Green Accounting for Sustainable Development: Case Study of Industry Sector in West Bengal

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Abstract

The challenge of sustainable development in developing countries is to probe deeper into the visible and invisible areas inhibiting the cause of green economy - raising the standard of living but with due consideration to resource use and environmental impact. Sector-wise assessment of the environmental indicators can help to reflect the realities of economic growth and development. The conventional national income accounting (SNA) or the Gross Domestic Product (GDP) cannot be a complete indicator of sustainable development because it deals only with changing stock and flow of man-made capital but not of natural capital such as land, water, air, forest etc., and of its depleting stock as used up through its present economic activities. Continuous effort to find the right indicator as appropriate signaling mechanism of sustainable development, green accounting emerged as one of the possible indicators of sustainability. This paper demonstrates how an industrial resource account for two vital resources – water and air resources for West Bengal can be prepared using mainly secondary data from different government publications. The paper shows the data gaps. This study provides the methodology and data types which can help in improving the green accounting system of the state as well as the country to help in sustainable development oriented policy formulations.

1. Introduction: Sustainable Development and Green Accounting

1.1 The focus of all developing nations is on building up "Green Economy" which signifies human well-being and social equity together with reducing environmental risks and ecological scarcity. The challenge of sustainable development in developing countries is to consider the cause of green economy - raising the standard of living but with due consideration to resource use and environmental impact. The indicators of sustainable development are to be chosen in such a way so as to reflect the realities of economic growth and development. The conventional national income accounting (SNA) or the Gross Domestic Product (GDP) cannot be a complete indicator of sustainable development because it deals only with changing stock and flow of man-made capital but not of natural capital such as land, water, air, forest etc., and of its depleting stock as used up through its present economic activities. System of National Accounts has been defined as a statistical compendium showing the expenditures and income of the nation on an annual basis (Kadekodi, 2004). It consists of a coherent, consistent and integrated set of macroeconomic accounts, balance sheet and tables based on a set of internationally agreed concepts, definitions, classifications and accounting rules. The accounting is entirely done on the commodities which are valued in terms of the market prices.

1.2 Continuous effort to find the right indicator as appropriate signaling mechanism of sustainable development, green accounting emerged as one of the possible indicators of sustainability. Appropriate quantification of natural asset would help in the assessment of stock and flow. So representation of development processes through indicators of

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sustainability can provide a reasonable tool for policy making and monitoring of implementation. In the context of the shift of thrust from the Millennium Development Goals to Sustainable Development Goals (SDG), the issue has gathered more impetus. The SDG has seventeen agenda but among them, Agenda3 (dealing with good health and well being), Agenda 6 (dealing with clean water and sanitation), Agenda 7 (dealing with affordable and clean energy), Agenda 11 (dealing with responsible consumption and production) and Agenda 13 (dealing with climate change) are particularly important to the case of preservation and the optimal use of resource in the appropriate manner. And, therefore, green accounting will enable proper resource planning addressing all these issues.

1.3 Accounting of these natural resources can be in different lines- Sector-wise assessment of Natural Resource or Region-wise assessment of Natural Resource or overall gross assessment of the resource. But for proper quantification, it needs to be from the grass root level so as to identify the different stakeholders in the process and their role in appropriate management of the natural resource for its sustainability. Natural resources or natural capital are like the man-made capital and the accounting of the resources will be in the line of capital formation i.e. generation of natural capital must be added whereas the degradation must be subtracted to arrive at a net value.

1.4 Environmental accounts provide a way to measure total wealth and monitor changes as possible indicator of sustainability. Thus, greening the accounts or creating the environmentally adjusted GDP can generate an indicator that can guide the nations to consume without impoverishing itself. The principal concern of sustainability and of environmental accounting is the impact of ill-informed social choices on inter-generational equity. It is a valuable tool as it has the potential to provide an insight into the impact of human activities on the environment and their subsequent effect on human welfare.

