state of environment report-II

WEST BENGAL

WEST BENGAL POLLUTION CONTROL BOARD

DEPARTMENT OF ENVIRONMENT

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Disclaimer

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Chapter 11

Wetlands

Chapter 11

Wetlands

Wetlands, the dynamic, highly productive and valuable interface between land and water are tentatively defined as the habitats permanently or temporarily saturated with groundwater, exposed to greater water level fluctuations and usually dominated by higher micro and macrophytic vegetation, including a large diversity of habitats such as fresh water and salt marshes, swamps and mangroves, bogs and fens, shallow lakes, lagoons, temporary ponds, fish ponds and aquaculture systems as well as the littoral zones of lakes, riparian habitats in the river valleys and vast flood plains of large rivers as well as their deltas and many other tributaries.

Wetlands may be considered as ecotones or transitional zones of tension between well-drained uplands and permanently flooded deepwater environment. Wetlands are vulnerable system, that can be easily drained or filled for human uses and these wetlands are indeed disappearing rapidly. Globally wetlands are in danger. Wetlands are periodically flooded or at least saturated to near the surface water, they have unique hydric soil and they always support plant species adapted to wet situations, i.e., hydrophytes and they do not support vegetation intolerant of flooding. Wetlands usually support more plant, animal species and they produce more organic materials than either adjacent habitat as they have attributes of both. Wetlands are complex ecosystems that provide unmeasured products and services that benefit people. Wetlands are globally threatened.

A published report of the Department of Environment, Govt. of India 2012 mentioned that India is facing a crisis due to loss of wetlands and water bodies and deterioration in the water quality of these life-sustaining systems. Apart from the depletion of biodiversity and silent assault on human health due to non-point source (agro-chemical) pollution other resultant environmental risk factors include the reduction in rainwater retention capacity and the loss of livelihood support for the poorest section of the wetland-dependent communities.

Wetland ecosystem of West Bengal comprises of freshwater temporary or permanent large and small fish ponds and aquaculture systems, salt marshes, swamps and mangroves, shallow lakes, fresh, brackish and saltwater lagoons, a vast expanse of sewage fed waterbodies, potholes as well as the littoral zones of lakes, riparian habitats in the river valleys, hill streams, and vast flood plains of large rivers as well as their deltas and many other tributaries.

According to a report of the Ministry of Environment and Forests, Government of India (1990), Indian wetlands covers 4.1 million ha (excluding paddy field and mangroves) of which 1.5 million ha are natural and 2.6 million ha man-made. Area of natural wetland encompasses about 2,91,963 ha while manmade wetland covers 52,564 ha and a vast portion of wetlands in this state is still not computed. Different types of wetlands and water bodies in India with their natures and utilisations are depicted in Table 11.1.

Table 11.1: Area of Wetlands in India

Serial no.	Types and nature of utilisation	Area (million ha)
1.	Area under paddy cultivation	40.9 million ha
2.	Total area for Pisciculture	3.6 million ha
	i. Freshwater fish culture	1.6 million ha
	ii. Brackish water fish culture	2.0 million ha
3.	Area under capture fisheries	2.9 million ha
4.	Mangroves	0.4 million ha
5.	Estuaries	3.9 million ha
6.	Backwaters	3.5 million ha
7.	Rivers including main tributaries	28,000 km
8.	Canals and irrigation channels	1,13,000 km
	Total Area of Wetlands (excluding rivers)	58.2 million ha

Source- Anonymous 1990.

According to Ramsar Bureau (Ramsar.org), 38 wetlands have been designated as Ramsar sites in India up to 20th October 2020 of which West Bengal contributed two Ramsar sites, viz., East Kolkata Wetlands and Sundarban wetland (see: Factsheets, Ministry of Environment and Forest, Government of India MoEF CC, 2020).

Apart from these, there are about fifty four natural and nine man-made wetlands in West Bengal, which are more than 100 ha. Apart from rivers and riverine wetlands, there are numerous small water bodies including ponds, puddles, canals, constructed irrigation canals, manmade potholes, natural depressions, oxbow lakes, lakes and other types of waterbodies locally mentioned in different names. Major identified functions of wetlands ecosystem associated with aquatic vegetations:

- Groundwater discharge, recharge and streamflow maintenance
- Flood mitigation and desynchronization
- Shoreline stabilization and reduction of erosion
- Sediment trapping, nutrient retention
- Carbon sequestration and amelioration of global temperature rise
- Nutrient removal, water purification, food chain support
- Biodiversity functions, i.e., supporting plant, animal and microbial diversity habitat with special references to fish and other wildlife habitats
- Active recreation and passive recreation and age-old cultural heritage values
- Traditional wetland practices and subsistence livelihood support

Most of the wetlands adjacent to the river system act as *Buffer* by virtue of the bio filtering properties of the microphytes as well as macrophytes present in these wetlands. Biological, chemical and physical processes in wetlands are often able to immobilize and transform a wide range of environmental contaminants including the drastic load of faecal coliforms and nutrients, which, in excess, would cause severe eutrophication and pollution. Heavy metals, pesticides and industrial wastes, for instance, can be bound to soil and sediment particles and thereby rendered more or less inert. Regular deposition of nutrient rich-silt contributed to the success of agriculture along large rivers. Sediment is also vital for maintaining aquatic fertility and physical stability of flood plains and deltas. The wetlands act as filters for certain kinds of waste and soluble contaminants. The process is important for controlling supplies of water for human consumption and also in maintaining the flow of groundwater which may support other wetlands at the point of discharge. Discharge of wetland stored groundwater may be important in sustaining the agricultural production of surrounding land. The task of valuing an ecosystem involves both the valuation of the components and the identification of the synergism they generate. These wetlands and water bodies are extremely significant for their carbon sequestration values and thus are naturally important for global temperature amelioration.

According to physiography and hydrology, wetlands of West Bengal can be divided into four regions. These are:

- Wetlands of the Gangetic alluvial plains
- Coastal wetlands
- Wetlands of the semi-arid regions, i,e, Rarh region
- Sub-Himalayan wetlands

Gangetic Alluvial Plains

These are mainly confined to alluvial plains of lower Gangetic delta of West Bengal ranging between $21^0 39'$ N to $22^0 32'$ N latitude to $88^0 03'$ to $88^0 20'$ E longitude. These parts include a spectacular range of variation of aquatic flora and fauna. Based on water quality, wetlands and waterbodies of this region can be divided into oligotrophic, mesotrophic, eutrophic, brackish and saline water types. There is a sharp variation of plants and animals communities in these diverse type of water bodies as well as species richness and association.

Water bodies present in these regions are both perennial and temporary types. The temporary wetlands can be termed as cyclical wetlands in respect to hydrology. These water bodies are locally called ponds, beels, baors char, dighi, bheri, sarobar, bandh, haor, sayar, nayanjali etc. Part of the irrigation canals and numerous potholes sometimes cannot be ignored from their diversity context. However, most of the ponds and beel fisheries in Gangetic West Bengal are extensively managed for fish farming and are thus not a good domain for adequate aquatic flora and fauna. Wetlands of the alluvial plains are the domain of maximum representative wetland families in West Bengal.

The Gangetic alluvial plains include transboundary wetlands like Bhutnir Char, Bhatia Beel in the district of Maldah, Balli Beel in the North 24 Parganas, temporary cyclical wetlands like Borti Beel, Nangla Beel of North 24 Parganas. Changing the direction of Ganges from its usual course has resulted in several horse-shoe shaped oxbow lakes like Chaltia Beel, Chander Beel, Bishnupur Adi Ganga, Dhopghati, Bhandardah Beel, Bhabta Beel (Hariharpur), Kaldanga Ghat (Islampur) and Ahiran Beel in the district of Murshidabad and Bhomra Beel, Chand Beel, Kulia Beel in

Nadia district, east and west Panishala wetlands, Sagardighi, Rasik beel are among the permanent wetlands (cut-off meander type) in the district of Koch Bihar. Wetlands around Dankuni and Mrigala (district Hugli) and transboundary wetland Balli Beel, adjacent to Swarupnagar, North 24 Parganas and Bangladesh are significant for their wide range of submerged hydrophyte diversity with diverse faunal associations.

