COMMERCIAL, INDUSTRIAL & INSTITUTIONAL WATER USE IN BANGALORE

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BBMP	Bruhat Bengaluru Mahanagara Palike
BDA	Bangalore Development Authority
BMPC	Bangalore Metropolitan Planning Committee
BMRDA	Bangalore Metropolitan Region Development Authority
BRR	Business Responsibility Reporting
BWSSB	Bangalore Water Supply and Sewerage Board
CETP	Common Effluent Treatment Plant
CFE	Consent For Establishment
CFO	Consent for Operation
CGWA	Central Ground Water Authority
CII	Commercial, Industrial and Institutional
CPCB	Central Pollution Control Board
ELCITA	Electronics City Industrial Township Authority
GRI	Global Reporting Initiatives
IIRC	International Integrated Reporting Council
IR	Integrated Reporting
IT & ITES	Information Technology & Information Technology Enabled Services
KGWA	Karnataka Ground Water Authority
KLD	Kilo Litre per Day
KSPCB	Karnataka State Pollution Control Board
LPED	Litre Per Employee per Day
MLD	Million Litre per Day
NIC	National Industrial Classification
PCB	Pollution Control Board
PSU	Public Sector Unit
RWH	Rain Water Harvesting
SDG	Sustainable Development Goal
SEBI	Securities and Exchange Board of India
SEEA-Water	System of Environmental-Economic Accounting for Water
SPCB	State Pollution Control Board
STP	Sewage Treatment Plant
TTW	Tertiary Treated Water
ULB	Urban Local Body

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EXECUTIVE SUMMARY

Urbanisation and rapid growth have increased freshwater demand in Bangalore city. The city's water needs are met through piped water supply from the Cauvery river and local groundwater. Although the largest demand is for meeting domestic needs, the **C**ommercial, **I**ndustrial and **I**nstitutional (**CII**) water demand is not only significant but also important to consider in the context of freshwater resource scarcity, and increasing water demand.

This report is focussed on CII water use in Bangalore city, for the years 2005, 2012 and 2015 based on a study conducted in 2015-16 using primary and secondary data. It reviews different sources of data and methods of estimation of commercial/ industrial water use and documents the challenges in the context of Bangalore. Water consumption by the CII sector is estimated using two different approaches: 1) establishment-level data to determine sectoral water use coefficients, 2) utility data along with "source mix ratios". Corporate reporting of water use and water-related metrics is briefly reviewed to assess its viability for use in estimation.

First, the water-use coefficient approach involves correlating establishment-wise water use to an establishment-level variable (i.e., employee strength) to derive a coefficient for each industrial/ commercial category. The sample data on water use and employees at the establishment level were obtained from primary surveys and secondary records (i.e., KSPCB records of industrial and commercial establishments). These data are self-reported. The derived coefficients are assumed to apply to all establishments within each industrial/ commercial category. Based on this approach, the commercial sector water use for Bangalore (BBMP region), estimated by applying the coefficients to employment data of the Economic Census, is approximately 52 MLD and 80 MLD for the years 2005 and 2012 respectively. Similarly, the industrial sector water use is estimated to be approximately 25 MLD and 19 MLD for the years 2005 and 2012 respectively.

Second, the piped water component of CII water use was obtained from metered piped supply records of the city. The self-supply component that consists of groundwater abstraction was estimated using an approximate zone-wise source mix ratio, determined from a sample of primary and secondary data on source dependency, i.e., what fraction of the water supplied was being sourced from piped water, groundwater and recycled water. The billed piped supply quantum of 92 MLD was divided by the fractions that the establishments self-declared to be from piped water, to estimate total use. By this approach, the total water use by the commercial and institutional sector in 2015 was estimated to be approximately 338 MLD of which 246 MLD is from groundwater. Similarly, the total water use by the industrial sector was estimated to be approximately 34 MLD, of which 26 MLD is from groundwater.

Comparing the water use estimates obtained using the two methods; it is observed that the coefficient-based method greatly under-estimates water use. As the BWSSB billed records of commercial and institutional water consumption are based on metered data, at a minimum, commercial and institutional water use cannot be less than 92 MLD. Since even industries have reported using 30-90% groundwater, it is unlikely that total water use can be only that much. This suggests that the water use coefficients, derived from data self-reported by industrial/ commercial establishments are very low and the coefficient-based approach used in this study does not provide a reliable estimate of CII water use.

Sustainability reports and annual reports by companies include varying degrees of disclosure related to water sources and use. Only two of the ten companies we reviewed provided quantitative information on water use in the “Business Responsibility Reports (BRR) mandated by the Securities and Exchange Board of India (SEBI). We found that water use details are best stated in sustainability reports and in the company annual reports that incorporate the Integrated Reporting (IR) framework.

This study contributes to improving an understanding of water use by the non-domestic sector in a large city context in India. By providing estimates of CII water use for Bangalore city using two different approaches and outlining their scope and limitations, the report sets a reference for further assessments to improve water planning in the city. Specifically, the recommendations are centred on improvements needed concerning a) data, and b) estimation.

Better Data:

1. Groundwater consumption by the CII sector is a critical missing information gap.
2. For the aggregation of CII data from different databases, there is a need for two important tags: a) Unique identifier for each CII establishment; which is tagged in all the databases where the establishment is listed, b) The latest and the previous version of NIC code applicable to the establishment at 2-, 3-, 4- and 5- digit level.
3. Within the Pollution Control Boards, there is a need for a comprehensive database that collates information from different compliance records for each CII establishment. Moreover, the integrated database needs to be computerised so that it is easier to access and use the data.

Better Estimation Methodology

1. The use of multiparameter water use coefficients would better account for water use especially in water-intensive manufacturing units. To scale up coefficients, there is a need for a variable that directly or indirectly indicates the scale of production. This requires comprehensive CII databases that include variables on technology, production capacity and employee strength.
2. A local comprehensive city-level database of CII establishments tagged with NIC codes at multiple levels can reduce the degree of assumptions involved in water use estimates.

1

INTRODUCTION

With the rapid growth of Bangalore city over the past two decades, the demand for water has increased significantly. As the commercial and industrial hub of Karnataka state with a population exceeding 10 million, the water demand by the **C**ommercial, **I**ndustrial and **I**nstitutional (**CII**) sector in Bangalore is substantial. The city depends primarily on two sources of water – 1) local groundwater, and 2) surface water imports, from the river Cauvery pumped from a distance of about 100 km. With depleting groundwater in parts of the city and legal limits on water imports from the Cauvery, the city needs to efficiently and equitably manage its water to meet the needs of different sectors ensuring sustainability of the resource and resilience against drought and climate change. However, there are critical knowledge gaps on how much water is actually used by different sectors, particularly the CII sector.

This report discusses the various sources of data related to water use by the CII sector and their limitations. We provide an estimate of CII water use for Bangalore city and discuss potential solutions that can help address the data gaps.

1.1 Bangalore's growth and the CII sector

Bangalore city has grown rapidly with ~97% decadal growth rate in population over the period 2001-2011 [1]. The city limits have been expanded to include smaller neighbouring towns and villages. The present municipal corporation limits (i.e. Bruhat Bengaluru Mahanagara Palike – BBMP) encompasses an area of 712 sq km (Figure 1).

The growth of the city (see Figure 2) is underpinned by different phases of industrial and commercial development. Historically a commercial hub in Mysore state, Bangalore had a thriving textile industry. It underwent a phase of deindustrialization during the colonial period. Industrial growth revived as several large public sector units (PSUs) were established in the period 1940s-1970s and large research institutions and private sector units were established in the growing city. Post 1980s, the industrial growth was driven by the private sector with the emergence of garment and electronic goods industry. Post 1990s, the information technology (IT) and its enabled services (ITES) industry witnessed rapid growth in the city [3]. Today, software products, machinery and readymade garments are listed as the three most important commodities manufactured within BBMP limits [1].

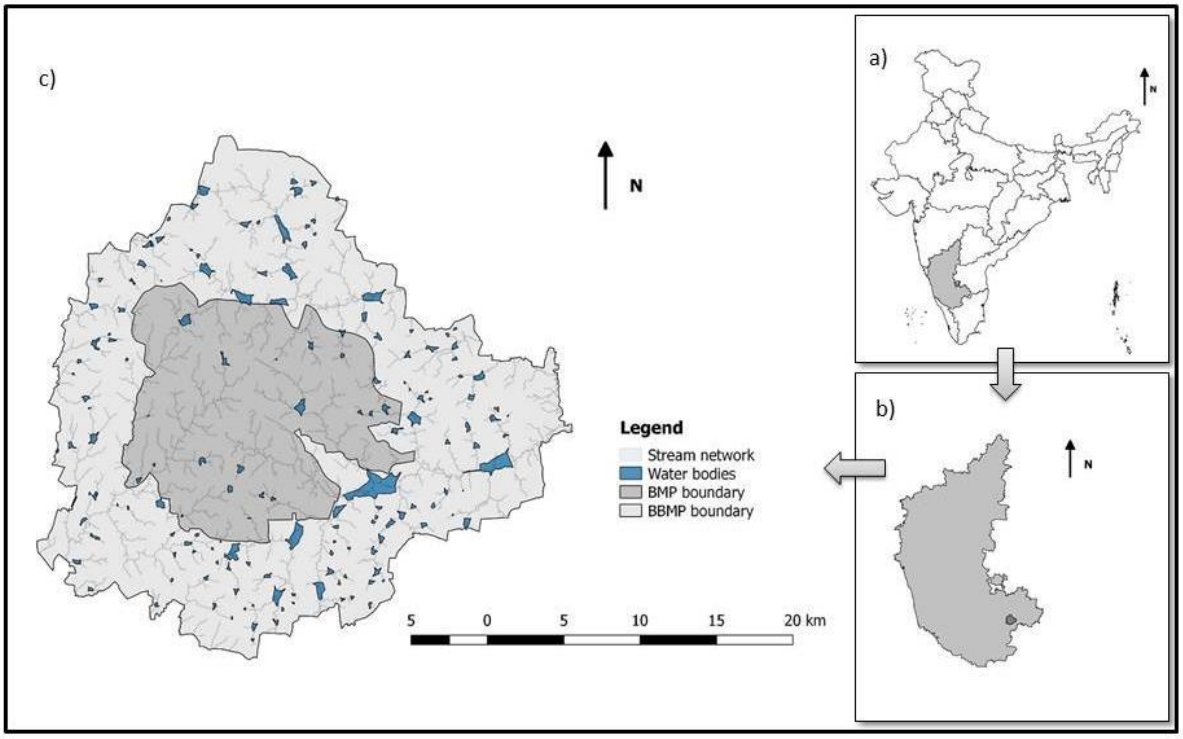

Figure 1: a) & b) Location of Bangalore in Karnataka state in India, c) Map of Bangalore city showing erstwhile BMP boundary (until 2007) and present BBMP boundary[1].

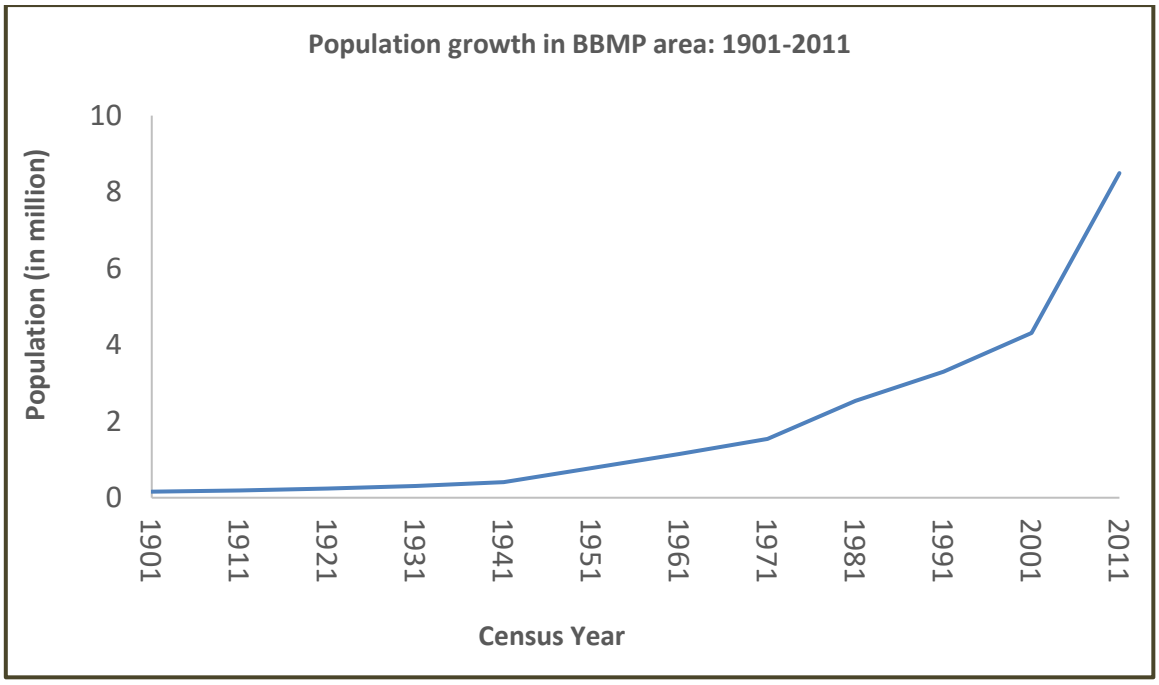

Figure 2: Population growth in BBMP area: 1901-2011 ***(Data Source: Census, 2011)***

[1] *The planning authority, Bangalore Development Authority (BDA) proposes a larger local planning area of 1207 sq km and a conurbation limit of 884 sq km* [2]. *The extent of the wider regional influence of the city is evident from the 8005 sq km area demarcated by the Bangalore Metropolitan Region Development Authority (BMRDA).*

1.2 Bangalore's water supply situation

Bangalore is situated at an elevation of 920 m above mean sea level and receives an average annual rainfall of about 860 mm. It is located at a ridge and water from the city drains out through three watersheds – the Vrishabhavathy, the Hebbal and the Challaghatta into the rivers Arkavathy and the Dakshina Pinakini. The city has a set of interconnected cascading lake series. Barring a few, most of these were constructed as irrigation tanks. However, as the city urbanised, these water bodies have become polluted with sewage and the water is not being directly used to meet the cities growing water demand.