1.5 Considering green accounting as an appropriate indicator, research started world-wide as how to go to about with this resource accounting. In 1993, SNA included a satellite account which is primarily based on the environmental-economic accounting. Following this, the United Nations also published a handbook of National Accounting: Integrated Environmental and Economic Accounting. After the publication of System of Integrated Environmental and Economic Accounting (SEEA), several developed and developing countries tried experimenting with the implementation on environmental accounting. A revised version of this Handbook was built later upon a wide consultation process that concluded in 2002. It has been issued in 2003 by the United Nations, the International Monetary Fund (IMF), the Organization of Economic Cooperation and Development (OECD), the European Commission and the World Bank.

1.6 The System of Integrated Environmental and Economic Accounting (SEEA) of UN, 2003 aimed at integrating environment and social dimensions in the accounting framework at least through satellite system of accounts following the capital approach to sustainable development. The satellite system of natural resource account is a modified system of income accounting showing environmental related sectoral activities separately along with their physical account flow changes valuation and possible link to main SNA. The System of Integrated Environment and Economic Accounting (SEEA) are primarily created with the intention to expand conventional national economic accounts in order to better reflect interactions between the market economy and the natural environment.

1.7 This paper is an attempt to explore

i. What can be the appropriate framework for industrial natural resource account?

ii. What are the scopes of improvement that can be entertained in the methodology of data collection in preparing the Industrial Green account?

1.8 Lack of documentation leading to data gaps makes the accounting a much more difficult task. But the prospect of this study is that it can be used by policy maker for monitoring development pathway on sustainable development direction. This study provides the methodology and, if updated from time to time, lead to revision of policies based on the findings, addressing the priorities on a periodical basis.

2. Review of Literature

2.1 Different countries have executed sector-wise accounting of water resource. Water account of Australia[2] contains information on physical and monetary supply and use of water in accordance to SEEA. They have all information regarding water use and consumptive practices of all industries and, therefore, they are able to arrive at the conclusion that water consumption in industries is less than half the amount used in agriculture. Eurostat[3], for example, has data on all aspects of Industry for most of the European Union countries. Eurostat collects data on a) water abstraction b)water use c)intensity of water use and d)waste water generation and discharge for four major industrial sectors – mining and quarrying, manufacturing, production of electricity and construction and other industrial activities. This data bank helps to understand the nature of water use, its productivity and appropriate technologies are taken up for waste water treatment so as to reduce the volume of waste water discharge over time for better environment. The water intensity which is basically the reverse of water productivity can be an important policy instrument for water-scarce regions where there is competition for water between various uses, water is likely to be allocated for the less intensive use. In case of Air account, Eurostat provides Green house emission data with respect to different economic activities, but detailed industry-wise break up is not available.

2.2 In India, Malik and Mittal (2015) has rightly pointed out that very few industries have adequate information about environmental issues. And those who have mainly concentrates on type of device installed for pollution control, steps for energy consumption, steps for waste water generation etc. Thus appropriate information with regard to resource use is not really available. But such information are crucial for practising sustainable development. In Murty and Gulati 's report (2006)[4] the aspect of industrial water accounting was emphasised based on a case study of Himachal Pradesh and Andra Pradesh and in The Natural Resource Accounting in Goa , in Phase-II[5] the case study of different industries causing air pollution has been highlighted. In the state of West Bengal, an attempt was made to account for the air and water resource in the Natural Resource Accounting for

[2]http://www.abs.gov.au/ausstats/abs@.nsf/mf/4610.0
[3]http://ec.europa.eu/eurostat/statistics-explained/index.php/Water_use_in_industry
[4]http://mospi.nic.in/Mospi_New/upload/ssd_natural_resource_account_project.pdf
[5]http://mospi.nic.in/mospi_new/upload/Goa_report_21apr08.pdf
[6]http://mospi.nic.in/mospi_new/upload/nra_report_ju_final.pdf

West Bengal for the Sectors: Air and Water (2008)[6] under Ministry of Statistics and Programme Implementation, Government of India. SyamRoy (2013) has tried to extend the framework and make a more detailed study on Air and water resources accounting based on the SEEA framework. But these are all resource specific regional studies.

