits (high-proof), distilled spirits (low proof), wines, 100% juice, non-carbonated beverages, carbonated soft drinks, and bottled drinking water. These are often recognised as different kinds of industries - brewery, distillery, winery, or bottling - based on the primary process.

Water is used in beverage production and packaging (including water contained in the product), Cleaning/sanitizing processes, Cooling, Heating and Sanitation, besides Landscaping.

Production of alcoholic beverages is accounted as the actual volume of the product irrespective of the alcohol content. Hence, water consumption includes the water in the product itself.

As mentioned earlier, lots of water is used in various upstream processes which include agriculture (production of raw materials), flavour production, and production of other ingredients. These are not included in the estimation of water used by the beverage industries.

5.5.2 BREWERY: PROCESSES

For the purposes of the benchmarking study, a brewery may be defined as: *A facility conducting all processes after the malting process to produce beer (mashing/ lautering, boiling, fermenting, aging, and packaging).* Breweries generally conduct bottling operations on site; a small number may also ship product off site in bulk containers to a separate bottling facility. The grain used in brewery has to be malted first. Generally, malt preparation which also requires large volumes of water, is done separately in some units, and malt is then used in brewery. Water is used in a brewery unit largely for beverage production and packaging (including the water contained in the product), Cleaning/sanitizing processes, Cooling and Heating, beside domestic use.

The processes and the flow chart of water through the brewery industry are shown in Figure 5.3 and 5.4, using the example of UBL, at Bhiwadi (provided the Unit). The raw water (surface or ground water) withdrawn by the industry requires pre-treatment for reduction of TDS and pathogens, if any. Besides the amount of water consumed in the product itself, a large volume of water is required in cleaning/washing operations. Water used in boilers and cooling towers, RO rejected water and other waste water can be recycled after recovery through MEE.

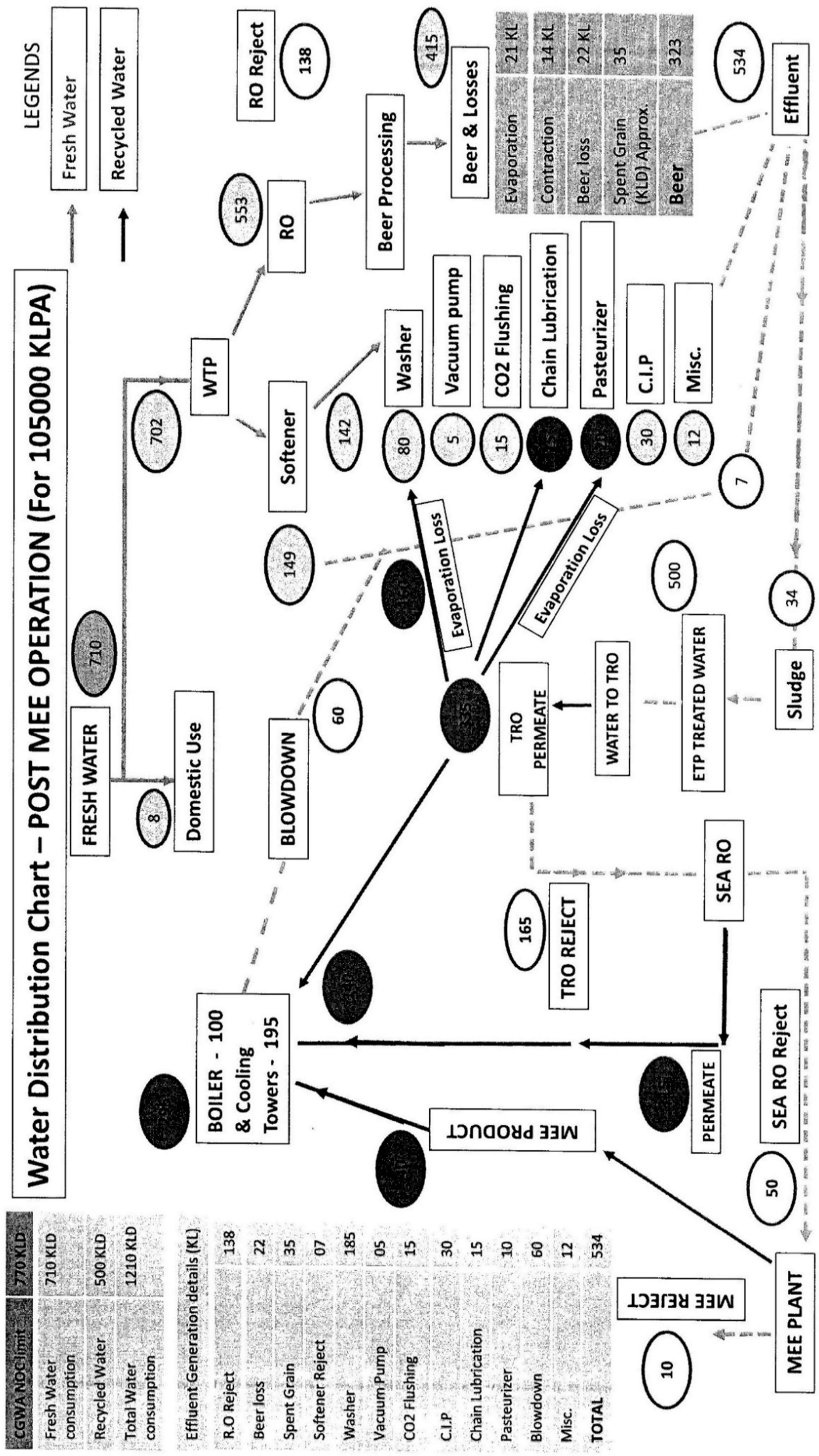


Figure 5.3: Flow chart of water in the Brewery. (courtesy UBL, Bhiwadi)

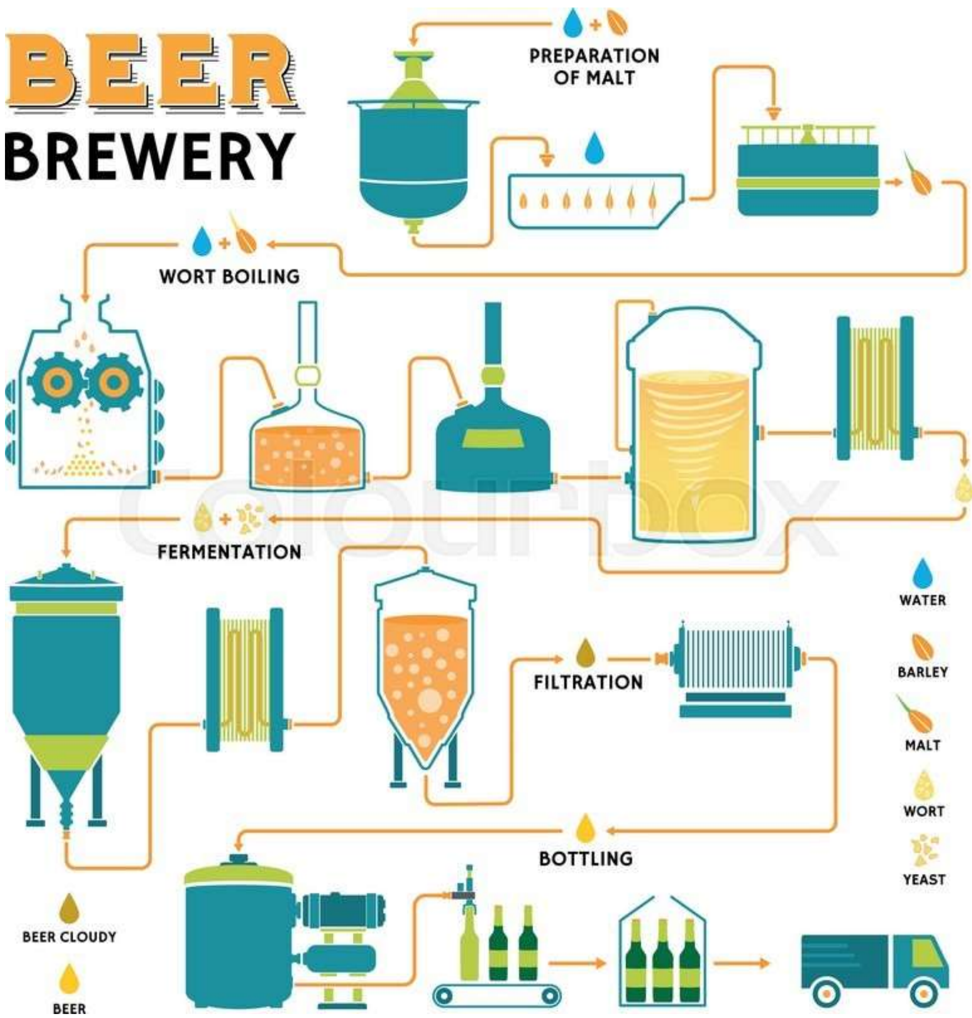


Figure 5.4: Flow of the processes in a brewery (from https://www.colourbox.com/)

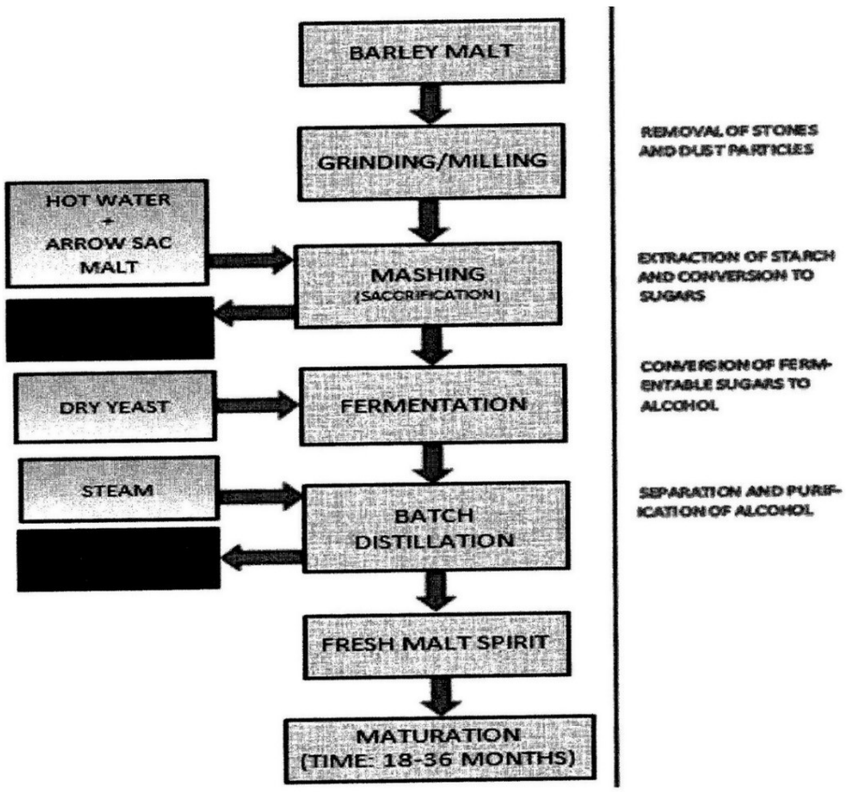
5.5.3 Distillery: Processes

For the purposes of the benchmarking study, a distillery is defined as: *Any facility that receives agricultural inputs (grains, molasses, etc.) and conducts processes (cooking, fermenting, distilling and storage/maturation, blending & bottling) to make bulk alcohol.*

Production volume at distilleries is reported as the bulk volume of alcohol produced at the facility independent of alcohol content. The basic processes involved in alcohol production are shown in Figures 5.5.

Alcohol content is also related to the water use ratio in distilleries. The spirits that result from the distilling process have a range of alcohol content; thus, a lower proof spirit has more water in the final beverage product than a high proof spirit. Additionally, due to transportation regulations and proximity to the bottling facility, some products are partially blended to a lower proof at the distillery.

Distilleries produce a wide variety of products, each of which can require a different number of manufacturing processes that can impact the total water use at the facility, including differences in the distillation process itself. Facilities that produce a single product or product-type, however, experience lower water use ratios than those facilities that produce more than one type of spirit, due to reduced cleaning requirements.

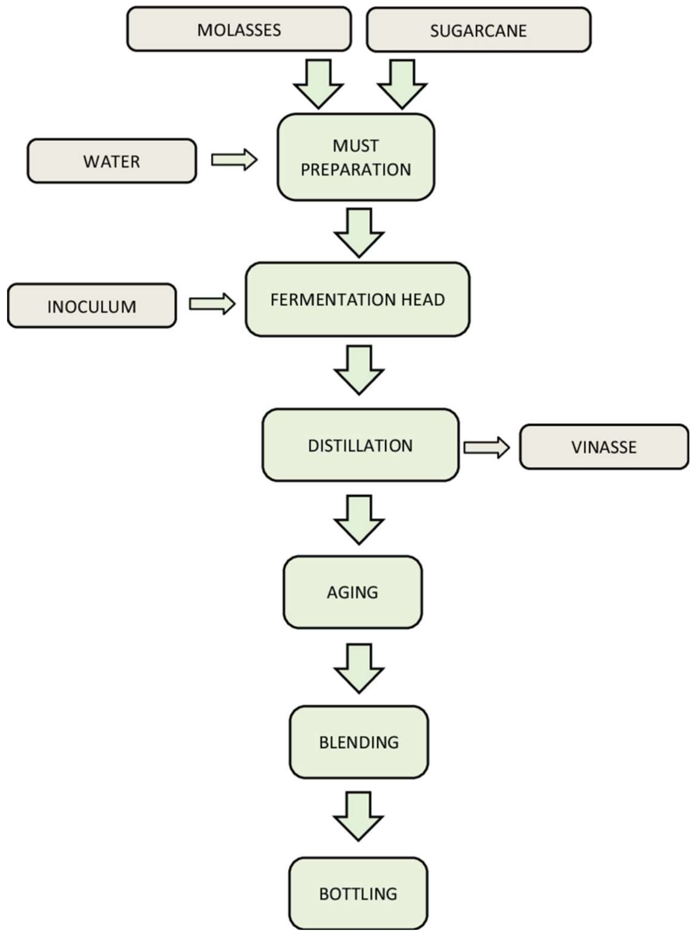


Fresh Malt Spirit (FMS) Production Flow Chart

Figure 5.5: Fresh Malt Sprit Production Flow Chart.

5.5.4 Winery

The winery processes include: *crushing and pressing of grapes, fermentation, storage/aging and bottling of the product.* Large range of water use ratios among different units result from the size of the unit, type of inputs used (concentrated juice, grapes or both); and the type/blend of product (red, white or sparkling wine). There is no winery in Rajasthan, and hence not discussed further.



Flow Chart for Rum Production

5.5.5 Brewery & Distillery in Rajasthan

There are only nine industrial units producing alcoholic beverages in Rajasthan:

1 Mount Shivalik Industries, Vill. Gunti, Distt. Alwar

2 Winsome Breweries, Vill. Sarekhurd, Distt. Alwar

3 Sab miller Unit Rochees Breweries, Vill. Neemrana, Distt. Alwar

4 United Breweries, Chopanky Alwar Chopanky Alwar

5 Devan Modern Breweries, Keshwana Kotpootly Jaipur Keshwana Kotpootly Jaipur

6 Calsberg India Pvt. Ltd., M. I. A. Alwar

7 Mahou India Private Limited (Arian Breweries & Distilleries Ltd.), Bhiwadi, Dist. Alwar

8 M/S United Breweries, Shahjahanpur, Behror, Alwar

9 Starlight Bruchem Limited, Village Sundni Distt. Banswara

5.5.6 Water Use by Breweries and Distilleries in Rajasthan

The data available for the few breweries and distilleries in Rajasthan are summarised in Table 5.6. The data exhibit very large variation. Even in case of bottling plants, large water consumption is claimed that is not justifiable. The water consumption in breweries and distilleries worldwide is highly variable (Table 5.7). In a detailed study, Oyebode and Adewumi (2014) reported on water consumption in breweries of Nigeria and some other African countries. They reported a value of 7.91 L/L for two Nigerian breweries and noted that "most breweries in Nigeria are still far from the accepted international best practice benchmark level of 6.5 L/L", whereas the best technology level is 4 L/L. They reported a water consumption of 9.0 to 22.0 L/L beer in Ethiopia, 7.4 to 9.5 L/L in Ghana and 7.3 to 9.0 L/L in Uganda. The 2017 Sustainability Benchmarking Report of the Brewers' Association in the USA reported, on the basis of a survey of 118 breweries, that the water consumption declined steeply with the increasing volume of beer production. During 2014 to 2016, they recorded a value of 4.52 to 4.96 L water use per Litre of beer.

Thus, the values for the industries in Rajasthan are generally within the global range (Table 5.8), but there is definitely much scope for reduction in water consumption through recycling. The quality of raw water abstracted by the industry is an important factor because the water has to be pre-treated and demineralised, leading to large wastewater generation. Recycling is however possible at most of the steps by carrying the wastewater to MEE or MVR evaporators.

Table 5.7: District wise Water Requirement in Breweries Industry

District	Product (KL)	Gross Water use KL	Net Water KL	Range of Production (KL)	Range of Gross Water use (KL)	No. of Industries
Rajasthan		**0.36**	**0.33**			**12**
Alwar		4.44	4.04			
	Beer	4.74	4.22	150 to 346	2.24 to 9.66	4
	Bottling of Scotch Whisky/IMFL	0.43	0.31	30	0.43	1
	Grain Neutral spirit Production	8.87	8.79	95.76	8.87	1
Banswara	Bottling of country and Indian made foreign Liquor	362.5	325	0.8	362.5	1
Jaipur	Beer	4.86	4.56	241.94	4.86	1
Kota						2
	Beer	1.45	1.25	684.93	1.45	1
	Bottling of Country Liquor	0.0	0.0	26400	0.0	1
Sirohi	Wine & Jam	8.27	8.27	362.67	8.27	1
Ganganagar	Rectified Sprit	10.33	9.17	30.0	10.33	1

We were informed that the UBL unit at Bhiwadi has achieved fairly high efficiency of water use as they use only about 2.6 L water per L of beer production. The benchmark can possibly be lowered still further.

Table 5.8: Global range of water use (L/L) in beverage industry and change with time.

Beverage	**Range of Water Use L/L**	**Mean**	**Range (2011)**
Brewery	3.26-7.44 (av. 4.74-4.28; 2008-10)	4.00	3.17-6.62
Distillery	9.11-63.6 (av. 22.10-21.86; 2008)	34.55	7.87-126.32
Winery	1.55-18.6 (av. 3.0-3.93l 2008)	4.74	1.99-18.48
Carbonated drinks	1.5-4.11 (2.28-2.11; 2008)	2.02	1.48-3.95
Bottled water	1.20-2.28 (1.53; 2008)	1.47	1.17-2.22

Source: Beverage Industry Environmental Roundtable (BIER): Water Use Benchmarking in the Beverage Industry. Trends and Observations, 2011

5.6 BENCHMARKING IN TEXTILES INDUSTRY

5.6.1 About the Industry, Industrial Processes and Products

FIBRES

The term ‘textile’ refers to any material made by interlacing of fibres. The fibres are categorised into *natural* (staple) fibres and *man-made* (synthetic) fibres. Natural fibres include *vegetable fibres* (e.g. cotton, jute, flax and hemp) and *animal fibres* (such as silk obtained from the cocoons of silk worms, and wool which comprises of hairs of different mammals, mainly sheep). *Man-made fibres* include natural-polymer regenerated *organic fibres* (viscose) and modified-cellulose fibres (made from wood or other natural sources of cellulose). *Synthetic organic fibres* are also made from chemical raw materials (from petrochemical industry) and include polyamide, polyester and polyacrylic fibres. Manmade fibres are produced by extruding polymer melt or solution through fine holes to forms long or short fibres. There are also natural mineral fibres (such as basalt fibres and asbestos) and man-made inorganic fibres (such as glass fibres and carbon fibres).

5.6.2 The Textile Industry

The textile industry starts from the production of fibres to their transformation into yarn, fabric and the finished goods. The major processes involved with cotton fibres, wool or synthetic fibres are shown in Figure 5.7. Textile industries based on man-made fibers differ from the cotton industries mainly in the processing of the raw material.

Staple fibres of cotton are turned into yarn through a series of processes such as ginning, blending, carding, combing, scouring, and spinning. Yarn is then converted into fabric through weaving or knitting. Dyeing is applied either to the yarn or the fabric. The fabric may then be printed in various colours and designs. The processes differ according to the nature of the fibre used and the end product.