Urban water supply has gradually transitioned from local sources to distant river water imports. Until 1895, Bangalore relied on local wells, tanks and stepped ponds. This was followed by protected water supply from the Hesaraghatta lake and the Thippagondanahalli reservoir across the river Arkavathy. The piped water supply from the river Cauvery that started in 1974 with 135 MLD[2] (1st stage) has been incrementally increased over the years to meet the growing water demand [4]. As of January 2014, a volume of 1260 MLD of water was supplied from the Cauvery[3] (ongoing 4th stage) and this is in the process of being augmented. At present, the supply is 1350 MLD [5]. New sources are being sought for further water imports.

Apart from the formal piped water supply system via the Bangalore Water Supply and Sewerage Board (BWSSB), Bangalore's residents rely on alternative sources of water to meet their requirements. Groundwater drawn from open wells and borewells is an important source. The peripheral parts of the city, which are yet to be supplied with piped water, are completely dependent on groundwater. The heavy dependence on groundwater by the domestic, CII as well as the construction sectors, has led to groundwater depletion. There are increasing reports of borewell failures and deepening of existing wells. A recent study on groundwater in Bangalore that monitored a network of (predominantly unused) municipal bore wells has found the average depth to groundwater levels in the peripheral parts of the city to be in the range 30 to 230 ft [6]. The data on bore wells owned by the BWSSB indicates well depths ranging from 15 to 1200 ft. However, in the central parts of the city that receive ample piped water, groundwater levels are shallow and open wells are in use. This has been attributed to lower groundwater dependency as well as substantial groundwater recharge from leaking pipelines [6].

In addition to these sources, private tanker water operators cater to both domestic and non-domestic consumers. The tankers source water from borewells within and outside the city. There is also a market for packaged drinking water to meet potable water needs. Reverse osmosis-based water kiosks (or water ATMs) also serve as alternative sources of potable water.

Additionally, roof-top rainwater harvesting is mandatory in the city since 2010 for existing and upcoming buildings with a minimum area of 2400 sq ft and 1200 sq ft respectively [7]. Reuse of treated wastewater is limited and is yet to be tapped effectively.

The main institutions and their roles related to water use by the CII sector are briefly described in **Appendix A**. They include agencies involved in various aspects of water management such as water supply, distribution, treatment and regulation.

1.3 Need for CII water use estimation

Estimation of water use by different end users is essential for managing water resources in the city and the surrounding regions. Yet, there are surprisingly few reliable estimates.

Water demand by different end users - residential, CII and the construction sector – has witnessed an increase with the city's rapid growth in recent decades. While most of the water demand is by residential consumers, water consumption by the CII sector is believed to be quite significant. BWSSB billing records show that piped water consumption by the CII sector alone is of the order of 110 MLD in 2015, i.e., about 16% of the total billed water consumption in the city [8]. Yet, this represents only a fraction of the total water demand by the CII sector because most establishments access water from local groundwater.

[2] *MLD refers to Million Litre per Day*

[3] *Data source: BWSSB*

It is known that heavy dependence on groundwater by different water users has led to its depletion in parts of the city. By 2013, the entire Bangalore district has been 'notified' to be over-exploited with respect to groundwater, which has led to restrictions on groundwater abstraction, especially for water intensive industries (discussed further in **Appendix A**). As the city has almost reached its allocated limit to water withdrawal from the river Cauvery, the state has been exploring supply augmentation options through more distant surface water imports across river basins [9]–[12]. But while there has been attention on domestic water use in Bangalore [13]–[15], there are information gaps with respect to total water demand, particularly by the non-domestic sector and existing estimates vary [16].

An estimate of CII water use can better inform city planning and future development for several reasons. First, the CII sector does not require high quality potable water to meet its full requirements. Fresh water use can be reduced through the use of tertiary treated water (TTW), process recycling and reuse of water, rain water harvesting (RWH), and water conservation measures. We need better baseline water use estimates, both to evaluate the potential for industrial process reuse and plan and operationalise common effluent treatment plants (CETPs) and sewage treatment plants (STPs) as well as design and target water use efficiency programmes. Second, there are several new industrial and commercial parks and zones proposed in Bangalore and the growing peri-urban regions such as in Devanahalli. However, the new commercial and industrial zones are often planned without any systematic assessment of water demand by different end users, which can adversely impact regional development.

This discussion paper primarily considers the BBMP boundary of the city to estimate CII water use. Although, it is important to also understand water use by the existing and newly designated industrial areas in the larger BMRDA[4] region to improve planning and management of water in the region, this requires further investigation and is beyond the scope of the current analysis.

[4] *BMRDA refers to Bangalore Metropolitan Region Development Authority.*

2

ESTIMATION OF CII WATER USE

2.1 Definitions

Typically, commercial and institutional establishments such as hotels, office buildings, retail stores, schools, and hospitals use water for the same end uses that households do – for drinking, cooking, cleaning, washing, toilets and landscaping. However, the quantum of water used for these purposes differs and predominantly constitutes domestic and landscaping. On the other hand, industries additionally use water for industrial process uses. Water is commonly used in industrial facilities to change temperature (cooling towers), to clean equipment (washing), to move products, or to prevent drying between the stations of a manufacturing assembly line. It may also be incorporated into the final product. The definitions of commercial, institutional and industrial water users as discussed in this paper are described below [4].

Commercial

Commercial users refer to private establishments providing a product or service [5] such as hotels, restaurants and office buildings. In this paper, both private and public establishments such as hotels and restaurants, offices, retail shops, hospitals, educational institutions and party halls are considered as commercial users.

Institutional

Institutional users refer to public establishments meant for public service [5] such as government buildings, government schools and public hospitals. In this document, institutions are defined as large establishments such as defence establishments, large public sector undertakings, railways and university campuses. Institutional establishments are considered as a subset of commercial establishments and not treated separately.

Industrial

Industrial water users are described to include only manufacturing enterprises as defined by the National Industrial Classification 2004 (NIC-2004) and 2008 (NIC-2008). A detailed note on the NIC system is provided in **Appendix B**.

Some manufacturing enterprises, like readymade garment factories and plastic extrusion units, have low or no process water use. Therefore, their water use patterns are similar to commercial establishments. Similarly, service-based industries, including software development, business process outsourcing, consulting, and research and development establishments are treated as commercial enterprises as far as the estimation approach is concerned.

2.2 Accounting for CII Water Use

At the macro level, such as at the country level or the river basin level, the need to account for water use in an integrated manner is gaining recognition. This involves accounting for water use and consumption by all sectors including the industrial and commercial sector. One such water accounting framework is the System of Environmental-Economic Accounting for Water (SEEA-Water), which was adopted by the UN Statistical Commission as an interim international statistical standard in 2007 [6]. As of 2017, it is reported that India has not yet adopted the framework but intends to utilize the SEEA framework in future [7]. In some countries like Norway, Australia and Canada, the government aggregates data and estimates water use by different sectors at the regional and national levels for reporting and supporting policy decisions.

In India, state level water budgets are being developed under the National Water Mission, under the National Action Plan on Climate Change. For the first time in the country, comprehensive state-wise budgets of water supply, demand and management partitioned by sources and end use sectors (including the CII sector) is being attempted [8]. This would provide estimates of aggregate water consumption by the CII sector at the state level.

Macro level water accounting necessitates details of water use by different sectors. This is done by aggregating data at the micro-level from different government and non-government agencies. The relevant sources of data and at what scale such data is available are presented as follows.

Sources of Data

On the supply-side, records of water supplied to CII establishments are maintained by water utilities. In Karnataka, the KIADB has the responsibility to ensure water supply within the industrial estates developed by them; in Bangalore city, the BWSSB maintains metered records of water supplied to CII users. However, CII establishments fulfil their water requirements to a large extent through self-supply of water, either from private bore wells, purchases from water tankers or direct withdrawals from rivers.

Self-supply is a crucial missing piece of data that is not systematically documented anywhere.

For large withdrawals from the river, permitted allocations and limits are recorded by the State Pollution Control Boards (SPCB). Groundwater withdrawals by the industries require permits from the relevant Ground Water Authority (refer **Appendix A**) in notified areas. The problem is that data on groundwater withdrawals by industries and commercial establishments is partial and weak, especially in states such as Karnataka.

Clearly, data on formal supply of water to industrial and commercial areas can be aggregated from different government agencies, but only if they are metered and records are systematically maintained. At present, there is no mechanism for aggregation of establishment level data on self-supply through groundwater and surface water sources. In Bangalore, the extent to which the KGWA[5] monitors industrial groundwater withdrawals is not clear. Anecdotal evidence suggests that the records of groundwater withdrawals are partial and do not represent the true magnitude of self- supply through groundwater.

On the consumption-side, in the absence of any systematic surveys of facility level CII water use by the state or municipal governments, quantification of even CII water use depends on self-reported data. Primary sample surveys may not be feasible with limited budgets. Surveys are also limited by the willingness of industrial/ commercial enterprises to share information.

However, the SPCBs do maintain (partial) self-declared data on water consumption by water-intensive industries (such as paper industries, textile industries) and large commercial establishments that fall within the purview of the Water Act, 1974[6]. The amount of water cess paid by such industries under the Water Cess Act[7] was also significant given their high-water consumption, and this dataset offered another source

[5] *KGWA refers to the Karnataka Ground Water Authority*
[6] *Water (Prevention and Control of Pollution) Act, 1974*
[7] *Water (Prevention and Control of Pollution) Cess Act, 1977; it was repealed in 2017*

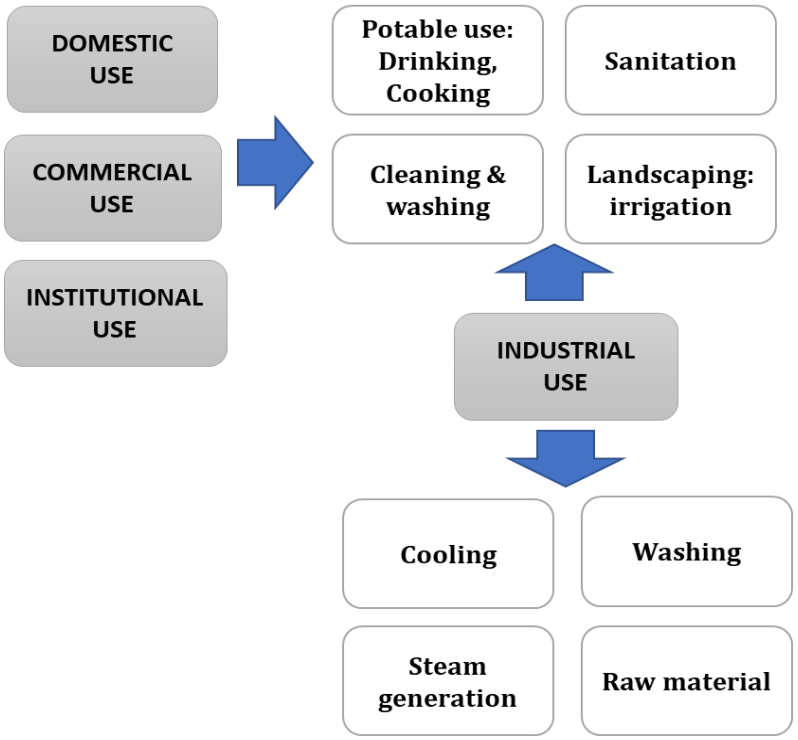

Figure 3: Types of water use by the domestic and CII sector

Figure 4: Sources of data on CII water use

of information on water consumption until it was repealed in 2017.

Additionally, many industries have begun to report their water consumption figures, water conservation and water use efficiency measures through their annual corporate sustainability reports. But, aggregation of facility-level data gleaned from SPCB records and sustainability reports, to obtain reliable regional estimates, poses a major challenge for several reasons as discussed later in this report (see Chapter 5).

Finally, most of the data sources discussed here, are with respect to political units (ward, town, municipal corporation), not hydrologic units. Aggregating estimates at the watershed or river basin scale requires additional spatial information on the location of industries, which is largely absent.