2.3 In this paper we intend to focus deeply into the sectoral aspect of resource use considering the Industrial sector of West Bengal - that is a framework to understand the industrial use of natural resources, waste discharged to the environment in order to facilitate comparisons for appropriate policy decisions and actions.

3. Accounting for the Air and Water Resources: Case Study of Industries in West Bengal

3.1 The manufacturing industries in the state of West Bengal mainly comprises of Basic Metals, Coke and Refined Petroleum Products, Chemicals and chemical products , Food Products, Textiles, Electrical Equipment and Non Metallic mineral Products. Apart from these, some other important industries are engineering, automobiles, pharmaceuticals, ceramics, paper, glass, leather and software electronics and information technology. The natural resources, policy incentives and infrastructure in the state, support investments in major sectors such as iron and steel, biotechnology, coal, leather, jute products, tea, IT, and gems and jewellery. Climatic conditions suitable for cultivation of tea and jute have made West Bengal a major centre for these products and related industries. West Bengal also occupies a predominant position in the development of micro and small scale industries. (Roy Chowdhury and Ray Chaudhuri, 2012). Most of these units are located in Kolkata and the urban agglomeration of Kolkata and other industrial areas like Haldia, Durgapur, Kharagpur, Kolaghat, Asansol, Farakka, Siliguri etc. The WBPCB has identified 17 types of critically polluting industries in the state as shown in Table 1.

3.2 The accounting of resources with respect to the Industrial sector of West Bengal is being done taking into account two vital resources – water and air. The industrial green account will be a valuable economic tool as it has the potential to provide an insight into the impact of industrial activities on the environment and their subsequent effect on human welfare. This could contribute to major decisions which have to be taken to check environmental degradation and redesign resource use in appropriate manner and, therefore, help in managing sustainable development.

3.3 In this connection, it must be remembered that the methodology of accounting varies from resource to resource. Following the various approaches suggested for natural resource accounting, we have developed water account in a manner that is consistent with SEEAW (UN 2003, 2006). United Nation Statistical Division (2006) contributed significantly in preparing the Integrated Environmental and Economic Accounting for Water Resources (SEEAW). The SEEAW was developed in support of SEEA (2003) with special focus on water resources. The SEEAW has primarily focussed on the satellite system of accounts – the account links data on water to economic accounts through a shared structure, set of definitions and classifications. In case of Air accounts, the UN Handbook SEEA (2003) does not provide any guideline in the preparation on the account. So we have reviewed various literatures which considered air accounting. ESCAP (Volume II), 1997 Chapter 2 shows how to prepare the air quality account in a step-by-step manner. But none of these literatures considers sectoral accounting of resources rather they focus on the regional accounting of the resource. Garg, Amit, Bhattacharya, Sumana, Shukla, P.R., Dadhwal, V.K., have estimated for 1990 and 1995 the inventory of greenhouse gases CO_2, CH_4 and N_2O for India at a national and sub-regional district level. They have pointed out that the district level estimates are important for improving the national inventories as well as for developing sound mitigation strategies at manageable smaller scales. Therefore, this paper is unique in its attempt to provide a framework to account for resources specifically considering a particular sector of the economy – the industrial sector.

3.4 Water Account

The accounting of the Industrial Water resource has been done with reference to some of the components of UN's SEEAW(2006) which has been taken as a satellite system of SNA based on the SEEA-2003 framework (UN et al. 2003) which are as follows:

3.4.1 Supply and Use Tables in Physical Units

3.4.1.1 This category consists of physical supply and use tables which provide information on the volumes of water exchanged between the environment and the economy (abstractions and returns) i.e. the industry in this case and within the economy (supply and use within the economy) as well as the emissions by industry.