The fabric manufactured after weaving or knitting, is known as grey (also called greige) fabric which has to pass through a wet processing before the finished product is obtained. The wet processing of grey fabric includes desizing, scouring and bleaching, singeing and mercerizing. These processes involve the use of several chemicals to remove natural impurities and chemicals used in yarn making, and requires several washings, rinsing and drying steps. Generally, the industries are separated into those manufacturing yarn and/or fabric, and those processing the fabric (mainly dyeing and printing). However, yarn is also dyed before turning it into fabric, mostly in the case of synthetic fibres.

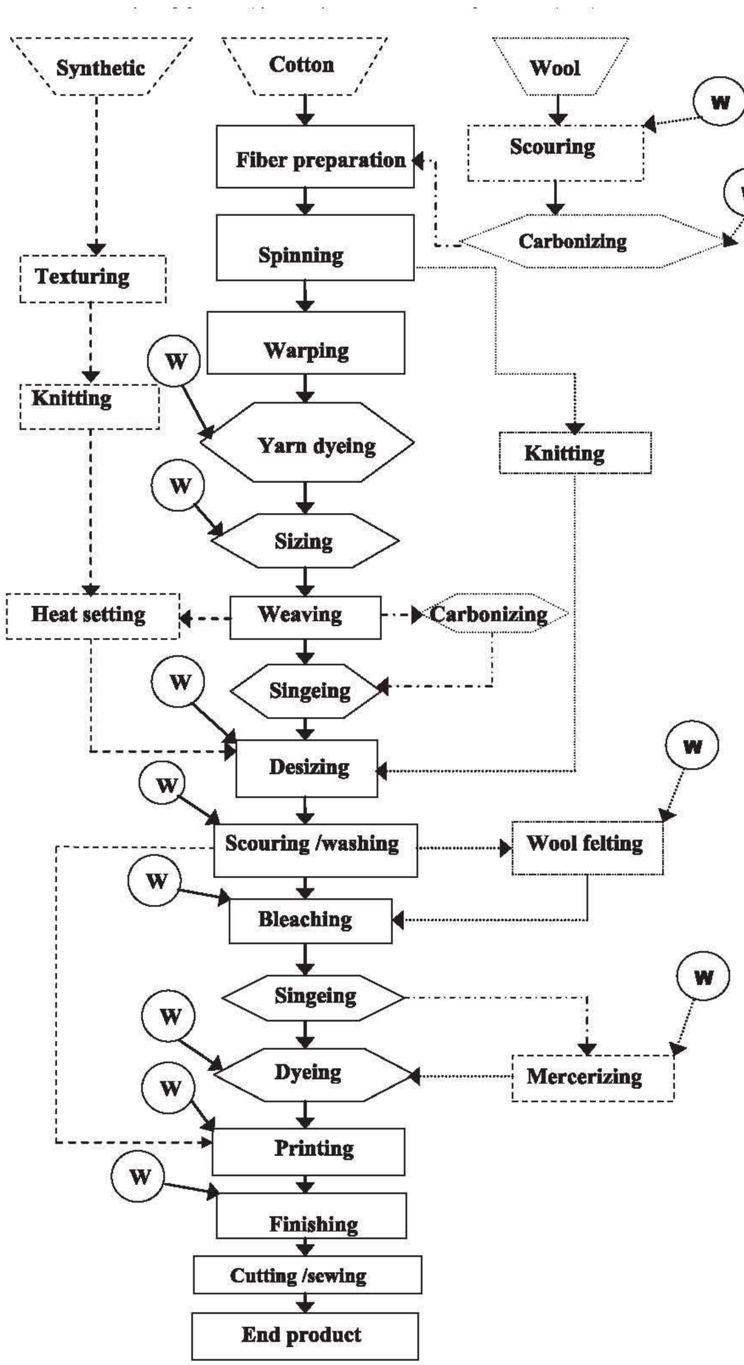


Figure 5.7: Flow chart of process steps in textile industry from fiber to finished fabric. (from Volmajer Valh et al. 2011)

Mention may be made here of Technical Textiles which are used primarily for their technical performance and functional properties rather than their aesthetic or decorative characteristics, in agriculture, engineering, medicine, etc. (Ministry of Textiles 2011). These are not considered here.

5.6.3 Water Use in Textile Industry

Water is required in practically all processes beginning with the making of yarn itself. A certain level of humidity has to be maintained during the manufacture of yarn and the fabric. Later, water is used in various wet processes mentioned earlier. The amount of water used varies widely in the industry, depending on the nature of yarn and fabric, various specific processes involved at the mill, kind of dyeing machinery and other equipment used, and prevailing management practices concerning water use. Examples of these variations are provided below from different sources in Tables 5.9 to 5.13. Wool and felted fabric processes are more water intensive than other processing subcategories such as wovens, knits, stock, and carpet. In the case of cotton, most of the industries are involved in processing the grey cloth.

Table 5.9: Water Consumption and Effluent Generation in Different Wet Processing Stages in Textile Industries (kl/100kg)

Activities	Water consumption		Effluent
	Variation	Average	Variation
Sizing/slashing	0.05-0.82	0.435	0.05-0.80
Desizing	0.25-2.1	1.175	0.25-2.10
Bleaching			
Yarn (hypochlorite)	2.4-4.8	3.6	2.25-4.60
Yarn (H_2O_2)	2.4-3.2	2.8	2.25-3.05
Cloth (hypochlorite)	4.0-4.8	4.40	3.80-4.60
Cloth (H_2O_2)	1.7-3.2	2.45	1.70-3.20
Mercerizing	3.6-17.0	10.6	3.50-17.50
Dyeing			
Yarn (light & medium shade)	3.60-4.80	4.20	3.50-4.70
Yarn (dark shade)	4.80-6.40	5.60	4.70-6.30
Yarn (very dark shade)	6.60-8.80	7.70	6.50-8.70
Cloth (light and medium shade)	7.80-9.60	8.70	7.70-9.50
Cloth (dark shade)	10.40-12.80	11.60	10.30-12.70
Cloth (very dark shade)	14.30-17.60	15.95	14.20-17.50

Source: Garrett et al. (2000)

Table 5.10: Amount of water used (L/kg) in textile wet processing

Fibre/Fabric	**Minimum**	**Median**	**Maximum**
Wool	111	284	658
Woven other	5	114	508
Knit other	20	83	378
Hosiery	6	69	289
Carpet	8	47	162
Tarn & Stock	3.4	98	556
Non-woven	2.5	40	82
Felted fabric	33	213	932

Source: from Smith 1987.

Table 5.11: Water use and liquor ratios of dyeing machines

Dyeing machine	**Water used** (L/Kg)	**Liquor: Goods ratio**
Continuous	167	1:1
Beck	233	17:1
Jet	200	12:1
Jig	100	5:1
Beam	167	10: 1
Package	184	10: 1
Paddle	292	40: 1
Stock	167	12:1
Skein	250	17:1

Source: (from Smith 1987)

Table 5.12: Specific water consumption in cotton textile mill in Turkey and other countries 8.- US-EPA, 9.- U.K., 10.- USA 11.- S. Africa

Processing subcategory	**Previous Studies**				**Present Study**
	8	**9**	**10**	**11**	
Sizing (1/kg Product)			0.5-7.8		3.9
Dyeing (1/kg Product)					
Continuous		9.4-63			22
Sulphur			24.2-213.6		23
Vat			8.4-166.9		21
Indigo Dyeing	8.4-50				21
Finishing (1/kg)					
Cotton woven fabric finishing				140	40
Woven complex processing	10.8-276.9				40
Total (1/kg product)	5-508				166

Source: from Alanya et al. 2006.

Table 5.13: Specific water consumptions and their distribution based on the wet processes in cotton/polyester dyeing industry.

Source of water consumption	**Specific water consumption**		
	Average Specific water consumption (min.-max)	**Unit**	**% of total water consumption (average)**
Raw water	97 (95-102)	(L/kg product)	100
Facility cleaning	5 (4-6)	(L/m^2-day)	2
Processes water	95 (93-100)	(L/kg product)	98
HT-over flow process	88 (85-90)	(L/kg product)	60
Pretreatment	30 (29-31)	(L/kg product)	18
Dyeing and finishing	66 (64-68)	(L/kg product)	42
Pad-batch process	61 (55-64)	(L/kg product)	22
Pretreatment	25 (22-26)	(L/kg product)	9
Dyeing and finishing	41 (37-43)	(L/kg product)	13
Steam generation	7 (6-7)	(L/kg product)	7
Ion-exchanger regeneration	9 (8-12)	(L/kg product)	10
Domestic usage	43 (28-45)	(L/person-day)	0.3

Source: Ozturk et al. 2014.

5.6.4 Textile Industry in Rajasthan

In Rajasthan, Krishna Mills in Beawar was the first textile mill set up in 1889. Until 1976, there were only 10 spinning and 7 composite mills in Rajasthan. Currently there are 63 textile mills of which 35 are spinning mills (11 cotton, 16 synthetic and 8 both cotton and synthetic yarn), 12 composite mills (3 cotton, 3 synthetic and 6 both) and 5 technical textile mills. However, 30 mills are closed (at present RTMA website).

However, dyeing and printing of cotton fabric have been, since centuries, among the most important industries in most of Rajasthan where several places have been famous for a specific imprint of their styles, colours, designs and processes, such as Bagru and Sanganeri prints, tie & dye, bandhani and kota-doriya fabrics.

Today, the textile industry of Rajasthan in concentrated in the districts of Jodhpur, Pali, Barmer, Bhilwara, Jaipur, Udaipur, Kota, and Banswara. Whereas industries for dyeing and printing of cotton fabric dominate in western Rajasthan and Jaipur, the textile mills in Bhilwara, Banswara and Kota are largely focused on man-made fibers (viscose & polyester) besides cotton and spinning. Some industries have also diversified into technical textiles. Traditional block printing is still practiced in several industries though on a small scale. According to a CPCB report (2016) to the Parliamentary Standing Committee for their visit to Udaipur & Mt Abu, textile processing units were operating in clusters and contributing lot of wastewater. These units are located at Pali (approx 551 units), Balotra (approx 400 units), Jasol (approx 69 units), Bithuja (approx 214 units), Jaipur (approx 250 units), Jodhpur (approx 227 units), Bhilwara (approx 35 units) and Bhiwadi (approx 05 units).

5.6.5 Water Use by Textile Industries in Rajasthan

Water use in textile industries varies greatly depending upon the material and the processes is different units. The Central Ground Water Board has listed textile Spinning, Dyeing and Printing separately under water-intensive industries. Spinning actually require a relatively small amount of water for maintaining some level of humidity. Dyeing and printing processes may occur together in the same unit or in separate units. According to the data collected from the RSPCB records of Consent to Operate, the textile industrial units may be grouped on the basis of their products as noted below:

A) Blended Synthetic Yarn Dyed
B) Bleached & Dyed Cotton
C) Dyed Bleached & Printed Cloth
D) Dyed Bleached, Printed Cloth & Finished Cloth
E) Mercerized Dyed & Finished Cloth
F) Printed Cloth
G) Processing of Synthetic Fabric
H) Woollen Yarn Dyeing & Weaving
I) Washed & Finished Cloth

5.6.6 Data Used in the Study of Textile Industries

A) We used only secondary data obtained from the records of the Rajasthan State Pollution Control Board. We surveyed the representative industries and discussed the subject with their management. They provided the same information that they regularly submit to the Board of the industries and related entirely to the wastewater discharge and pollution control measures. Any data on the quantities of raw materials and the products could not be obtained.

B) We analysed the data for water resource benchmarking according to these groups only in the absence of required information on water used in different processes.

C) In case of textiles, the amount of fabric processed yields the same amount of finished product. Therefore, the data are presented in terms of the amount of water abstracted per unit amount of fabric processed. We had to make several **assumptions** for the amount of fabric itself. In the first place, the fabric varies in its thickness (weight per sq. m) and also in its width. Second, the industries record the amount of cloth in terms of 'thaan' which varies in length from 80 to 120 meters (depending upon the thickness). In many cases the industries reported the material in terms of total length (meters). We therefore used an average value of 100 meters per 'thaan' and an average grammage of 60 g per meter of cotton fabric. In case of denims and polyester, the grammage is substantially higher (up to 200 g/sq. m). Therefore, the values of gross water use (abstracted) per ton of fabric processed can only be considered indicative of the water requirement for the purpose of comparison with the industries elsewhere in India or in other countries.

D) The data on gross water used in different textile industries was that of abstraction allowed to the industrial unit (at the time of consent). Because 90 to 95% of the water used in the textile industry is returned as wastewater for treatment (see Sharma 2015), and the rest is lost to evaporation, we did not examine the net consumption. This was also not possible because the water used for domestic purposes (mostly sanitation) was not segregated either at the stage of abstraction or as wastewater. The situation is further complicated by the fact that a few of the industries recycle some water within the industrial unit but maintain no record of it. We have, therefore simply recorded the fact of recycling and wastewater discharge to the ETP/CETP for the group on industries in each district (Table 5.6).

E) In several cases, the values of fabric processed or the water abstracted were unrealistic extremes(outlawyer). In a few such cases the data were ignored in computing the averages. It was practically impossible to verify all the values of water abstracted and wastewater generated (despite the CADA system being in place) but in some sample cases, these did not match with each other.

5.6.7 Range and Trend of Water Use in Textiles

In general, the data in Table 5.13 show a very wide range of variation in the kinds and amounts of fabrics processed as well as the gross amount of water abstracted. All industries depended practically entirely on the groundwater.

Our analysis of the data also reveal that larger industries abstracted relatively lesser amount of water and also generated less waste per unit of production. Similarly, some synthetic textile industries used less water and generated lesser wastewater. However, these data may not reflect the actual and accurate picture of water use because the data for actual production (fabric processed for individual process or processes) are not available, and the water abstraction figures represent the consent only. Quite a reasonable amount of monthly or seasonal as well as interannual variability is expected in both the production and water use. However, there are no available data on such variability and how the industries cope with it. These figures of water consumption are also not comparable with those of provided in the Environment Protection Rules 1986 [Schedule-VI (Part-B)] which permit quite high wastewater effluents from synthetic textile industries (120 m^3/ton for nylon & polyester and 150 m^3/ton for viscose rayon) though no values were given for cotton textiles.

5.6.8 Comparison with Textile Industries Elsewhere

All studies from different countries across the world have reported a very wide range of values of water used in the textile industries. There are a large number of factors responsible for such a variation some of which are mentioned above (see Tables 5.9-5.12). A study in India conducted by the UNIDO (Kumar et al. 1998, also UNIDO 1998) compared three different textile units in India with the Indian and US standards (Table 5.7). It records the existence of an Indian standard referred to by ATIRA (1989), However, we could neither find this publication nor the application of these standards in any industry in the country. The data presented in the UNIDO report also shows significant variation between industries. Our data for the industries in Rajasthan in Table 5.6, show that vast majority of them have a very low water use, whereas a few exceed the use by several times the so-called ‘standards’ or that reported in other countries. We ascribe it largely to the nature of the cotton fabric and the processes involved.

Table 5.14: Water consumption: assessment and comparison for Indian textile units [lit./kg-product]

Process stages	Indian Standards	USA Standards	Inventory [lit./kg]		
			Factory A	Factory B	Factory C
Desizing + scouring +					
Bleaching	27.00	NA	23.00	36.12	29.40
Mercerizing	20.00	NA	25.00	25.18	NA
Dyeing (continuous)	25.00	NA	9.00	29.94	30.00
Dyeing (discontinuous.)	100.00	NA	NA	NA	215.00a

Wet finishing + drying	NA	1.98	5.39		
Printing	80.00	NA	100.00	NA	NA
Other purposes[b]	NA	207.00	200.37	NA	
Total	**252.00**	**276.9**	**365.98**	**297.50**	**274.40**

Notes: (adapted from Diebaecker 2000, based on UNIDO 1998) See ATIRA et al. (1989), US EPA (1997). NA: not applicable; A Includes water used for ``other purposes''; B Includes water used for purposes not related to the process stages.

5.6.9 Process-Wise Water Requirement in Textile Industry

Several publications refer to the proportion (% of total) of water used in different processes but these are general estimates and not the monitored values. In India, recently Dr D.K. Sharma of HP State Pollution Control Board, Shimla (Sharma 2015) reported on the water consumption (abstraction only) and waste generation in each process in two cotton textile industries – one making yarn and the other processing fabric (place not disclosed). He reported an annual average volume of water abstracted to be 127.6 KL per ton for yarn (including dyeing) and 118.2 KL per ton of fabric, along with some seasonal variation. He reported 40-47% water consumption is in pre-treatment processes scouring & bleaching, neutralization, mercerisation and washing), 41-43% in dyeing and washing process and 12-17% in finishing stage, but again did not specify the water use for each individual process.

5.6.10 Textile Industry in Different Climatic Zones of Rajasthan

The available data do not exhibit any clear difference between the water used by textile industries for the same kind of fabric and similar processes in different districts/climatic zones. However, the concentration of textile industries in the western arid zone and semi-arid zone (Pali, Barmer, Jodhpur, Jaipur) itself reflects excessive pressure from this industry on the groundwater resources. Most of the groundwater blocks in the districts with high concentration of textile industries are already listed among the over-exploited and notified blocks. Also, the groundwater in these areas has higher salinity, and high chloride and fluoride concentrations.

A study made in village Jasol (Barmer) in Rajasthan (Garrett et al., n.d.) and another study from Haryana with similar semi-arid conditions (Restiani and Khandelwal 2016) focus on wastewater treatment and governance issues respectively, without touching upon the need for reduction in water use and improving water use efficiency.

5.6.11 Potential for Reuse of Effluents

Textile industry is not listed in the EIA notification of 2006 or even the Draft EIA notification 2020, thereby setting up a textile unit does not require environmental clearance. However, the yarn/ textile processing involving any effluent/emission generating process, bleaching, dyeing, printing and scouring are categorised as RED, and those without emissions are categorised as Orange, in relation to their pollution load. The textile industry effluents are characterised by very high TDS, high COD and SAR, as well as moderately high BOD. The use of caustic soda, a variety of other chemicals including acids, and dyes are the main factors governing the effluent characteristics. Even after treatment, the TDS remains very high.

There are several technological developments which allow for the recovery of caustic soda and lower requirement of other chemicals and dyes. There is enough scope of recycling wastewater within the industrial units.

Available technologies such as Multiple Effect Evaporation (MEE) and Mechanical Vapor Recompression (MVR) can eliminate the need for conventional effluent treatment followed by the RO systems. These are already in use, and should be promoted in all textile units. MVR Evaporator is currently the lowest energy consumption technology. A large proportion of wastewater can be recovered as a good quality water for reuse.

Combined use of caustic recovery system, employing more efficient dyeing technology, and MVR can reduce the pollution load as well as the pressures on water resources.

5.6.12 Suggestions for Increasing Water Use Efficiency in Textile Industry

- Dyeing is a major wet process requiring large amounts of water. Studies show that the use of bio- or nature-based biodegradable materials for bio-polishing, enzymatic desizing and bio-scouring will help reduce pollution and water use.
- Use of advanced dyeing and washing machinery and technologies can save lot of water.
- Recycling of wastewater at different process steps is the most desirable and cost-effective measure.