2.3 Review of Methods of CII Water Use Estimation

Different methods of estimating CII water use have been reported in literature, depending on what data are available and accessible. Obviously, primary data surveys and site-specific information are the ultimate source of data. These are typically augmented with secondary data sources such as water utility and regulatory agency records. The most reliable secondary dataset on CII water use is metered records of water supplied to establishments. But in regions where self-supply of water is significant, and there are no direct records of groundwater abstraction, this data would be incomplete.

CII water use estimates may be determined using a combination of methods – such as water supply data and water use coefficients [4] or primary surveys, secondary data and source mix ratios [9].

The water-use coefficient approach involves correlating facility-wise water use to a facility-level variable (such as production capacity or employee strength) to derive a coefficient. This coefficient is assumed to apply to all facilities within that industrial category. Regional water use is obtained by multiplying the coefficient by the number of industries within each category.

For commercial establishments such as office buildings (where the dominant water use is for sanitation), employee-based water use coefficients in terms of Litre Per Employee per Day (LPED) are commonly used [5]. But, for some industrial categories, especially the manufacturing sector, the correlation between employees and water use is poor. Despite this, they remain preferred as a scaling factor, because industry-wise employment data is collected periodically by governments in most countries [10]. Other coefficient based approaches based on building area [11] and economic turnover [12] have been applied to estimate water use by sector. But these approaches are only feasible when the relevant scaling data — building area or economic turnover as the case may be -- are also readily available by industry category and census unit for the whole region of interest.

In regions where water use information partitioned by source is known for a sample of establishments (e.g. river water to groundwater ratio), such a ratio is applied to water supply data records of other similar establishments in the region to estimate total water use by such establishments. This is especially useful in regions where water supply from one source is metered and available (such as piped water) and there is complete absence of secondary data on other sources such as groundwater.

2.4 Study Objectives

1. To estimate aggregate water consumption by CII users in Bangalore city;
2. To estimate the relative contribution of piped water supply and groundwater sources to total CII water use and the spatial variations across the city.

In this study, water consumption by the CII sector is estimated for the years 2005, 2012 and 2015. The spatial scope of the study is limited to Bangalore city that falls under the jurisdiction of the municipal corporation, the BBMP.

2.5 Methods and Data

In case of Bangalore, estimation of water use by the non-domestic sector is difficult primarily due to the lack of adequate local datasets. Therefore, the framework used to estimate aggregate CII water use is based on the availability and accessibility of relevant, local data. Specifically, CII water use estimates obtained through two different methods (Table 1) are triangulated.

2.5.1 Method 1: Water Use Coefficients

Employee based water use coefficients are applied to employment data obtained from secondary records to estimate CII water use. The coefficients are derived using water use and employment data from a sample consisting of primary and secondary data.

Freshwater use in industrial/ commercial establishments can be conceptualised as being a function of establishment size (as reflected by employee strength, production capacity, or technology), landscaping area, water tariffs, and the extent of recycling and reuse of water, etc.

In establishments like offices, where water use is likely to be proportional to employee strength, it is relatively

Table 1: CII Water Use Estimation Methods

Method	Available Data	Estimated/ Assumed Parameters	Water Use Estimates
Method 1	Number of CII establishments and employment data from the Economic Census 2005 & 2012.	Employee based water use coefficients (in LPED) for different industrial and commercial categories.	Total water use estimates.
Method 2	BWSSB piped water supplied to the CII sector in 2015.	Ratio of piped water to groundwater use in different regions in the city.	Groundwater component estimated & added to BWSSB piped supply volume to obtain total freshwater use estimates.

easy to estimate water use in terms of litre per employee per day (LPED). For other categories, water use coefficients need to account for end use processes unique to the industrial category and are likely to depend on the technology or equipment used and whether investments in efficiency and recycling have occurred.

Overall, the LPED coefficients reported in literature were found to be not relevant to the Indian context. So, in our study, these were derived from locally available data sources. For categories for which no data were available, suitable assumptions were made for the coefficients.

The Economic Census (refer **Appendix C** for further details) which contains data on employee strength of every industrial and commercial establishment in India, was used to scale up facility-level water use to the whole region. As this was the only relevant scaling variable that was widely available, the litre per employee per day (LPED) coefficient was applied to estimate industrial and commercial water use in Bangalore.

To derive the LPED coefficients, data was collected from three sources:

1) Primary survey of select commercial establishments,
2) KSPCB records of select categories of industrial and commercial establishments,
3) ELCITA records of commercial and industrial total water use.

Primary Survey of Commercial Water Use

A short survey of commercial establishments was conducted during the period Aug 2015 and Dec 2015-Feb 2016 for the following categories of commercial water users: schools, hospitals, hotels and restaurants, marriage/ party halls.

The survey was designed based on the following assumptions:

a) Unless water consumption is metered[8], the facility manager is unlikely to be aware of the actual water use.
b) However, it is likely that the facility manager would have a sense of the proportional dependency on different water sources.

[8] Piped and well water use can be monitored through water meters. For water tankers, an alternative to water meters would be to account for the number of tanker loads purchased (assuming full loads).

As piped water is the only source that is universally metered in the city, BWSSB billing records were used as the survey sampling frame. Establishments with identifiable names and addresses were proportionately sampled from all BWSSB subdivisions. The primary survey was conducted on a set of 78 small and medium commercial establishments. The objective of the survey was to collect data to derive a) the water source-mix ratios for commercial enterprises across spatial regions in the city, and b) the water-use coefficients with respect to employee strength and size of the establishment for different categories of commercial enterprises.

The survey included questions related to establishment characteristics, and water supply infrastructure (**Appendix D**), data related to actual BWSSB water consumption (verified from the water bill), non-piped water sources and the source mix ratio as stated by the respondent.

KSPCB Records of Commercial/ Industrial Water Use

Water use data self-reported to the KSPCB by commercial and industrial enterprises was collected during the period Apr 2015 and Sep - Oct 2015. Data was collected primarily from consent records, annual environmental statements and cess records (wherever applicable) for the following categories of commercial enterprises: hospitals, large hotels, office buildings.

Data for 56 commercial establishments and 115 industries was collected from 7 regional offices of the KSPCB in Bangalore city. The sample of industries also included large public sector undertakings with residential campuses. The data was collected from Bangalore South, West and East offices, Mahadevapura, Bommanahalli, Peenya and Dasarahalli regional offices. The type of industries sampled from KSPCB records are shown in Table 2.

The objective of the secondary data collection exercise was to derive:

a) Water source-mix ratios for commercial/ industrial enterprises in different regions in the city,

b) Water-use coefficients with respect to employee strength and size of the establishment for select categories of commercial/ industrial enterprises, and

c) Assess quality of self-reported water use data.

2.5.2
Method 2: Source Mix Ratios

The piped water component of CII water use is obtained from metered piped supply records of the city. The self-supply component that consists of groundwater abstraction is estimated. An approximate zone-wise source mix ratio is determined from a sample of primary and secondary data on source dependency in different zones of the city. This is applied to the known piped supply component to estimate both groundwater use and total use.

The total water use by the CII sector includes freshwater water use from piped water and groundwater as well as recycled water sources.

There is no single dataset that records groundwater and recycled water use by sector.

In the absence of groundwater use records, the self-reported filings by industrial establishments containing details on groundwater consumption had to be used.

Table 2: Type of industries sampled from KSPCB records

S. No.	Industrial categories	Sampled sub-categories
1	Food processing	Dairy, baked products
2	Textile processing & garments	Garment washing, dyeing, garment stitching
3	Chemical products	Pharmaceutical formulation
4	Metal-related & machinery	Electroplating, machinery
5	Electrical & electronics	Batteries, electrical products, electronics assembly

Industries and commercial establishments are required to provide details of their water consumption and volumes accessed from different sources to their respective State Pollution Control Boards as per provisions of various legislations including the Water (Prevention and Control) of Pollution Act, 1974 (see **Appendix E** for details). In Bangalore, these records are maintained by 11 separate regional offices of the KSPCB, depending on the jurisdiction within which the industries fall. For industrial/ commercial establishments across Bangalore, data on water consumption partitioned by source is archived in the KSPCB consent records.

As the ratio of piped water to groundwater use vary across the city depending on the availability of piped water, zone-wise source mix ratios were estimated based on the industries sampled for each zone. The source mix ratios were scaled using the piped water consumption volumes for each region to obtain estimates of the regional groundwater use volumes. For instance if BWSSB reported supplying 10 MLD water to the non-domestic sector in Zone 1, and the (self-reported) KSPCB records showed that on average industries obtain only 20% of their water use from piped water supply, the non-domestic water use for Zone 1 would be estimated to be 50 MLD (10 MLD/ 20%). The total zone-wise freshwater use by the CII sector is determined by adding piped water and groundwater use in each region. The extent of recycled water use is limited and in this case was estimated separately from the data collected. One limitation of this approach is the inability to estimate water use in areas that are completely dependent on groundwater.

BWSSB Billing Records of Piped Water Use

The total piped water use is determined from the BWSSB billing records for the CII sector. The BWSSB billing records of January 2015 was used to determine commercial, institutional and industrial piped water consumption. The source mix ratios are estimated for different regions in the city using data from the KSPCB consent records and commercial water use survey.

ELCITA Records of Total Water Use

The total quantity of water supplied to industrial and commercial establishments in Electronics City located in South Bangalore was collected from ELCITA for the year 2015. This data excludes self-supply from private bore wells and water tankers by individual CII establishments.

3

CII WATER USE

The commercial, institutional and industrial water use estimates for Bangalore city derived from the two approaches is presented. The derivation of employee-based water use coefficients and source mix ratios from primary and secondary data is discussed.

3.1 Commercial and Institutional Water Use

3.1.1 Method 1: Employee based Water Use Coefficients

The employee-based water use coefficients are derived using data from the commercial water use survey and KSPCB records of commercial establishments.

Water use coefficients

The coefficients estimated from the commercial survey and KSPCB secondary data records are listed in Table 3 below. The details of the methodology are presented in **Appendix F**.

Typology of Commercial Establishments

The various types of commercial establishments listed in the Economic Census 2012 for Bangalore city and their relative proportions are shown in Figure 5. The commercial categories are aggregated from 3-digit NIC-2008 codes of Economic Census 2012.

The typology is indicative of the proportion of commercial categories although the dataset may represent an undercount of establishments.

Commercial Water Use Estimation

The commercial sector water use for Bangalore (BBMP region) estimated by applying the coefficients to employment data of Economic Census is approximately 52 MLD and 80 MLD for the years 2005 and 2012 respectively. The category-wise estimated water consumption is shown in Table 4 for the years 2005 and 2012.

The estimated total water consumption for 2012 partitioned spatially by BWSSB division boundary in Bangalore is shown in Table 5.

The estimates are based on aggregation using ward-level details of establishments available in Economic Census 2012.

Figure 5: Typology and Employment in Commercial Establishments in Bangalore city
(Source: Economic Census 2012)

Table 3: Employee based water use coefficients (illustrative list) - Commercial

NIC-2004 Code	Description	Water use coefficient (LPED)		
		< 10 employees	10 - 50 employees	> 50 employees
5510	Hotels	50^	88#	744*
5520	Restaurants	427#	427#	427#
8511	Hospitals	149*	371#	540*
8512	Clinics	50^	149^	149^
8010	Primary education *(schools)*	37#	37#	37#
8021	General Secondary/Senior Secondary education *(schools)*	37#	122#	122#
8022	Technical & vocational Secondary/Senior Secondary education	122#	122#	122#
8030	Higher education *(University/ college)*	122#	122#	122#
8090	Other education {Distance learning, coaching centres, tuitions}	30^	30^	30^
7229	Other software consultancy and supply *(generalized for all types of offices)*	50^	50^	50*
5211	General stores *(similar coefficients applied to other stores)*	10^	10^	50^
5232	Retail sale of textiles, clothing, footwear and leather goods	10^	30^	50^

Table 4: Category-wise estimates of total water use for 2005 and 2012 - Commercial

Aggregated Commercial Categories	Average daily water consumption (MLD) - 2005	Average daily water consumption (MLD) - 2012
Hotels and Restaurants	20.9	39.4
Healthcare Establishments	8.9	13.6
Educational Establishments	5.6	6.2
Offices	9.7	10.8
Stores and Storage	5.3	5.9
Miscellaneous	1.3	4.1
Total water consumption (approx.)	***52***	***80***

Table 5: Zone-wise estimates of total water use for 2012 (Method 1)

BWSSB Division	Average daily water consumption by the commercial sector (MLD)
Central	50.7
East	9.0
North	3.6
South	6.9
South East	3.6
West	5.2
Total consumption (approx.)	**80**

Table 6: Category-wise BWSSB piped water use by the commercial sector in 2015

Commercial category	Average daily piped water consumption (MLD)
Hotels and restaurants	6.1
Hospitals and clinics	5.4
Shopping malls, cinema theatres and party halls	0.9
Non-Domestic connections	38.0
Partial Non-Domestic connections	41.5
Total water consumption (approx.)	**92**

3.1.2 Method 2: Source Mix Ratios

Piped water consumption is estimated from BWSSB billing records of 2015. Zone-wise source-mix ratios are applied to the piped water consumption figures to estimate total and groundwater use.