3.4.1.2 From the demand side, water uses in West Bengal can be categorized into – Domestic use of water, Industrial use of water, demand for water for the energy sector, water demand for forests in West Bengal and last, but most important, water for agriculture or irrigational water demand (Table 2). Thus we understood from Table 2 that Industrial water demand which was 2.47% of the total in 2001 increased to 4.11% in 2011. The detailed district-wise industrial water demand of West Bengal has been given in Table 3. If we make a more detailed analysis based on industry-wise demand we get the table 4.

3.4.1.3 However, lack of data in case of 2000-01 and also unavailability of data for 2010-11 do not allow us to get a proper analysis of the changing water demand of the different industries. With rising industrial production, the water demand is expected to rise. The Figure-1 shows the projected annual water demand of the industries.

3.4.1.4 Therefore, yearly data for industries should be collected district-wise to have proper assessment and appropriate planning. In addition to this, collection of supply information (both surface and ground water) to the industries will enable us to have the actual level of use based on availability and whether policy interventions are required for more efficient system of operation. Moreover, data on sector-wise waste water generation are not available. We tried to calculate it based on personal communication with the West Bengal Pollution Control Board as to the approximate waste water generation as a percentage of total water use. We have taken the water demand of the different sectors in the previous chapter as a proxy of water use though we know that the entire water demand cannot be meted as there is a deficit in water supply. We have taken the industrial sector that generates 80% of the water used as waste water. Table 5 shows the approximate discharge of waste water based on whatever information is available.

3.4.1.5 But these are mere approximate estimates and actual estimates are needed for actions such as installations of waste water treatment plants. These are also very important if environmental service and payment for environmental service becomes a policy issue and incentives can be designed to drive sustainable development action.

3.4.2 Hybrid and Economic Accounts

3.4.2.1 The hybrid accounts bring in together the supply and use tables with the economic accounts. The name hybrid originates from the combination of different types of units of measures in the same category of accounts. The hybrid account helps to decide upon possible trade-offs that may be entertained for efficient water utilization and to ensure optimum possible outcome with regard to the water resource.

3.4.2.2 This account is also necessary for implementing polluter's pay principle as the users in most cases do not bear the full cost of water being supplied to them and are generally borne by the government.

3.4.2.3 Hybrid account or Hybrid supply use table try to interlink the physical and monetary information related to water. However, monetary information with regard to a resource which is almost treated as a "free good" is difficult to obtain specially in our state. We have tried to collate whatever small information is available to gather some information with regards to hybrid account.

3.4.2.4 For industries, we have got from the ASI data, the total quantity of water purchased by different industries and the value associated with that quantity of purchase. Since we donot have current data availability we have taken the 1994-95 data as shown in Table 6.

3.4.2.5 We have seen that for the year 1994-95, the quantity of water purchased is 11032 million litres i.e. 11.03 mcm. But for 2001-02, water demand is 2600 mcm, thus the cost of water for the Industrial sector is Rs 8805820.50.

3.4.2.6 Thus we form the following water table which has both the physical as well as monetary account within the same table (Table 7). The total volumes of water used in the industries were known and dividing by their corresponding production level, we get the water productivity of the respective industries.

3.4.2.7 But, the problem with this type of productivity calculation is that different commodities are measured in different units and, therefore, it is difficult to compare across industries.

3.4.2.8 Therefore, we have also tried to calculate water productivity in terms of a single unit i.e. we intended to calculate the productivity in monetary terms. Since we do not have data on value added by each sector, we have used the sectoral contribution to the gross domestic product and tried to find the productivity of water in terms of its value.

3.4.2.9 While discussing the accounting practices taken up in different countries, we have mentioned that water intensity which is the reverse of water productivity is important for policy intervention with regards to industrial location in water-scarce region and where there is competition among various industries, water can be allocated based on necessity and relevance of the economy and in less intensive use.