Coastal Wetlands

Coastal Wetlands of West Bengal constitutes lower parts of the Bengal basin in the western fringes covering about 27% coastline (Purba Medinipur) and about 73% coastline on the central and eastern part (24 Parganas- South and North) are mostly saline (polyhaline to eurohaline) in nature. Active deltas in the coastal regions form the world's largest mangrove region- The Sundarbans ecosystem – having a wide spectrum of biological diversity, is aesthetically, ecologically and economically important in the national and international level as this is important for its age-old traditional and cultural values and it has now become the World Heritage site declared by the UNESCO. Gobaria beel near the Sundarban mangrove forest is also a productive tidal wetland. In addition to this Dadanpatrabar-Alampur coastal tidal wetland complex in the Purba Medinipur district is a combination of sand dune, mudflat and creek within the CRZ-I and is significant from its biodiversity values.

Wetlands and Water bodies of the Rarh Region

Geographically the Rarh region can be divided into Rarh plain and Rarh plateau (consisting of rolling upland). Most of the water bodies in this region are of man-made perennial reservoir type. All these water bodies are rain-fed (annual average rainfall is about 1300 mm) and remain saturated during monsoon to winter months, and get dried in summer. Water bodies distributed in these regions Water bodies studied in these regions mainly consist of ancient as well as perennial reservoirs standing on old alluvial or laterite alkaline soil with occasional coarse sand or gravels located at about 50-100m above mean sea level. Several perennial water bodies in this region are the host of several primitive plant families with rare representatives (*Caldesia oligococca*, *Caldesia* parnassifolia, *Butomopsis latifolia*, wetland orchid representative like *Spiranthes australis* etc.) and threatened and also a few endemic species.

Wetlands and Water bodies of the Northern Bengal

Geographically the North Bengal can broadly be divided into Terai and Duars and water bodies of the Terai and the Duars are distinctly different from their hydrology and physiography. Waterbodies of the Duars region includes hilly streams (locally called Jhora), rivers and few perennial and seasonal lakes and reservoirs mainly distributed in the Darjiling districts. The Terai region comprising of marshes, backwater wetlands and man-made ponds, ditches, lake, dighi etc. distributed in Jalpaiguri, Koch Bihar, Dinajpur Uttar and Dinajpur Dakshin. Sukhia pokhri, Jorpokhri and several other ditches of the district Darjiling is the only habitat in India for the Himalayan Newt or Salamander. More than 75 macrophytic species have been described from this region like *Pogostemon stellatus*, *Rotala densiflora*, *Rotala rotandafolia*, Hydrocotyle sibthorpioides *Marsilea quadrifolia* (in upper altitude), *Aponogeton natans*, *Blyxa octandra* and others. Water cress or *Nasturtium officinale* (above 3000 ft from the m.s.l.) is an interesting species cultivated by the locals in the watercourses of upper altitude having significant medicinal properties. Macrophyte based wastewater treatment bed has been set up in the National lake of Mirik (Darjiling district) in 2006-

2007 for better conservation of water quality and biological diversity of the lake.

Precautionary Classification of Wetlands for Facilitating Protection

Indeed, all the wetlands and waterbodies of this state cannot be conserved, however, we have to set a strategy for conservation of wetlands at least, which have a rationale. One such classification of wetlands for prioritisation of conservation issues for the Indian subcontinent is mentioned here. The most practicable initiative will be to introduce the precautionary classification of wetlands that divides wetlands into three separate schedules as under:

Schedule I Wetlands that are outstanding or highly significant will have to be conserved with or without minor modifications/up-gradation for their critical importance to the community.
Schedule II Wetlands, which require a transformation of the existing water regime for a different set of wetland functions and uses for the community to enhance the sustainability and efficiency of the resource base.
Schedule III Wetlands, which may be filled up to allow more pressing development needs for the general well-being of the community. Schedule III Wetlands will again be divided into two groups.
Schedule III A: Wetlands that will be filled up elsewhere and will be replenished.
Schedule III B: Wetlands that will be filled up and for which no replenishment is possible.

In West Bengal, specific legal protection for conservation of wetlands of pisciculture importance already exists; what is lacking is environmental consciousness of a specific group of people who are becoming the real actors of degradation of nature by any means.

District-wise Distribution of Wetlands

A compilation of district-wise distribution of wetlands in West Bengal has been prepared by the IWMED, Department of Environment, Govt of West Bengal from the satellite imagery data. In this treatment waterbodies less than 2.25 ha have been ignored but considering the huge number of such waterbodies steps should be taken for their necessary conservation as given in Table 11.2.

Table 11.2: District Wise Distribution of Wetlands (≥ 2.25 Ha) in different Districts of West Bengal

District	Geographical area (sq. km.)	Area in ha.
Darjiling	3149	271.79
Jalpaiguri	6627	1089.99
Koch Bihar	3387	4930.51
West Dinajpur (undivided)	5350	10699.37
Maldah	3733	29416.95
Murshidabad	5324	22076.89
Birbhum	4545	1727.1
Barddhaman(undivided)	7024	6412.34

District	Geographical area (sq. km.)	Area in ha.
Bankura	6882	6913.60
Puruliya	6259	16804.89
Medinipur (undivided)	14081	20807.22
Hugli	3149	1631.19
Nadia	3927	21874
Kolkata	185.39	87.32
24 Parganas (undivided)	14054	367258.24
Haora	1467	1925.65

Source: Bhattacharya et.al. 2001, Vass, 1989 & Statistical Abstract of West Bengal

Note: 1 Ha equals 0.01 Sq Km

Spatial distribution of wetlands varies from one district to another, both in numbers as well as in the area. Among the natural wetlands, seasonal waterlogged type of wetland (WSL) is prevalent in Medinipur, cut-off meander (COM) common in Koch Bihar, marsh and swamp in West Dinajpur while oxbow types lakes (OL) are common in Nadia. The maximum number of reservoirs are observed in Bankura, tanks in Puruliya, man-made waterlogged (MMWL) in Birbhum, abandoned quarries (AQ) in Barddhaman and ash ponds/ cooling ponds in Murshidabad and Medinipur district.

In terms of the spatial distribution of different types of inland wetlands in the districts of West Bengal, WSL class is most abundant, occupying an area of 20,956.49 ha in Maldah district. Lakes/ ponds in Murshidabad occupy 8069 ha and swamps in West Dinajpur (undivided) cover 5477.68 ha. Another important type of wetlands, viz. COM/ OL occupy 6543.14 ha in Murshidabad district. In case of IMMW, reservoirs in Puruliya are spread over 15012.82 ha, tanks in Barddhaman are extended over 1789.37 ha. Ash pond/ cooling ponds occupy an area of 667.03 ha in Murshidabad district, AQ in Barddhaman district covers an area of 415.07 ha and IMMWs in Birbhum occupy 215.65 ha. Coastal wetlands mostly fall in two districts, viz., South 24 Parganas and Medinipur. Among this, mangroves of the Indian part occupy 175322.55 ha and aquaculture ponds extend up to 4148156 ha. The study indicates about 7056 wetlands (2.25 ha) in West Bengal covering approximately 504306.56 ha. The research team of IWMED has done an intensive survey in Barddhaman, Birbhum, Nadia and 8 selected wetlands in West Bengal.

Beel fisheries have been estimated to be 46,000 ha representing 22% of the total freshwater area excluding river and tributaries. There are 116 Beel fisheries in five districts, viz., Hugli, Nadia, Murshidabad, North 24 Parganas and Birbhum significant for fish and macrophytes given in Table 11.3.