Piped Water Use

The BWSSB billing records explicitly tag specific categories of commercial establishments like hotels and hospitals. The larger set of commercial establishments is tagged as “Non-Domestic” which primarily includes shops and commercial establishments, educational institutions and offices as well as a few industries. Piped water consumption by

commercial establishments partitioned by category is shown in Table 6.

The billing records also include "Partial Non-Domestic" connections[9], which refers to connections to properties that have both residential and commercial uses of water. The water use for this category has been estimated by including all large institutional consumers listed within this category and assuming that 50% of the remaining consumers use water for commercial activities.

Total water use including piped and groundwater

The total water use by the commercial and institutional sector in 2015 is estimated to be approximately 338 MLD of which 246 MLD is from groundwater.

Piped water consumption as classified by BWSSB division is shown in Table 7. Applying the estimated source mix ratios, groundwater use and total use is estimated.

Detailed freshwater use estimates for the aggregated CII sector is presented in **Appendix G**. The groundwater dependency in different regions of Bangalore estimated using data from KSPCB records are also presented in Appendix G.

3.1.3
Discussion

Comparing the water use estimates obtained using the two methods; it is observed that the coefficient-based method greatly under-estimates water use. As the BWSSB billed records of commercial and institutional water consumption are based on metered data, at a minimum, commercial and institutional water use cannot be less than 92 MLD. Since even industries by their own admission are using 30-90% groundwater, it is unlikely that total water use can be only 92 MLD. This suggests that the LPED ratios are very low.

Similarly, the commercial water use estimates shown in Table 4 are clearly underestimates, they do not account for water use by large institutional consumers. Institutional water use in large campuses in Bangalore is significant; this requires primary data on water consumption, and cannot be estimated through employee-based water use coefficients.

The groundwater use and total water use estimated using Method 2 is sensitive to the applied source mix ratio. Therefore, there are large uncertainties in the actual groundwater use and total water use. However, overall, we believe that the source-mix method is closer to the actual number.

3.2 Industrial Water Use

3.2.1
Method 1: Employee based Water Use Coefficients

Water use coefficients

Using secondary data of stated water use and employment from a sample of KSPCB records of industrial establishments, employee-based water use coefficients are derived for different types of industrial categories in the city. The water use for 2012 was estimated by applying employee-based coefficients to economic census records classified according to the NIC-2008 3-digit level. For 2005, the estimation was based on economic census records classified by the NIC-2004 4-digit level. The difference in levels of classification also contributes to additional errors in estimation.

The findings and coefficients estimated from the KSPCB secondary data records are shown in **Appendix H**. However, a sample list for key water-intensive industries is presented in Table 8.

[9] This category also includes some apartment complexes. Also, the defence sector constitutes a significant use of water through this type of connection.

Table 7: BWSSB division-wise piped water use by the commercial sector in 2015

BWSSB Division	Average daily piped water consumption (MLD)	Source Mix Ratio (Piped: Groundwater)	Estimated groundwater use (MLD)	Estimated total water use (MLD)
Central	61.6	40:60	92.4	154.0
East	8.7	15:85	49.3	58.0
North	4.3	20:80	17.4	21.7
South	6.6	15:85	37.2	43.8
South East	4.5	15:85	25.5	30.0
West	6.2	20:80	24.7	30.8
Total (approx.)	**92**		**246**	**338**

Table 8: Employee based water use coefficients (illustrative list) - Industry

User categories	NIC-2004 Code	Water use coefficient (LPED)		
		S/ Micro	M	L
Food processing	1512	30	30	30
	1513	30	30	5792
	1520	51	51	51
	1541	168	168	168
	1542	30	30	30
	1543	101	101	101
	1544	30	30	30
	1549	73	73	366
Alcoholic beverages	1551	132	132	132
	1552	140	140	4266
Textile processing	1711	30	30	81
	1712	30	953	953
	1713	30	30	81
	1714	30	953	953
Readymade garments	1810	30	42	42
Chemicals & chemical products	2422	30	30	30
	2423	24	24	210
Machinery, tools & appliances	2911	30	30	173
	2912	30	30	173

Typology of Industrial Establishments

The industrial establishments listed in the Economic Census 2012 and their relative proportions are shown in Figure 6. The industrial categories are aggregated from 3-digit NIC-2008 codes of Economic Census 2012.

The industrial sector water use for Bangalore (BBMP region) estimated by applying the coefficients to employment data of Economic Census is found to be approximately 25 MLD and 19 MLD for the years 2005 and 2012 respectively. The category-wise estimated water use is shown in Table 9 for the years 2005 and 2012.

3.2.2
Method 2: Source Mix Ratios

The estimates of piped water consumption are derived from the BWSSB billing records of 2015. Total water use and groundwater use are estimated from the

average source mix ratio derived from KSPCB records of stated water use for manufacturing firms.

Piped water use

The BWSSB piped water supply to industrial establishments in 2015 is estimated at 8.1 MLD from the billing records. This includes bulk water supply of ~ 2.5 MLD to organised industrial estates within Bangalore city. This accounts for industrial establishments with 'industrial' connections and the industries with 'non-domestic' connections. This data cannot be disaggregated by specific industrial categories.

From the BWSSSB records, the total billed piped water consumption by 'industrial' connections is ~18 MLD. For manufacturing industries defined as 'industrial' in this report, the water use is ~ 8.1 MLD.

Total water use including piped and groundwater

The total water use by the industrial sector in 2015 was estimated to be approximately 34 MLD of which 26 MLD is sourced from groundwater. An average groundwater dependency of 76% was applied to the piped water use estimate. This was derived from self-declared groundwater dependency reported in a sample of 101 manufacturing firms[10] across Bangalore.

3.3 Discussion: Reliability of Water Use Estimates

There remain large uncertainties in the industrial water use estimation. First, both the NIC categories and the BBMP boundary changed between 2005 and 2012, making inter-comparison difficult. The water use estimates corresponding to Bangalore municipal corporation (BBMP) show a lower industrial water use in 2012 when compared to 2005 (refer Table 9). But when assessed at the district-level, there appeared to be no change in water use. Bangalore municipal corporation boundary was expanded in 2007 to include surrounding smaller towns and villages. For 2012, the new municipal corporation boundary (BBMP) has been considered. For 2005, the estimate includes both the former smaller municipal corporation of Bangalore and the smaller municipalities that were later merged into it.

Second, as we observed with the commercial water use estimate, the coefficient-based estimates appear to be an underestimate. If piped water supply to industries was 8 MLD, it is highly unlikely that total water use is only 18 MLD. Overall, it is likely that industrial water use in Bangalore is closer to the 35 MLD estimated by the Source-Mix method.

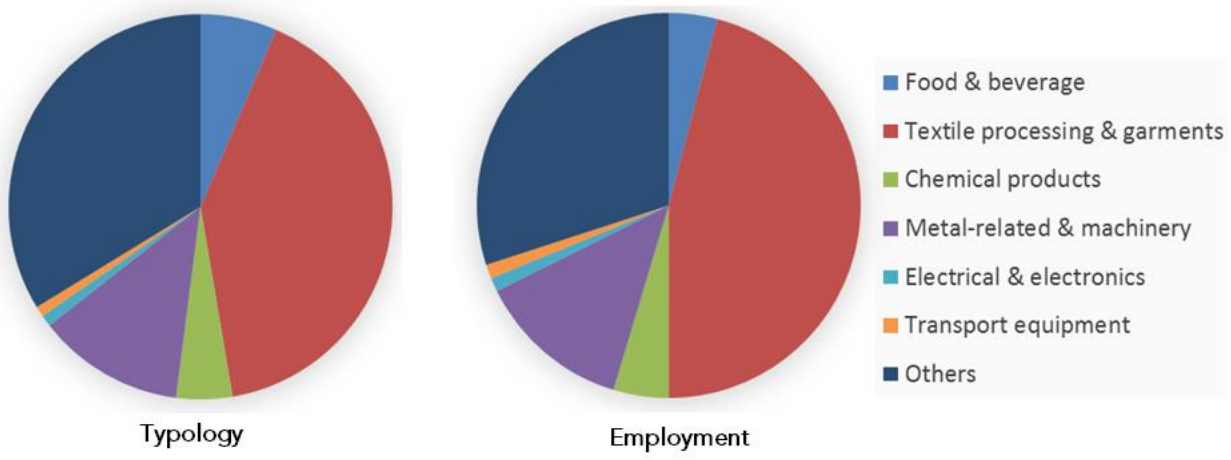

Figure 6: Typology and Employment in Industries in Bangalore city
(Source: Economic Census 2012)

[10] *For estimating the source mix, a) public sector undertakings, and b) large manufacturing firms with water consumption > 1 MLD, were excluded.*

Table 9: Category-wise estimates of total water use for 2005, 2012 (BBMP area) - Industrial

Aggregated Industrial Categories	Average daily water use (MLD) - 2005	Average daily water use (MLD) – 2012
Food & beverage	9.8	3.8
Textile processing & garments	7.9	9.3
Chemical products	1.6	1.6
Metal-related & machinery	2.4	1.6
Electrical & electronics	1.3	0.4
Transport equipment	0.2	0.5
Others	1.4	1.7
Total water consumption (approx.)	**24.6**	**18.8**

4

CORPORATE REPORTING OF WATER USE

In addition to datasets available with government agencies either as piped water supply billing records or statements of water use archived by pollution control boards, CII establishments have also begun to voluntarily disclose sustainability initiatives related to energy, water and waste management. An overview of corporate reporting of water use and practices in the global and Indian context is briefly discussed in this chapter.

4.1 Global Initiatives

Since the late 1990s, an independent international organization called the Global Reporting Initiatives (GRI) pioneered sustainability reporting by industries. A suite of structured, modular and inter-related reporting standards called the GRI Standards are issued by the Global Sustainability Standards Board. Industries may choose to disclose their activities and initiatives voluntarily in accordance with the GRI Standards.

As of March 2017, more than 160 organizations in India had filed more than 530 sustainability reports over the years in the publicly accessible GRI Sustainability Disclosure Database. Of these, about 78% of the organizations belonged to the 'large' category. The GRI database is thus a useful source of information on sustainability measures undertaken by large companies. The GRI reporting framework outline and the provisions related to water are described in **Appendix I**.

More recently since 2012, in a move towards integrated reporting of financial and non-financial aspects of businesses, the International Integrated Reporting Council (IIRC), a global non-profit coalition that includes regulators, investors and companies, developed the International Integrated Reporting Framework. This framework employs a principle-based approach to corporate reporting. It seeks to embed integrated thinking and decision making in mainstream business practice.

One of the goals of integrated reporting is to enhance accountability and stewardship of corporate entities for a set of capitals (that include financial, manufacturing, intellectual, human, social and relationship and natural) and to promote understanding of their interdependencies. The inclusion of different capitals in the framework is intended as the theoretical underpinning of the concept of value creation. Water is one of the aspects that may be reported under natural capital. Although the framework does not prescribe a format for reporting key performance indicators, measurement methods or specific disclosures; it provides a set of guiding principles and content elements to support integrated reporting (described in **Appendix J**) [13].

In parallel with the reporting initiatives, since 2007 an initiative called the CEO Water Mandate has been mobilizing businesses on advancing water stewardship, sanitation and SDGs in partnership with stakeholders. It is a special initiative of the UN Secretary-General and the UN Global Compact implemented by the Pacific Institute. As of 2018, 145 companies have endorsed the principles outlined in the mandate to improve water stewardship in the areas of direct operations, supply chain & watershed management, collective action, public policy, community engagement and transparency [14]. In short, the CEO Water Mandate provides operational guidelines for large industries to engage with water policy and work towards sustainable water management in the extended industrial locations [15].

More recently, there is an emerging recognition of the broader context of the river basin and other basin water users in regions where industrial establishments are located. The idea of shared water challenges in a river basin (by multiple stakeholders) and setting of water targets and metrics within the context specificities of the basin are efforts to improve corporate water stewardship [16]. This initiative is still in a nascent conceptual stage.

There are also sector-specific networks and initiatives at the global level that aim to benchmark and incorporate sustainability practices through their affiliated member industrial organizations. This includes improved water use efficiency, reducing water footprint, cleaner methods of production and waste management. For example –

1. The Sustainable Apparel Coalition (SAC) is one such network with more than 200 members in the apparel, footwear and textile industry including manufacturing facilities. The SAC has developed a suite of tools called the Higg Index to measure and report their sustainability performance. This includes tools to measure environmental and social sustainability impacts [17].

2. The AgWater Challenge is a joint initiative launched by Ceres and WWF in 2016 to encourage agricultural and beverage companies to adopt water stewardship initiatives through their agricultural supply chains [18].

3. The Cement Sustainability Initiative (CSI) consists of 24 major cement producers that account for 30% of the world's cement production. The need to reduce the industry's water footprint has been identified among other sustainability themes [19], [20].

For accounting of water use, various tools and methods have been developed such as water footprint, life-cycle assessment, global water tool by WBCSD[11], and water sustainability tools by GEMI[12] [21].