3.4.3 Water Quality Accounts

3.4.3.1 The quality accounts are generally the asset accounts which try to account for the change in the quality of the stock of water over the period of consideration. Quality account plays a vital role with respect to accounting of environmental resources of industry as the pollution load will take into account the environmental regulation and compare them with the pollution loads corresponding to natural assimilative capacity of environmental media. The physical quality account needs to reflect both the quality of water that is being used by the industries, the waste water quality and the place of discharge and whether there is any possibility of treatment.

3.4.3.2 In the Natural Resource Accounting for West Bengal for the Sectors Air and Water (2008)[7], we find an attempt was made to account for the quality of emission water of the most water intensive industry – the paper and pulp industry. The place of waste water discharge, quality of untreated and treated water and water quality index for the effluents both before and after treatment was shown. The abatement cost was also calculated along with a tax rate and it was found that if the tax rate is imposed on all the firms then this will induce firms to take low waste technology in the production process. This has serious policy implications that if proper information is made available, then a small tax will induce the firms to take up treatment of waste water and low waste technology. This will hold true for all industries. Therefore, the situation calls for appropriate data collection and sharing among all the stakeholders that can improve the conditions of environmental resource for a more sustainable future.

3.5 Air Quality Accounts

3.5.1 In case of another important resource – air, the quality of air has also deteriorated sharply over the last few decades. Rapid industrial development, sharp increase in automobile fleet and huge combustion of fossil fuels have aggravated the situation of air pollution. The major air pollutants include Suspended Particulate Matter (Total and Respirable), Sulphur Dioxide (SO2), Hydrocarbons (HC), Nitrogen Oxides (NOx), Carbon Monoxide(CO), Photochemical Oxidants (Smog), Sulphates and Lead (Pb). The air pollutants are classified as primary and secondary pollutants depending on the process of formation. The primary air pollutants are generated directly from the source whereas the secondary pollutants are produced from primary pollutants by complex chemical reactions. In West Bengal, the major sources of air pollution are the industrial emission and automobile emission (Green Governance, WBPCB, April 2006). Air pollution along with the associated diseases are presented below:

Air Pollutants and Related Health Impacts:

Pollutants	Short-term health effects	Long-term health effects	Source
Suspended Particulate Matter (SPM)	Sneezing, coughing, eye irritation, increase asthma attack	Many components of SPM are toxic and carcinogen	Motor vehicle use, Combustion products from space heating, Industrial processes, Power generation.
Respiratory particulate matter (RPM or PM_{10})	coughing, wheezing, shortness of breath, aggravated asthma	lung damage, premature death of individual with aggravated heart and lung disease	burning of fossil fuels in vehicles, power plants and various industrial processes
Sulphur Dioxide (SO_2)	Increased asthma attack	Reduced lung function	fossil fuel combustion, smelting, manufacture of sulphuric acid, conversion of wood pulp to paper, incineration of refuse and production of elemental sulphur
Oxides of Nitrogen (NO2)	Eye and Nasal irritation, cough	Increased susceptibility to respiratory infection and adverse changes in cell structure of the walls of lungs	nitrogen dioxide is a traffic-related pollutant, emissions are generally highest in urban rather than rural areas

[7]http://mospi.nic.in/mospi_new/upload/nra_report_ju_final.pdf

3.5.2 Therefore, what is needed is an appropriate framework to account for sector-wise emission. If data are available on the emission for different sectors the policy makers can go for introduction of cleaner technologies wherever required, enforce tax rate where compliance is not achievable.

3.5.3 To find the emission of the Industrial sector, we were only able to calculate the emission due to coal consumption in Table 9. And for that, we have taken the coal consumption of the different industries in case of West Bengal. Data with regards to other fuel consumption is not available.