Table 11.3: Distribution of Beel Fisheries in Five Districts of West Bengal

Sl. No.	Characteristics	District				
		Hugli	Nadia	Murshidabad	North 24 Parganas	Birbhum
1.	Number of Beel fishery	6	43	43	23	1
2.	Range of effective area (ha)	3-75	2-130	7-210	12-600	100
3.	Depth distribution (m)	2.5-3.5	2.5-7.0	3-5	3.5-8	2.5
4.	Drainage pattern	ND	D/ND	ND	ND	D
5.	Connected river	Farraka, Ganga	Ganga, Ichhamati, Bhagirathi, and Jalangi	Ganga and canals	Ichhamati	Mayurakshi
	Total area (ha)	174	15982	13161	1742	100

Adapted from Vass, 1989 D – Drainage ND – Non Drainage

Increasing population pressure, massive expansion of real estate business, rapid urbanization and fencing in wetlands by the name of industrialization results in the encroachment of vast expanse of wetlands for so-called development overlooking environmental imbalance have led to social and ecological disorders.

The Health of the Wetland Ecosystem

In general, the health of the aquatic ecosystem in India is in a deteriorating stage. Mixing of inadequately treated sewage water in the mainstream river is the major cause of degradation of water quality. CPCB (Central Pollution Control Board) mentioned critically polluted river stretches are gradually increasing in India. CPCB also indicated that dissolved oxygen and coliform bacterial load is much higher in several stretches of Ganga water in comparison to drinking water even during the lockdown period due to Covid-19 pandemic.

In West Bengal, majority wetlands are exploited for organized pisciculture practice, which results in time scale change of physicochemical parameters of water and bottom sediments. Here for the urgent need of the society, it is hardly possible to find out wetland without pisciculture practice. Nutrient addition for better food supplement is the practice in pisciculture, where natural food chain or energy flow is altered by socioeconomic pressure.

A good fish pond or ecosystem means a transparent water table with submerged flora in controlled condition, plenty of food, solar radiation and oxygen and also a clear substratum, which enables the spawning and laying eggs for the fish species. The bottom should be a good domain for aquatic worms and other bottom dwellers to be consumed by the fishes. These are the prerequisites for a healthy aquatic ecosystem. There should be scattered floating leaf and floating stem species and free-floating species only at the margin to provide shade and halt for the epizootic fauna as well as provide support for shoreline stabilization.

All this is possible with traditional ecological eyes which can see long term benefit for the fishes. Unfortunately, ecology has to surrender to the grasp of unit productivity of the system.

The traditional fishermen community of the East Kolkata Wetlands consider colour, odour and taste for the management of their ecosystem, which is unique in the world. Likely in Bhaluka wetland (Nadia), the fisherman community accept aquatic plants in their water bodies which provide better ecosystem functions, nutrient flow and food chain support with sound productivity. Attention should be paid to empower the wetland active stakeholders who have nothing to lose but the piece of wetlands that nurture them since birth to the last day of their existence in the earth. These people for the grace of their traditional knowledge are well aware that good fish cannot be produced without aquatic herbs and shrubs in controlled conditions. It needs no mention that in our neighbouring country, Bangladesh, homestead ponds in flood plains are a rich resource of floodplain biodiversity. In our state, these homestead ponds may play a critical role in abating flood menace, particularly in the flood plains. Wave action of the flash flood can be reduced by these homestead ponds. These small naturally decorated ponds can be maintained as rural wetland gene bank for wetland supplementary vegetables, wetland based medicinal plants. Moreover, aquatic vegetation in these ponds will maintain aquatic animals like Annelids, Arthropods, Mollusks, Pisces, Amphibians, Reptiles, Birds and Mammals. This is the uniqueness of coexistence of aquatic plants and animals in a pond ecosystem, which play significant roles in providing subsistence to the stakeholders even in the phase of severe economic crisis due to Covid-19 pandemic in West Bengal.

Habitat requirement for the growth and development of plants and animals in the wetlands is one of the important parameters for the management of wetlands. Inter-relationships between various factors of an ecosystem are complex. In West Bengal, for better health and management of the wetlands, water quality parameters must be taken into consideration for reaching restoration of critical species in the system. Plants starting from algae to angiosperm plays a pivot role in the management of hydrology and water quality of the wetlands. In addition to these, advance knowledge of ecosystem management may help in stopping the deterioration of water quality. Very recent (2017 to 2019) observations of the author reveal that richness and density of submerged hydrophytic community is gradually thinning in the freshwater wetlands due to changes in water quality parameters, minimizing light penetration, eutrophication and overexploitation. The health of the pond and lake ecosystems has been affected by anthropogenic pressure like overuse or somewhere unwise use. Furthermore, two consecutive disasters like *Aila* in 2009 and *Amphan* in 2020 have imposed massive impacts on the aquatic ecosystem. Freshwater waterbodies nearby coastal river system, particularly those which are lies within Sundarban Biosphere reserve in Indian part were flooded by coastal saline water which resulted in more or less permanent changes in salinity level from 0 ppt to 8 or 9 ppt or even more. This changing salinity has a direct impact on flora and fauna of the area including the vast microbial community. Thus critical study is needed in this area to assess impacts of these disasters on biodiversity at the genetic level and also socioeconomic impacts on the livelihood of the affected area.

Conversion of freshwater wetlands to wastewater wetlands or freshwater wetlands to brackish water wetlands for commercial production of fish or shrimp results in deterioration of ecosystem health in the Gangetic Bengal.

Massive destruction of submerged plant species in the Rabindrasarobar Lake (National Lake) during the last two decades has altered the ambient water quality of the lake which leads to fish-death due to change in water quality in recent times.

Water is essential for all ecosystems and all activities of human beings. Water makes up nearly 90% of all living cells of the body. Out of 1.4 million cubic kilometres of water in the earth about 97.5% is sea and brackish water and nearly

75% of the remaining 2.5% is locked up in icecaps and glaciers. Thus only a fraction of a percentage point of the total water on earth remains available for human utilization. Unfortunately, today, 1.2 billion people do not have access to an adequate supply of safe water, and 2.2 billion people do not have adequate sanitation. The water-borne disease causes millions of preventable deaths especially among children in developing countries. World Water Council predicts, by 2025 as many as 52 countries with more than three billion people will be water-stressed. Presently per capita water supply around the globe is about one-third lower than what it was 25 years ago. The Council also alarmed that the expected growth of population over the next 30 years can extend to at least 8 billion, which means the water demand to be more than 650%. Agriculture is the largest (about 70%) consumer of water in the world (source: World Water Council – Six years Progress: 1994-2000). Rapid population growth in the developing countries will enhance the demand for water in the next 25 years particularly for domestic, municipal, and industrial use as well as for treatments of waste.

West Bengal occupies 2.77% of India's land area and accommodates 8.06% of its population. According to a study by the South Asia Research Society, Kolkata, the actual pressure of population upon West Bengal may indeed be higher than what is estimated from Census data, which are seldom complete. According to census data (2011), West Bengal population is more than 9.13 crores. The most populous district of West Bengal is North 24 Parganas (1,00,82,852). North and South 24 Parganas, Maldah, Uttar and Dakshin Dinajpur districts are significant for transboundary wetlands. Infiltration from neighbouring Bangladesh to these districts results in an additional anthropogenic pressure, which has direct impact on the wetlands of these districts. At least 2-3% population of these three districts is otherwise dependent for their livelihood support from wetland-based resources.

Hydrology and trophic structure of aquatic ecosystems are governed by the interactions of plant, animal and microbial communities of wetlands. Aquatic animals are completely dependant for their survival on aquatic plants. Even diversity of avifauna and also the molluscs and amphibians are directly correlated with the aquatic plants. Wetlands and human interdependence are well-addressed, Algae alone covers 40% of the known biodiversity in wetlands aquatic plant and are an important source of dissolved oxygen, a food source for waterfowl and herbivorous fishes as well as nesting and roosting ground for birds, amphibians, reptiles and aquatic mammals.