4.2 The Indian Context

In India, some of the larger companies have adopted GRI standards for sustainability reporting. Beginning in 2009, the Ministry of Corporate Affairs, Government of India released a set of guidelines for corporate social responsibility. In 2011, it brought out the "National Voluntary Guidelines on Social, Environmental and Economic Responsibilities of Business" (NVGs) which suggested a framework for business responsibility reporting (BRR). Following these guidelines, the Securities and Exchange Board of India (SEBI) created a new reporting requirement for the top 100 listed companies (based on market capitalization) [22], later extended to top 500 listed companies in 2015. SEBI specified a format for the BRR report which is to be included in the annual report. One of the aspects of BRR is the reporting on environmental performance [22]. Further, in early 2017, recognizing the value of integrated reporting, SEBI advised the top 500 listed companies to adopt integrated reporting format on a voluntary basis from 2017-18. It referenced the International Integrated Reporting Framework of IIRC [23].

To review the status of corporate sustainability reporting in India, we analysed a random sample of 10 companies for their latest annual reports and corporate sustainability reports. The sample was drawn from the Bombay Stock Exchange list of top 100 companies (by market capitalization) as of October 2018. We found that all 10 companies had included

[11] WBCSD refers to World Business Council for Sustainable Development

[12] GEMI refers to Global Environmental Management Initiative

the BRR within their annual reports, and 70% of them also had separate sustainability reports.

4.2.1
Business Responsibility Reports

Of the sample, only 2 companies provided quantitative information on water use in their BRR. The other companies reported initiatives taken towards Life Cycle Sustainability (Principle 2) and the Environment (Principle 6) mainly in qualitative terms. This included initiatives related to reducing green-house gas emissions, energy and water use efficiency and conservation. As the BRR does not provide a framework for companies to report on specific environmental parameters in quantitative terms, it is not surprising that companies merely adhered to answering the required questions under BRR for compliance. Thus, BRRs do not provide useful data on corporate water use.

4.2.2
Sustainability Reports

Of the companies that issued separate sustainability reports in addition to their annual reports, all (with one exception) were in conformance with the GRI reporting standards. All the sampled sustainability reports contained some details related to water use. The degree of detail disclosed varied by the company.

4.2.3
Annual Reports

A third of the companies in the sample adopted the Integrated Reporting (IR) framework in their annual reports. They all have stated their total water consumption, extent of water recycling and specific water consumption within the *Natural Capital* section of the report. Although the IR framework does not define specific parameters to report related to water, it was observed that these companies have stated water use details in conformance with GRI reporting standards.

From the sample, it is found that water use details are best stated in the sustainability reports and in the annual reports that incorporate the IR framework. The typology of reports containing details of water use is shown in Figure 7. It is observed that the adoption of GRI guidelines enables companies to explicitly report on useful water related parameters in a quantitative manner. This is because the GRI reporting framework provides clear definitions and guidelines for reporting related to water.

The types of water related metrics reported by the companies in the sample in one or more reports is shown in Table 10. It is to be noted that this sample is drawn from the top 100 listed companies and will not be representative of the larger set of industries. There is a need for improvement in reporting of disaggregated information on water consumption from different sources and at different offices/ plants as this data is more usable and relevant than total water consumption. It is necessary to improve reporting on specific water consumption in terms such as litre per employee per day, kilo litre per tonne of product, etc. Concomitantly, there is a need for benchmarking of specific water use for different industrial and commercial activities as this can serve as a reference point for improving water use efficiency.

In the period 1980-2012, separate documents were published by the Central Pollution Control Board (CPCB) for different types of industries, noting their environmental issues and providing guidelines for reducing environmental impacts. These documents, the Comprehensive Industry Document Series (COINDS), also included water use benchmarks for some of the industries. However, most of these documents are not accessible either online or through hard copies purchased from the CPCB. To our knowledge, since then, these have not been updated and there has been no other industrial water use benchmarking initiative by the government that is published in the public domain.

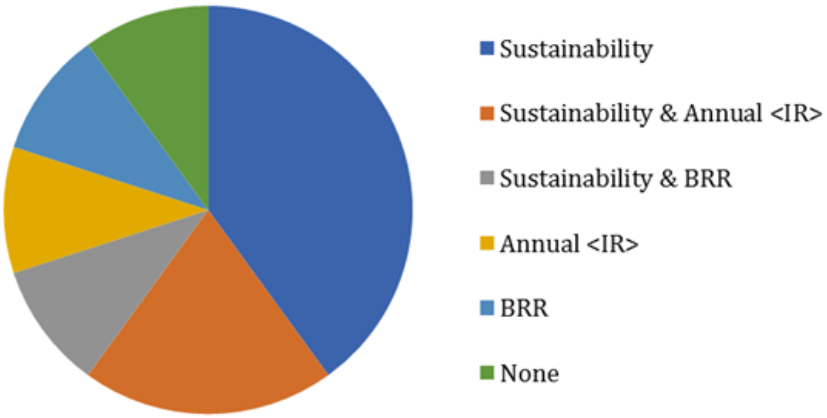

Figure 7: Types of corporate disclosures reporting water use

Table 10: Water related metrics reported by companies

S. No.	Water related metrics	% companies reported
1	Total water consumption	60
2	Disaggregated water consumption by source	40
3	Disaggregated water consumption by location	40
4	Quantity or extent of recycling/ reuse	60
5	Specific water consumption	60
6	Comparison of water use over time	70

5

DISCUSSION AND RECOMMENDATIONS

With increasing pressure on freshwater resources, it is important to have quality baseline information on water use by different sectors in a river basin or within an urban area. While quantification of water use is not an end goal in itself, it provides critical information required for decision-making on water allocations to different sectors, improving water use efficiency, planning and designing sustainability measures and mitigating water conflicts. In case of the CII sector, water use estimation is challenged primarily by the lack of reliable data that is accessible and usable. This chapter identifies and recommends key areas where changes are needed in order to address the challenges in water use estimation. Although the discussion draws from the context of Bangalore, it holds relevance for several cities and towns in India. The discussion is centred on two key aspects – **data** and **estimation**.

5.1 Improved Data

5.1.1
Meter and regulate groundwater consumption

Metered records are the most reliable of the data-sets on water consumption. In Bangalore, the BWSSB billing database is based on metered readings on establishment-level piped water consumption. As CII users mainly depend on groundwater (bore wells and water tankers) to meet their needs, metered records of groundwater consumption are important.

The KSPCB dataset has information on self-reported total water use by CII establishments (including groundwater). Although most establishments do report groundwater use in the various record formats maintained by the KSPCB, this is may not be reliable as most often groundwater use is unmetered despite the metering requirement under the Water Cess Act, 1977. Of the sample commercial and industrial establishments listed in KSPCB records reporting borewell as a water source (N = 77), only about 48% reported metering of their bore wells.

Therefore, groundwater consumption by the CII sector is a critical missing information gap.

There is a need for the pollution regulatory authorities to enforce groundwater metering. This was mandated as per the provisions of the Water Cess Act, 1977 (which was repealed in 2017). It is recommended that permits for drilling of new bore wells be coupled with mandatory water metering.

5.1.2
Unique identifiers and NIC codes for establishments

There are multiple agencies that collect data pertaining to subsets of establishments in the commercial and industrial sector. For aggregation of data from these databases, there is a need for two important tags:

a) Unique identifier for each CII establishment; which is tagged in all the databases where the establishment is listed.
b) The latest and the previous version of NIC code applicable to the establishment at 2-, 3-, 4- and 5-digit level.

The tags would serve as common links to identify establishments across databases. At establishment level, the unique identifier could be a registration or license number.

To our knowledge, only the economic census defines establishments on the basis of the NIC coding system. The KSPCB records define industrial and commercial categories primarily based on pollution potential of industries as classified through colour codes – red, orange, green and white (see **Appendix K**). Similarly, the BWSSB billing database specifies the type of connection (e.g. non-domestic, industrial, etc.) and provides no indication of the type of industrial enterprises.

5.1.3
Create comprehensive, usable databases

Presently, the SPCBs like the KSPCB maintain self-declared CII water use data collected through various records (refer **Appendix E**). First, within KSPCB, there is a need for a comprehensive data base that collates information from all these records for each CII establishment. Second, the integrated data base needs to be computerised so that it is easier to access and use the data.

The SPCB records apply to only specific subsets of industrial and commercial establishments as specified in the colour-coded lists (see **Appendix K**). Therefore, there is a need for integration of CII water consumption data recorded in smaller industrial databases and by multiple agencies including the water utility, industrial boards, large institutional campuses and main water-intensive industries.

Further, there is a need to develop an aggregate database of CII establishments from smaller databases, even if they contain fragmented information on specific categories of establishments. Smaller industrial databases are maintained by various institutions such as the Department of Factories, Boilers, Industrial Safety and Health; Khadi and Village Industries Commission; Department of Industries and Commerce, etc. Various industrial associations maintain listings of associated industries. Commercial enterprises registered with the Karnataka Shops and Commercial Establishments Act, 1961 are enlisted with the Department of Labour. The municipal corporation, the BBMP has a listing of commercial establishments on the basis of the trade licenses issued.

Different agencies collect and archive CII data at different time-intervals (see **Appendix L** for KSPCB). It is important to recognise this while comparing across datasets.

At the city-level, there is a need for the relevant planning authority to conduct water audits that include comprehensive assessments of CII water use and future demand. For Bangalore, this is an important assessment that should be undertaken by the BBMP and the Bangalore Metropolitan Planning Committee (BMPC)[13]. For smaller towns, there is a need for the Urban Local Bodies (ULBs) to conduct water audits.

At the state-level, the ongoing National Water Mission programme by the government is a positive move towards aggregating sectoral water use and developing baseline estimates.

5.1.4
Validation of CII databases at the city and regional level

There is a need to validate the number of establishments of each category as aggregated in the locally created CII database with the Economic Census and vice-versa.

In this study, it was observed that the number of firms as detailed by the Economic Census database for certain industrial categories does not always reflect the actual number of firms. This was noted in case of a few manufacturing categories based on local knowledge of

[13] The Bangalore Metropolitan Planning Committee (BMPC) was constituted in 2014 as per the Constitution (74th Amendment) Act, 1992.

existing industries in the city and industrial typology as reflected from the KSPCB database.

One possible reason for this discrepancy could be with the actual field methodology used in enumeration. While the field enumerators qualitatively describe the economic activity involved in each unit on the enumeration schedules, the corresponding NIC-code is appended at the district level by the Directorate of Economics and Statistics of the state. There could be possible errors in interpreting the description and assigning appropriate NIC-codes.

The discrepancy could also be explained by an under-listing of establishments in the Economic Census dataset which has been observed by [24]. The paper notes that the under-listing of establishments is atleast 22%.

5.2 Improved Estimation

In the absence of reliable and complete CII water use databases, water use was estimated using coefficient-based approaches.

5.2.1
Multiparameter water use coefficients

The use of multiparameter water use coefficients would better account for water use especially in water-intensive manufacturing units where water consumption is correlated more with production capacity and process technology rather than employee strength.

In the absence of any locally created comprehensive database of CII establishments in the city, in this paper, the economic census database is utilised for scaling up employee-based water use coefficients to estimate CII water use. In this dataset, employee strength is the only useful variable for water use estimation. It lacks any variable that directly or indirectly indicates the production capacity of the firms or the scale of production, the manufacturing process involved, the physical area of the establishment including landscaping area.

For improved estimation, multiparameter water use coefficients can be applied to locally created comprehensive CII databases (see Section 5.1.3) that include variables on technology, production capacity and employee strength.

5.2.2
Reduce assumptions

A local comprehensive data base of CII establishments listed with the relevant NIC codes at multiple levels and years (see Section 5.1.2) can be very useful to improve water use estimates. For example:

A) The Economic Census 2005 describes commercial and industrial establishments by the NIC-2004 code at the 4-digit level. At this level of description, there are industrial categories that include multiple manufacturing processes (with differing water requirements) and end products within the same NIC-code. For example – the NIC-2004 code ‘1712’ that refers to ‘textile finishing’ includes several operations such as bleaching, dyeing, printing, etc. Some firms may be involved in all operations while some may specialize in a single operation leading to differential water use.

If there is a local comprehensive computerised database of CII establishments in the city created by aggregating city-level databases and assigned NIC codes, then this can provide information on the proportion of textile bleaching, dyeing vs. printing establishments in the city that fall under the broader category of ‘textile finishing’.

B) Economic Census 2012 references establishments by NIC-2008 codes at the 3-digit level. Although the NIC-2004 and 2008 coding systems are reasonably comparable, the difference in the level of coding (i.e. 4 digits and 3 digits) makes it possible to compare the two databases only at the higher level of aggregation (i.e. 3-digit level). This implies that estimation of CII water use using the Economic Census 2012 dataset involves a greater degree of approximation. This may lead to under or over-estimation of water use based on the assumptions made.

A city-level database of CII establishments tagged with NIC codes at multiple levels can help reduce the degree of assumptions involved in water use estimates.

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All the errors in this document are our own.

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Appendix A

Institutions associated with CII water use in Bangalore

BWSSB

The Bangalore Water Supply and Sewerage Board (BWSSB) is a parastatal agency that supplies piped drinking water to domestic, commercial and industrial consumers within the city. It was constituted as an independent and autonomous body under the Bangalore Water Supply and Sewerage Act, 1964 for water supply and sewerage services in Bangalore Metropolitan Area. The BWSSB imports water from the R. Cauvery, treats it and distributes it through its various sub-divisions delineated within the city.