Table 5.15: District wise Process wise Water Abstraction by Textile Industry (Data from Consent Applications to the RSPCB)

District	Products	Gross Water use KL/ton	Effluent Generated- No. of units	Recycled by No. of units	Range of Production (ton)	Range of Gross Water use KL/ton	Number of Industries	Industries with no Data on water
	Textile						991	
Alwar		**10.29**					**10**	
	Synthetic Yarn	5.26	E-2	R-1	5.45 to 45.2	0.02 to 13.76	3	
	Cotton Yarn	24.67	E-1	R-1	80.5	24.67	1	
	Dyed Finished Fabric	6.8-21.05	E-2	R-1	2.5 to 6.5	6.8 to 21.05	2	
	Mechanized Laundry	5.90	E-1	R-1	14.23	5.90	1	
	Suiting Cloth (Weaving)	1.00			1.50	1.0	1	
	Hosiery	27.27	E-1	R-0	0.02	27.5	1	
	Textile Dyeing &Printing	0.42	E-1	R-1	60	0.42	1	
Banswara		**92.3**					**5 ***	
	Fabric Processing /Dying	122.8	E-2	R-3	7.97 to 276.0	9.26 to 236.5	2	
	Denim Fabric	172.22	E-1	R-1	9	172.22	1	
	Cotton Spun Yarn/ Synthetic Blended Yarn/Synthetic Blended Fabric	2.73	E-1	R-0	53.04	2.73	1	
	Dyeing Fibre Yarn	40.61	E-1	R-1	39.40	40.61	1	
Barmer		**62.14**					**330**	
	Dyed, Washed, Bleached, Padded Cloth /Fabric	87.63	E-6	R-2	0.1 to 9.0	13.89 to 215.69	6	
	Dyed, Printing and Finished Cloth	37.13	E-6	R-3	2.40 to 9.60	11.25 to 97.37	6	
	Dyeing of Cloth	35.58	E-37	R-11	0.90 to 18.0	4.0 to 133.33	37	
	Dyeing and Printing Cloth	22.18	E-11	R-2	1.50 to 15.00	15.36 to 42.78	11	
	Finished Fabric	56.55	E-89	R-83	0.20 to 15.0	10.83 to 650.0	91	5
	Dyed Washing, Mercerizing, Finishing Cloth	74.12	E-175	R-32	0.36 to 4.50	6.06 to 229.0	175	
	Printed and Washed Cloth	12.88	E-4	R-0	3.0 to 36.0	1.81 to 20.0	4	

Bhilwara		**268.38**					**31**	
	Processing of Synthetic Fabric	480.63	E-14	R-13	0.22 to 66.67	3.97 to 4704.55	16	
	Sized Yarn	9.93	E-10	R-6	0.83 to 420.17	1.30 to 37.06	12	
	Denim Fabric	5.6	E-1	R-1	5.6	66.67	1	
	Surgical Cotton	11.88	E-1	R-1	0.8	11.88	1	
	Woollens Yarn / Tops	18.11	E-	R-1	9.0	18.11	1	
Chittorgarh	Dyeing &Weaving of Cloth	**80.56**	E-1	R-1	1.80	80.56	**1**	
Dholpur	Carpets Durries, Bathmats &home furnishing (Per Piece)	17.52	E-1	R-0	428	17.52	1	
Jaipur		**138.54**					**27**	**2**
	Dyed Woollen Yarn	16.0 to 30.0	E-2	R-1	0.5 to 1.5	16.0 to 30.0	2	
	Sewing Thread	14.0	E-2	R-0	0.03	14.0	1	
	Napkin Face towels	26.0	E-1	R-1	1.0	26.0	1	
	Carpet Weaving & Processing	116.67 to 147.93	E-2	R-2	0.09 to 0.12	116.67 to 147.93	2	
	Coated Textile Fabric	58.67	E-1	R-1	1.44 to 1.50	58.67	2	1
	Cotton Fabric Cloth	62.50 to 481.48	E-2	R-1	0.01 to 0.12	62.50 to 481.48	2	
	Dye & Printed Cloth	252.62	E-4	R-2	0.03 to 1.20	58.33 to 500.0	4	
	Made-up & Garments	140.66	E-6	R-4	1.35 to 41.25	106.02 to 171.35	6	
	Printing Dyeing Fabric	28.83 to 250.00	E-2	R-1	1.0 to 4.0	28.83 to 250.00	2	
Jhalawar	Blended Synthetic Yarn Dyed	4.53	E-0	R-0	85.0	4.53	**1**	
Jodhpur	Printed Cloth	258.84	E-0	R-0	**0.06 to 6.0**	**7.33 to 808.8**	**147**	**11***
Pali		**65.25**					**429**	**14***
	Bleach Dyed and Printed cloth	74.62	E-39	R-2	1.71 to 15.4	15.2 to 326.39	39	1

	Cotton Cloth/ Fabric	85.65 to 117.42	E-2	R-0	0.13 to 0.18	85.65 to 117.42	2	
	Desized Dyed Printed & Finished Cloth	76.33	E-5	R-0	0.42 to 1.80	2.22 to 222.22	5	
	Dyed Printed Cloth	76.5	E-85	R-3	0.12 to 51.0	0.24 to 723.38	86	3
	Dyed, Mercerized Printed Cloth	66.67 to 190	E-2	R-0	0.28 to 0.75	66.67 to 190	2	
	Dyed, Finished Cloth	48.73	E-58	R-0	0.18 to 16.32	7.62 to 196.1	58	
	Finished Cloth	28.15	E-12	R-1	0.14 to 12.0	0.25 to 170.37	13	
	Mercerized Bleached Desized; Washing Printing and Finishing	51.55	E-124	R-0	0.18 to 18.0	3.33 to 231.67	125	
	Printed Cloth	85.54	E-92	R-0	0.02 to 42.0	0.33 to 666.67	92	
	Synthetic Fabric Processing	243.11	E-0	R-0	6.79	243.11	1	
	Washed & Finished Cloth	22.8	E-4	R-1	1.20 to 4.20	7.92 to 33.33	4	1
	Cotton Blended Yarn/Fabric	21.85	E-1	R-0	100.70	21.85	1	
Sirohi	Blended Synthetic Yarn Dyed, Blended Synthetic Yarn Gray	54.22	E-0	R-0	0.46	54.22	**1**	
Udaipur		**3.66**					**3**	
	Synthetic Polyester & Viscose	0.06	E-0	R-0	6000	0.06	1	
	Cotton Sewing Thread	0.25	E-0	R-0	450	0.25	1	
	Synthetic Fibre Dyeing	10.65	E-0	R-0	65.70	10.65	1	

- These industries were excluded from the computation because either there was no data or the values were at extremes and hence ignored as outliers.

5.7 BENCHMARKING IN THERMAL POWER PLANTS

5.7.1 Thermal Power Industry and Water Use

There is strong nexus between water and energy. We need energy every day for all our activities. Industries are among a major user of energy, even if they do not use water. Energy is required to make use of water - abstracting surface or ground water, pumping of water supplied to different users, for irrigation, and for treatment of raw water or wastewater, etc.

However, most of the energy, except solar and wind energy to a great extent, is also generated by using water. Out of the total electricity generation in India, more than 80 percent is generated from thermal power plants (CEA 2017). The generation of thermal power requires steam to drive the turbines. The steam is generated by heating water using a variety of fuels (coal, gas, refined oils, biomass, and nuclear material). While the steam is cooled down and condensed into water that is usually used again, a much larger volume of water is required for cooling the system. Coal-based thermal power plants are among the oldest sources of electricity, and even today provide about The hydropower generation where the potential energy of water is exploited to run the turbines in the power house by storing huge volumes in a reservoir behind a dam, and then transferring it through penstocks to the turbines, constitutes only about 12% of the total power produced in India. According to the Ministry of Power (Government of India), as on 31 July 2020, thermal power generation accounted for 62.2% of the total electricity, and the coal-based energy was 86.3% of the total thermal power (or 53,3% of the country's total energy (https://powermin.nic.in/en/content/power-sector-glance-all-india).

Most of the thermal power plants (TPPs) use freshwater from dam reservoirs, rivers and canals though some of them located near the sea coast use on sea water. Beside the water 'consumed' for steam production, and the water used in cooling, several other processes within a TPP require fairly large volumes of water, such as that for handling coal and ash, in demineralization plant, firefighting, and domestic needs of the staff and workers. The consumptive water requirement (steam production) for old thermal power plants with cooling tower is reported to be about 8-9 cu.m (=KL) per MWh. Cooling and ash handling are the major processes requiring water of which cooling alone may account for 80-90% of the total water requirement, especially in coal-based TPPs. The Central Electricity Authority has discussed in their 2012 report, various aspects of water use in coal based TPPs and steps to minimise it, focusing especially on the cooling technology.

There are three types of cooling systems:

a) **Once through cooling system (OTC):** Water is withdrawn from the source and run once through the power plant to cool down the steam. The heated water is then discharged back to the source. This requires a very high amount of water withdrawal from the source, and causes thermal pollution in the water bodies resulting in severe impacts on biota.

b) C**ooling towers (CT):** In this system, the hot water is cooled and stored in a reservoir. Then it is pumped again to the condenser for condensing the steam from the turbine.

c) **Dry cooling system:** The steam is condensed in air cooled condenser

The water withdrawals and consumption coefficients of various kinds of TPPs and the cooling technologies used are given in Table 5.16. The choice of cooling technology has a significant impact on the power generation and the CAPEX requirement. The lesser the water withdrawal, the higher is the cost of the technology, as well as the efficiency penalty on power production. Dry cooling technology reduces the power production by 7-8 percent.

Based on the data on wastewater discharge published by the Central Pollution Control Board [CPCB] in "Water quality in India (status and trends) 1990-2001", the Centre for Science and Environment (2004) estimated that the thermal power plants account for about 88% of all the water used in the industries in India. However, comprehensive information on the water use by the power plants in India is not readily available in public domain. Recently, Luo et al. (2018) have reviewed the water consumption in India's TPPS and highlighted the issues concerning water availability in water-stressed regions. The report observes that 50% of the TPPS are located in India's most water stressed regions.

Table 5.16: Water withdrawal* and consumption coefficients for various TPPs

Fuel	**Cooling technology**	**Water withdrawal (m3/MWH)**	**Water used (m3/MWH)**
Coal (Conv. Pul.)	OTC	216	1.6
	CT	3.8	2.6
Refined liquids	CT	4.6	3.13
Gas	CT	1.62	1.1
Biomass	CT	4.35	2.75
Nuclear	OTC	242.7	1.5
	CT	6.42	3.8
	CSP	2.67	2.67
	PV	0.1	0.1
Geothermal		6.8	6.8

* Water withdrawal is the total amount of water that is abstracted from a surface- or groundwater source, whereas consumption is the amount of water that is not returned to the water source (the rest may be lost in evaporation or returned as wastewater).

In 2015, the Ministry of Environment, Forests and Climate Change (MOEF-CC), issued a notification dated 7th December 2015, which amended the environmental norms for the coal-based TPPs and specified modified limits for specific water consumption by TPPs. The notification insists to convert existing once-through based condenser cooling (OTC) system to recirculation type. The notification requires that:

1 All plants with Once Through Cooling (OTC) shall install Cooling Tower (CT) and achieve specific water consumption up to maximum of 3.5 m3 /MWh within a period of two years from the date of publication of notification.

2 All existing CT-based plants reduce specific water consumption up to maximum of 3.5 m^3 /MWh within a period of two years from the date of publication of notification

3 New plants to be installed after 1st January 2017 shall have to meet specific water consumption up to maximum of 2.5 m^3 /MWh and achieve zero waste water discharged.

However, in October 2017, the government relaxed these norms for even plants that started operations on or after January 1, 2017, by an amendment to the Environment (Protection) Rules, 1986, that allows the TPPs to use up to 3 cu.m per MWH.

Also, worth attention is the STATEMENT made by the Hon'ble Minister for Power in the Rajya Sabha on 10.04.2017 regarding thermal power plants in water scarce areas:

"Coal based Thermal Power Plants are set up keeping in view the availability of land, water, fuel etc. Allocation of water for Thermal Power Projects is done by Water Resources Department of the concerned State Government, where the project is located after due diligence, taking into consideration various requirements, such as drinking water, other human needs and irrigation / agricultural requirement etc. of the State."

"Government of India has notified new Tariff Policy on 28.01.2016 wherein it is mandated that the thermal power plant(s) including the existing plants located within 50 km radius of sewage treatment plant of Municipality / local bodies / similar organisation shall, in the order to their closeness to sewage treatment plant, mandatorily use treated sewage water produced by these bodies and the associated cost on this account be allowed as pass through in the tariff."

5.7.2 Thermal Power Plants in Rajasthan

In Rajasthan, there are 56 TPPs which are based on coal, oil, gas, biomass and uranium. While most of the biomass, oil and gas-based power plants use cooling towers, the coal-based TPPs and a nuclear power plant use once through cooling (OTC) system. The water withdrawal and use per unit power generated as well as per unit fuel used, based on the data obtained the records of the RSPCB, are summarized in Tables 5.17 and 5.18.

Table 5.17: Fuel-wise Water Requirement in Power Industry in Rajasthan

Fuel for Power	Gross Water KL/MW	Net Water use KL/MW	Range of Production (MW)	Range of Gross Water use (KLD)	Number of Industries
					56
Biomass	64.64	63.55	4.8 to 20	4.58 to 218.40	17
Coal	269.41	54.56	1.3 to 2800	0.0 to 4801.30	23
Coal+ LDO, HDO	79.33	83.44	125 to 1320	63 to 108.29	6
Natural gas	12.25	9.97	110 to 1000	0 to 45.15	5
Natural uranium	84.42	44.42	220 to 1400	0.80 to 153.60	5

Table 5.18: Water Requirement (KL/MWH) in Power Industry using different fuels

District	Fuel used	Gross Water use, KL	Net Water use KL	Range of Production (MW)	Range of Gross Water use (KLD)	No. of Industries
	Power					**56**
Ajmer	**Pet Coke**	5.71	0.0	368.2	5.71	1
Alwar	Biomass	193.33	185.33	7.5	193.33	1
Baran		**56.57**	**59.41**			**8**
	Biomass	95.88	95.00	8.0	11.63 to 180.13	2
	Coal	52.16	57.06	250. to 1320.0	29.95 to 69.58	5
	Natural gas	0.0	0.0	330.0	0.0	1
Banswara		**4.33**	**4.33**			**3**
	Biomass	13.0	13.0	6.0	13.2	1
	Coal	0.0	0.0	1320.0 to 2800.0	0.0	2
Barmer	**Lignite**	80.40	69.92	125.0	80.40	1
Bikaner		**94.97**	**83.61**			**2**
	Lignite	94.97	83.61	135.0 to 250.0	81.64 to 108.29	2
Bundi	Natural gas	0.0	0.0	1000.0	0.0	1
Chittorgarh		**84.42**	**44.42**			**5**
	Natural Uranium	84.42	44.42	220.0 to 1400.0	0.80 to 153.0	5
Dausa	Biomass	25.63	16.25	8.0	25.63	1
Dholpur		**39.85**	**59.33**			**2**
	Coal	34.55	24.36	330.0	34.55	1
	Natural gas	45.15	37.97	330.0	45.15	1
Ganga Nagar		**132.59**	**120.88**			**8**
	Biomass	169.32	173.08	7.8	169.32	1
	Coal	133.06	116.80	1.2 to 250.0	108.0 to 258.0	6
	Coal LDO/HFO	93.18	93.18	1320.0	93.18	1
Hanumangarh	Biomass	10.70	11.30	10.0	10.70	1
Jaipur	Biomass	111.49	107.52	4.8 to 7.5	4.58 to 218.40	2
Jaisalmer	Natural gas	8.05	7.44	110.0 to 160.0	6.56 to 9.55	2
Jhalawar		**45.66**	**45.55**			**2**
	Biomass	23.20	23.20	10.0	23.20	1
	Coal LDO/HFO	68.10	67.90	1200.0	68.10	1
Kota		**987.28**	**28.40**			**5**
	Biomass	21.25	23.50	8.0		1
	Coal	1228.8	29.62	17.5 to 330.0	14.91 to 4801.3	4

Nagaur		**23.75**	**23.67**			**2**
	Biomass	18.0	18.0	10.0	18.0	1
	Coal	29.49	29.34	59.0	29.49	1
Pali	**Coal**	49.17	49.78	1.13 to 41.0	49.17	4
Sawai Madhopur	Biomass	15.42	16.17	12.0	15.42	1
Sirohi	Biomass	10.80	10.80	20.0	10.80	1
Tonk	Biomass	61.21	61.59	8.0	61.21	3

The data for the TPPs in Rajasthan clearly show that their water abstraction is very high. The WRI report (Luo et al. 2018) also reports that Rajasthan's TPPs have the second highest freshwater withdrawal intensity (74.4 cu.m/MWH) in the country, after Madhya Pradesh (83.8 cu.m/MWH).

From the viewpoint of benchmarking, it must be pointed out that the CEA and MOEF-CC have issued norms only for cooling water. As of July 2019, according to a RTI-based report, several steps had not complied with the norms either partly or fully (https://www.manthan-india.org/wp-content/uploads/2019/07/Water-Use-Norms-Violations-FINAL.pdf). Interestingly, Rajasthan did not respond to RTI query.

Further, the norms do not consider the withdrawal of water for purposes other than cooling. A significantly large amount of water is required for the disposal of fly ash in coal-based TPPs. Although, the practice is being phased out, and the fly ash is used mandatorily used in cement industry, the problem remains to be completely eliminated.

Finally, the water consumption in TPPs can be brought down still further by recycling the cooling water and switching the cooling technology to dry cooling.

5.8 BENCHMARKING IN CEMENT INDUSTRY

5.8.1 The Industry and Manufacturing Process

Cement is a material required in construction industry. Cement is a mixture of compounds comprising mainly of silicates and aluminates of calcium, formed out of lime, silica, and oxides of iron and aluminium as raw materials. It is a binder used to bind sand and gravel (aggregate) together. Cement mixed with sand forms mortar for masonry work, or with sand and gravel forms concrete. India is the world's second largest producer of cement and employs in general the latest technologies. Cement industrial units are largely located in areas with rich limestone deposits, especially in Andhra Pradesh, Madhya Pradesh, Gujarat, Rajasthan, Karnataka, Chhattisgarh and Tamilnadu.

The process of cement manufacturing starts with mining of raw materials such as limestone, gypsum and iron ore. It is followed by their transport to the cement plant, where they are crushed and ground in a grinding mill, blended and calcined at high temperatures in a kiln to obtain a pre-product (clinker). Th clinker is milled again with gypsum and other additives such as fly ash to obtain cement.

The cement manufacturing may follow a dry process (dry grinding of the raw materials into a fine powder) or a wet process (raw material is ground in water to form a slurry which may then be dried or fed directly into a kiln). Some industries use an intermediate semi-dry or semi-wet process (IL&FS Ecosmart 2009). The main processes in cement production are shown in Figure 5.8.

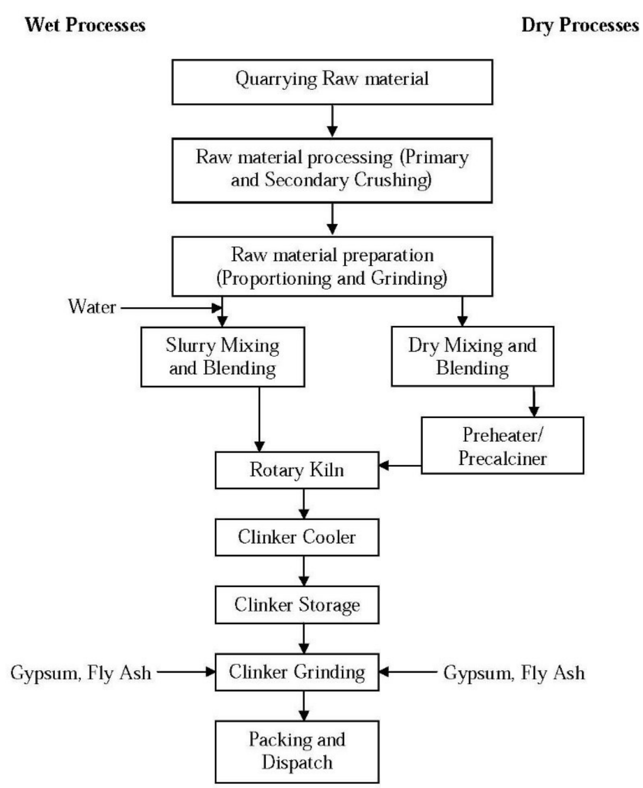


Figure 5.8. Flow diagram of processes in cement production

Water is used at a number of stages during the production and its amount varies according to the process followed in the industry. process. In some cases, water is used for the preparation of raw material, in making clinker and its burning and cooling processes, such as the cooling of gases, as well as in the technological process for slurry production. In the semi-dry process, water is used for pelletising the dry raw meal. Plants using the wet process use more water (per tonne of cement produced) in preparing the kiln feed slurry. Water is also used for clinker cooling. A major requirement of water is for dust suppression during mining and crushing of the raw materials. The kiln dust is now precipitated, and sometimes recycled. Cement is also an energy intensive industry, and usually a captive power plant is associated with it, demanding water for power generation. The fly ash generated from the power plants is also now consumed by the cement plants, thereby eliminating or significantly reducing the demand on water for its disposal.

Water required in the cement industry is abstracted from a nearby river or water body or the ground water. Rainwater is also harvested in the mine quaries, alhough in many cases the mining pierces through the aquifer itself.