Diversity of Macrophytes in Aquatic and Wetland Habitat of West Bengal

Wetlands are significant for their hydrophytic vegetation. Aquatic plants play a significant role in the maintenance of the health of the Wetlands of West Bengal covering a meagre of 8.5% of the wetland areas (considering water bodies >100 ha) of India provide shelter for more than 60% diversity of aquatic and wetland plants.

Diversity of wetland plants of West Bengal is richest in India represented by more than 380 species belonging to 176 genera and 81 families. In general, wetlands of the alluvial plain of the lower Ganga deltas are richest in macrophytic plant diversity in aquatic habitat due to variations in physicochemical parameters of water and bottom sediments. Highly saline coastal wetlands are vegetated with mangroves and sea-grasses. Wetlands of the sub-Himalayan and semi-arid regions are also distinguished for their physiography, hydrology and floristic composition. Perennial water reservoirs in the semi-arid regions are rich sources of floristic diversity.

Aquatic and Wetland Pteridophytes

At least 8 genera and 26 species of aquatic and wetland pteridophytes distributed in 7 families in the Indian wetlands. The wetlands of West Bengal represent 6 genera and 8 species belong to 6 families which are 75 % of the reported aquatic and wetland pteridophytes of India and about 8.6 per cent of the world at the genus level. However, the species-level diversity of aquatic and wetland pteridophytes of West Bengal is about 31% of India and a little more than 2% of the world-known population given in Table 11.4. *Salvinia molesta* mostly occupies the water bodies receiving saline flush or nutrient loads from the catchment. But this species is not abundantly distributed in wetlands of other parts of India or neighbouring states of West Bengal. There is no gymnosperm representative in the wetlands of West Bengal.

Table 11.4: Wetland Pteridophytes of West Bengal with respect to their representatives in India and World

Family	Genera					Species				
	World wide (no.)	India (no.)	West Bengal (no.)	% of World	% of India	World wide (no.)	India (no.)	West Bengal (no.)	% of World	% of India
Aquatic and Wetland Pteridophytes										
1. Azollaceae	1	1	1	100	100	6	1	1	16.6	100
2. Isoetaceae	1	1	1	100	100	130	11	1	0.77	9.09
3. Marsileaceae	3	1	1	33.3	100	72	7	1	1.38	14.28
4. Polypodiaceae	1	1	1	100	100	60	1	1	0.625	100
5. Pteridaceae (=Parkeriaceae)	2	2	2	100	100	7	3	2	28.57	66.6
6. Salviniaceae	1	1	1	100	100	10	2	2	20	100
Total-6	9	7	7	77.77	100	285	25	8	2.80	32

Source: Ghosh 2005

Freshwater Angiosperms

Freshwater strictly aquatic angiosperm of the world is represented by more than 141 genera and 1023 species of which the Indian subcontinent support 54 genera and 122 species. Wetland habitat of West Bengal represents 26 genera and 43 species.

Strictly Aquatic and Wetland Monocot Representatives

The Indian subcontinent supports 12 families, 30 genera and 75 species of strictly aquatic monocot (Table-11.5). The wetlands of West Bengal support 32 species belonging to 19 genera and 10 families. The Indian wetlands represent nearly 40 per cent of the world strictly aquatic families. Hydrocharitaceae and Lemnaceae are among the dominant families.

Table 11.5. Strictly Aquatic Monocot representatives of West Bengal with respect to their counterpart in India & World

Family	Genera					Species				
	World wide	India	West Bengal	% of	% of	World wide	India	West Bengal	% of World	India
	(No.)	(No.)	(No.)	World	India	(No.)	(No.)	(No.)		
1. Alismataceae	11	5	3	27.27	60	100	7	5	20	71.4
2. Aponogetonaceae	1	1	1	100	100	45	10	3	6.66	30
3. Hydrocharitaceae	17	8	5	29.4	62.5	100	13	5	20	38.5
4. Lemnaceae	4	4	3	75	75	35	15	5	14.3	33.3
5. Limnocharitaceae	3	2	1	33.3	50	12	2	1	8.33	50
6. Najadaceae	1	1	1	100	100	50	10	3	6	30
7. Pontederiaceae	8	2	2	25	100	32	3	3	9.37	100
8. Potamogetonaceae	3	1	1	33.3	100	108	6	4	3.7	66.6
9. Ruppiaceae	1	1	1	100	100	7	1	1	14.3	100
10. Typhaceae	1	1	1	100	100	11	2	2	18.2	100
Total = 10	50	26	19	38	73.07	500	69	32	6.4	46.37

Source: Ghosh 2005

Strictly Aquatic and Wetland Dicot Representatives

The Indian subcontinent supports 9 families, 24 genera and 47 species of strictly aquatic. In the wetland habitat of West Bengal, there are 8 families, 8 genera and 12 species (Table 11.6). This is about 33% at genus level and about 25% at species-level diversity of the strictly aquatic plants of India. The entire Nymphaeaceae family is now under threat as the rhizomes of the members of Nymphaeaceae family are randomly harvested for alternative vegetables and medicines in rural Bengal. There is no representative of the family Podostemaceae in West Bengal.

Table-11.6. Strictly Aquatic Dicot Representatives of West Bengal with respect to their counterpart in India & World

Family	Genera					Species				
	World wide	India	West Bengal	% of World	% of India	World wide	India	West Bengal	% of World	% of India
	(No.)	(No.)	(No.)	(No.)		(No.)	(No.)	(No.)	(No.)	
1. Cabombaceae	2	2	1	50	50	5	2	1	20	50
2. Ceratophyllaceae	1	1	1	100	100	4	2	1	25	50
3. Elatinaceae	2	2	1	50	50	36	5	2	5.55	40
4. Menganthaceae	5	1	1	20	100	39	8	2	5.13	25
5. Nelumbonaceae	1	1	1	100	100	2	1	1	50	100
6. Nymphaeaceae	6	5	1	16.6	20	65	7	2	3.07	28.57
7. Sphenocleaceae	1	1	1	100	100	1	1	1	100	100
8. Trapaceae	1	1	1	100	100	3	2	2	66.6	100
Total = 8	19	14	8	11.4	33.3	449	47	12	2.67	25.53

Source: Ghosh 2005

Overlapping Families in the Wetland Habitat

In West Bengal, there are about 273 species and 103 genera distributed in 39 families (Table- 11.7) have a representative in both the wetland and terrestrial habitat, i.e. overlapping family. Orchidaceae in the Indian subcontinent is represented by two genera, viz., *Spiranthes australis* and *Zeuxine strateumatica* and both the two species have been reported from the wetlands of West Bengal. Among the overlapping families, Cyperaceae is dominant, having 72 species and 13 genera, followed by Poaceae having 45 species and 24 genera and Scrophulariaceae having 27 species and 6 genera.