3.5.4 In case of Industrial emission due to coal consumption, we have estimated it by multiplying the calorific content of coal consumption with the emission coefficient. The data on consumption of coal is taken from the Annual Survey of Industries. The emission coefficient is available from the website.[8]

3.5.5 We present the industrial contribution to air pollution for West Bengal in Table 10.

3.5.6 But these are only fractured idea of contribution of air pollution of the industries. Since the ultimate objective of any particular state is to reduce air pollution, assessment of detailed contribution of air pollution of all the sectors may help in this situation. The detailed accounting will provide insight as to the true percentage contribution. On basis of that, proper controlling mechanism with suitable enforcement will help the economy to a more sustainable state. Considering the issue that there may exist a trade-off between development and environmental quality, if command and control system cannot be enforced, other mechanisms like tradable pollution permits and introduction of tax may also be effective in reducing pollution level. Heavy reliance on the Command and Control technique for environmental regulation are not always cost effective as experienced by OECD countries. In certain cases, OECD countries depend on subsidy schemes to speed up private pollution abatement and reduce financial burden of compliance (Lovei, 1995). Some Industrial countries developed new technologies and designed industrial processes to reduce pollution and other adverse environmental impacts. Expenditures on pollution control measures rose rapidly in some highly polluting industries and guidelines and codes of conduct were published covering safety of products and plant operations, trade practices, technology transfer, and international cooperation (UN, 1987). Once the pricing system is introduced, the compliance mechanism works in a better way.

3.5.7 The West Bengal Pollution Control Board is taking up various policies to combat and control air pollution particularly at the industrial and the automobile sector level. This will also enable economists to calculate the cost of industrial pollution and the associated abatement cost and cost of mitigation strategies which will reflect the actual welfare of the people in general addressing the intergenerational aspect also.

4. Policy and Conclusion

4.1 Based on the data available from secondary sources, we have presented a framework for Industrial Green account in accordance with the methodology as suggested

[8](http://www.eere.energy.gov/buildings/appliance_standards/residential/pdfs/k-3.pdf)

by SEEA/SEEAW and other literatures as discussed. The following points are the important conclusions that we can arrive at based on our study:

4.1.1. In case of water account

- The supply and use table can be used as a data base on the percentage of industrial water demand, inter-sectoral requirement and, therefore, can facilitate comparisons across time periods. However, as we have seen there are huge data gaps in this area, which, if addressed properly, will help in water resource management with water conservation, preservation and recycling thereby improving water use efficiency.
- The hybrid water account is also very important, particularly in our state, where water is not priced to the level it should be. We have presented the account but if more recent and robust data could be included in the industrial data bank, the water efficiency parameter can be calculated by policy makers for industrial settlement in water-stressed areas with less water-intensive industries.
- When we come to the emission account, there is no concrete information regarding industry-specific volume of waste water discharge, the quality of discharged water, the volume of treated water etc. But proper estimates are required for understanding the industrial waste water generation.

With all these information, it will be possible to get industrial water account which is consistent with UNSEEAW as given below:

Water Account format

	Manufacturing
Within economy	
Reuse	
Waste water to sewerage	
To the environment	
Lost in transport	
Treated waste	
Untreated waste water	
Total Supply	
Consumption	

4.1.2 In case of Air account, the ultimate objective of all states is to reduce air pollution. But for that, assessment of air pollution of all the sectors is needed. In our case, while preparing the Industrial air account, we could only account for the emission due to coal consumption of Industries in West Bengal.

4.1.3 But due to lack of data, emission due to other fuel use was not calculated. Therefore, what we need is Industrial use of all fuels and the corresponding emission of different pollution parameters. In addition to this, supplementary information regarding exposure of the industrial workers to the industrial air pollution, their health impact, if any, can truly reflect the air quality account of Industries.

4.2 The most important conclusion is for sustainable development, the first step is proper accounting for the natural resources at the industry level and public access to the data which will create the much needed awareness and, therefore, change the resource use pattern to promote efficiency.

4.3 West Bengal is a diversified state in terms of its socio-economic features and, therefore, the approach of accounting needs to be bottom-up approach, that is, firstly the data building should be at the district level with appropriate access, availability and correction and ultimately consolidating it to the aggregate state level accounting. This secondary data sources can facilitate the process of forming fairly good sustainable development indicator -water account and air quality account can be prepared and used by policy maker for monitoring development pathway on sustainable development direction. This can be updated from time to time and based on the findings, there needs to be a revision of policies addressing the priorities on a periodical basis. However, further improvement should also be in the agenda of the development planners.