5.8.2 Cement Industry in Rajasthan

Rajasthan being rich in limestone has a large number of cement producing units. There are at least 43 units spread across 11 districts in the state. The oldest cement plant in Rajasthan was set up at Lakheri (Bundi district) during 1912-13. The Department for Promotion of Industry and Internal Trade (DPIIT) of the Ministry of Commerce & Industry, has developed a Cement Information System where the list of cement industries in India is regularly updated.

We analysed the water use in various industries in Rajasthan based on their reported ground water abstraction and the installed production capacity (Table 5.19). These exhibit large variation – from 0.02 KL/ton to 0.54 KL/ton of cement. These values are nearly similar to those reported elsewhere (Selvaranan et al. 2017) but do not reflect the actual water consumption of the cement industry for several reasons. Some industries fully exploit the rainwater accumulated in the mine pits whereas some receive supplies from PHED as well. Some of the larger industries have also developed large colonies for their staff and report complete reuse of treated wastewater. Recycling of blowdown water from the boilers is also reported. Some industrial units report a fairly high requirement for dust suppression, and green belt development. Flow chart of water within a typical cement industry (as provided by the industry itself) is reproduced in Figure 5.9. The available data show that very high volumes of water are used by the cement industry but no water is returned or discharged. The high rate of water consumption is attributable to dust suppression and cooling whereas relatively small amounts of water are actually used in the process and that too are lost to evaporation. Some cement industries have their captive power plants and they do not segregate the water use between the cement industry, domestic use and the power generation, besides the horticultural operations.

Water consumption in the cement industry can be reduced significantly by employing dry process for clinker production, and advanced air cooling systems. Domestic wastewater can be safely used after treatment for dust suppression

Table 5.19: District wise water use in cement industry in Rajasthan

District	Product	Gross Water use, KL	Net Water use, KL	Range of Production Tons/day	Range of Gross Water use (KL)	No. of Industries
	Cement Industries					43
Ajmer		**0.11**	**0.11**			**4**
	Synthetic Gypsum	0.35	0.35	1350	0.35	1
	Cement, Clinker	0.04	0.0	10000 to 12700	0.04	2
Alwar		**0.02**	**0.02**			**10**
	Ordinary Portland Cement	0.04	0.04	50 to 150	0.0 to 0.22	5
Bundi		**0.02**	**0.13**			**2**
	Cement	0.05	0.11	5000	0.05	1
	Fly Ash	0.0	0.0	650	0.0	1
Chittorgarh		**0.07**	**0.07**			**6**
	Cement, Clinker	0.02	0.02	5152 to 21212	0.02 to 0.05	4
	Clinker	0.16	0.16	7576 to 10606	0.08 to 0.25	2
Dausa	Cement (Clinker Grinding)	**0.0**	**0.0**	**50**	**0.0**	**1**
Jaipur	Cement (Clinker Grinding)	**0.03**	**0.02**	**5797**	**0.03**	**1**
Jodhpur		**0.15**	**0.15**			**1**
	Cement, Clinker	0.15	0..15	7182	0.15	1
Kota		**0.63**	**0.60**			**3**
	Fly Ash	1.74	1.64	150	1.74	1
	Cement, Clinker	0.08	0.08	7658 to 10586	0.08 to 0.54	2
Nagaur		**0.23**	**0.24**			**3**
	Cement, Clinker	0.54	0.57	2040	0.54	1
	Cement	0.08	0.08	50	0.08	1
	Ordinary Portland Cement	0.08	0.08	22727	0.08	1
Pali		**0.07**	**0.07**			**9**
	Synthetic Gypsum	0.37	0.37	1560	0.37	1
	Cement	0.07	0.07	1435	0.0 to 0.14	2
	Cement, Clinker	0.01	0.01	10013 to 16232	0.0 to 0.01	2
	Clinker	0.04	0.05	1014 to 4348	0.0 to 0.10	3
Udaipur	Cement, Clinker	**0.0**	**0.0**	**14321**	**0.0**	**1**

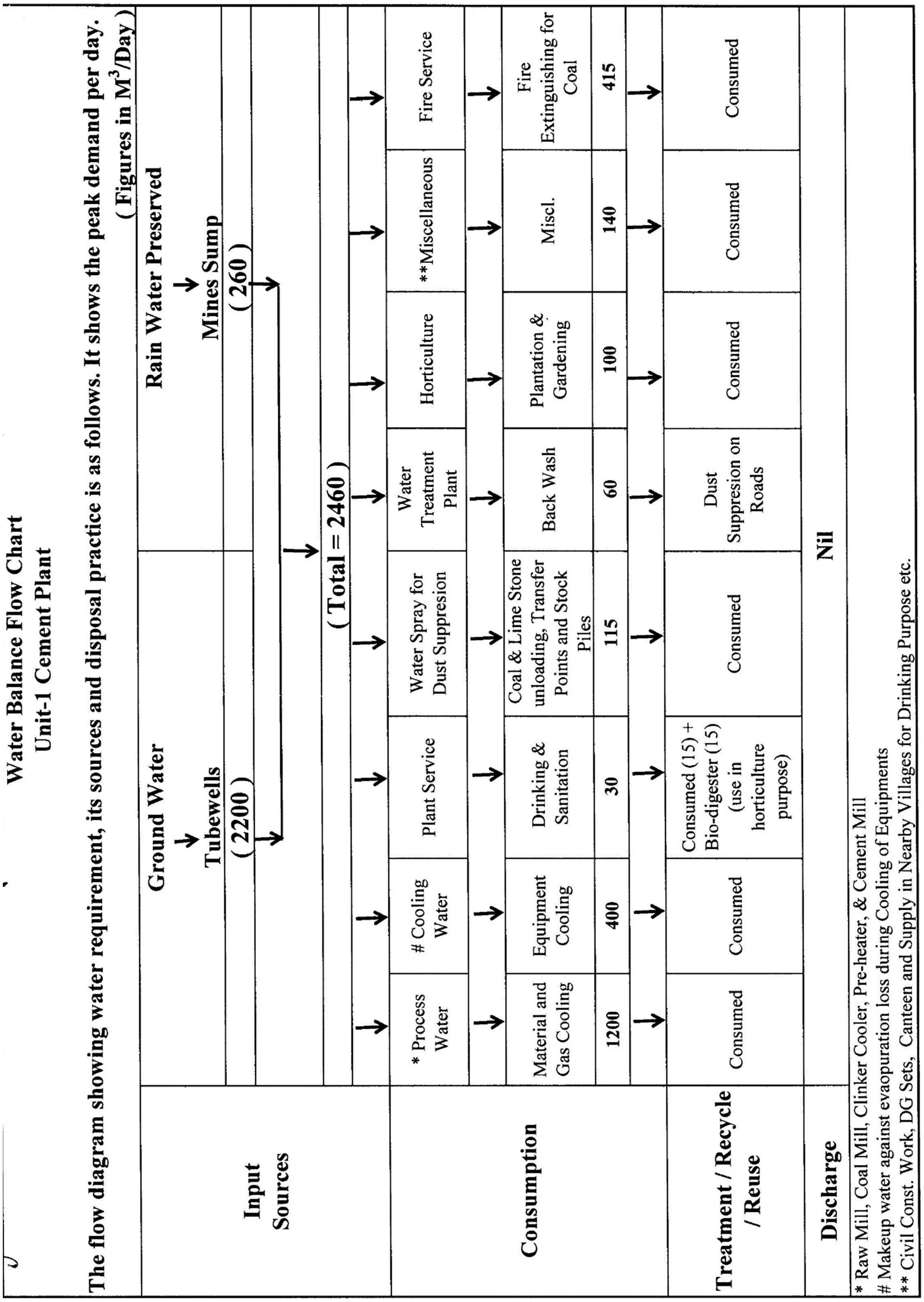


Figure 9: Flow chart of water within a typical cement industry

5.9 BENCHMARKING IN FERTILIZER & CHEMICAL INDUSTRIES

5.9.1 The Fertilizer Industry and Processes

Fertilizers are natural or synthetic compounds which are applied to the soil (sometimes also sprayed on plants) to provide plant nutrients essential to the growth of plants. They enhance the natural fertility of the soil or replace the chemical elements removed from the soil by the plants or lost in erosion. Fertilizers consist of the three essential nutrients for agriculture: nitrogen, phosphorous and potassium. Nitrogen is provided in form of urea or ammonium sulphate, or/and in combination with phosphorus as diammonium phosphate (DAP). Phosphorus is provided directly as phosphate, most common being the single super phosphate (16% P_2O_5). Potassium is provided as muriate of potash or as potassium sulphate. The three nutrients are also combined into a complex NPK fertilizer. Secondary nutrients such as sulphur and magnesium and a variety of micronutrients required for plant growth in very small amounts, according the nature of the crop and soil conditions,

India, with its huge human population, depends heavily upon agriculture for both food and livelihoods. Green revolution of the 1960s was partly supported by the fertilizers, besides high yielding varieties and irrigation. The fertilizer industry therefore makes a significant contribution to agricultural production. Of these, urea and superphosphate (SSP) are the most important.

Urea is manufactured by reacting ammonia and carbon dioxide in a reaction vessel at high temperature and pressure, to form ammonium carbamate. The ammonium carbamate in concentrated into molten urea which is later dehydrated under vacuum to obtain granular urea. The processes involved are shown diagrammatically in Figure 10.

Single super phosphate is produced by converting a source of phosphorus such as phosphate rock into a form which can make phosphate ions available to the plants. This involves reactions with strong sulphuric acid or nitric acid. While SSPs are also manufactured directly, the processes can be integrated (integrated “Nitrophosphate” process) to produce compound fertilizers containing ammonium nitrate, phosphate and potassium salts. This process aims to produce nitrate-containing straight and compound fertilizers starting from rock phosphate and using all the nutrient components in an integrated process without solid wastes and with minimal gaseous and liquid emissions. The processes and their relations are summarily shown in Figure 11.

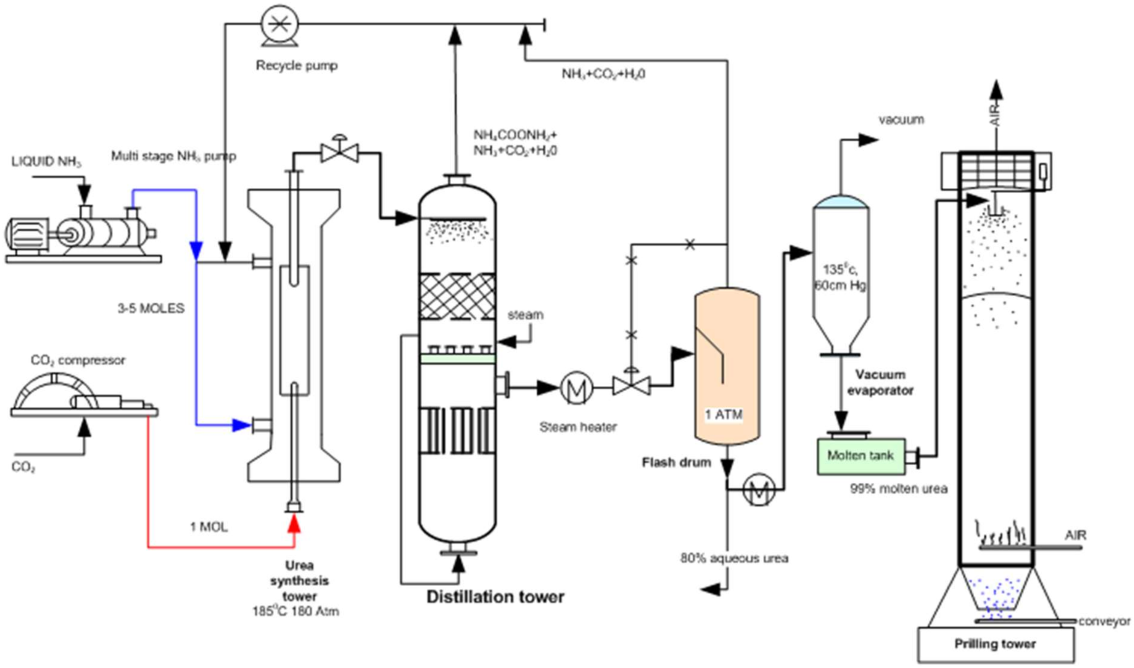


Figure 10: Flow-diagram-of-urea-production-process.
(from http://enggyd.blogspot.com/2010/09/flow-diagram-of-urea-production-process.html)

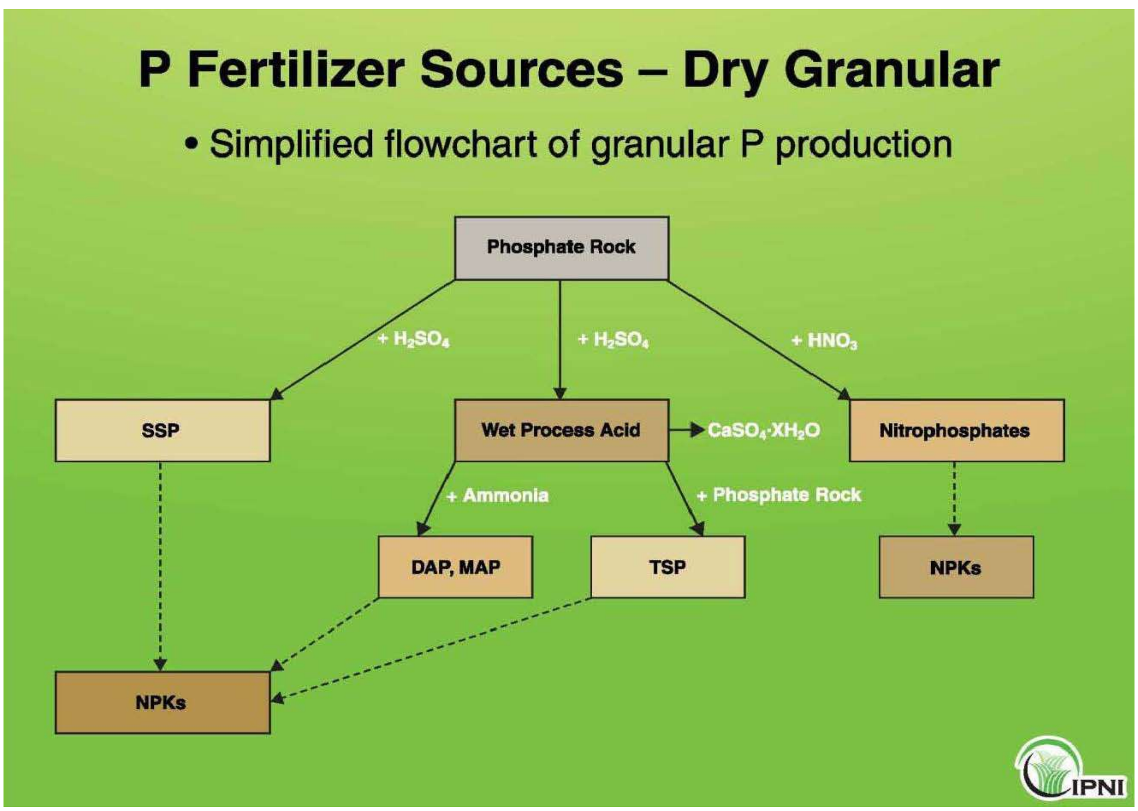


Figure 11: Flow chart of processes involving production of phosphatic fertilizers

There is another group of chemicals manufactured for enhancement of crop production by protecting the crops against a variety of plants (weeds), insect pests and pathogens. These organic synthetic compounds are referred to as herbicides, pesticides, weedicides, bactericides, fungicides, and nematicides, depending upon their target organisms for control. Some pesticides and insecticides are also used in areas other the agriculture.

5.9.2 Fertilizer Industry in Rajasthan

Rajasthan has some of the most important fertilizer industries in the country. Chambal Fertilizers and Chemicals and Shriram Fertilizers and Chemicals are the two major urea producers out of 32 in India. There is one Triple Super Phosphate industry in Udaipur, and there are 25 Single Super Phosphate manufacturing units concentrated in Kota, Udaipur and Chittorgarh districts of Rajasthan (Dept of Fertilizers 2018). Some of these industries also produce various protection chemicals (herbicides, pesticides, etc.). There are a large number of smaller industries manufacturing biofertilizers and biopesticides in Rajasthan.

We have examined the water use in the two urea producing a few SSP producing industries. As is normally reported, the SSP requires a relatively very small amount of water where urea production is a water guzzler (Table 20). Basically, urea is produced in ammonia solution and later the water is evaporated to obtain the dry granules. This evaporated water is not fully recovered. Recently, the CSE conducted a Environmental performance rating of the urea manufacturing industry in India (Chandra Bhushan et al. July 2019). They used the same data for the two units in Rajasthan, and observed the water consumption by these units to be among the lowest (4.55 cubic metres per ton). Some units elsewhere had a higher water use of up to 12.73 cubic metres/tonne of urea.

Table 5.20: District wise Water Requirement in Fertilizer Industry in Rajasthan.

District	Product	Gross Water use KL/ton	Net Water KL/ton	Range of Production (ton)	Range of Gross Water use (KL)	No. of Industries
Bhilwara	SSP	0.04	0.04	200	0.04	1
Chittorgarh	GSSP	0.11	0.11	350.0 to 1056.7	0.06 to 0.19	3
Kota		1.87	1.71			3
	GSSP	0.26	0.28	500.0 to 800.0	0.04 to 0.49	2
	Urea	5.07	4.55	1900.0	5.07	1

5.10 OTHER CHEMICAL INDUSTRIES

All other chemical industries use water in the process or as an ingredient in the product, but primarily as a coolant in most manufacturing processes, for generating steam for various important tasks, and for domestic use including cleaning and sanitation. Since these industries manufacture a large variety of products in different amounts, and often one compound is the base or raw material for other compound or group of compounds, it is nearly impossible to assess the water use efficiency of various categories of chemical industries. The pharmaceutical industry presents a far more complex situation because they require water of very high purity, and often produce small amounts of ultra pure water through distillation and other processes which consumes huge quantities of water.

5.11 OTHER WATER INTENSIVE INDUSTRIES

We have examined briefly another two categories of industries which are considered to be water intensive. We do not discuss them in detail for the reasons described below for each of them, and make only a few observations.

5.11.1 LEATHER PROCESSING INDUSTRY

There are only a few leather processing units in Nagaur and Jaipur districts according to the records accessed by us in the RDPCB. However, to our knowledge, only one cluster operates in a single industrial area in village Manpura Macheri in Jaipur district, notified by RIICO especially for leather processing (tanning). The data presented in Table 5.21 below show that the amount of water required in quite low (10 to 50 litres per skin). However, we could not find data for such processing elsewhere. We could not discuss the issue with any of the staff of these units. It is well known that leather tanning produces hazardous wastes, particularly chromium.

Table 5.21: District wise Water Requirement in Leather Industry

District	Product (Ton)	Gross Water use KL/skin	Net Water use KL/skin	Range of Production (skins)	Range of Gross Water use (KL/skin)	No. of Industries
Rajasthan						**6**
Jaipur	Wet Blue to Finished Leather	0.02	0.05	1000 to 2000	0.0 to 0.05	4
Nagaur	Wet Blue to Leather	0.01	0.0	2000	0.01	1

5.12 HOTELS

The hotel industry is highly varied in its characteristics and are distributed in all large and small cities and towns, and also along highways. They vary in the number of rooms for visitors, the basic facilities in the rooms and for dining, and additional facilities for relaxation, recreation, meetings, swimming etc. The hotels are categories by a star rating from 0 to 7, depending upon the infrastructure and available facilities.

We examined the data on some of the hotels from the Board's records. The data on the water use reported by these hotels per room (irrespective of occupancy) varied by an order zero magnitude. We tried to obtain specific details from several hotels but none was willing to share any information on the actual average occupancy, amount of water abstracted, water used in different places (kitchen, laundry, floor washing etc.).

Table 5.22: District wise Water Requirement in Hotel Industry

District	Gross Water use, KL/room	Net Water use, KL/room	No. of Rooms	Range of Gross Water use KL/room	Number of hotels
Rajasthan	**1.48**	**1.16**			**69**
Ajmer	0.54	0.40	39 to 70	0.34 to 0.64	4
Alwar	1.71	1.03	30 to 120	0.13 to 3.78	4
Bharatpur	5.65	3.92	78	5.65	1
Jaipur	1.09	0.85	20 to 362	0.12 to 2.59	32
Jaisalmer	1.78	1.71	43 to 83	0.49 to 3.97	4
Jodhpur	1.73	0.97	64 to 84	1.14 to 2.55	2
Sawai Madhopur	1.36	1.27	11	1.36	1
Sirohi	0.34	0.22	28 to 100	0.19 to 0.46	7
Udaipur	2.50	2.07	30 to 300	0.28 to 22.67	14

We initially considered comparing the water use in thee hotels with the CPHEO norm for domestic water supply (1999) which allows 135 litres per capita per day in urban areas. However, we found that the old norms have been revised in 2016. The CGWA which regulates groundwater withdrawal and is concerned with the depleting ground water levels, has allowed the following water withdrawal for hotels of different categories (CGWA 2016).