Table 11.7: Flowering Plant Families having Representatives in Wetland Habitat of West Bengal with respect to their Counterparts in India

Name of the Families	Genera			Species		
	India (No.)	West Bengal (No.)	% of India	India (No.)	West Bengal (No.)	% of India
1. Acanthaceae	3	1	33.3	9	3	33.3
2. Amaranthaceae	2	2	100	4	4	100
3. Amaryllidaceae	1	1	100	1	1	100
4. Apiaceae	3	3	100	3	3	100
5. Araceae	6	5	83.3	37	9	24.32
6. Asclepiadaceae	1	1	100	1	1	100
7. Asteraceae	9	7	77.8	18	9	50
8. Balsaminaceae	1	1	100	1	1	100
9. Boraginaceae	3	2	66.6	7	3	42.85
10. Brassicaceae	1	1	100	1	1	100
11. Burmanniaceae	1	1	100	5	2	40
12. Campanulaceae	1	1	100	3	2	66.6
13. Cannaceae	1	1	100	1	1	100
14. Caryophyllaceae	1	1	100	1	1	100
15. Commelinaceae	4	3	75	12	10	83.3
16. Convolvulaceae	3	1	33.3	5	2	40
17. Cyperaceae	26	13	50	171	72	42.1
18. Droseraceae	2	1	50	4	3	75
19. Elatinaceae	2	1	50	5	2	40
20. Eriocaulaceae	1	1	100	39	8	20.5
21. Fabaceae	4	4	100	12	9	75
22. Gentianaceae	1	1	100	2	1	50
23. Haloragaceae	1	1	100	5	2	40
24. Hydrophyllaceae	1	1	100	2	1	50
25. Lamiaceae	1	1	100	4	1	25
26. Lentibulariaceae	1	1	100	27	15	55.5
27. Lythraceae	3	3	100	38	11	28.9
28. Onagraceae	1	1	100	6	4	66.6
29. Orchidaceae	2	2	100	2	2	100
30. Poaceae	42	24	57.14	75	45	60
31. Polygonaceae	1	1	100	7	5	71.4
32. Ranunculaceae	1	1	100	1	1	100

Name of the Families	Genera			Species		
	India (No.)	West Bengal (No.)	% of India	India (No.)	West Bengal (No.)	% of India
33. Rubiaceae	2	2	100	3	3	100
34. Scrophulariaceae	14	6	42.85	66	27	40.9
35. Solanaceae	1	1	100	1	1	100
36. Sphenocleaceae	1	1	100	1	1	100
37. Trapaceae	1	1	100	2	2	100
38. Verbenaceae	2	2	100	2	2	100
39. Xyridaceae	5	1	20	7	2	28.57
Total	157	103	65.6	591	273	45.85

Source: Ghosh, 2002, Ghosh, 2005

Due to habitat alteration and change in physicochemical parameters of water bodies, species like *Aldrovanda vesiculosa* have either been shifted or become extinct from the wetland habitat of West Bengal. Several species like *Solanum glaucum* restricted in salt-water ditches in the coastal West Bengal. *Alternanthera philoxeroides* is an exotic weed that invades open water interface of the wetlands extensively next to *Eichhornia crassipes* in plains. *Canna* sp. belonging to the monotypic family Cannaceae is found in both the wetland and terrestrial conditions in the tropics. *Sagittaria montevidensis* ssp. *montevidensis*, *Rumex dentatus*, *Eichhornia crassipes*, *Colocasia esculenta*, *Cyperus exaltatus* and grasses like *Panicum* spp., *Paspalidium punctatum* are common in sewage fed waterbodies.

Coastal Wetlands and Diversity of Saltwater Angiosperms

In the Indian subcontinent, saltwater angiosperms are mostly dominated in the mangrove ecosystems. The total mangrove area of India is about 6560 sq km of which the mangrove area of the Indian Sundarbans covers about 4267 sq km. Distribution of different mangrove categories is depicted in Table 11.8.

Table 11.8: An Overview of the Distribution of Salt-Water Angiosperms in the Indian Sundarbans

Distinctive groups	Family	Genus	Species
Major Mangrove elements	5	8	18
Minor mangrove elements	10	11	15
Mangrove associates	26	35	46
Total:	41	54	79

Mangroves of the Indian Sundarbans comprising of 79 floral species, as shown in Table 11.9, which are distributed into 41 families and 54 genera and among this 35 species are true mangrove types. The herbaceous plants of the Sundarban mangrove and mangrove-reclaimed areas are represented by 30 species belonging to 25 genera and 13 families. A new mangrove associate species *Acanthus albus* has been included recently by H.S. Debnath, B.K. Singh and P. Giri. Sundarban mangrove forest has been devasted by the recent super cyclone Amphan

Table 11.9: List of True Mangroves in the Indian Sundarbans with their Family and Local Names

Family	Name of the species	Local names
1. Acanthaceae	*Acanthus ilicifolius*	*Haraguja, Sea Holly*
2. Acanthaceae	*Acanthus volubilis*	*Lata haraguja*
3. Myrsinaceae	*Aegiceras corniculatum*	*Khalsi*
4. Aegialitidaceae	*Aegialitis rotundifolia*	*Satari, Tora*
5. Meliaceae	*Amoora cucullata*	*Amur*
6. Avicenniaceae	*Avicennia alba*	*Kala baen*
7. Avicenniaceae	*Avicennia marina*	*Peara baen*
8. Avicenniaceae	*Avicennia officinalis*	*Sada baen*
9. Tiliaceae	*Brownlowia tersa*	*Lata, Bola Sundari*
10. Rhizophoraceae	*Bruguiera cylindrica*	*Sona champa, Thushia*
11. Rhizophoraceae	*Bruguiera gymnorrhiza*	*Kankra, Natinga*
12. Rhizophoraceae	*Bruguiera parviflora*	*Champa, Kankra Bokul*
13. Rhizophoraceae	*Bruguiera sexangula*	*Banduri, Kankra*
14. Rhizophoraceae	*Ceriops decandra*	*Goran*
15. Rhizophoraceae	*Ceriops tagal*	*Mat Goran*
16. Fabaceae	*Cynometra ramiflora*	*Shingara*
17. Fabaceae	*Derris trifoliata*	*Kalilata*
18. Fabaceae	*Derris umbellatum*	*Panilata*
19. Euphorbiaceae	*Excoecaria agallocha*	*Genwa, Blinding tree*
20. Euphorbiaceae	*Excoecaria bicolor*	*Genwa*
21. Sterculiaceae	*Heritiera fomes*	*Sundari*
22. Sterculiaceae	*Heritiera littoralis*	*Sundari*
23. Malvaceae	*Hibiscus tortuosus*	*Paras*
24. Rhizophoraceae	*Kandelia candel*	*Goria*
25. Combretaceae	*Lumnitzera racemosa*	*Kripa*
26. Arecaceae	*Nypa fruticans*	*Golpata, water coconut*
27. Arecaceae	*Phoenix paludosa*	*Hital, sea date palm*
28. Rhizophoraceae	*Rhizophora apiculata*	*Garjan*
29. Rhizophoraceae	*Rhizophora mucronata*	*Garjan*
30. Sonneratiaceae	*Sonneratia apetala*	*Keora*
31. Sonneratiaceae	*Sonneratia caseolaris*	*Keora*
32. Tamaricaceae	*Tamarix dioica*	*Nona Jhau*
33. Tamaricaceae	*Tamarix gallica*	*Nona Jhau*
34. Meliaceae	*Xylocarpus granatum*	*Dhundul, Pohar*
35. Meliaceae	*Xylocarpus mekongensis*	*Pitamari*

Compiled from Naskar and Guha Bakshi, 1987; Mangroves of the Sundarbans, Volume 1: India, by A. B. Chaudhuri and A. Choudhury, IUCN, 1994.

The Sundarbans mangrove ecosystem is also a unique corridor for the vertebrate fauna. The forests and water bodies of the Sundarbans provide dwelling places, habitats, breeding sites and roosting ground for a wide range of vertebrate species encompassing about 250 species of fishes, 8 species of amphibians, 57 species of reptiles, 161 species of birds and 40 species of mammals many of which are endangered in other parts of the world. Nearly half a million poor coastal people depend for their livelihood support on the resource of Sundarban mangrove forest.

Significance of the Mangrove Vegetation

Mangroves vegetation of the Sundarbans of both the Indian territory and Bangladesh provide tangible and intangible benefits to the stakeholders. This unique ecosystem regulates the economy of certain areas in the coastal part of the globe for its manifold benefits to coastal population. Summary of the diverse benefits derived from the mangrove ecosystem is highlighted below:

Golpata (*Nypa fruticans*) palms can provide many useful products to local people living near the mangrove areas. The most important commercial product of *Nypa* is sugar produced from its sap. The sap can also be used for vinegar and alcohol production. The dried leaves of this palm are used for thatching roofs of houses of people living in this area. In Bangladesh golpata is extensively marketed in Khulna district for making roofs of earthen huts.

The mangrove vegetations are economically very significant for their products like timber, firewood, honey, wax, alcohol, tannins and even medicines.