The BWSSB supplies water to limited industrial establishments located in the city. The majority (almost 80%) of the piped industrial water connections are located in a large industrial area called the Peenya Industrial Area (PIA) although the bulk of the BWSSB industrial water consumption occurs within the city outside this area. Several of the industries which have BWSSB water connections supplement their water requirement through private bore wells and tankers. In addition to this, there are several industries which are completely dependent on groundwater.

KSPCB

The Karnataka State Pollution Control Board (KSPCB) is the regulatory agency responsible for control of pollution within the state. This agency constituted as a State Board under the Water Act (1974) defines its spatial jurisdiction through a set of regional offices spread across the state. In Bangalore district, the 11 regional offices of the KSPCB are engaged in monitoring and inspection of defined classes of industrial units and commercial enterprises within their respective regions. These enterprises are required to obtain the consent to establish and operate from the KPSCB according to prescribed formats under various acts including the Water Act, 1974. This process also requires the industrial units and commercial enterprises to state their water use details to the KSPCB.

KIADB

The Karnataka Industrial Areas Development Board (KIADB) is a statutory agency that promotes the development of industries and industrial areas by easing land acquisition and providing infrastructural facilities. It was constituted under the Karnataka Industrial Areas Development Act, 1966. The board has developed more than 150 industrial areas in the state till date including several in Bangalore region.

Water supply is one among the infrastructural facilities provided by KIADB in the industrial areas established by it.

Ground Water Authorities

The Central Ground Water Authority (CGWA) was constituted in 1997 under Section 3(3) of the Environment (Protection) Act, 1986. The objective of the authority is to regulate and control groundwater abstraction in areas notified to have critical and over-exploited reserves. In notified areas, abstraction of groundwater is not permissible for any purpose other than drinking and domestic use. The authority's jurisdiction extends to states that have not constituted state level ground water authorities.

In Karnataka, a state level legislation was enacted in 2011 leading to the constitution of the Karnataka Ground Water Authority in 2012. There are restrictions on groundwater abstraction by industries in areas where groundwater development is notified as being over-exploited or critical. In areas with over-exploited groundwater aquifers, new permits for groundwater extraction cannot be issued to those industries which are water-intensive or where water is a raw material such as packaged drinking water, distilleries, breweries, soft drinks, textiles, and paper and pulp[14]. Bangalore North and South taluks and Anekal were notified as overexploited areas for this restriction. As of 2013, all groundwater assessment blocks in Bangalore district were notified as being over-exploited[15].

ELCITA

The Electronics City Industrial Township Authority (ELCITA) was setup on 18 March 2013 as the first industrial township in Karnataka. It covers an area of approximately 903 acres. Although the formation of ELCITA is recent, the area had been developed as Electronics City since the late 1970s by the Karnataka State Electronics Development Corporation Limited (KEONICS) and the KIADB. While electronic industries were initially promoted, since 1990s the area has seen the development of information technology firms and presently 158 companies are operating within the township[16,17].

ELCITA is vested with the powers of a municipality including collection of property tax, issuing trade licenses, provision of water supply and waste management.

Institutional Bulk Supply

Large institutional campuses within the city have one or more piped water connections which are distributed internally to working and residential quarters in the

[14] Guidelines for Evaluation of Proposals/ Requests for Ground Water Withdrawal for Drinking & Domestic Purposes and Industry/ Infrastructure Project Proposals in Notified Areas and Non-notified Areas (Karnataka Ground Water Authority, undated)

[15] http://cgwb.gov.in/CGWA/List-Notified-Areas.html

[16] http://www.elcita.in/ (Last accessed in Sep 2019)

[17] M. Idiculla, 'New Regimes of Private Governance: The Case of Electronics City in Peri-urban Bengaluru', *EPW*, vol. 51, no. 17, Apr. 2016.

campus. This includes large educational institutions, Public Sector Units (PSUs) and IT parks. Piped water is most often supplemented with groundwater sources – either private bore wells or tanker water supply at the level of institutional bulk supply or individual enterprise or both.

Water Tankers

Private water tankers supply water to several CII establishments, especially in peripheral parts of the city. The tankers source water from bore wells. It is reported that there are approximately 1000 – 3000 water tankers operating in the city, serving both domestic and non-domestic water users[18].

[18] A. Rajashekar, 'Do Private Water Tankers in Bangalore Exhibit "Mafia-like" Behaviour?', Master's thesis, Massachusetts Institute of Technology, 2015.

Appendix B

National Industrial Classification System

Most countries have a codified system of classification of industrial and commercial activities. In India, the National Industrial Classification (NIC) system codifies commercial and industrial activities into several groups. It is a multi-level classification system that is compatible with international classification systems.

The NIC-2004 codes at the 4-digit level have been used to reference CII establishments in the 5th Economic Census, 2005. For the manufacturing sector, the codes are between 1511 and 3720. These codes are comparable with ISIC Rev. 3.1 up to the 4-digit level. ISIC refers to 'International Standard Industrial Classification of All Economic Activities' and the revised version 3.1 refers to the year 2002. Table 11 shows the various divisions under the manufacturing section according to the NIC-2004 classification system. An example of codes at the 4-digit level of classification is shown in Table 12 for Division 17 (Manufacture of textiles).

The subsequent **6th Economic Census of 2012 references the updated NIC-2008 coding system at the 3-digit level.** These codes are comparable with ISIC Rev. 4 (up to the 4-digit level). For the manufacturing

sector, the codes are between 101 and 332. Table 13 shows the various divisions under the manufacturing section according to the NIC-2008 classification system. An example of codes at the 3-digit level is shown in Table 14 for Division 13 (Manufacture of textiles).

Comparing Tables 12 and 14, it is clear that there is a difference in the level of description for economic activities under the 4-digit and 3-digit levels of the NIC 2004 and 2008 classification systems. Economic Census 2012 provides information on economic activities at a more aggregated level.

Table 11: Divisions under manufacturing units according to NIC-2004 classification

Division	Description
Division 15	Manufacture of food products and beverages
Division 16	Manufacture of tobacco products
Division 17	Manufacture of textiles
Division 18	Manufacture of wearing apparel; dressing and dyeing of fur
Division 19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
Division 20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
Division 21	Manufacture of paper and paper products
Division 22	Publishing, printing and reproduction of recorded media
Division 23	Manufacture of coke, refined petroleum products and nuclear fuel
Division 24	Manufacture of chemicals and chemical products
Division 25	Manufacture of rubber and plastics products
Division 26	Manufacture of other non-metallic mineral products
Division 27	Manufacture of basic metals
Division 28	Manufacture of fabricated metal products, except machinery and equipment
Division 29	Manufacture of machinery and equipment n.e.c.
Division 30	Manufacture of office, accounting and computing machinery
Division 31	Manufacture of electrical machinery and apparatus n.e.c.
Division 32	Manufacture of radio, television and communication equipment and apparatus
Division 33	Manufacture of medical, precision and optical instruments, watches and clocks
Division 34	Manufacture of motor vehicles, trailers and semi-trailers
Division 35	Manufacture of other transport equipment
Division 36	Manufacture of furniture; manufacturing n.e.c.
Division 37	Recycling

Table 12: Classification at the 4-digit level for textile manufacturing (NIC-2004 system)

NIC-2004 Code	Description
1711	Preparation and spinning of textile fiber including weaving of textiles (excluding khadi/handloom)
1712	Finishing of textile excluding khadi/handloom (This class includes finishing of textiles of Class 1711 by operations such as bleaching, dyeing, calendering, napping, shrinking or printing).
1713	Preparation and spinning of textile fiber including weaving of textiles (khadi/handloom)

NIC-2004 Code	Description
1714	Finishing of textiles (khadi/handloom)
1721	Manufacture of made-up textile articles, except apparel
1722	Manufacture of carpet and rugs other than by hand [manufacture of linoleum and other hard surface floor coverings is classified in class 3699]
1723	Manufacture of cordage, rope, twine and netting
1724	Embroidery work, zari work and making of ornamental trimmings by hand
1725	Manufacture of blankets, shawls, carpets, rugs and other similar textile products by hand
1729	Manufacture of other textiles n.e.c.
1730	Manufacture of knitted and crocheted fabrics and articles

Table 13: Divisions under manufacturing units according to NIC-2008 classification

Division	Description
Division 10	Manufacture of food products
Division 11	Manufacture of beverages
Division 12	Manufacture of tobacco products
Division 13	Manufacture of textiles
Division 14	Manufacture of wearing apparel
Division 15	Manufacture of leather and related products
Division 16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
Division 17	Manufacture of paper and paper products
Division 18	Printing and reproduction of recorded media (excludes publishing activities)
Division 19	Manufacture of coke and refined petroleum products
Division 20	Manufacture of chemicals and chemical products
Division 21	Manufacture of pharmaceuticals, medicinal chemical and botanical products
Division 22	Manufacture of rubber and plastics products
Division 23	Manufacture of other non-metallic mineral products
Division 24	Manufacture of basic metals
Division 25	Manufacture of fabricated metal products, except machinery and equipment
Division 26	Manufacture of computer, electronic and optical products
Division 27	Manufacture of electrical equipment
Division 28	Manufacture of machinery and equipment n.e.c.
Division 29	Manufacture of motor vehicles, trailers and semi-trailers
Division 30	Manufacture of other transport equipment
Division 31	Manufacture of furniture
Division 32	Other manufacturing
Division 33	Repair and installation of machinery and equipment

Table 14: Classification at the 3-digit level for textile manufacturing (NIC-2008 system)

NIC-2008 Code	Description
131	Spinning, weaving and finishing of textiles
139	Manufacture of other textiles

Appendix C

Note on the Economic Census

The Economic Census is a complete count of all enterprises within the country. It is conducted periodically by the Central Statistical Organization under the Ministry of Statistics and Programme Implementation, Government of India. It includes all industrial and commercial units constituted under different types of ownership – public sector units, private co-operatives, unincorporated proprietary firms, partnerships firms, corporate enterprises as well as non-profit institutions. It includes unregistered as well as registered enterprises under the Factories Act, 1948, Shop and Establishment Act, State Directorate of Industries, etc.[19]

The unit-level Economic Census dataset includes variables on number of 'workers', source of power, type of ownership, registration category, etc. linked with the National Industrial Classification (NIC) code that specifies the type of economic activity involved.

[19] GoI, 'Provisional Results of Economic Census 2005 (All India Report)', Ministry of Statistics and Programme Implementation, GoI.

Geographically, it is coded up to the ward level in urban areas and village level in rural areas.

The recent Economic Census datasets are for the periods 2005 and 2012. They are linked to NIC-2004 4-digit codes and NIC-2008 3-digit codes respectively.

Some of the limitations in the use of this dataset are briefly discussed as follows:

1) The dataset does not include any variable that directly or indirectly indicates the production capacity of the firms or scale of production, the manufacturing process involved, the physical area of the establishment including landscaping area. The only useful variable from the viewpoint of estimating water use is employee strength. This constrains the use of multi-parameter water use coefficients that would better account for water use especially in water-intensive manufacturing units where water consumption is correlated more with production capacity and process technology rather than employee strength.

2) The 2005 dataset includes NIC-2004 codes at the 4-digit level. At this level of description, there are industrial categories that include multiple manufacturing processes and end products within the same NIC-code. For example – the NIC-2004 code '1712' that refers to 'textile finishing' includes several operations such as bleaching, dyeing, printing, etc. (refer **Appendix B**). Some firms may be involved in all operations while some may specialize in a single operation leading to differential water use. The equivalent NIC-2008 code at the 3-digit level is '131' and it refers to spinning, weaving and finishing of textiles. Clearly, this is at a higher level of codification wherein 'textile finishing' is one among other activities. Therefore, it is possible to only estimate water use coefficients to approximately represent the NIC-codes. The errors associated with using the coefficients are higher in case of the 2012 dataset which is classified based on NIC-2008 3-digit codes.

Appendix D

Commercial Water Use Survey

The survey questionnaire was pilot tested on a set of 14 establishments and revised to its final form. The questionnaire used for restaurants is appended below. The questionnaire used for other types of commercial establishments had a similar structure but differed partially with respect to the questions related to establishment characteristics and water infrastructure.