Category	Domestic (LPHD)	Flushing (LPHD)	Total (LPHD)
Hotels (up to 3 star) excluding laundry, kitchen, staff and water bodies	120	60	180
Hotels (4 star and above) excluding laundry, kitchen, staff and water bodies	260	60	320

A footnote further adds that the additional water demand for kitchen, laundry and clinical water shall be computed as per actual requirements.

In view of the regulatory authority itself having recommended the norms, there is no need to consider any other benchmark for the hotel industry.

Chapter 6.
CRITERIA AND GUIDELINES FOR SITING INDUSTRIAL AREAS AND WATER-INTENSIVE UNITS

6.1 Industrial Growth and Environmental Pollution

Industrial activity in India can be traced back to pre-British period. The first cotton mill, jute mill and coal mine were established in 1850-55, and by the end of the 19th century, there were 194 cotton mills and 36 jute mills in Maharashtra and Gujarat. However, the British did not promote the growth and development of the industries. At the time of independence in 1947, major industries in India were manufacturing Cotton textile, Jute textile, Iron and steel, Sugar and Cement. There were a couple of automobile industries.

Soon after India's independence, the industries manufacturing goods of different kinds were brought under the control of the central government with the enactment of the Industries (Development and Regulation) Act, 1951, with the objective to promote industrial growth. It listed the industries to be regulated in the First Schedule of the Act.

Within two decades, after the United Nations Conference on Human Environment in Stockholm (1972), the problem of water pollution, particularly in the rivers, due to industrial effluents as well as domestic sewage, was realized and the Water (Prevention and Control of Pollution) Act 1974 was adopted by the Parliament. However, it took another seven years to recognize the pollution in air and enact another legislation for prevention and control of air pollution in 1981. Gradually, other kinds of wastes causing environmental pollution and affecting human health, such as biomedical wastes and hazardous wastes, were recognized. An Environment Protection Act was also adopted in 1986, and Environmental Impact Assessments were made compulsory. However, the locations and sites of industrial areas and/or industrial units which cause water and air pollution did not receive any attention. Their establishment has been determined so far by the availability of the land, roads and highways, railheads, raw materials, labour, markets and similar considerations. Often the sites are decided by political considerations emphasizing the need for economic development of a region, and then the required infrastructure is provided by the industrial development and investment promotion institutions of the States.

Although, under Article 17(1)(n) of the Water Act 1974 concerning the Functions of the Boards, the ***State Pollution Control Boards were required*** "***to advise the State Government with respect to the location of any industry the carrying on of which is likely to pollute a stream or well***", the locations/sites of industries were not determined or regulated by the Pollution Control Boards. The Boards' regulatory functions were restricted to setting standards for the discharge of solid wastes, liquid effluents (including sewage) and gaseous emissions from different kinds of industries, and to ensure compliance to meet these standards. It is a different matter that the failure or malfunctioning of the pollution control equipment and wastewater treatment plants often results in the violation of the standards. It is important to note that the total quantum of the pollutants released into the environment and the pollutional load carrying capacity of the environment have not yet received any consideration.

6.1.1 Classification of Industries

For the first time, a categorization of the industries was introduced through the Micro, Small and Medium Enterprises Development (MSMED) Act, 2006, based on their investment, into micro, small, and medium enterprises. The Enterprises under the manufacturing category were classified as under:

(i) a Micro enterprise, where the investment in plant and machinery does not exceed twenty-five lakh rupees

(ii) a Small enterprise, where the investment in plant and machinery is more than twenty-five lakh rupees but does not exceed five crore rupees; or

(iii) a Medium enterprise, where the investment in plant and machinery is more than five crore rupees but does not exceed ten crore rupees;

In July 2018, a Bill was introduced in the Parliament to amend section 7 of the Act regarding the classification of industries. It proposed to classify industries on the basis of the annual turnover, to promote ease of doing business and to facilitate compliance of the tax regime, as under:

Micro enterprise: a unit where the annual turnover does not exceed Rs 5 crores;

Small enterprise: a unit where the annual turnover is more than Rs 5 crore but does not exceed Rs 75 crore;

Medium enterprise: a unit where the annual turnover is more than Rs 75 crore rupees but does not exceed Rs 250 crore.

This could not be adopted before the term of the Parliament, and hence it lapsed. The Government announced a new definition on 13 May 2020, and issued a notification **S.O.1702 (E), dated the 1st June, 2020, thereby removing the distinction between the manufacturing and service sector of enterprises, and the MSME were redefined on the basis of investment and turnover as under:**

S.N.	Enterprises	Investment in and Turnover	Limit
(i)	Micro Enterprise	Investment in plant and machinery or equipment; AND	does not exceed Rs one crore
		Turnover	does not exceed Rs. 5 crore
(ii)	Small Enterprise	Investment in plant and machinery or equipment; AND	does not exceed Rs. 10 crore
		Turnover	does not exceed Rs. 50 crore
(iii)	Medium Enterprise	Investment in plant and machinery or equipment; AND	does not exceed Rs. 50 crore
		Turnover	does not exceed Rs. 250 crore

The new classification comes into effect from 1 July 2020. Accordingly, the status of some of the industries in Rajasthan is expected change in respect of their categorization.

6.1.2 Categorisation of Industries in Relation to Pollution

The Ministry of Environment, Forest and Climate Change (MoEFCC) had brought out notifications in 1989, with the purpose of prohibition/ restriction of operations of certain industries to protect ecologically sensitive Doon Valley. The notification introduced the concept of categorization of industries as “Red”, “Orange “and “Green” with the purpose of facilitating decisions related to location of these industries. Subsequently, the application of this concept was extended in other parts of the country not only for the purpose of location of industries, but also for the purpose of ‘Consent’ management and formulation of norms related to surveillance / inspection of industries. The concept of categorization of industries continued to evolve and as different State Pollution Control Boards interpreted it differently, a need arose to bring about necessary uniformity in its application across the country. In order to harmonize the ‘Criteria of Categorization’, Directions were issued by the Central Pollution Control Board (CPCB) under Section 18(1)(b) of the Water (Prevention & Control of Pollution) Act, 1974 to all State Pollution Control Boards (SPCBs) and Pollution Control Committees (PCCs) to maintain uniformity in categorization of industries as red, green and orange as per list finalized by CPCB, which identified 85 types of industrial sectors as ‘Red’, 73 industrial sectors as ‘Orange’ and 86 sectors as ‘Green’.

Recently, based on the document prepared by the CPCB after detailed consultation (CPCB 2016), the Union Ministry of Environment, Forests and Climate Change released on 5 March 2016, a new categorisation of industries according to which industries which pollute the most have been put in the `Red' category while the moderately polluting units are classified `Orange'. Industries that have a significantly low pollution load have been placed in the `Green' category while those that operate without causing any pollution have been categorised as `White'. The newly introduced `White' category of industries has been exempted from environmental clearance. The categorisation recognises the importance of relative pollution potential of the industrial sectors based on the computation of a Pollution Index. Further, some industrial sectors have been split considering the use of raw materials, manufacturing processes and the expected pollutants.

The new categorisation has placed 60 industrial sectors in Red category, 83 in Orange category, 63 in Green category and 36 in White category. The Rajasthan State Pollution Control Board has followed the new categorisation since 31 May 2016, and later amended the list of industries in different categories on 8 May 2018.

6.2 SITING OF INDUSTRIES

As early as 1990s, the Central Pollution Control Board had recognized that most of the problems of pollution and costs thereof can be avoided by preventing indiscriminate siting of industrial units. The CPCB also recognised that an important pre-requisite for judicious siting of industries was to consider the environmental profiles of the proposed sites.

In an initial exercise, the industries were classified according to their air, water and soil pollution potential, as noted below:

W3 category - industries with wastewater from domestic use/cooling or boiler blowdown (having no temperature variation and metals or other contaminants) or generating no wastewater or industries with complete recycling system/reutilization with 'Zero' discharge

W2 category - industries generating wastewater which is easily biodegradable and non-toxic, industries generating slurries and high temperature effluent

W1 category - industries generating wastewater of inorganic nature or organic waste of not easily biodegradable or toxic nature or combination of all in W2, W3 categories

A3 category - industries having emission only from boilers of steam generation capacity less than 2 ton/hr but not using coal, or noise of <70 dBA, or using diesel generator sets up to 50 KVA

A2 category - industries with combustion emission from usage of coal 125 ton/hr or equivalent, or generating noise levels between 70-90 dBA, or using diesel generator sets >50 KVA

A1 category – industries with emission from combustion of fuels using coal 125 ton/hr or equivalent fuel, or industries having process emission emitted through organised let out system (stack) or having fugitive emission or odour nuisance, or industries generating noise levels of 90 dBA and above

S1 category - hazardous waste as defined under rule 3(i), 3(n) and 4 of the Hazardous Waste Management and Handling Rules, 1989 or waste water of not easily biodegradable and toxic nature.

S2 category - inorganic and organic compostable waste and all wastes with leachate potential or wastewater of easily biodegradable and non-toxic nature

S3 category - solid waste of inert nature or no waste or with recycling arrangements. No discharge of waste water on land.

Based on the combined pollution potential derived from the above criteria and categorisation of industries, nine zones were identified for their suitability for various types of industries:

Zone I:

Siting of any type of air and/or water polluting industries should not be allowed. Siting of industries with very low pollution potential (A3 and/or W3) may be considered based on micro-level studies (suitable for A3 W3 only);

Zone II:

Industries having high water pollution potential (W1) and/or any type of air pollution potential (A1/A2/A3) should not be allowed in these zones. Siting of industries with very low air pollution potential (A3) 1 based on micro-level studies, and/or medium or low water pollution potential (W2/W3) may be considered (suitable for A3W2, A3W3 only);

Zone III:

Industries which are water polluting in nature (W1/W2/W3) but not having any type of air pollution potential (A1/A2/A3 -A3 based on local conditions) may be considered for siting in this zone (suitable for W1A3, W2A3, W3A3 only);

Zone IV:

Industries having air pollution potential whose impact is not likely to exceed 2 km (A2) or industries – having very low pollution potential (A3) but not having any type of water pollution (W1/W2/W3 - W3 based on local conditions) may be considered for siting in this zone; Industries with high air pollution potential. (A3) or high or medium water pollution potential (W2/W1) should not be allowed Zone 11: in this zone; (suitable for A2W3, A3W3 only);

Zone V:

Industries having air pollution potential whose impact is not likely to exceed 2 km (A2) or industries having very low pollution potential (A3) and/or having medium or low water pollution potential ' (W2/W3) may be considered for siting in this zone; Industries with high air pollution potential (A1) or ; high water pollution potential (W1) should not be allowed in this zone; (suitable for A2W2, A3W2, A3W3, A2W3 only);

Zone VI:

water Industries having air pollution potential whose impact is not likely to exceed 2 km (A 2) or industries having very low air pollution potential (A3) and/or water polluting in nature (W1/W2/W3) may be considered for siting in this zone; (suitable for A2W1, A2W2, A2W3, A3W1, A3W2, A3W3 only);

Zone VII:

Industries having air pollution potential of A1/A2/A3 but not having any type of water pollution (W1/W2/W3 -W3 may be considered based on local conditions) may be considered for siting in this zone; (suitable for A1 W3, A2W3, A3W3 only.

Zone VIII:

Industries having air pollution potential of A1/A2/A3 and/or having waste water discharges of only W2/W3 categories may be considered for sitting in this zone; Industries having waste water of not easily biodegradable and toxic nature should not be allowed in this zone; (suitable for A1W2, A2W2, A3W2, A1W3, A2W3, A3W3 only); and

Zone IX:

All types of air polluting industries (A1/A2/A3) and/or all types of water polluting industries (W1/W2/W3) may be considered for siting in this Zone (suitable for A1W1, A1W2, A1W3, A2W1, A2W2, A2W3, A3W1, A3W2, A3W3).

6.3 ZONING ATLAS FOR SITING OF INDUSTRIES

The CPCB initiated, in December 1994, in collaborations with the State Pollution Control Boards (SPCBs) and German Association for Technical Cooperation (GTZ; now called GIZ), National Atlas & Thematic Mapping Organisation (NATMO), and the National Remote Sensing Agency (NRSA), the environmental planning programme known as "Zoning Atlas for Siting of Industries" (ZASI) for identifying environmentally acceptable sites for industries, at a district level, based on the pollution potential of the source and assimilative capacity of the receiving environment. More than 100 districts were covered in 21 participating States. Nineteen Districts were selected in 14 states in the first phase. Udaipur and Rajsamand districts were selected in Rajasthan (Parivesh- CPCB ENVIS Newsletter June 1996). By the end of 2004, work on the Zoning Atlas for Siting of Industries had been taken up for 142 Districts and 60 districts were proposed to be added during the 10th Five Year Plan (Minister of State, Ministry of Science & Technology, Reply in Lok Sabha on 27 May 2005). Of these, only four were in Rajasthan (Kota and Alwar added after 1995).

However, this project was closed at CPCB in 2004 as the States were considered to have been adequately trained to continue the work further. The CPCB continued to provide specific guidance whenever requested by the States. It is also important to note that the atlases were prepared on a scale of 1:250,000, which were not useful after 2010. Some States continued the work of preparing the atlases at 1:50,000 scale, and in some cases the maps were prepared on 1:5,000 scale (personal communication from CPCB).

In Rajasthan the State Pollution Control Board continued to work on the Zoning Atlas for the districts of Udaipur and Rajsamand, Kota and Baran, Sirohi and Bhilwara, and Alwar until around 2009. However, the atlases were not finalised or published and the zoning was not implemented.

6.3.1 Method Adopted for Preparing Zoning Atlas

The method employed for preparing Zoning Atlases is summarised below based on a CPCB presentation. The preparation of Zoning Atlases involved the following steps:

1. Preparation of a District Environmental Atlas comprising of maps of the administrative division of the district, physical features, Land Capability, Climate, Socioeconomic conditions, Surface water use, quality, flow, Drainage Pattern, Ground water use, groundwater potential, groundwater table, groundwater quality, environmental quality, pollution load, etc.

2. Zoning Atlases then considered the following aspects:

Areas to be avoided *for their Biological diversity, Incompatible Landuse, and being Environmentally Sensitive Zones*

For their known Biological Diversity, the areas to be avoided were: Sanctuaries, National parks, Game reserves, Tiger reserve/elephant reserves, turtle nesting ground, breeding grounds, Core areas of Biosphere reserves, Wetlands, Areas with threatened (rare, vulnerable, endangered) flora and fauna, protected corals, Reserved/Protected Forest, besides any other locally specified areas.

Areas of Incompatible Land Uses were identified as Public water supply areas (river, reservoir, groundwater), monuments, flood prone areas, CRZ, World Heritage Site, Religious places, Tourist places, protected tribal settlements, Agriculture Research Stations, Air Port and any other area specified by the State or local Government.

Air Pollution Sensitivity (Sites for air polluting industries)

Sites for industries causing only air pollution were considered for their air pollution sensitivity. The sensitivity assessment was based on the potential of the industry to cause air pollution without the installation of pollution control equipment.

Air pollution sensitivity is assessed by (a) categorising the industries according to their pollution potential in terms of the distance from the source (<2 km to >7 km), and (b) the distance of the areas to be avoided (as listed above) and certain physiographic features such as hills or areas with frequent inversion conditions, from the industry site (<2 km to >7 km, divided into 4 zones). The suitability of a site for locating an industry is determined from the matrix of industry category and zone of sensitivity. Thus, the industries could be located in an area which lies away from the listed avoided features at a distance greater than their air pollution potential. Industries with impact potential of less than 2 km could be considered for siting anywhere in the district based on micro-level conditions, except in the areas that are to be avoided.

Surface Water Pollution Sensitivity (Sites for water polluting industries)

Water pollution sensitivity assessment considered the following aspects:

(a) surface water quality (high, medium or low, based on designated Best Use Criteria)
(b) category of industries according to the pollution potential (very high, high, medium to high, and low) based on the volume and BOD/COD ratio, toxicity and/or TDS load of effluent discharge. Industries with <25 kld discharge of effluents with a BOD/COD ratio of >0.7 and without toxic substances were considered to have low pollution potential.
(c) Sensitivity of surface waters use was categorised on the basis of the distance of the watershed from the periphery of the industry (< 5 km to >15 km). Following water uses were recognized:

- National Parks /Sanctuaries/ Mangrove area/ Wetlands /
- Core zone of biosphere reserve
- Tiger reserve/elephant reserve/turtle nesting ground, breeding grounds/ Game reserve
- Gene Banks / Zoological gardens/ Botanical gardens/Wetlands
- Areas with threatened (rare, vulnerable, endangered) flora/fauna, protected corals/ Habitat for migratory birds
- Monuments of national significance/ World Heritage Sites
- Public drinking water supply or industrial water supply areas from rivers/surface water bodies with or without conventional treatment and areas known to be entirely dependent on surface water for drinking
- Coastal water used for salt pans, shell fishing, mariculture, bathing, contact water sports, and commercial fishing or having other ecological sensitivity
- River stretches or water bodies used for propagation of wild life and fisheries
- Catchment areas of irrigation projects (dams/reservoirs)
- Public water supply areas from ground water
- Ground water recharge areas
- Core areas of scenic areas/tourism areas/hill resorts with over 5 lakh tourists/ visitors per year
- Core areas of religious places, pilgrim centers including organized bathing areas with visitors/pilgrims over 5 lakhs per year
- Protected tribal settlements
- Agricultural research stations
- Critically polluted or 'low' water quality zone
- Any other closed/protected area under the Wild Life (Protection) Act, 1972
- Any other feature as specified by the State or local government/or locally applicable

Surface water flows (river stretches) were categorized into High, Medium or Low sensitivity zones, based on the dilution (ten times to more than 100 times) provided throughout the year for the pollution load proposed to be discharged from the industry in that zone into the river. The sensitivities of surface waters based on use and flows were then combined to determine the overall sensitivity (High, Medium and Low).

Site Suitability for Water Polluting Industries (without considering air pollution) was then assessed by a decision matrix combining the sensitivities of the waters to pollution, and the category of industries for their pollution potential. All areas to be avoided as listed earlier were also excluded. An assessment based on microlevel conditions was considered necessary before a decision on site suitability.

Further analysis required the zoning of the district into 8 zones of site suitability (Areas to be avoided, four very high to low risk zones for air polluting industries and 3 high to low risk zones for water polluting industries). Considering both air and water pollution from the industries, these zones are converted into 12 combinations. Similarly, the categories of industries can be combined into 16 groups based on their air and/or water pollution potential.

Finally, a matrix formed by the interaction of these 12 zones and 16 groups of industries provides the most suitable areas for siting the particular industry after installing appropriate pollution control technologies to meet the Minimum National Standards.

It was suggested that the areas for developing industrial estates may be identified from the above zones, in consultation with other Departments of the Government, such as the Industries Department, the Town & Country Planning Department, the Electricity Department, PWD, the Industrial. Development & Investment Corporation, etc. which will take care of the economic considerations such as water supply, electricity network, industrial development needs, etc. Detailed micro-level studies (region-based based studies on 1: 250,000 scale and environmental impact assessment) in an area of 25-km around each of the identified sites should be made. While selecting such areas, preference may be given to wastelands.

Further, the 'high risk' zones shown in the groundwater sensitivity map are very sensitive to groundwater polluting activities and hence, disposal of effluents or solid/hazardous waste on land should not be allowed. The 'medium' risk areas are suitable for controlled and limited discharges of only easily biodegradable and non-toxic effluents. The 'low risk areas provide scope for disposing hazardous wastes, based on micro-level studies.

Limitations

The CPCB recognised the following limitations of the Zoning exercise:

- Data on environment related parameters are normally characterised by certain limits regarding precision,
- The concept provided covers only the macro-level aspects, and for micro-level planning detailed studies are to be carried out. The information provided by the set of maps are primarily to be used for a reconnaissance of the planning area.
- The Zoning Atlas considers only the environmental aspects.
- The identified zones for industrial sitting are based on studies in 1: 250,000 scale and based on available data,
- Hence, the conclusions drawn from this Atlas only provide, guidelines for taking decisions on industrial ng and should not be considered as a consent to establish industries, Micro level detailed studies are to be carried to evaluate environmental impact assessment (EIA) before taking decision on siting an industry.
- The conclusions in the present Atlas are on rapid EIA and hence, in the identified industrial zones, even if the risks due to pollution are high/medium/low, there should not

be any discharge of effluent/emission/waste without treatment and meeting the required environment standards.