Certain mangrove species are highly efficient in detecting or assessing the change of ambient environment. Bioaccumulation of heavy metals by certain mangrove species (specially, kalo baen (*Avicennia alba*) and *keora* (*Sonneratia apetala*) can act as bio-purifier or bio-filter. The concentration of heavy metal pollutants in different parts of mangrove plants may be useful for water quality monitoring programme in the Sundarbans.

The precious wood of *sundari* (*Heritiera fomes*) serves as a valuable source for timber wood and has a good export value that may support the rural economy.

Capture fisheries, honey, forest wood, rearing of prawns are few of the significant means of livelihood support in the Sundarban area of India. The annual total yield of fish and prawn from the Sundarbans area is about 20,285.2 to 39999.7 ton , which represent about 91.6 – 95.5% of the fish and prawn catch from the entire Hugli-Matla estuarine system. In addition to these several thousand rural women folks in the Sundarbans survive on collection of molluscs from the Matla riverbed in Canning (South 24 Parganas).

Exotic Wetland Weeds

Exotic weeds mostly of South American origin now occupy the major portion of the open water interface of the unmanaged waterbodies in the wetlands of West Bengal. *Eichhornia crassipes* and *Alternanthera philoxeroides*, *Sagittaria montevidensis* ssp. *montevidensis* occupies the water edges of wastewater canals in lower Bengal, however, *Sagittaria sagittifolia* is common in the nutrient-enriched wetlands of North Bengal. Free-floating aquatic weeds like *Salvinia molesta* and *S. cucullata* are also common in the brackish water and nutrient-rich water bodies.

Threatened Plant Species in the Wetlands of West Bengal

Several species have become rare in their earlier native area due to habitat modification, alteration in the physicochemical parameters of water and the bottom sediments due to anthropogenic pressures (Table 11.10).

Table 11.10: Some Significant Threatened Plants in Fresh Water Wetlands of West Bengal.

Name of the species	Assumed threats
Aldrovanda vesiculosa	This plant was last collected from India during 1957 from Tripura see Deb, 1957; Deb, 1975. Now probably *Aldrovanda vesiculosa* is extinct from West Bengal due to habitat alteration and changes in water quality parameters.
Caldesia oligococca	Distribution became restricted due to habitat alteration, human intervention in its areas of occurrence and also changes in physicochemical parameters of water bodies.
Caldesia parnassifolia	Same as *Caldesia oligococca*.
Drosera burmannii	Overgrazing and anthropogenic pressures.
Drosera indica	Overgrazing and anthropogenic pressures.
Euryale ferox	No natural population has been recorded from Bengal except in Maldah and Jalpaiguri where it is cultivated for commercial purpose.
Isoetes coromandelina	Habitat modification, overconsumption by pigs in its place of origin and also lack of awareness of common people about this species.
Najas marina	Change in physicochemical parameters of the habitat and anthropogenic pressures.
Spiranthes australis	Very poorly explored taxa, and its rarity might be due to reproductive failure or unfavourable habitat
Utricularia striatula	Intra-specific and inter-specific competition, grazing and habitat modification.

Source: Ghosh, 2005

East Kolkata Wetlands: The Ramsar Site of West Bengal

The East Kolkata Wetlands (earlier the saltwater lakes at the eastern fringes of Kolkata) is one of the 17 case study sites designated by the Ramsar Bureau for understanding wise use of wetlands. This is a unique example of a natural or near-natural wetland type found within the appropriate biogeographic region considered under Criterion-1 under Group-A of the Ramsar sites Criteria for identifying wetlands of international importance. This is a Ramsar site which is conserved as ecosystem bias rather than species bias. The East Kolkata Wetlands (22° 25' to 22° 40'North Latitude and 88° 20' to 88° 35'E Longitude) is popular for its waste recycling properties. The halophytic vegetation of the earlier Sundarbans during the early 1930s largely dominated the East Kolkata cluster of wetlands. Later on, a gradual change has been taken place that resulted in the change of water quality from polyhaline condition to almost freshwater with a change in the profile of flora and fauna of the region. During 1945, the total area of the wetlands of the eastern part of Kolkata was about 8097 ha out of which about 4684 ha has been converted for fish farming with city sewage. Lack of regulatory control on these wetlands and expansion of Kolkata city towards its eastern fringes led to gradual encroachment. This resulted in the shrinking of these wetlands and the present area of the conservation boundary is about 3905 ha.

These clusters of sewage-fed waterbodies consist of 286 *bheries*. However, in recent times more than 25% active areas of these *bheries* became inactive or otherwise altered for other than conservation purpose. Illegal encroachment and lack of supply of raw sewage due to siltation in the artery channels are among the major threats faced by these clusters of wetlands. The existing system minimises the nutrient load of wastewater discharged from the

Kolkata Metropolitan city through algae-bacterial symbiosis phenomenon using solar energy and produces marketable surplus viz., indigenous fish, fresh vegetables and mostly winter paddy that provides a subsidy for the urban population of the Kolkata Metropolis and its suburbs.

Significance of the Study of Aquatic Vegetation for Management Purpose

Aquatic and wetland vegetation in almost all the parts of the globe is considered as weed and during the last few decades, several attempts have been made to identify the active components of the aquatic weeds which provide livelihood support. It needs no further mention that quite a good number of aquatic and wetland plants provide food and fodder but their overgrowth in the culturable aquatic ecosystem, particularly those utilised for pisciculture, cause serious problems. In water bodies, where fish culture is regularly practised conglomeration of aquatic weeds, particularly of submerged and of floating growth forms cause direct problems for growth and development of the fish population. Although there are a lot of herbicides like 2,4-D amine salt, Dalapon, Maleic Hydrazide, Diquat, Dichlobenil, etc. in the market for controlling weeds in the fishponds none of these is efficient to control all the plant species at recommended levels without disturbing other living communities. Extensive use of these herbicides has resulted in the development of a wide range of susceptible aquatic plants and these aquatic plants sometimes develop phenotypic alterations.

In addition to these, extensive use of herbicides has also been accounted for loss in diversity of wild fish species. Biological control of aquatic weeds has been recommended in India by the introduction of herbivorous grazer fishes like *Ctenopharyngodon idella*, several freshwater snails, exotic natural enemies like *Neochetina bruchi*, *Neochetina eichhorniae* and *Orthogalumna terebrantis* for the control of *Eichhornia crassipes*.

Wetlands for Commercial Significance

Commercially significant wetlands in India can be broadly divided into two heads, viz., and conventional and non-conventional types. Paddy and jute fields are commonly treated as conventional types and such types of wetlands are not included in this. Apart from 170 Indian wetland sites studied by WWF-India including two Ramsar Sites and 16 lakes, rest of the freshwater wetlands are mostly utilized for either aquaculture or are somehow managed for Traditional Commercial Practices (TCP).

Fresh Water Aquaculture and Estuarine Fisheries

Nearly 0.2 million ha freshwater wetlands are distributed in West Bengal, Assam, Valley districts of Manipur, Northern Bihar, foothills of Arunachal Pradesh, Meghalaya and Eastern Uttar Pradesh. Average fish yield in freshwater fisheries is estimated about 100-200 kg/ha/yr but these wetlands are capable of producing even up to 5-10 t /ha/yr if managed properly.

Estuarine fisheries of the Sundarban delta of the Indian territory include nearly 1392 saline water area is having 3 to 260 ha size covering approximately an area of 43,000 ha. Estuarine wetlands of the Sundarban yield about 36,167.5 t / year commercial fish.