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Fig1: Estimated Annual Water Demand for Industries Based on the Data Given in Appendix

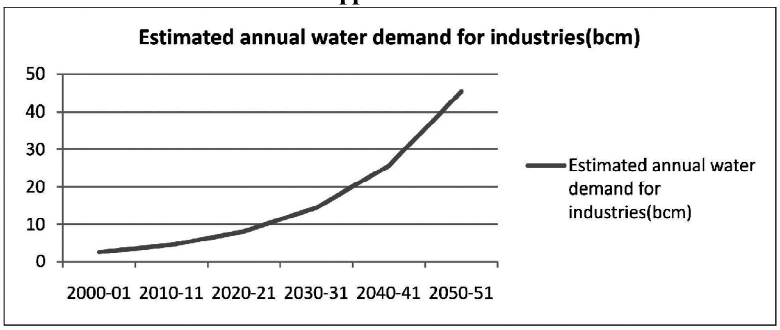

Table 1: Major Polluting Industries in West Bengal

17 categories of Major Polluting Industries	Numbers in West Bengal
Alumunium Smelter	0
Basic Drugs and Pharmaceuticals	6
Chlor – Alkali	2
Cement (Capacity>200 TPD)	12
Copper Smelter	0
Distillery	3
Dye and Dye Intermediate	1*
Fertiliser	7
Integrated Iron and Steel	2
Tannery	1#
Oil Refinery	1
Petrochemical	1
Pesticide	4
Paper & pulp (Capacity>30 TPD)	10
Sugar	2
Thermal Power Plant	15
Zinc Smelters	0
* 1 Dye and Dye intermediate unit closed	
# Besides, about 540 tanneries located in east Kolkata	

Source: Air Quality Status of West Bengal – A State of Environment Report, WBPCB 2004

Table 2: Sector-wise Water Use for West Bengal, 2001 and 2011

Sectors	Water Use 2001 (in mcm)	Percentage of Total 2001	Water Use 2011 (in mcm)	Percentage of Total 2011
Domestic	1980.83	1.88	2270.98	2.02
Forest	23447.95	22.27	23447.95	20.88
Agriculture	73671.00	69.96	73671.00	65.60
Energy	3600.00	3.42	8300.00	7.39
Industry	2600.00	2.47	4610.00	4.11
Total	**105299.80**	**100.00**	**112299.90**	**100.00**

Source: Calculated on basis of the information available based on Water Resource and its Quality in West Bengal, West Bengal Pollution Control Board, 2009

Table 3: Industrial Water Demand for the Districts of West Bengal

Districts of West Bengal	Estimated annual water demand for the industrial sector (mcm) 2001	Estimated annual water demand for the industrial sector (mcm) 2011
Bankura	92.95	164.81
Burdwan	258.04	457.53
Cooch Behar	62.07	110.06
Dakshin Dinajpur	44.72	79.30
Darjeeling	61.93	109.82
Howrah	150.22	266.36
Hooghly	167.42	296.86
Jalpaiguri	103.86	184.16
Malda	91.56	162.34
Murshidabad	155.57	275.85
Nadia	150.62	267.06
North 24 Parganas	234.55	415.87
South 24 parganas	197.53	350.23
Purba Midnapore	158.44	280.93
Paschim Midnapore	158.44	280.93
Purulia	61.76	109.51
Uttar Dinajpur	54.68	96.95
Birbhum	79.13	140.31
Kolkata	316.47	561.13
West Bengal	2600.00	4610.00

Source: Calculated on basis of the information available based on Water Resource and its Quality in West Bengal, West Bengal Pollution Control Board, 2009