- The industries adopting clean technology for manufacturing process may not have the pollution generation potential similar to those without the clean technology and hence, may be suitable even for 'medium' and 'high' risk zones.

- The Atlas and the recommendations are developed based on the current scenario in the district. The Atlas needs modification/updating as and when the scenario of the land uses or the environmental quality or any theme (data/information) relating to air/water pollution sensitivity changes.
- The most relevant criteria for Rajasthan the water availability in quantitative terms was not considered.

6.3.2 District Level Guidelines

Based on the district level Zoning Atlas for Siting of Industries, the Central Pollution Control Board initiated also the development of district level guidelines for the siting of industries (http://cpcb.nic.in/district-specific-site-guidelines/) that included information on processes or operations to be restricted, and potential zones for siting of air and water polluting industries in the district. We are not aware of such district level guidelines for any district of Rajasthan.

In August 2010, the MOEF published a Technical Guidance Manual for Industrial Estates, prepared by the IL&FS Ecosmart Ltd. The manual included two annexures on the "Identification of Suitable Sites and Industries" and "Site Establishment Factors" where the criteria and methodology developed earlier for zoning was presented with minor modifications. Again, the water availability in quantitative terms was not considered.

6.4 NEED FOR CHANGES IN THE EXISTING SITING CRITERIA AND GUIDELINES

These siting criteria emphasised upon a balance between economic and environmental considerations. In most cases, the highways, major settlements, markets for products and raw material resources are considered desirable. Various environmental protection measures are also considered and often applied through various regulatory mechanisms. However, the availability of adequate water resources is given the least importance as water is sought to be brought from distant places or the groundwater is exploited. Even the wastewater was allowed to be discharged on the land or in nearby surface waters after prescribed treatment (only partially or without treatment in many cases). Often, there is no attention paid to the hydrologic constraints as well as those imposed by geology and hydrogeology. Excessive use of water in water-intensive units and the large amounts of wastewaters place heavy burden on the accessibility of water by other users, and cause serious environmental impacts that are nearly impossible to mitigate.

The MOEF and CPCB guidelines do not consider the availability of water at all among the criteria for siting an industry. These guidelines are aimed at only considering the potential of the industry for polluting land, air and water. The requirement of an EIA and EMP is also directed at the impacts from the viewpoint of pollution only.

It has never been thought necessary to consider water as a resource input in the industries (and even for siting settlements/townships). Apparently, it has been assumed that wherever surface water resources are not available, the ground water shall be available and can be used freely.

Environmental regulations have been evolving over the past 45 years (since the first Water Act 1974). It is well known that humans developed their settlements close to water bodies to ensure water supply for both domestic and agricultural use. It is also well known that Emperor Akbar had to abandon his plans to develop the capital at Fatehpur Sikri simply because of non-availability of water. Even nearer home, in Jaipur, Maharaja Sawai Jai Singh shifted the capital from Amber to newly founded city- Jaipur in view of better water availability in the area between the two rivers - Dravyavati flowing south and another flowing east from the Amber hills.

It is surprising that whereas the pollution arising from the industries based on the processing of their raw materials and other processes has been given due attention, there has been hardly any consideration of the quality of water used by the industries. In practically all industries, the surface or groundwater available in their area is not used directly, but has to pre-treated usually to soften it (remove TDS and hardness, and other impurities). This treatment itself generates a lot of wastewater and sludge which are discharged with the process wastewater. Often the domestic wastewater within the campus of the industry is also discharged and treated together with the process wastewater.

Similar to the recognition of the need to segregate solid wastes before their management, there is urgent need to segregate the wastewater streams within each industry, that will make recycling/reuse simpler, and reduce the costs of STPs/ETPs.

We propose here **criteria for siting industrial units by giving high consideration to the water availability** for the industrial sector in the context of total availability, all other demands in order of priority, future growth of population and projections of climate change, potentials for water conservation, options for increasing water use efficiency, etc. These criteria may be used differently for each of the four climate zones of the State, and possibly for different river basins.

6.5 SUGGESTED APPROACH TO SITING OF NEW INDUSTRIAL AREAS AND INDUSTRIAL UNITS

The categorization of the industries into air polluting and water polluting industries ignores the fact the air pollution also affects the water quality of surface waters as the pollutants enter the water bodies with the rain water. Besides the widely known phenomenon of acid rain, the effects of pollutants released in the case of Bhopal gas leak on the water bodies and aquatic life are also well known. It is desirable to consider the interactions between air and water pollution.

We however focus on the availability of water in the area proposed for the siting of industries. The availability of water has two dimensions: first, its use in the industry, and second, as the potential recipient of wastewater. National Water Policy accords highest priority to the use of water for drinking by humans and then livestock, and for domestic use including sanitation. Agriculture gets the second priority. In many parts of Rajasthan, as discussed earlier, water is not available or is highly scarce even for drinking. The livestock receive practically little water in the absence of surface water bodies. Agriculture depends entirely upon rain and the soil moisture thereafter. Wherever rain water is stored in ponds/tanks under various minor irrigation schemes, both the humans and livestock do not get their share of water, and a large proportion of water is lost in evaporation. Under these situations, the ground water is the only alternative that is indiscriminately exploited by anyone who has access to energy and other resources to extract water. As presented earlier, in most parts of Rajasthan the ground water has reached a semi-critical or critical state of over extraction. Many blocks are already overexploited (to the tune of over 200% of their annual recharge). Currently available data show that many industries are located in these critical and over-exploited areas. Recently, the CGWB has issued guidelines which restrict the extraction of water from these areas, and particularly the notified over-exploited blocks only to a limited extent by allowing such extraction on payment of a Water Conservation Fee and the condition that groundwater will be recharged. The Hon'ble NGT has already stayed this order except for accepting the CPCB recommendations with respect to environmental compensation to be charge for violations of the conditions mentioned in the NOCs.

While the issue of allowing withdrawal of groundwater by industries from different critical, semi-critical and over exploited areas is being adjudicated by the NGT, we are of the view that such withdrawal should be based on the water budget of each block in the district. The total withdrawal by all the existing industries should not exceed the annual recharge potential of the particular block, after allowing the requirement of the prioritized use for humans, livestock and agriculture. Additional withdrawal by an industry for its expansion or any new industry in the area (block)- not just a particular industrial estate- should be allowed on the basis of actual availability, and not the prescribed obligatory requirement of groundwater recharge from harvested rainwater.

The maximum amount of rainwater that can be harvested (assuming 70% efficiency on annual basis after allowing for evaporation, from roof tops but less than 50% from ground surfaces) is 700 m^3 per ha per year for every 100 mm rain. The maximum rainwater harvest in an area with 500 mm annual rainfall is less than 10 m^3 per day per hectare (=10 kLd/ha). This means than an industry occupying 10 ha land area cannot harvest 100 kLd rainwater even if the entire area is paved and taken into consideration.

The 2015 guidelines of the CGWA required the industries to recharge groundwater equivalent to 50% (semi-critical areas), 100% (critical areas) or 200% (overexploited areas) of their groundwater withdrawal. It translates to the requirement of, for example, 100 kLd recharge by an industry with 10 ha land area and withdrawing only 100 kLd in a critical block. It is obvious that the industries extracting more than the potentially harvestable rainwater cannot meet the prescribed obligation. An industry withdrawing 500 kLd groundwater was required to recharge 250 kLd that requires a rainfall of at least 1250 mm per year and a project site area of more than 10 ha in a semi-critical zone.

It appears that in view of the impracticality of such a requirement, the provision has been done away with in the latest notification of December 2018.

It will be prudent to consider groundwater recharge by the industries only as a measure towards restoration of the groundwater tables instead of a substitute for withdrawal.

It will be desirable to restrict the groundwater abstraction to a specified portion of the total water requirement in the industry (typically the make-up water) and meet its remaining requirement from recycling and reuse of treated water at different process steps. Further, a larger part of the water requirement can be met from the rainwater if it is harvested and stored appropriately on the site. About three month's total water requirement can be met from the harvested rainwater alone by any medium sized industry. The use of rainwater will be cost-effective and energy saving because of its better quality (than the best groundwater) and reduced groundwater withdrawal. The amount of water harvested and used can be readily measured and accounted for in the water budget.

Although the discussion in the NGT has focused only upon the use of the groundwater, the availability of the surface water should also be taken into account. As described earlier, the rivers in Rajasthan are only seasonal or ephemeral, except Chambal and therefore, the industries cannot rely on their flow. Moreover, in most parts of Rajasthan, the surface water bodies are also seasonal. The water stored by various medium and minor irrigation projects is not adequate for the agricultural use alone. Only rarely domestic supplies depend upon such reservoirs (e.g., Bisalpur dam on R. Banas). Yet, industries have been allowed the use water from some lakes (see ROLTA Report) and from the canals (imported water). Water from the River Chambal is also used by a few industries.

In case of surface waters, the abstraction for any purpose must account for the requirement of the natural ecosystems, particularly the aquatic biodiversity. It is important to recognize that the groundwater availability in the areas around the streams, rivers, lakes and reservoirs depends entirely on the recharge from these water bodies, and therefore, these water bodies should not be over-exploited.

RIICO has mentioned on their website that "Allotment of land to Water Intensive Industries shall be subject to "CGWA Guidelines/Criteria for evaluation of proposals/requests for ground water abstraction (With effect from 16.11.2015)"

6.6 APPLICATION OF THE WATER AVILABILITY CRITERION

First the total water availability has to be assessed for each block in a district. At present it is not easy to assess the availability at the level of a village or group of villages. The parameters required for such an assessment are listed below.

The water availability has to be considered then separately for three groups of industries:

a. The existing industries and industrial areas
b. New industries in existing industrial areas
c. New industrial areas and new industries

In case of the **existing industries and industrial areas**, the water supply or permission for extraction of groundwater should be regulated on the basis of the current water availability, current use (extraction) and future projections. This is currently under consideration of the NGT. We are of the opinion that any amount of Water Conservation Fee cannot make the water available in the area. It is therefore in the interest of the industries to adopt technologies for saving water consumption, and for recycling and reuse to the maximum extent, thereby reducing or eliminating the need for groundwater extraction.

New industries should not be allowed in the existing industrial areas without assessment of the current consumption in relation to the total availability. Only industries without water requirement (except domestic use) may be permitted to establish in the existing industrial areas.

The establishment of **new industrial areas** and **industrial units** should be based on the availability of adequate water in the block after considering the existing areas/industries and other priority uses. The permission (EC) for new industrial areas must clearly specify the kind and number of industries that can be permitted in that industrial area. The State Government and the Industrial Development organisations (such as RIICO) should promote only those industries which do not require water in the water-starved regions. In case industries with small or medium water requirement are considered necessary, they may be permitted only if they agree to fully recycle and reuse their wastewater and do not discharge any wastewater (ZLD).

6.6.1 OTHER CRITERIA

6.6.1.1 Sites for Reuse of Treated Wastewater

The second important criterion for siting of an industrial area or industry should be the proximity of another industry or agricultural area where the wastewater treatment facility can be set up and the treated wastewater can be used, with minimum cost of conveyance.

In case the industries cannot comply with ZLD requirement, and have to necessarily discharge wastewater, the sites for treatment (STP and ETP or CETP) should be predetermined. An important consideration for the selection of the sites for treatment plants should necessarily be the reuse of the treated wastewater – either in an industry or for agriculture or horticulture.

The STPs and ETPs (or CETPs) should be mandated to treat the wastewater to meet a specific level of water quality that is appropriate for its use in the particular industry or agriculture. The water quality of the treated effluent should be strictly monitored on a daily basis. Following is a list of information that should be taken into account:

6.6.1.2 Parameters for Siting Industrial Areas/units based on Availability of Water

1. Assess Currently Available Water
   Rainfall (mean annual)
   – partitioning into soil moisture;
   Evaporation;
   Groundwater recharge;
   Surface runoff into streams;
   Storage in ponds, tanks, reservoirs
   Surface Water
   Rivers/streams
   Lakes/Reservoirs/ponds
   Groundwater – Available for extraction
   Imported Water (if already available)
   Projected change in precipitation due to Climate Change

2. Assess Current Water Requirement /Committed Use:
   Domestic requirement/supply (from human population – rural/urban)
   Livestock requirement (from livestock population)
   Agricultural requirement/use
   Rainfed
   Irrigated (surface water)
   Irrigated (groundwater)
   Committed Industrial requirement/ use
   Environmental Water requirement
   – natural ecosystems and aquatic ecosystems
3. Projected Increase in requirement over the next 10yr and 20 yrs.
   For natural increase in human population
   For natural increase in livestock population

4. Surplus Water Available, if any
5. Potential savings in Agriculture by micro-irrigation
6. Potential use of treated domestic sewage effluents
   In Agriculture
   In Industries
   In Domestic use
7. Potential for reuse/recycling of industrial effluents

The above Water Budget can be computed for the State, Climate Zone, River Basin, District or Tehsil depending upon data availability.

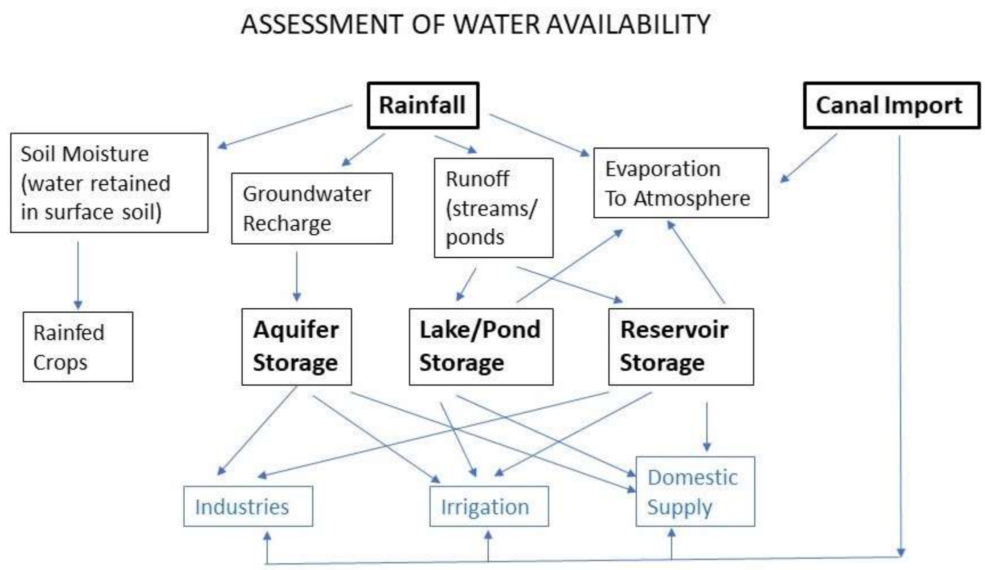
In addition to these considerations, we need to take into cognizance the existing laws, rules, regulations, notifications and various relevant judgements of the High Court, Supreme Court and the NGT. The extent of violations of these laws, rules and judgements may also be looked into. The land use policy, issues of water governance, and the role of various relevant regulatory authorities may also be considered.

6.6.1.3 Assessment of Water Availability in the Block

Name of the Block
Geographic Coordinates (add a Map)
District
Total Land Area
Topographic Features (Plain, Hills, Streams, Water Bodies)
Human Settlements- towns, villages
Livestock population
Agriculture: cultivated land area
    Irrigation sources
Existing Industrial Area (s)
Kinds and number of Industries
Existing Water Intensive Industries

Sources / Parameters	Current	Projected (say 2040)
Rainfall (mean annual)		
Storage as soil moisture		
Evaporation loss		
groundwater recharge		
Surface runoff into streams		
Storage in ponds, tanks, reservoirs		
Available Surface Water		
Rivers/Streams (annual flow)		
Lakes/ ponds (total storage)		
Reservoirs (total storage)		
Evaporation loss (annual)		
Groundwater		
Available for extraction		
Annual recharge (potential)		
Imported Water (Canals inflow from outside State)*		

- Share allocated to district/block/village



Assessment of Water Requirement in the Block

User /Consumer	Water provided (current)	Projected Requirement
Domestic requirement		
Human population – Urban (@150 lpcd)		
Human population – Rural (@150 lpcd)		
Livestock requirement (from livestock population) (@20 lpcd)		
Agricultural requirement		
Rainfed Area – additional irrigation		
Irrigated Area -Double Cropped (surface water)		
Irrigated Area -Double Cropped (groundwater)		
Irrigated Area -Triple Cropped (surface water)		
Irrigated Area - Triple Cropped (groundwater)		
Existing Industrial requirement		
Number of Industries with only domestic water requirement (say <2 kld)		
Water using Industries Already permitted water withdrawal		
Environmental Water requirement		
natural ecosystems and aquatic ecosystems**		

** Amount of water (or flow regime) required to be maintained in the rivers, lakes, ponds, wetlands, and other aquatic ecosystems to ensure their biodiversity and ecosystem services.

6.6.1.4 Wastewater Generated and Treated

Domestic Wastewater

Total generated (based on supplies) – Urban
Total generated (based on supplies) – Rural
Total intercepted in sewerage (as per policy)
Total Sewage treatment Capacity Installed
Total sewage treated (available treated effluent for reuse)

Industrial Wastewater

Total generated (based on Consent)
Total generated (actual) – after recycle/reuse within units
Total treatment capacity installed – CETPs
Total treatment capacity installed – ETPs
Total effluent treated in CETP/ETP
Total treated effluent reused

Quality of Treated Wastewater

Does it meet the prescribed standards?
List the parameters and their values; provide data for the past one year

Is the treated wastewater used currently?
Within the industry (specify amount & location)
In another Industry (specify amount & location)
In Agriculture (specify amount & location)
In green belt development (specify amount & location)
Discharged directly on land or in a water body (name the lake/stream)

Potential for Reducing Consumption/Demand

Potential reduction in Agriculture
by micro-irrigation
by crop diversification

Potential reduction in Industries
By improved machinery/ technology/ inputs
By improved processing

Potential reuse of treated domestic sewage effluents
In Agriculture
In Industries
In Domestic use

Potential for reuse/recycling of industrial effluents
In Agriculture
In Industries
In Domestic use

Chapter 7
CONCLUSIONS AND RECOMMENDATIONS

Knowing that water is essential for the existence of life of the Earth and the survival of all organisms – from microbes to mammals including humans;

Recognising that water is critical to all biological, social, cultural needs of humans as well as for their economic development;

Being aware that the availability of water on the Earth varies between extremes, both temporally and spatially;

Further recognizing the fact that the State of Rajasthan is the largest but the driest state of India (with 11.4% of India's land area and only 1.5% of India's total water resources);

Also noting that the State of Rajasthan imports currently about 40% of its total water requirement from the river systems in the neighbouring states;

Expressing concern at the rapid decline of the groundwater resources which are also affected by widespread salinity and high fluoride content;

Realising that it is necessary to dovetail the industrial development with the availability of water in different ecoclimatic zones;

Taking cognizance of the Rajasthan State Sewerage and Wastewater Policy, 2016; and

Stressing upon the need for Reducing, Recycling and Reuse of water in the industrial sector, especially for the water-intensive industrial units;

Following recommendations are made for implementation by the Government of Rajasthan through its concerned Departments and Organisations including the State Pollution Control Board:

7.1 Siting of New Industrial Areas / Industrial Units.

Sites for all new industrial estates or units should be selected by according highest consideration to the overall (net) water availability in that specific area, taking into account both the surface and groundwater, the existing consumption by all sectors (domestic, agriculture, existing industries) and their projected demand over the next 20-25 years. The changes in water availability resulting from climate change should also be factored in.

The Industrial Zoning exercise undertaken in the past should be revived and the water availability in each village/block should be included as the most important parameter in the zoning process.

All those areas which have very low water availability (rain, surface water or groundwater), including the over-exploited blocks notified by the Central Ground Water Board, should be identified as prohibited areas for setting up any new industry that requires significant amounts of water for industrial process.

7.2 Consent to Establish / Consent to Operate

Cumulative water requirement of already approved/setup industries should be taken into account before granting approval (consent to establish and consent to operate) for new industries requiring any amount of water for use in various processes (other than domestic use).