Traditional Commercial Practices in Wetlands of West Bengal

Traditional commercial practice or TCP (other than paddy and jute cultivation and fish farming) in the wetlands of West Bengal is an indigenous culture of not less than 300 years. Unproductive wetlands were the natural harbour of reeds, cattails and other emergent hydrophytes having reasonable market value. Rural people in different parts of the state, particularly 24 Parganas (South and North), Hugli, Haora and Medinipur were responsible for commercialisation of major wetland products obtained from plant resources like *Typha elephantina* and *Typha domingensis* (*hogla*), *Aeschynomene aspera* (*shola*), *Cyperus pangorei* and *Cyperus corymbosus* (*madurkathi*), *Trapa natans* var. *bispinosa* (*paniphal*), *Euryale ferox* (*makhana*) etc. The entire information relating to TCPs in the wetlands of West Bengal is vast but incomplete. The present information has been done to bring this unmarked resource base to the fore to attract the attention of policymakers for conserving the resource base and to promote research in future. In West Bengal at least 2-3% of the rural population otherwise dependent on the nonconventional wetland resources for their livelihood support at least up to subsistence level. Traditional commercial practices of wetland plants in West Bengal can be broadly divided into 'major practices' and 'minor practices'.

Major Commercial Practices

Mat Cultivation

Commercial mat is obtained from two species of sedges, viz., *Cyperus pangorei* and *Cyperus corymbosus*. Inferior quality of the mat is also prepared from several members of the family Cyperaceae like *Cyperus malaccensis*, *Cyperus iria*, *Cyperus exaltatus* etc. A coarse quality mat is also obtained from *Typha elephantina* and *Typha domingensis* in several parts of the tropics. Commercial cultivation of mat plants is reported in two districts of West Bengal, namely Medinipur and North 24 Parganas. During the study period, nearly 95 per cent of the Integrated Rural Development Programme (IRDP) loan for the district was provided for mat cultivation in Sabang Block. More than 12,000 families benefited from this practice.

Hogla (cattails) cultivation

Cultivation and management of cattails, locally called *hogla*pati (*Typha elephantina* and *Typha domingensis*) is more than a century-old practice particularly found in the wetlands of lower Bengal. Surprisingly, even today records of *hogla* cultivation at the village/block level remain inadequate. More than 20,000 rural people of the districts of 24 Parganas (South and North), Haora, Hugli and Medinipur are engaged in mat cultivation management and marketing of products obtained from *hogla*. More than 3000 ha wetland area is now exploited for hogla cultivation practice in West Bengal. *Typha* swamp also exhibits biodiversity of associated flora and fauna. *Typha* is a significant species for ecological restoration of wetlands. This species is also important for its economic rehabilitation at least at the subsistence level.

Shola (hat plant) cultivation

'Shola' is obtained from the soft stem pith of *Aeschynomene aspera* and *Aeschynomene indica*. Commercial shola pith used for artworks is obtained from *A. aspera*. Cultivation of *A. aspera* is restricted to mostly North 24 Parganas in West Bengal. Recently local farmers of Maheshpur of South 24 Parganas district have taken initiatives to reclaim wetlands for *shola* cultivation. More than 20,000 people of Maheshpur (Mathurapur P.S. of South 24 Parganas) were dependent on *shola*art in the state and presently more than one lakh people of West Bengal are otherwise dependent on different phases of shola arts. A less remunerative boro paddy cultivation is also practised somewhere in these wetlands when the water level recedes. About 150 to 200 families (mostly migrated from Bangladesh) are the major harvester of *shola* plants in Swarupnagar area adjoining to the transboundary wetlands of Balli Beel.

Makhana (fox nut) cultivation

Makhana is commercially cultivated in more than 900 ha wetland area in West Bengal and about 5000 people are somehow dependent on *makhana* cultivation practice in the district of Maldah (Ghosh, 2002a). *Makhana* is very recently cultivated in the Railway trackside wetlands or *nayanjali* near New Jalpaiguri station of the district Jalpaiguri. Makhana cultivation recently extended in adjacent districts also. *Makhana* seeds harvested from this region is hopefully remunerable and presently the productivity of raw *makhana* seed is 2000 kg to 3500 kg per ha per year in Harishchandrapur area. Food value of makhana is depicted in Table 11.11.

Table 11.11: Analysis of Proximate Components of *Makhana* Seed Ample Collected from Maldah, West Bengal, India

Parameters studied	*Makhana* Seed (Edible Part) (Wt. %)	*Makhana* Product (Wt. %)
Moisture	27.83 - 35.11	10.30 - 14.24
Ash (Minerals)	0.39 - 0.31	0.57- 0.51
Fat	0.21 - 0.17	13.91 - 13.51
Protein	13.71 - 11.11	11.32 - 10.36
Crude Fibre	0.28 - 0.22	0.47 - 0.41
Carbohydrate	57.58 - 53.08	63.43 - 62.97

Source : Ghosh, 2002a

Minor Commercial Practices in Wetlands: Cultivation of Paniphal and Supplementary Vegetables

Vast expanse of wetland and waterbodies of West Bengal are significant for cultivation of Water chestnut locally called '*paniphal*' or '*singhara phal*' (*Trapa natans* var. *bispinosa*), lotus (Nelumbo nucifera) and supplementary vegetables.

Harvesting and selling of supplementary vegetables from wetlands is a common practice in rural Bengal for subsistence livelihood support. Leafy twigs, petioles and rhizomes of several aquatic herbs are traditionally consumed by many communities in Bengal of which *Ipomoea aquatica* or *Kalmi* is the most prominent one. *Kalmi* is cultivated in the city fringes of Kolkata and Dhamua, canning and other areas of South 24 Parganas in lower Bengal. Also, other aquatic herbs like *Kachu* (Colocasia esculenta), *Hincha* (*Enhydra fluctuans*), *Sushni* (*Marsilea minuta*), alligator's weed locally called *Jalsakhi* or *ban-hincha* (*Alternanthera philoxeroides*) and *shaluk*, i.e.., water lilies (*Nymphaea nouchali* and *Nymphaea pubescens*) are significant for their market potential. Several other aquatic herbs like *thankuni* (*Centella asiatica* and *Hydrocotyle sibthorpioides*), *Kulekhara* (*Hygrophila schulli*) and *bramhi* (*Bacopa monnieri*) and *shimraiya* (*Nasturtium officinale*) are also consumed as supplementary vegetables for their medicinal value.

In addition to this, a wetland fern (*Diplazium esculentum* (Retz.) Sw. ex Schard.), locally called *dhenki-shak* is also sold in the metropolitan market as a supplementary vegetable. *Dhenki shak* has a very good market in Assam, particularly in Guwahati and Malegaon markets. The plant is also sold in city markets as secondary supplementary vegetables. D*henki shak* harvested from the foothills of Assam is more palatable when cooked than its counterparts in Bengal (for details cultivation and economic aspects of the plant see Ghosh, 2002c). Among these, the cultivation practice of Kalmi shak (*Ipomoea aquatica*) in less remunerable wetlands is popular in the state. Quite a good number of people are also dependent on wetlands for the cultivation of aquatic medicinal herbs and aquarium plants in the local markets. Nearly1 % of the state rural population is otherwise dependent on minor wetland practices for their subsistence livelihood support.

During the recent disastrous pandemic situation (2020) due to Covid-19, it is observed that the rural population of West Bengal otherwise dependent on traditional commercial practices based on wetland products were adversely affected. It is estimated from a local market survey in Kolkata Metropolis and its suburbs that selling of supplementary vegetables has been minimized by nearly 50% in major markets. Likely selling of both cattail and mat plant-based mat, as well as handicrafts obtained from hat plants, has been decreased significantly. Still survey in rural areas reveals that these supplementary wetland vegetables provided major support to the people lives in below poverty level during pandemic situation that proves the dependency of wetlands for subsistence livelihood support in West Bengal.

Table 11.12: Summarized Statement of Traditional Practices in Wetlands Studied in Eight Districts of West Bengal during 1997-2000

Districts	Wetlands under traditional practices (ha)	Dependent population	% population supported by TCP
South 24 Parganas	530.17	1,78,600	3.1
Kolkata	27	50,000	1.1
Haora	369	20,000	1.08
Hugli	127.4	10175	0.23
Nadia	753	45443	5.2
Bankura	700	12000	0.5
Puruliya	100	10,000	0.45
Medinipur (undivided)	4798	252011	4.4

Source: Ghosh, 2002

The rural people also face occupational hazards from these practices due to lack of health awareness.