Table 4: Detailed Industry-wise Water Demand and Use

Industry	Unit of Production	Minimum water demand (cubic meters per unit)	Minimum water demand (cubic meters per unit)	Production in WB in 2000-01	Water use in 2000-01(mcm)
Automobile	Vehicle	40	40	NA	NA
Distillery	Kilolitre Alcohol	122	170	29400	4.29
Fertilizer	Tone	80	200	NA	NA
Leather	100 kg (tanned)	4	4	NA	NA
Paper	Tone	200	400	NA	NA
Special quality paper	Tone	400	1000	NA	NA
Straw Board	Tone	75	100	NA	NA
Petroleum Refinery	tonne (crude)	200	250	NA	NA
Steel	Tone	200	250	3142000	706.95
Sugar	tonne (cane crushed)	1	2	425	0.001
Textile	100 kg (goods)	6	14	20434	0.20

Source: Water Resource and its Quality in West Bengal, West Bengal Pollution Control Board, 2009

Table 5: Sector-wise Discharge of Waste Water

Industry	Total Water Use(in mcm)	Waste Water Generation(in mcm)
Year 2001	2600	2080
Year 2011	4610	3688

Source: Estimated on the basis of Table and approximate estimates provided by WBPCB

Table 6: Industry-wise Water Purchased and the Corresponding Value

Industry	Quantity of Water Purchased (in million litres) 1994-95	1994-95 Value of Water (Rs.'000)
Allopathic Pharmaceutical Preparation	1	57
Inorganic Fertilizer	881	2644
Organic Fertiliser	101	322
Iron and Steel Industry (in primary forms in the integrated steel plants and mini steel plants)	6045	12942
Iron and steel in primary form	2126	5374
Refined petroleum	1443	15482
Other Petroleum Products	NA	6
Consumer goods of leather and substitute of leather other than apparel	NA	7
Semi-finished Iron and Steel Products (n.e.c)	1	4
Copper	2	7
Alluminium	432	512
Total	**11032**	**37357**

Source: Annual Survey of Industries
Note: value= cost of purchasing quantity of water

Table 7: Hybrid Account 2001 having Water Demand as well as Value

Sectors	Industry
Water Use (mcm)	2600
Money value of water (Rs'000)	8805821
Gross capital formation	NA

Note: value =the cost of water use

Table 8: Value of Water Productivity

	2003-04 GSDP at current prices (Rs Crores)	Water use (in mcm)	Water Productivity
Manufacturing	37574.45	2600	14.45

Source: Author's estimate based on Table and Statistical Abstract 2005

Table 9: Emission from Industrial Sector in West Bengal

Industries	2002-03 production (in thousand tones)	Carbon emission 02-03 (tones)	SO2 emission 02-03 (tones)	NO2 emission 02-03 (tones)
Steel	2521	157966.90	2075.90	2964.55
cement	9	563.94	7.41	10.58
Fertiliser	NA	NA	NA	NA
Paper	72	4511.55	59.29	84.67
Textile/Rayon	65	4072.93	53.52	76.44
Coke Oven	NA	NA	NA	NA
Soft Coke	NA	NA	NA	NA
Hard Coke	NA	NA	NA	NA
Bricks	1064	66670.67	876.14	1251.20
Colliery Consumption	3	187.98	2.47	3.5278
Dump	NA	NA	NA	NA
Power	24661	1545268	20306.85	28999.86
Total	**28395**	**1779242**	**23381.59**	**33390.82**

Source: Author's estimate

Table 10: Emission Account for Air Resource in West Bengal

West Bengal	Emission CO tonnes	Emission NO2 tonnes	Emission PM10 tonnes	CO2 EMISSION	Emission SO2 tonnes	Carbon emission
Industrial Coal Consumption	NA	33390.82	NA	NA	23381.58	1779242

Source: Author's estimate

Appendix

Table A1: Projected Estimated Annual Water Demand for Industries

Year	Estimated annual water demand for industries (bcm)
2000-01	2.60
2010-11	4.61
2020-21	8.17
2030-31	14.48
2040-41	25.66
2050-51	45.48