Achievement of the objective of reduction in water use (in terms of abstraction) and meeting the desired standards for effluents should supersede the technological restrictions.

The Application Forms for obtaining Consent to Establish/Consent to Operate should be suitably modified to require information on the specific water use in different processes and on the proposed quantum of each product, as well as the steps proposed to be taken for recycling/reuse of wastewater.

7.3 Existing Industrial Areas/Industrial Units

Further expansion of existing industries should be prohibited in areas identified for their low water availability. In areas where water consumption has already reached the limits of safe sustainable availability, industries may be required to relocate or change to another kind. (mention areas highly or medium stressed)

7.4 Reduction in Water Consumption/Withdrawal

All efforts should be directed at reducing water consumption at every stage / in each process in the existing industrial units.

Adoption of all measures which help in reducing the overall consumption of water should be promoted and incentivized. These may include a change in the nature and quality of inputs, processes, and machinery.

Various regulations, rules and procedures should be amended to facilitate and promote the adoption of latest technologies. Industries should be at liberty to choose the technology that they deem appropriate for saving water and energy directly and/or through recycling and reuse, and reducing the discharge of wastewater.

7.5 Monitoring Water Use

Monitoring of water abstraction, use and wastewater generation at each process step should be mandatory and the meters installed for the purpose should be connected to dataloggers, accessible to the regulatory institutions. Rectification of any malfunctioning of the meters should be responsibility of the industry.

Daily, monthly, and seasonal variation in production should be reported, and any significant reduction must be reflected clearly in the water consumption and wastewater generation. An increase in production without additional water abstraction and without increasing wastewater discharge should be readily permissible.

7.6 Rainwater Harvesting

Rainwater harvesting that is currently mandatory in all industries should be linked with the use of water in that industry. All industries should be required to store the harvested rainwater appropriately, and use it in their respective units, thereby effectively reducing the withdrawal of ground water or surface water. The amounts of water harvested and used within the industry should be made reportable and verifiable.

The current policy of rainwater harvesting should be changed at the earliest from the one of mandatory groundwater recharge through specifically designed recharge structures, to the one requiring compulsory use of the harvested rainwater and lowering the permissible groundwater or surface water abstraction. This will eliminate the need for granting exemptions from recharge to the industries in those areas where the water table is quite high and hence, recharge wells cannot be installed.

Rainwater harvesting requirement should also be set according to the actual rainfall in various districts and the potential for harvesting it (instead of as a percentage of water consumed by the industry).

7.7 Recycling and Reuse of Wastewater (Industrial Effluents)

All technological measures for resource recovery, recycling and reuse of wastewater should be encouraged, actively promoted (or made mandatory) and incentivized. The wastewater can be used within the same industrial unit or another industry.

Industrial effluents from some sectors may be appropriate, without or after treatment, for reuse in agriculture, horticulture or silviculture. Such reuse should be promoted in nearby fields especially in view of the availability of the industrial effluents throughout the year, and their use in agriculture will reduce groundwater abstraction for irrigation in the dry season.

Industries should be required to stop discharging any effluent (i.e., zero liquid discharge) even after treatment on land or into a surface water body or into the ground water.

Industrial sectors where total ZLD may not be feasible should be identified based on the nature and quality of their effluents.

There should be a regular water audit of all water consuming industries, particularly the water-intensive industries. Besides the data on water as obtained from monitoring mentioned above, the industries should be required to provide data on the raw material used and the production of various goods in each unit, based on the bills/invoices, for use in their water audit.

7.8 Changes in EIA Process

The availability of adequate water within the area where the industry is proposed to be set up should be included as a determining factor in the EIA process by MOEFCC/SEIAA. The proponent should declare in the proposal that the site lies or does not lie in a block notified by the CGWA or the block with critical or semi-critical state of groundwater. Further it should be the responsibility of the proponent to inform the current committed use/withdrawal of water by the existing industries, settlements (domestic use) and agriculture within the block.

In this context, it should be noted that by its order of 13 July 2020 in the case OA no. 1176/2015 of Shailesh Singh v s Hotel Holiday Regency, Moradabad, the National Green Tribunal has directed the CGWA that, *"**There must be no general permission for withdrawal of ground water, particularly to any commercial entity, without environment impact assessment of such activity on individual Assessment units in cumulative terms covering carrying capacity aspects by an expert committee**"***.**

In order to promote the reuse of industrial wastewater in agriculture or another industry, the EIA process may include a pre-project tie-up with farmers/industry within the specified area (block), in order to ensure that the wastewater meets the standards required by the recipient.

7.9 Changes in Policies

Industrial policy may be modified to consider water availability (and its projection over the next 50 years) as the prime factor in granting approval to establishment of new industrial areas and industrial units which require water beyond the carrying capacity of the area.

Appropriate institutional arrangements should be made to ensure intersectoral cooperation for implementing the policies in letter and spirit.

7.10 Education and Awareness

Industrial workers should be involved in the management of water and wastes within the industry. Education and awareness programmes should be organized regularly to sensitize them about the importance of water consumption and the impacts of wastewater in an integrated manner.

7.11 Promotion of Water Conservation in the Industries

In order to promote the adoption of measures for reducing water consumption, for recycling and reuse of water, and for minimizing or elimination of wastewater discharge, the industries should be encouraged to participate in an annual or biennial rating of their performance with respect to water use and wastewater (quantum and quality).

Such rating exercise may be used exclusively for a new ‘ecolabelling’ of the products of water-intensive industries to emphasize and highlight the importance of water conservation for the consumers of these products and the public in general. Quantitative aspects of water use and wastewater discharge and overall water efficiency should also be accorded due importance, among other environmental performance indicators, for rating and ecolabelling scheme of the MOEF-CC.

7.12 Further Studies

Benchmarking of water use efficiency in various industries requires detailed studies over at least two years for collection and analysis of data related to water use in each process of all kinds on industries. This is necessary to account for the daily and seasonal variability, efficiencies of various processes and machinery, the nature of waste stream from each process and its reuse/recycling potential, various inputs and energy linkages, product quality and socio-economic considerations.

Such a detailed study requires that the industries maintain a log of water abstracted, received from RIICO or through any other source, water consumed in every process on a daily basis, the amount and quality of waste generated in each process, amount of wastewater reused/ treated or disposed, or sent to the CETP/ETP, and the fate of the water coming out of the CETP/ETP.

Further studies are also required on the detailed mapping of groundwater and its quality along with changes over time in the industrial areas. The likely impacts of industrial water use in agriculture, on soils and vegetation, and on groundwater need systematic investigations for all kinds of water-intensive industries. Field level studies are required to investigate the potential and efficacy of nature-based solutions to treatment of industrial wastewaters, including the recovery of resources wherever feasible.

Benchmarking is in the interest of industries themselves for improving their resource use efficiency, gaining economic benefits in the long term, and serving the cause of environment (corporate environmental responsibility).

The is also recommended that the industries be requested to regularly provide detailed information on their water abstraction, process wise use, recycling-reuse, and wastewater discharge. Suggested formats are given in Annexure III.

7.13 Roles and Responsibilities of Various Stakeholders

Siting of New Industrial Areas / Industrial Units	**Dept responsible for action**
Sites for all new industrial estates or units should be selected by according highest consideration to the overall (net) water availability in that specific area, taking into account both the surface and groundwater, the existing consumption by all sectors (domestic, agriculture, existing industries) and their projected demand over the next 20-25 years. The changes in water availability resulting from climate change should also be factored in.	Dept of Industries; RIICO WRD/CGWB
The Industrial Zoning exercise undertaken in the past should be revived and the water availability in each village/block should be included as the most important parameter in the zoning process.	RIICO; RSPCB
All those areas which have very low water availability (rain, surface water or groundwater), including the over-exploited blocks notified by the Central Ground Water Board, should be identified as prohibited areas for setting up any new industry that requires significant amounts of water for industrial process.	RIICO; RSPCB
Consent to Establish / Consent to Operate	
Cumulative water requirement of already approved/setup industries should be taken into account before granting approval (consent to establish and consent to operate) for new industries requiring any amount of water for use in processes (other than domestic use).	RSPCB
Achievement of the objective of reduction in water use (in terms of abstraction) and meeting the desired standards for effluents may supersede the technological restrictions.	RSPCB
The Application Forms for obtaining Consent to Establish/Consent to Operate should be suitably modified to require information on the specific water use in different processes and on the proposed quantum of each product, as well as the steps proposed to be taken for recycling/reuse of wastewater.	RSPCB
Existing Industrial Areas/Industrial Units	
Further expansion of existing industries should be prohibited in areas identified for their low water availability. In areas where water consumption has already reached the limits of safe sustainable availability, industries may be required to relocate or change to another kind. (mention areas highly or medium stressed)	RSPCB

Reduction in Water Consumption/Withdrawal	
All efforts should be directed at reducing water consumption at every stage / in each process in the existing industrial units.	Industries; CII etc
Adoption of all measures which help in reducing the overall consumption of water should be promoted and incentivized. These may include a change in the nature and quality of inputs, processes, and machinery.	Dept of Industries; RSPCB
Various regulations, rules and procedures should be amended to facilitate and promote the adoption of latest technologies. Industries should be at liberty to choose the technology that they deem appropriate for saving water and energy directly and/or through recycling and reuse, and reducing the discharge of wastewater.	CPCB
Monitoring Water Use	
Monitoring of water abstraction, use and wastewater generation at each process step should be mandatory and the meters installed for the purpose should be connected to dataloggers, accessible to the regulatory institutions. Rectification of any malfunctioning of the meters should be responsibility of the industry.	CGWB; PHED; RIICO; RSPCB; Industries
Daily, monthly, and seasonal variation in production should be reported and must be reflected clearly in the water consumption and wastewater generation.	Industries
Rainwater Harvesting	
Rainwater harvesting that is currently mandatory in all industries should be linked with the use of water in that industry. All industries should be required to store the harvested rainwater appropriately, and use it in their respective units, thereby effectively reducing the withdrawal of ground water or surface water. The amounts of water harvested and used within the industry should be made reportable and verifiable.	CGWB; WRD;
Accordingly, the current policy of rainwater harvesting that mandates groundwater recharge through specifically designed recharge structures should be changed and communicated for implementation at the earliest. This will help avoiding the exemptions from recharge to be granted to the industries in those areas where the water table is quite high and hence, recharge wells cannot be installed.	CGWB
Rainwater harvesting requirement should also be set according to the actual rainfall in various districts and the potential for harvesting it (instead of as a percentage of water consumed by the industry).	CGWB
Recycling and Reuse of Wastewater (Industrial Effluents)	

All technological measures for resource recovery, recycling and reuse of wastewater should be encouraged, actively promoted (or made mandatory) and incentivized. The wastewater can be used within the same industrial unit or another industry.	RSPCB; PHED; Industries Dept
Industrial effluents from some sectors may be appropriate, without or after treatment, for reuse in agriculture, horticulture or silviculture. Such reuse should be promoted in nearby fields especially in view of the availability of the industrial effluents throughout the year, and their use in agriculture will reduce groundwater abstraction for irrigation in the dry season.	RSPCB; CPCB; Agriculture Dept;
Industries should be required to stop discharging any effluent (i.e., zero liquid discharge) even after treatment on land or into a surface water body or into the ground water.	CPCB, RSPCB;
Industrial sectors where total ZLD may not be feasible should be identified based on the nature and quality of their effluents.	CPCB, RSPCB;
Changes in EIA Process	
The availability of adequate water within the area where the industry is proposed to be set up should be included as a determining factor in the EIA process by MOEFCC/SEIAA. The proponent should declare in the proposal that the site lies or does not lie in a block notified by the CGWA or the block with critical or semi-critical state of groundwater. Further it should be the responsibility of the proponent to inform the current committed use/withdrawal of water by the existing industries, settlements (domestic use) and agriculture within the block.	MOEF-CC; SEIAA; SECA
In order to promote the reuse of industrial wastewater in agriculture or another industry, the EIA process may include a pre-project tie-up with farmers/industry within the specified area (block), in order to ensure that the wastewater meets the standards required by the recipient.	Agriculture Dept; Industries Dept; RSPCB
Changes in Policies	
Industrial policy may be modified to consider water availability (and its projection over the next 50 years) as the prime factor in granting approval to establishment of new industrial areas and industrial units which require water beyond the carrying capacity of the area.	Dept of Industries; Central/State Groundwater Board
Appropriate institutional arrangements should be made to ensure intersectoral cooperation for implementing the policies in letter and spirit	All concerned Deptts of the State Government
Education and Awareness	

Industrial workers should be involved in the management of water and wastes within the industry. Education and awareness programmes should be organized regularly to sensitize them about the importance of water consumption and impacts of wastewater in an integrated manner. Awareness and education programs are also required among the farmers and other stakeholders who may use the industrial effluents. Strict quality control measures will also be required.	RIICO; Industries Dept; RSPCB; NGOs; Industry Associations
Promotion of Water Conservation in the Industries	
The industries should be encouraged to participate in an annual or biennial rating of their performance with respect to water use and wastewater (quantum and quality). Such rating exercise may be used exclusively for a new 'ecolabelling' of the products of water-intensive industries	RSPCB, NGOs, and Industry Associations
Further Studies	
Industry-wise detailed studies are required for collection and analysis of data related to water use in each process of all kinds on industries. This should account for the daily and seasonal variability, efficiencies of various processes and machinery, the nature of waste stream from each process and its recycling / reuse potential, various inputs and energy linkages, product quality and socio-economic considerations. Such a detailed study requires that the industries maintain a log of water abstracted, received from RIICO or through any other source, water consumed in every process on a daily basis, the amount and quality of waste generated in each process, amount of wastewater reused/ treated or disposed, or sent to the ETP/ CETP, and the fate of the water coming out of the CETP/ETP.	RSPCB; Universities, IITs and other Research institutions; NGOs, Industries throughout the State RSPCB asks the industries to maintain a log and report the data every month.
Studies required on detailed mapping of groundwater and its quality along with changes over time in the industrial areas. Investigations on the likely impacts of industrial water use in agriculture, on soils and vegetation, and on groundwater, for all kinds of water-intensive industries. Field level studies to investigate the potential and efficacy of nature-based solutions to treatment of industrial wastewaters, including the recovery of resources wherever feasible.	RSPCB; Groundwater Dept, Universities, IITs and other Research institutions; NGOs,

REFERENCES

Chapter 1

CPHEEO. 2013. Manual on Sewerage and Sewage Treatment Systems, Ministry of Urban Development, New Delhi.

GWP (Global Water Partnership). 2000. 'How to Bring Ecological Services into Integrated Water Resources Management', Report from GWP Seminar, Beijer Occasional Paper series. Stockholm: Beijer Institute and Global Water Partnership.

Mihir Shah Committee. 2016. A 21st Century Institutional Architecture for India's Water Reforms. Report of the Committee on restructuring CWC and CGWB. New Delhi, MOWR-RDGR

Ministry of Jal Shakti. http://mowr.gov.in/schemes-projects-programmes/schemes/pmksy

National Water Framework Bill, 2016. Ministry of Water Resourcesm River Development and Ganga Rejuvenation, New Delhi.

Statistical Year Book India 2018. Government of India, New Delhi.

WWAP (United Nations World Water Assessment Programme)/UN-Water. 2018. The United Nations World Water Development Report 2018: Nature-Based Solutions for Water. Paris, UNESCO

Chapter 5

Breweries Industry

Beverage Industry Environmental Roundtable (BIER). 2011. Water Use Benchmarking in the Beverage Industry. Trends and Observations, 2011. 14 pages.

Brewers' Association. 2017 Sustainability Benchmarking Report. 66 pages.

Oyebode, O. Joshua and Ife Kehinde Adewumi. 2014. Life Cycle Assessment and Management of Water Use in Selected Breweries in Nigeria. Civil Engineering and Architecture 2(5): 191-201.

Textile Industry

Alanya, S., E. Ozturk, F. Morova, U. Yetis, F.B. Dilek, G.N. Demirer. 2006. Environmental Performance Evaluation of Textile Wet Processing Sector in Turkey. 9th annual EMAN conference. Middle East Technical University, Ankara, Turkey, http://www. metu. edu.tr

Arputharaj, A., Raja, A., Saxena, S., 2016. Developments in sustainable chemical processing of textiles. Green Fashion 217–252.

CPCB. 2016. Environmental Status of Rajasthan. Information for Study Visit of the Department - related Parliamentary Standing Committee on Science & Technology, Environment & Forest to Udaipur & Mount Abu from 28th June to 1st July, 2016. CPCB, New Delhi.

Diebaecker, Marc. 2000. Environmental and social benchmarking for industrial processes in developing countries: a pilot project for the textile industry in India, Indonesia and Zimbabwe. Integrated Manufacturing Systems 11/7: 491-499. (based on UNIDO Report)

Environmental Technology Best Practice Programme (ETBPP), 1997. Water and Chemical Use in Textile Dyeing and Finishing (No. GG62). Retrieved from http:// www.wrap.org.uk/sites/files/wrap/GG062.pdf.

European Commission, 2003. Reference Document on Best Available Techniques for the Textiles Industry (BREF). Retrieved from http://eippcb.jrc.es/reference/ BREF/txt_bref_0703.pdf.

Environmental Technology Best Practice Programme (ETBPP), 1997. Water and Chemical Use in Textile Dyeing and Finishing (No. GG62). Retrieved from http:// www.wrap.org.uk/sites/files/wrap/GG062.pdf.

European Commission, 2003. Reference Document on Best Available Techniques for the Textiles Industry (BREF). Retrieved from http://eippcb.jrc.es/reference/ BREF/txt_bref_0703.pdf.

Garrett, B., Shorofsky, B., & Radcliffe, R. (n.d.). Evaluation of textile treatment and treatment alternatives for the village of Jasol in Rajasthan, India. A Collaboration of the Jal Bhagirathi Foundation and the Northwestern University Global and Ecological Health Engineering Certificate Program. Retrieved from http://www.civil.northwestern.edu/ EHE/HTML_KAG/Kimweb/files/FINAL%20Report%20for%20JBF.pdf

Gulzar, Tahsin, Tahir Farooq, Shumaila Kiran, Ikram Ahmad, Arruje Hameed. 2019. Green chemistry in the wet processing of textiles. In: The Impact and Prospects of Green Chemistry for Textile Technology. Elsevier, Amsterdam. p. 1-20.

Kumar, Ritu, Nebiyeleul Gessese and Yasuo Konishi. 1998. Responding to Global Standards: A framework for assessing social and environmental performance of industries. United Nations Industrial Development Organization, Vienna. 220 pages.

Ministry of Textiles, Govt of India. 2011. Technology Mission on Technical Textiles:Compendium on Centres of Excellence. New Delhi. 106 pages.

Ozturk, E., Hasan Koseoglu, Nevzat Ozgu Yigit, Ulku Yetis, Mehmet Kitis. 2014. Optimization of water and chemical use in a cotton polyester fabric dyeing textile mill. 9th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES13 Conference), Dubrovnik.

Ramesh Babu, B., A.K. Parande, S. Raghu, and T. Prem Kumar (2007). Textile Technology-Cotton Textile Processing: Waste Generation and Effluent Treatment. The Journal of Cotton Science 11(2007), p. 141–153.

Restiani, Phillia and Khandelwal, Aparna. 2016. Water Governance Mapping Report: Textile Industry Water Use in India. Focus on the Faridabad-Ballabgarh Textile Cluster in the State of Haryana. Stockholm International Water Institute, Sustainability Outlook, and Sweden Textile Water Initiative. 56 pages.

Saxena, S., Raja, A., Arputharaj, A., 2017. Challenges in sustainable wet processing of textiles. In: Textiles and Clothing Sustainability. Springer, pp. 43–79.

Shaikh, Muhammad Ayaz. 2009. Water conservation in textile industry. Pakistan Textile Journal 58(11):48-51.

Sharma, D.K. 2015. Water and Wastewater Quantification in a Cotton Textile Industry. International Journal of Innovative Science, Engineering & Technology 2(6): 288-299.

Smith, Brent. 1987. Water and textile wet processing. Part I. American Dyestuff Reporter, July: 15-23.

Turkish Statistical Institute - TSI, 2008. Water Consumption Breakdown in Turkish Manufacturing Industry. Ankara, Turkey.

UNIDO. 1998. Survey paper on guidelines and norms for textile wet processing: preparatory assistance for the development of performance norms and benchmarks for industrial processes based on the life cycle concept" (prepared by Modak, Prasad), Vienna.

USEPA (US Environment Protection Agency) 1997. Textile Sector Notebook.