Survey Questionnaire for Restaurants - Bangalore

Investigator: _____ Date: _____
Ward No:
Restaurant Name:
Full Address:
Name of survey respondent:
Designation of survey respondent:
Contact number of survey respondent:
Name of BWSSB billing consumer:
Address on BWSSB bill:

1. Establishment Characteristics

1.1 Number of Full Time Employees _____

1.2 Number of Part-time/Contract employees _____

1.3 Type of Restaurant: *(Circle appropriate)*

1) Tea shop
2) Darshini
3) Cafeteria/ coffee shop with seating
4) Non-AC restaurant with sitting
5) AC restaurant
6) Three, four or five-star restaurant

1.4 Number of sitting tables *(put zero if standing only)* _____

1.5 Approximately how many customers are served every day? _____

1.6 How many days a week is the restaurant open? _____

1.7 What is the type of occupancy? *(Circle appropriate)*

1) Single occupancy – entire building belongs to the restaurant
2) Restaurant located in a shared commercial building
3) Restaurant located in a shared commercial/ residential mixed building
4) Restaurant located in a shared commercial complex/ campus with many buildings

1.8 Total built up area of the restaurant (sq ft) _____ (Non AC) _____ (AC)

1.9 Irrigated Garden/ Landscape area (sq ft) _____

(If maintained by this office in a shared space. The area must have plants/trees/ lawn)

2. Water Supply and Infrastructure

Water Sources

2.1 What are your sources of water? What percentage of your total use comes from these sources? *(Circle appropriate and write down percentages against the circled sources)*

1	BWSSB piped connection	
2	Open well	
3	Bore well	
4	Water tanker	
5	Packaged drinking water	
6	Rain water harvested on rooftops	
7	Water vendor (water by the pot)	
8	Treated recycled water (from STP)	
9	Others (specify)	

2.2 What is your typical monthly consumption of BWSSB supplied water?

_____ litre

Well Details

2.3 Please provide details of open wells and bore wells in your premises.

Code	Type (OW/BW)	Well depth (ft)	Status (A/F)	Year of construction	Year of failure	Frequency of use*

* Frequency of use codes:

1 = Almost everyday; 2 = One-three times a week; 3 = Once or twice a month;
4 = Less than once a month (not even once a month)
OW, BW, A, F: Open Well, Bore Well, Abandoned (non-functional), Functional respectively.

Sewage Treatment Plant (STP)

2.4. Does the restaurant have a sewage treatment plant (STP)? *(Circle appropriate)*

1) Yes 2) No

If yes, ask the remaining questions;

2.5 What is the capacity of the STP? _____ (KLD/ MLD) *(Circle the correct unit)*

2.6 Is the STP functioning? *(Circle appropriate)* 1) Yes 2) No

Recycled Water

(Recycled water is bathroom and kitchen waste water which is treated and used again)

2.7 Do you use recycled water in toilets? *(Circle appropriate)*

1) Yes 2) No

2.8 Do you use recycled water in the garden? *(Circle appropriate)*

1) Yes 2) No

2.9 Do you use recycled water for any other purpose?

1) Yes 2) No

2.10 If yes, specify _____

Appendix E

Pollution Control Board records on water use

The KSPCB monitors industries and certain categories of commercial establishments for compliance with various environmental laws including the Environment (Protection) Act – 1986, the Water (Prevention and Control of Pollution) Act – 1974, the Water (Prevention and Control of Pollution) Cess Act – 1977 and the relevant rules following these acts. Under each of the above mentioned laws, the industrial/ commercial enterprises are required to file forms related to water consumption in accordance with prescribed standard formats to the KSPCB.

i. Under Rule 14 of the **Environment (Protection) Rules – 1986**, establishments are required to submit an annual environment audit report for each financial year to the state pollution control board. This applies to industrial and commercial units that operate with consent under specific laws, one of which is Section 25 of the Water Act – 1974. The annual environmental statement is filed according to a standard form called '**Form V**' which includes details on annual water consumption for different industrial end uses and water consumption per unit of product produced.

ii. Under Rule 32 of the **Karnataka State Board for Prevention and Control of Pollution (Procedure for Transaction of Business) and the Water (Prevention and Control of Pollution) Rules – 1976**, proposed enterprises are required to seek consent from the KSPCB to establish their units. This is applicable to industrial and commercial establishments that fall under the purview of Section 25/ Section 26 of the Water Act – 1974. This rule also applies to existing establishments that intend to expand or diversify their operations with respect to Section 25 (Water Act, 1974). An establishment operating with the consent granted by the KSPCB is required to renew it periodically, the frequency of which is prescribed based on the type of establishment.

The prescribed format for application of consent under the Water Act – 1974 is 'Form XIII'. The relevant industrial and commercial establishments in Karnataka are required to renew their existing consents under the Water Act, 1974 (i.e., 'Consent to Operate' or CFO) by submitting this form to the KSPCB. Also, red category[20] units are required to seek consent to establish (CFE) or expand (CFEx) or diversify existing units through Form XIII. In case of orange and green category units, the KSPCB has prescribed a combined application form (Form OG) to seek consent to establish under both the Water Act - 1974 and the Air (Prevention and Control of Pollution) Act, 1981.

In both the forms, there are provisions to provide details on the quantity of water obtained from different sources (such as bore wells, public supply and tankers) as well as the quantity of water utilized for different end uses (such as domestic, industrial and landscaping). The forms also contain details on the production capacity of the units, manufacturing process, employee strength and the volume of waste water (domestic sewage and trade effluent) generated, treated and discharged.

iii. According to the **Water (Prevention and Control of Pollution) Cess Act – 1977**, specific industries are required to pay water cess to the Central Government. The relevant industries submit details of monthly water consumption for specified end uses as prescribed in Form I (Under Rule 4 of the Water (Prevention and Control of Pollution) Cess Rules – 1978) to the KSPCB. The cess returns filed by the industries under this form are assessed by the KSPCB to determine the amount of cess payable by them. The amount is paid by the industries to the KSPCB which in turn transfers the amount to Government of India. The Centre reimburses 80% of the amount so collected from various state pollution control boards back to them to augment their financial resources.

The industries are required to specify in Form I the volume of water consumed for domestic end use and three categories of industrial end uses along with information on the source of water for these four end-uses of water. The Cess Act – 1977 also requires industries to install water meters to measure volumetric water consumption for each of the specified end uses. The Cess Act was repealed in 2017.

The KSPCB thus maintains records related to industrial and commercial water consumption through the three described forms – 1) Form V - Environmental Statement, 2) Form XIII/ Form OG - Consent for Establishment/ Operation (CFE/ CFO), and 3) Form I - Water Cess Return. The main point to note with respect to these data sources is that they are self-declared by the industries and commercial establishments. While industries/ commercial establishments supplied with BWSSB piped water are metered, a large proportion of the industries relying on groundwater sources have no system for measuring their water consumption. This is despite the fact that some of these establishments fall under purview of the Water Cess Act, 1977 that requires metering. In the absence of metering, the water consumption values stated in the forms are generally based on estimated water use and hence, may not be reliable.

[20] Industries are classified into a colour classification scheme based their pollution potential. Industries fall into red, orange or green (ROG) categories where red category signifies industrial with high pollution potential. In 2016, a new colour category, 'white' was added to the prevailing ROG classification scheme. White category industries are considered to be least polluting and are exempt from the consent mechanism.

The KSPCB dataset presents various limitations making it difficult to use it for obtaining reliable estimates of CII water use for a region:

1. The KSPCB maintains data pertaining to industrial/ commercial water use through various forms discussed earlier which apply to only specific subsets of industries/ commercial units. There is no comprehensive data base collating information from all these forms.

2. The lack of computerized and integrated data bases that contain complete information on each industrial/ commercial unit under the jurisdiction of the KSPCB makes it further difficult to access and use the existing data.

3. As discussed earlier, the water use information provided in the forms are self-declared by the industries/ commercial units and hence, not reliable. Metering of ground water use as required by the Water Cess Act is not practised.

Appendix F

Commercial water use coefficients

Commercial Water Use Survey

Schools

The survey findings for the four categories of commercial establishments are outlined as follows:

Water use in schools is primarily for toilet flushing, handwashing and mopping. In schools with kitchens and gardens, water is additionally used for cooking, washing and irrigation respectively. Thus, water use in schools is not only dependent on the size of the school but, also on the presence of kitchen and gardening area. The estimated water use coefficients in terms of litre per employee per day (LPED) are the mean values of the coefficients of the establishments:

- 37 LPED for schools without canteens (N = 5).
- 122 LPED for schools with canteens/ gardens (N = 6).

Of the 15 surveyed schools, only 3 schools reported to be completely dependent on BWSSB piped water supply.

Hospitals

Water use in hospitals is for medical and hygiene end uses. In hospitals with in-house kitchen, laundry facility or residential quarters for staff members, the water use is expected to be higher. The water use coefficients derived for hospitals showed high variability across establishments, ranging from 40 LPED to 1810 LPED in the sub-sample of hospitals with >= 10 beds. Excluding the outliers, the estimated mean water use coefficient for hospitals was found to be 371 LPED (N = 7) irrespective of the presence of laundry facilities and residential quarters.

The mean piped water supply fraction reported for the sampled hospitals (N = 20) is 51%.

Hotels and restaurants

In restaurants, water is primarily used for food preparation, washing and cleaning. The survey collected data from fast food and *darshini* type restaurants (N = 15). The mean water use coefficient was estimated to be 427 LPED (N = 9). This excluded samples where the reported data yielded low customer-based water use coefficients <= 3 litre per customer per day. The mean piped water supply fraction reported for the sampled restaurants is 52%.

In hotels, water is used additionally for sanitation and hygiene purposes as well as for irrigation in units that have gardens. It was possible to survey only a few hotels (N = 4) as it proved difficult to identify hotels from the BWSSB billing records. Therefore, water use coefficients were not estimated for hotels.

Marriage/ party halls

A survey of 20 marriage/ party halls was conducted. Monthly water consumption by such halls is variable depending on the number of events held each month. The number of events conducted is much higher during some months.

For the sampled halls, the number of rental days per year ranged from 12 days and 215 days and the mean capacity of the hall was 445 persons (N = 17). The mean employee strength reported was 4 persons (with one exception of a hall employing >100 people). Water use in such halls is dependent on the number of rental days, the number of people who attend the events and the size of the hall. There is no clear relation between employee strength and water use. The mean piped water supply fraction reported for the sampled halls was only 40% (N = 18).

KSPCB Records of Commercial Water Use

Office buildings

Water use data was collected from consent records of 17 office buildings. The sample consisted of office buildings of software companies and technology parks in Mahadevapura, Bommanahalli and Bangalore East regions. The water use is mainly for domestic end uses and irrigation.

- The mean water use was estimated to be 50 LPED (N = 15).
- For an office building with laundry facility, the water use was reported to be 108 LPED.

The entire sample is located in peripheral Bangalore with very limited BWSSB piped water connections. Only two establishments reported direct BWSSB connections.

The establishments reporting piped water use in Whitefield EPIP[21] zone mentioned access through either the KIADB or the EPIP. BWSSB bulk water supply to KIADB industrial estate in EPIP and ITPL[22] was 1.4 MLD in 2015.

Of the total sample, 59% reported groundwater use from either private borewells or water tankers. Reuse of treated wastewater for gardening was stated by 70% of the total sample in the consent records. In addition to gardening, 47% of the total sample reported treated wastewater reuse for toilet flushing.

Hospitals

Water use data of 26 hospitals was collected from consent records of Mahadevapura, Bommanahalli, Bangalore South and West zones. From the data, two

[21] *EPIP refers to the Export Promotion Industrial Park at Whitefield which is an information technology park that hosts several IT/ ITES firms.*

[22] *ITPL refers to International Tech Park (India) Limited located in Whitefield in Mahadevapura zone.*

ranges of employee-based water use coefficients were observed:

- Lower range mean water use: 149 LPED (N = 10); Range: 89-219 LPED
- Higher range mean water use: 540 LPED (N = 6); Range: 393-733 LPED

The estimates excluded 30% of the sample establishments for which water use data was incompletely reported/ missing or employment data was missing.

Of the sample, approximately 73% and 58% establishments reported piped water and groundwater use respectively.

Hotels

Water use data for 13 large hotels was collected from consent records. The sample was drawn from Mahadevapura, Bommanahalli and Bangalore West zones. The mean employee-based water use coefficient was estimated to be 744 LPED (N =11). This coefficient can be applied to hotels with more than 50 employees.

Of the sample hotels, 77% reported piped water consumption. Groundwater use was reported by 9 hotels in the sample, with 61% and 31% of the sample utilizing water from private borewells and water tankers respectively. Only 31% of the sample was exclusively dependent on piped water supply.

Appendix G

Detailed Freshwater Use Estimates

The source mix ratio is described in terms of groundwater dependency.

Table 15: Details of Commercial and Industrial Freshwater Use Estimates

Spatial Regions/ Users	Groundwater Dependency (%)	Sample Size	Billed BWSSB Piped Water Use (MLD)	Estimated Groundwater Use (MLD)	Estimated Total Freshwater Use (MLD)
Bangalore - Core					
Bangalore West	96 – E	13	4.4	105.6	110
Bangalore South	30 – E	7	8.3	3.5	11.8
Bangalore East	30 – A	-	11.9	5.1	17
Bangalore - Periphery					
Bommanahalli*	90 - E	13	1.7	15.4	17.1
Mahadevapura#	100 - E	10	0	11.8	11.8
Yelahanka	70 – A##	-	2.2	1.9	4.1
Rajarajeshwari Nagar	50 - A	-	1.1	1.1	2.2
Industrial Clusters					
Peenya - Dasarahalli	91 - E	51	2.1	21.7	23.8
Whitefield EPIP	71 - E	6	1.4	3.5	4.9
Electronics City	80 - E	5	2	7.5	9.5
Select Large CII Users$	-	-	15.3	13.2	28.5
Other Commercial Users$	-	-	58.1	32.1	90.2

E & A refer to Estimated and Assumed respectively.
** Bommanahalli BBMP zone excluding Electronics City industrial cluster.*
 # Mahadevapura BBMP zone excluding Whitefield EPIP and ITPL.
Groundwater dependency of 70% applied to most non-domestic connections; 20% applied to large industries.
$ Across geographical regions in Bangalore.