Volmajer Valh, Julia; Alenka Majcen Le Marechal; Simona Vajnhandl; Tina Jerič; Ernest Šimon. 2011. Water in the textile industry. In: P. Wilderer (ed) Treatise on Water Science, Vol. 4: 685-706 Elsevier, Oxford.

Dairy Industry

Ajiero, Ikenna, and David Campbell. 2018. Benchmarking Water Use in the UK Food and Drink Sector: Case Study of Three Water-Intensive Dairy Products. Water Conservation Science and Engineering 3: 1–17

Carawan, Roy E., V.A, Jones and A.P. Hansen. 1979. Water use in multiproduct dairy. Journal of Dairy Science 62: 1238-1242.

Envirowise, U.K. Benchmarking Water Use in Dairies. Envirowise, Didcot, Oxfordshire, U.K. 26 pages.

Mahrous, Hanan Mohamed and Wafaa Kamel Bahgaat, 2019. Efficiency of water resources in small and medium-sized dairy factories in Egypt. International Journal of Dairy Science 14: 1-11.

NDDB. 2016. Dairying in Rajasthan - A Statistical Profile. 2016. National Dairy Development Board, Anand, Gujarat. 134 pages.

Verheijen, L.A.H.M., D. Wiersema and L.W. Hulshoff Pol. 1996. Chapter 4. Dairy Industry. In Management of Waste from Animal Product Processing. FAO, Rome.

Wojdalski, Janusz, Bogdan Dróżdż, Janusz Piechocki, Marek Gaworski, Zygmunt Zander, and Jan Marjanowski. 2013. Determinants of water consumption in the daury industry. Polish Journal of Chemical Technologyy 15 (2): 61-72.

Xu, T., Ke, J., and Sathaye, J. 2011. User's Manual for BEST-Dairy: Benchmarking and Energy/water-Saving Tool (BEST) for the Dairy Processing Industry (Version 1.2). United States: N. p., Web. doi:10.2172/1026805.

Power Industry

Centre for Science and Environment [CSE] (2004), 'Not a Non-Issue', *Down to Earth*, Vol. 12, No. 19, February.

CEA. 2017. Growth of Electricity Sector in India from 1947–2017. Delhi: Government of India, Central Electricity Authority. http://www.cea.nic.in/reports/others/planning/pdm/growth_2017.pdf.

Tianyi Luo, Tianyi, Deepak Krishnan, and Shreyan Sen. 2018. Parched Power: Water Demands, Risks, and Opportunities for India's Power Sector. World Resources Institute, New Delhi.

Fertilizer Industry

Chandra Bhushan, Sanjeev Kumar Kanchan, Sugandha Arora, Vinay Trivedi, Shobhit Srivastava, Kapil Subramanian and Shreya Verma 2019. Grain by Grain: Green rating of the fertilizer sector, Centre for Science and Environment, New Delhi

Department of Fertilizers. 2018. Indian Fertilizer Scenario 2018. Department of Fertilizers, Ministry of Chemicals and Fertilizers, Government of India, New Delhi. 118 pages.

Hotel Industry

CPHEO. 1999. Manual on Water Supply and Treatment. Third revised edition. New Delhi.

CGWA. 2016. Estimation of water requirement for drinking and domestic use (Source: NBC 2016, BIS). Central Ground Water Authority, New Delhi.
http://cgwa- noc.gov.in/LandingPage/Guidlines/NBC2016WatRequirement.pdf

ANNEXURE 1

Environmental Guidelines for Industries

(from http://www.moef.gov.in/citizen/specinfo/enguin.html

In order to help the concerned authorities and the entrepreneurs,it is necessary to frame certain broad guidelines for siting an industry. It is also necessary to identify the parameters that should be taken into account while setting up an industry. With this in view, the following environmental guidelines are recommended for siting of Industries to ensure optimum use of natural and man-made resources in sustainable manner with minimal depletion, degradation and/or destruction of environment. Those are in addition to those directives that are already in existence under the Industries (Development and Regulation) Act.

AREAS TO BE AVOIDED

In siting industries, care should be taken to minimise the adverse impact of the industries on the immediate neighbourhood as well as distant places. Some of the natural life sustaining systems and some specific land uses are sensitive to industrial impacts because of the nature and extent of fragility. With a view to protecting such an industrial sites shall maintain the following distances from the areas listed:

- Ecologically and/or otherwise sensitive areas: at least 25 km;depending on the geo-clmatic conditions the requisite distance hall have to be increased by the appropriate agency.
- Coastal areas: at least 1/2 km from High Tide Line.
- Flood Plain of the Riverine Systems: at least 1/2 km from flood plain or modified flood plain affected by dam in the upstream or by flood control systems.
- Transport/Communication System: at least 1/2 km from highway and railway.
- Major settlements(3,00,000 population): distance from settlements is difficult to maintain because of urban sprawl. At the time of siting of the industry if any major settlement's notified limit is within 50 km, the spatial direction of growth of the settlement for at least a decade must be assessed and the industry shall be sited at least 25 km from the projected growth boundary of the settlement.

Pre-requisite: State and Central Governments are required to identify such areas on a priority basis.

Note:
Ecological and/or otherwise sensitive areas include (i)Religious and Historic Places; (ii)Archaeological Monuments (e.g. identified zone around Taj Mahal); (iii)Scenic Areas; (iv)Hill Resorts; (v)Beach Resorts; (vi)Health Resorts; (vii)Coastal Areas rich in Coral, Mangroves, Breeding Grounds of Specific Species; (viii) Estuaries rich in Mangroves, Breeding Ground of Specific Species; (ix)Gulf Areas; (x) Biosphere Reserves; (xi)National Parks and Sanctuaries; (xii) Natural Lakes, Swamps; (xiii) Seismic Zones; (xiv) Tribal Settlements; (xv) Areas of Scientific and Geological interest; (xvi) Defence Installations, especially those of security importance and sensitive to pollution; (xvii) Border Areas (International) and (xviii) Airports.

SITING CRITERIA

Economic and social factors are recognized and assessed while siting an industry. Environmental factors must be taken into consideration in industrial siting. Proximity of water sources, highway, major settlements, markets for products and raw material resources is desired for economy of production, but all the above listed systems must be away for environmental protection. Industries are, therefore, required to be sited, striking a balance between economic and environmental considerations. In such a selected site, the following factors must be recognized.

- No forest land shall be converted into non-forest activity for the sustenance of the industry (Ref: Forest Conservation Act, 1980).
- No prime agricultural land shall be converted into industrial site.
- Within the acquired site the industry must locate itself at the lowest location to remain obscured from general sight.
- Land acquired shall be sufficiently large to provide space for appropriate treatment of waste water still left for treatment after maximum possible reuse and recycle. Reclaimed (treated) wastewater shall be used to raise green belt and to create water body for aesthetics, recreation and if possible, for aquaculture. The green belt shall be 1/2 km wide around the battery limit of the industry. For industry having odour problem it shall be a kilometer wide.
- The green belt between two adjoining large scale industries shall be one kilometer.
- Enough space should be provided for storage of solid wastes so that these could be available for possible reuse.
- Lay out and form of the industry that may come up in the area must conform to the landscape of the area without affecting the scenic features of that place.
- Associated township of the industry must be created at a space having physiographic barrier between the industry and the township.
- Each industry is required to maintain three ambient air quality measuring stations within 120 degree angle between stations.

Siting Guidelines for Industries

Industrial development significantly contributes towards economic growth. However, industrial progress brings along with it a host of environmental problems. Many of these problems could be avoided if industries are located on the basis of environmental considerations, injudicious siting of industry can seriously affect the environmental features such as air, water, land, flora, fauna, human settlements and health of people. The entrepreneur should be fully aware of these implications and he should take necessary steps while setting up the industry so as to minimise the possible adverse effects on the environmental resources and quality of life. Often, an entrepreneur finds it very costly to install pollution control equipment and other mitigative measures after the industry is already set up. As such, preventive steps are needed at the time of siting rather than going in for curative measures at a later stage.

The **Industrial Policy Statement** of July 1980, recognised the need for preserving ecological balance and improving living conditions in the urban centers of the country. On the basis of this Policy, indiscriminate expansion of the existing industries and setting up of new industrial undertakings within the limits of metropolitan cities and the larger towns should not be permitted. However, the Policy has not touched upon the implications of setting up an industry in sensitive areas, both ecological or otherwise, which would have an effect on the overall development process.

At present, industries are being located on the basis of raw material availability, access to the market, transport facilities and such other techno-economic considerations without adequate attention to environmental considerations are recognised as an important criterion for setting of industry. To prevent air, water and soil pollution arising out of industrial projects, the industrial licensing procedure requires that the entrepreneurs before setting up the industry obtain clearance from Central/State Air and Water Pollution Control Boards. The Central State Pollution Control Boards stipulate that air (gases) and water (effluents) emanating from the industry should adhere to certain quality standards. However, these stipulations do not prevent the industry from affecting the total environment by wrong siting. Also, the cumulative effect of a number of industries at a particular place is not being studied upon, with the result that an industry or an industrial area over a period of time could cause significant damage to the surrounding environment and ecological features In respect of certain industrial development projects it is not only necessary to install suitable pollution control equipment but also to identify appropriate sites for their location. To give a concrete shape to this requirement, a select group of 20 industries has been notified by the Department of Industrial Development.

A formalised procedure has been stipulated for site selection from environment angle with regard to these projects.
According to this procedure for the select group of industries, the letters of intent should be converted to industrial licences only after the following conditions have been fulfilled:
The State Director of Industries confirms that the site of the project has been approved from environmental angle by the competent State Authority.
The entrepreneur commits both to the State Government and Central Government that he will install the appropriate equipment and implement the prescribed measures for the prevention and control of pollution.
The concerned State Pollution Control Board has certified that the proposal meets with the environmental requirements and that the equipment installed or proposed to be installed are adequate and appropriate to the requirement.
The State Department of Environment will be the competent authority for approval of project sites from environmental angle. In those States where such Departments have not yet been set up, approval should be obtained from the nodal agency designated for looking after environmental matters. With regard to projects where support from the Central Government/International Agencies is envisaged and which come under the purview of Industrial Licensing, approval of the project site from environmental angle should be obtained from the Ministry of Environment and Forests, Government of India. The entrepreneur should provide the details of proposed project site, pollution abatement measures and such other relevant information as required for review from environmental angle. The entrepreneur will be required to submit half-yearly progress report on installation of pollution control devices to the respective State Pollution Control Boards.

Depending on the nature and location of the project, the entrepreneur will be required to submit comprehensive Environmental Impact Assessment Report, and Environment Management Plans.

Environmental Impact Assessment (EIA)

1. The purpose of Environmental Impact Assessment (EIA) is to identify and evaluate the potential impacts(beneficial and adverse)of development and projects on the environmental system.It is an useful aid for decision making based on understanding of the environment implications including social, cultural and aesthetic concerns which could be integrated with the analysis of the project costs and benefits. This exercise should be undertaken early enough in the planning stage of projects for selection of environmentally compatible sites, process technologies and such other environmental safeguards.

2. While all industrial projects may have some environmental impacts all of them may not be significant enough to warrant elaborate assessment procedures. The need for such exercises will have to be decided after initial evaluation of the possible implications of a particular project and its location. The projects which could be the candidates for detailed Environment Impact Assessment include the following:-
   - Those which can significantly alter the landscape, land use pattern and lead to concentration of working and service population;
   - Those which need upstream development activity like assured mineral and forest products supply or downstream industrial process development;
   - Those involving manufacture, handling and use of hazardous materials;
   - Those which are sited near ecologically sensitive areas, urban centers, hill resorts, places of scientific and religious importance.
   - Industrial Estates with constituent units of various types which could cumulatively cause significant environmental damage.
3. The Environmental Impact Assessment (EIA) should be prepared on the basis of the existing background pollution levels vis-a-vis contributions of pollutants from the proposed plant. The EIA should address some of the basic factors listed below:
   - Meteorology and air quality: Ambient levels of pollutants such as Sulphur dioxide, oxides of nitrogen, carbon monoxide, suspended particulate matters, should be determined at the center and at 3 other locations on a radius of 10 km with 120 degrees angle between stations. Additional contribution of pollutants at the locations are required to be predicted after taking into account the emission rates of the pollutants from the stacks of the proposed plant, under different meteorological conditions prevailing in the area.
   - Hydrology and water quality
   - Site and its surroundings
   - Occupational safety and health
   - Details of the treatment and disposal of effluents (liquid, air and solid) and the methods of alternative uses
   - Transportation of raw material and details of material handling
   - Control equipment and measures proposed to be adopted
4. Preparation of Environmental Management Plan is required for formulation, implementation and monitoring of environmental protection measures during and after commissioning of projects.

Environmental Management Plan (EMP)

Preparation of environmental management plan is required for formulation, implementation and monitoring of environmental protection measures during and after commissioning of projects. The plans should indicate the details as to how various measures have been or are proposed to be taken including cost components as may be required. Cost of measures for environmental safeguards should be treated as an integral component of the project cost and environmental aspects should be taken into account at various stages of the projects:

- Conceptualization: preliminary environmental assessment
- Planning: detailed studies of environmental impacts and design of safeguards
- Execution: implementation of environmental safety measures
- Operation: monitoring of effectiveness of built-in safeguards

The management plans should be necessarily based on considerations of resource conservation and pollution abatement, some of which are:

- Liquid Effluents
- Air Pollution
- Solid Wastes
- Noise and Vibration
- Occupational Safety and Health
- Prevention, maintenance and operation of Environment Control Systems
- House-Keeping
- Human Settlements
- Transport Systems
- Recovery - reuse of waste products
- Vegetal Cover
- Disaster Planning
- Environment Management Cell

1. Liquid Effluents

- Effluents from the industrial plants should be treated well to the standards as prescribed by the Central/State Water Pollution Control Boards.
- Soil permeability studies should be made prior to effluents being discharged into holding tanks or impoundments and steps taken to prevent percolation and ground water contamination.
- Special precautions should be taken regarding flight patterns of birds in the area. Effluents containing toxic compounds, oil and grease have been known to cause extensive death of migratory birds. Location of plants should be prohibited in such type of sensitive areas.
- Deep well burial of toxic effluents should not be resorted to as it can result in re-surfacing and ground water contamination. Re-surfacing has been known to cause extensive damage to crop and livestock.
- In all cases, efforts should be made for re-use of water and its conservation.

2. Air Pollution

- The emission levels of pollutants from the different stacks, should conform to the pollution control standards prescribed by Central or State Boards.
- Adequate control equipment should be installed for minimising the emission of pollutants from the various stacks.
- In-plant control measures should be taken to contain the fugitive emissions.
- Infrastructural facilities should be provided for monitoring the stack emissions and measuring the ambient air quality including micro-meteorological data (wherever required) in the area.
- Proper stack height as prescribed by the Central/State Pollution Control Boards should be provided for better dispersion of pollutants over a wider area to minimise the effect of pollution.
- Community buildings and townships should be built up-wind of plant with one-half to one kilometer wide greenbelt in addition to physiographical barrier.

3. Solid Wastes

- The site for waste disposal should be checked to verify permeability so that no contaminants percolate into the ground water or river/lake.
- Waste disposal areas should be planned down-wind of villages and townships.
- Reactive materials should be disposed of by immobilising the reactive materials with suitable additives.

- The pattern of filling disposal site should be planned to create better landscape and be approved by appropriate agency and the appropriately pretreated solid wastes should be disposed according to the approved plan.
- Intensive programs of tree plantation on disposal areas should be undertaken.

4. Noise and Vibration
   Adequate measures should be taken for control of noise and vibrations in the industry.

5. Occupational Safety and Health
   Proper precautionary measures for adopting occupational safety and health standards should be taken.

6. Prevention, maintenance and operation of Environment Control Systems

- Adequate safety precautions should be taken during preventive maintenance and shut down of the control systems.
- A system of inter-locking with the production equipment should be implemented where highly toxic compounds are involved.

7. House – Keeping
   Proper house-keeping and cleanliness should be maintained both inside and outside of the industry.

8. Human Settlements

- Residential colonies should be located away from the solid and liquid waste dumping areas. Meteorological and environmental conditions should be studied properly before selecting the site for residential areas in order to avoid air pollution problems.
- Persons who are displaced or have lost agricultural lands as a result of locating the industries in the area, should be properly rehabilitated.

9. Transport Systems

- Proper parking places should be provided for the trucks and other vehicles by the industries to avoid any congestion or blocking of roads.
- Siting of industries on the highways should be avoided as it may add to more road accidents because of substantial increase in the movements of heavy vehicles and unauthorised shops and settlements coming up around the industrial complex.
- Spillage of chemicals/substances on roads inside the plant may lead to accidents. Proper road safety signs both inside and outside the plant should be displayed for avoiding road accidents.

10. Recovery - reuse of waste products
    Efforts should be made to recycle or recover the waste materials to the extent possible. The treated liquid effluents can be conveniently and safely used for irrigation of lands, plants and fields for growing non-edible crops.

11. Vegetal Cover
    Industries should plant trees and ensure vegetal cover in their premises. This is particularly advisable for those industries having more than 10 acres of land.

12. Disaster Planning: Proper disaster planning should be done to meet any emergency situation arising due to fire, explosion, sudden leakage of gas etc. Fire fighting equipment

and other safety appliances should be kept ready for use during disaster/emergency situation including natural calamities like earthquake/flood.

13. Environment Management Cell
    Each industry should identify within its setup a Department/Section/Cell with trained personnel to take up the model responsibility of environmental management as required for planning and implementation of the projects.

http://cpcb.nic.in/district-specific-site-guidelines/

State Level Siting Guidelines

Updated on: 27 Jul 2017

The State level industrial siting guideline will clearly bring out the areas to be avoided and the rules/norms/procedures to be followed to obtain consent to establish. After completion of State Environmental Atlas, State level industrial siting guidelines will be formulated. For the State of Madhya Pradesh draft report has been received and under finalisation at CPCB.

The district level siting guidelines, clearly bring out information on environmentally sensitive zones/areas to be avoided for location of industries or carrying of process or operations, industries or carrying of processes or operations to be restricted in the district, potential zones for siting of air and water polluting industries and industries or carrying of process or operations that may be considered for siting anywhere in the district, other than 'Environmentally sensitive zones/areas to be avoided' for priority districts. This will be an instrument for implementing the district level Zoning Atlas for Siting of Industries. These guidelines once completed are to be published after undertaking stakeholder consultations. The district level Zoning Atlas for Siting of Industries will be used to develop these guidelines.

Annexure II

Important Lakes and Reservoirs of Rajasthan

Lake Badi
Balsamand Lake
Dhebar Lake
Fateh Sagar Lake
Jalsen Talab
Nakki Lake
Nandeshwar Lake
Lake Pichola
Pushkar Lake
Rajsamand Lake
Rang Sagar Lake
Swaroop Sagar Lake
Udaisagar Lake
Ana Sagar Lake
Foysagar
Doodh Talai Lake
Kaylana Lake
Man Sagar Lake
Maota Lake (Amber)
Pachpadra Lake
Ramgarh Lake
Sambhar Salt Lake
Deedwana
Lunkaransar
Talwara Lake
Silisher (Alwar)
Anandsagar (Banswara)
Dailab lake (Banswara)
Jaitsagar (Bundi)
Kanaksagar (Bundi)
Nawalsagar (Bundi)
Gaibsagar (Dungarpur)
Gadisar (Jaisalmer)
Kishoresagar (Kota)

Bisalpur Dam
Gosunda Dam
Hemawas
Jaggar Dam
Jakham Dam
Jawahar Sagar Dam
Jawai Dam
Kalisindh Dam
Kanota dam
Khandip Dam
Kota Barrage
Mahi Bajaj Sagar Dam
Mansi Wakal Dam
Meja Dam (Bhilwara)
Morel dam
Parban Dam Project
Rana Pratap Sagar Dam
Sarju Sagar Dam
Sei Dam
Thikariya dam

Annexure III

FORMAT FOR DATA ON WATER USE IN INDUSTRIES

(kindly provide data for at least weekly average for one year)

Name of Industry

Address:

PRODUCTS Production per day (Volume or Weight)

1.
2.
3.

Raw Material(s) Quantity (Vol./Wt) per day

1.
2.
3

Water Used (actual) in each Process (KL per unit Raw Material or Product)

Processes **Water used** **Wastewater generated**

Wastewater recycled or reused

From which process In which Process Amount

Gross Water Withdrawal (Actual, KL/day)

Actual Effluent discharged (KL/day) -sent to ETP/CETP

Technology used for reduction in use of water or for recycling (process-wise)