Appendix H

Industrial Water Use Coefficients

Table 16: Employee based water use coefficients (full list) - Industrial

Code	*User categories*	*NIC-2004 Code*	*Water use coefficient (LPED)*		
			S/ Micro	*M*	*L*
1	*Food processing*	*1511*	*30*	*30*	*30*
		1512	*30*	*30*	*30*
		1513	*30*	*30*	*5792*
		1514	*30*	*30*	*30*
		1520	*51*	*51*	*51*
		1531	*30*	*30*	*30*
		1532	*30*	*30*	*30*
		1533	*30*	*30*	*30*
		1541	*168*	*168*	*168*
		1542	*30*	*30*	*30*
		1543	*101*	*101*	*101*
		1544	*30*	*30*	*30*
		1549	*73*	*73*	*366*
		15xx	*30*	*30*	*30*
2	*Alcoholic beverages*	*1551*	*132*	*132*	*132*
		1552	*140*	*140*	*4266*
		1553	*140*	*140*	*4266*
3	*Aerated drinks & mineral water*	*1554*	*30*	*30*	*30*
4	*Tobacco products*	*1600*	*10*	*10*	*10*
5	*Textile processing*	*1711*	*30*	*30*	*81*
		1712	*30*	*953*	*953*
		1713	*30*	*30*	*81*
		1714	*30*	*953*	*953*
		1721	*30*	*35*	*35*
		1722	*30*	*35*	*35*

Code	User categories	NIC-2004 Code	Water use coefficient (LPED) S/ Micro	M	L
		1723	30	35	35
		1724	30	35	35
		1725	30	35	35
		1729	30	35	35
		1730	30	35	35
		1820	30	30	30
		2430	30	81	81
		17xx	30	30	30
6	Readymade garments	1810	30	42	42
7	Leather tanning & leather products	1911	30	30	30
		1912	10	10	10
		1920	10	10	10
8	Wood and wood products	2010	10	10	10
		2021	10	10	10
		2022	10	10	10
		2023	10	10	10
		2029	10	10	10
		20xx	10	10	10
9	Paper/ pulp/ paper products	2101	30	30	50
		2102	10	10	10
		2109	10	10	10
		21xx	10	10	10
10	Publishing & printing	2211	10	10	10
		2212	10	10	10
		2213	10	10	10
		2219	10	10	10
		2221	10	10	10
		2222	10	10	10
		2230	10	10	10
11	Petroleum products	2310	30	30	50
		2320	30	30	50
		23xx	10	10	10
12	Chemicals & chemical products	2411	30	30	30
		2412	30	30	30
		2421	30	30	30
		2422	30	30	30
		2423	24	24	210
		2424	30	30	30
		2429	30	30	30
		24xx	30	30	30
13	Plastics	2413	30	30	50
		2520	10	10	10
		24xx	10	10	10
14	Rubber products	2511	10	10	10
		2519	10	10	10
		24xx	10	10	10

Code	User categories	NIC-2004 Code	Water use coefficient (LPED) S/ Micro	M	L
15	Glass/ ceramic/ cement products	2610	10	10	10
		2691	10	10	10
		2692	10	10	10
		2693	10	10	10
		2694	10	10	10
		2695	10	10	10
		2696	30	30	50
		2699	10	10	10
		26xx	10	10	10
16	Metallurgical industries	2711	30	30	30
		2712	30	30	30
		2713	30	30	30
		2714	30	30	30
		2715	30	30	30
		2716	30	30	30
		2717	30	30	30
		2718	10	10	10
		2719	10	10	10
		2720	10	10	10
		2731	10	10	10
		2732	10	10	10
		27xx	10	10	10
17	Fabricated metal products	2811	10	10	10
		2812	10	10	10
		2813	10	10	10
		2891	10	10	10
		2893	30	30	30
		2899	30	30	30
		28xx	10	10	10
18	Metal coating including electroplating	2892	60	60	60
19	Machinery, tools & appliances	2911	30	30	173
		2912	30	30	173
		2913	30	30	173
		2914	30	30	173
		2915	30	30	173
		2919	30	30	173
		2921	30	30	173
		2922	30	30	173
		2923	30	30	173
		2924	30	30	173
		2925	30	30	173
		2926	30	30	173
		2927	30	30	173
		2929	30	30	173
		2930	30	30	173
		3000	30	30	173

Code	User categories	NIC-2004 Code	Water use coefficient (LPED) S/ Micro	M	L
		29xx	30	30	173
20	Electrical industries including batteries	3110	30	30	264
		3120	30	30	264
		3130	30	30	264
		3140	85	85	85
		3150	30	30	264
		3190	30	30	264
		31xx	30	30	264
21	Electronics components & equipment	3210	30	30	264
		3220	30	30	264
		3230	30	30	264
		32xx	30	30	264
22	Instrumentation including clocks	3311	30	30	264
		3312	30	30	264
		3313	30	30	264
		3320	30	30	264
		3330	30	30	264
		33xx	30	30	264
23	Transport equipment	3410	30	30	264
		3420	30	30	264
		3430	30	30	264
		3511	30	30	264
		3512	30	30	264
		3520	30	30	264
		3530	30	30	264
		3591	30	30	264
		3592	30	30	264
		3599	30	30	264
		35xx	30	30	264
24	Furniture	3610	10	10	10
25	Jewellery	3691	10	10	10
26	Miscellaneous manufacturing	3692	10	10	10
		3693	10	10	10
		3694	10	10	10
		3699	10	10	10
27	Recycling	3710	2	2	2
		3720	2	2	2
		37xx	2	2	2

Appendix I

GRI Standards

The GRI standards suite consists primarily of two sets of standards –

- **Universal Standards** that is applicable to all organizations that choose to conform to GRI reporting standards, irrespective of size, type, sector or geographical location. This represents the minimum information that needs to be disclosed by organizations. The general disclosures include data on the activities of the organization, its scale, location, employees, supply chain, etc.

- **Topic Specific Standards** are additional disclosures that organizations may choose to report on. They are comprehensive standards on three topics – *Economic (GRI 200), Environmental (GRI 300) and Social (GRI 400)*. Organizations may report on one or more of these.

Water related Environmental Standards

Under Environmental Standards, there are two standards related to water: GRI 303 and GRI 306. These are applicable to organizations reporting from July 2018.

GRI 303: Water

This standard references the Ceres Aqua Gauge[23] and reports on the following parameters:

- Water withdrawal by source,
- Water sources significantly affected by withdrawal of water,
- Water recycled and reused (total volume and % of total withdrawal)

It does not include water footprints, water coefficients or benchmarks.

Although GRI 303 Water Standard is a useful source of data on CII water use, it may not contain data at the establishment level. From an analysis of reports by Indian companies, it was observed that when industries have multiple campuses in located in different cities, they may or may not state water use per campus. Some of them report aggregate water consumption of all campuses. Thus, this water use data cannot be used as an input for water use estimation at city or basin scale.

Further, being an optional reporting standard, among the organizations choosing to report by the GRI framework, only some may report on water. These are most likely organizations where water plays a crucial role in their activities or those who have incorporated water sustainability measures.

GRI 306: Effluents and waste

This standard references the Basel Convention, IMO Convention and Ramsar Convention and reports on the following:

- Total volume of planned/ unplanned water discharges (in the absence of metering of discharge, estimation to be based on withdrawal and consumption).
- Waste by type and disposal method
- Reporting on spills
- Transport of hazardous waste
- Water bodies affected by run-off/ water discharges

[23] https://www.ceres.org/resources/tools/ceres-aqua-gauge-comprehensive-assessment-tool-evaluating-corporate-management (Last accessed in Sep 2019).

Appendix J

Integrated Reporting Framework

The **Guiding Principles** of the integrated reporting framework comprise the following:

a) Strategic focus and future orientation
b) Connectivity of information
c) Stakeholder relationships
d) Materiality
e) Conciseness
f) Reliability and completeness
g) Consistency and comparability

An integrated report includes the following eight **Content Elements**:

1) Organizational overview and external environment
2) Governance
3) Business model
4) Risks and opportunities
5) Strategy and resource allocation
6) Performance
7) Outlook
8) Basis of preparation and presentation and in doing so, takes account of
9) General reporting guidance

Appendix K

PCB colour-coded industrial classification

The Karnataka Pollution Control Board classifies industries and commercial enterprises based on their pollution potential. Table 17 shows an indicative list of industrial and commercial categories classified into red, orange and green codes as per the classification of 2015. Red denotes industrial categories with higher pollution potential.

Table 17: KSPCB colour-coded industrial classification (illustrative list)

Industry/ Organisation/ Activity	Colour Code	Industry/ Organisation/ Activity	Colour Code
Cement	Red	Jute processing without dyeing	Orange
Copper smelter	Red	Flour mills with wastewater generation	Orange
Pharmaceuticals & bulk drug (excluding formulation)	Red	Jaggery manufacturing	Green
Manufacture of organic and inorganic chemicals	Red	Distilled water	Green
Healthcare establishment (defined in Biomedical Waste Management Rules)	Red	Mosaic tiles	Green
Printing ink manufacturing	Orange	Assembling of lead acid battery	Green
Garment – washing only	Orange	Software units	Green

Appendix L

KSPCB Records: Periodicity of Updating and Archival

Table 18: KSPCB Records – Forms and Types of Data

Periodicity	Form Type	Archival	Types of Data	Applicability	Comments
Monthly	Form I (Water Cess Return) (applicable until 2017)	Physical file for each establishment. After assessing the cess return, the assessment sheet is stored for a brief period electronically.	Water consumption data specified for four end uses - 1) Industrial cooling, spraying in mine pits or boiler feed, 2) Domestic purpose, 3) Processing whereby water gets polluted and the pollutants are easily bio-degradable, 4) Processing whereby water gets polluted and the pollutants are not easily bio-degradable and are toxic. Source of water for each end use specified from i) Municipal water supply mains, ii) well/ tubewell, iii) canal, iv) river, v) from any other source.	All industries whose water consumption is more than 10 KLD and all red category industries (irrespective of water consumption).	As the payable water cess is small for the SMEs, they tend to pay the aggregated amount for some months a few times each year.

Periodicity	Form Type	Archival	Types of Data	Applicability	Comments
Yearly	Form V (Environmental Statement)	Physical file for each establishment (Form V & consent forms either together or separately).	Water consumption data for specific end uses such as process, cooling and domestic. The water consumption per unit of the product produced in manufacturing industries. The quantum of raw materials used in the manufacturing process. Type of establishment and the installed and actual production capacity is specified in some cases.	All establishments (industrial and commercial) that operate with consent under Section 25/ 26 of the Water Act, 1974.	In practice, only a fraction of the applicable establishments submit environmental statements (generally large establishments whose statements are prepared by environment consultants).
One time	Form XIII (Consent for Establishment CFE)	Physical file for each establishment (Form V & consent forms either together or separately).	Water consumption details specified by source (bore well/ tanker, public water supply, river, other). Water consumption data specified by end uses such as domestic, gardening and industrial (process, washing, cooling, boiler feed, other). Wastewater generated, treated and discharged (domestic sewage and trade effluent) and type of treatment system. Expected employee strength, licensed production capacity and landscaping area. Details on water recycling, reuse and rain water harvesting.	All proposed red category industries and commercial enterprises that require consent under Section 25 of the Water Act, 1974.	Form XIII and Form OG are also used to apply for the consent for expansion or diversification.
	Form OG (Consent for Establishment CFE)			All proposed orange and green category industries and commercial enterprises that require consent under Section 25 of the Water Act, 1974.	

Periodicity	Form Type	Archival	Types of Data	Applicability	Comments
Variable	Form XIII (Consent for Operation CFO)	Same as above	Same as above	All red, orange and green category industries and commercial enterprises that require consent to operate under Section 25/ 26 of the Water Act, 1974.	The periodicity of consent renewal is specified based on the colour code of the establishment as well as its size (large, medium small). The size of the establishment is a proxy for initial capital investment of the establishment.
Regularly updated	CFE/ CFEx/ CFO	F - register	Basic details of each establishment (excluding details on water consumption and discharge, employee strength, production capacity and landscaping area) along with applicability of various acts and consent validity period are updated onto an electronic 'F-register'. This is the main database of industrial and commercial establishments maintained by the KSPCB. It is updated periodically from the consent files.	The F - register is the master list of all establishments under the purview of the KSPCB through various legislations, one of which is the Water Act, 1974.	
Variable	Inspection report	Archived in the individual consent files (physical) maintained for each establishment.	Details on water consumption by end use. Mentions the main and supplementary sources of water. The maximum volume of wastewater permitted to be discharged. Additional details on employee strength, licensed production capacity, landscaping area. Details on water recycling, reuse and rain water harvesting.	All industries and commercial enterprises would have been inspected atleast once.	The periodicity of subsequent inspections would most likely depend on the category of the enterprise. When an enterprise applies for CFO renewal/ CFEx, it is likely that the enterprise is inspected before granting the consent.

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