Problems Relating to Wetland Biodiversity

Unsatisfactory socio-economic status in the Indian subcontinent leads to overuse of natural resources of wetlands. The intensive search for alternative food resource from the wetlands for sustenance has forced an alarming level of modification of physicochemical parameters in the natural wetland habitat in the Indian subcontinent. This disturbance of natural wetland habitat, eutrophication, frequent change in the settlement pattern, mono-culture practice (like fisheries) for maximum profit earning and economic instability along with basic ignorance are the major driving forces for a mediocre diversity of wetland and aquatic macrophytes in the Indian subcontinent. In the National Biodiversity Strategic Action Plan, 2002 following threats were identified.

Major Threats of Biodiversity in Wetlands of West Bengal

1. Population explosion leads to encroachment of wetlands for other land uses.
2. Weed infestation in wetlands has resulted in

shrinkage due to excessive evapotranspiration.

3. Sedimentation in wetlands.
4. Unmanaged pisciculture practices with adequate nutrient addition in many parts of West Bengal has resulted in a change in water quality and decline of species diversity in wetlands.
5. Fertilisers and pesticides from agricultural runoff from have resulted in the decline of species diversities particularly in cases of wilderness fishes like *Ambassys chanda*, *Khalisa khalisha* etc.
6. Export of germplasm of few aesthetically and medicinally important aquatic and wetland plants is also identified as threats towards dwindling biodiversity.
7. Conversion of freshwater wetlands into brackish water fisheries (locally called nona bhery) in many parts of mangrove reclaimed areas of the Sundarbans has resulted in shifting of several species.
8. The traditional process of prawn fingerling collection in the coastal wetlands has been reported to have direct bearings towards decreasing fish population in West Bengal.
9. Monoculture practice and overuse of several economically significant taxa have resulted in a loss in diversity in wetlands.

Figure 11.1: Flagship species Rhino in forested wetlands with associated wetland birds: Chapramari Wildlife Sanctuary, Jalpaiguri *Copyright Subir K Ghosh*

Figure 11.2: *Pogostemon stellatus* occasional in wetland habitat of North Bengal *Copyright Subir K Ghosh*

Figure 11.3: Floral association in irrigation canal: Baranti lake, Puruliya dominated by Potamogeton nodosus, Typha domingensis, Nymphoides indicum supports numerous epizootic species *Copyright Subir K Ghosh*

Figure 11.4: Large waterbody in semi-arid region, Bankura with transparent water and floral association (Nymphoides indicum and Nymphaea pubescens)
Copyright Subir K Ghosh

Figure 11.5: Makhana (Euryale ferox) wetland cash crop cultivated commercially mostly in waterbodies of Maldah, and Jalpaiguri districts in North Bengal *Copyright Subir K Ghosh*

Figure 11.7: Coastal saline wetlands: Jharkhali, Sundarbans *Copyright Subir K Ghosh*

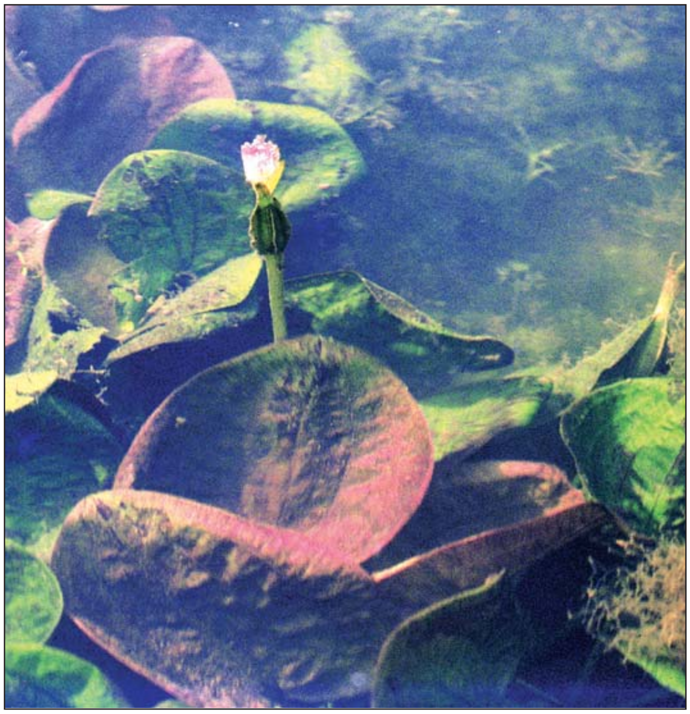

Figure 11.6: Submerged Hydrophyte *Ottelia alismoides* with underwater cleistogamous flower. Submerged plant habitat is threatened due to catchment pollution and encroachment
Copyright Subir K Ghosh

Identification of Gaps

1. Lack of proper information and scientific database at the district level
2. Significance of wetlands as a resource has not been incorporated in the district level planning processes except some attention towards fisheries.
3. Absence of law enforcement body for protecting wetlands.
4. Lack of field-based research on wetland biodiversity at the university level.
5. Lack of knowledge on biodiversity and human intervention.
6. Lack of adequate knowledge towards bearings of river pollution on the decreasing diversity of flora and fauna in riverine wetlands.
7. Addition of species in Biodiversity Register of any wetlands/locality with inadequate database sometime misleads biodiversity assessment.

Strategy for Future Wetland Management

- A state-level wetland management policy should be framed with adequate participation of the stakeholders and the policymakers. The recommendations adopted for wetland conservation should be taken into practice with the involvement of the rural community prioritizing the knowledge of traditional practices.
- Detailed mapping of water bodies of West Bengal by using GIS technique.
- Compilation of a district-level scientific inventory of freshwater aquatic and wetland plants of West Bengal.
- Compilation of a district-level scientific inventory

of aquatic and wetland animals of West Bengal.

- Preparation of district-level seed bank and herbaria of aquatic and wetland plants including scanned images of aquatic and wetland plants
- Identification of impacts of pesticides on the wilderness ichthyofaunal diversity
- Studies of flora and fauna of the river stretches of West Bengal
- A directory of traditional practices in wetlands should be prepared for the conservation of the diversity of traditional practices including the cultural heritages involved with these practices.
- Encouraging a wider study of tutorial ecosystems like East Kolkata Wetlands and possible replication with local modifications. Expansion of developmental works should be stopped immediately for conservational of this unique ecosystem for man and wetlands.
- Identification of major and minor threats in the conservation of wetlands and identification of threats of generic and species level for the biodiversity of aquatic and wetland flora & fauna.
- Studies on the scope of introduction of wetland ecology and their role in sustaining man and environment in the curriculum of the school, college and varsity level.

Action Plan

- Preparation of a corrected and widely accepted list of water bodies in West Bengal following GIS. (Suggested actors: Government, scientists, NGOs; timeframe: 5 years).
- Preparation of a district-level map of waterbodies by GIS technique (Suggested actors: Government, scientists; timeframe: 3 years).
- In-situ conservation of rare and endangered plant and animal species in at least one selected waterbody for each district (Suggested actors: government, scientists, other interested resource persons; timeframe: 3 years).
- Identification of waterbodies up to 0.16 ha. This will increase the number of wetlands reported and help in their mapping and conservation (Suggested actors: government, NGOs; timeframe: immediate).
- Time scale compilation of aquatic and wetland plants, including both the vascular and non-vascular hydrophytes. (Suggested actors: Government, scientists, any other bona fide resource person; timeframe: 5 years).
- Compilation of phytoplankton and zooplankton diversity in freshwater wetlands. (Suggested actors: government, scientists; timeframe: 5 years).
- Determination of ecotonal habitat and their biotic resources. (Suggested actors: government, scientists; timeframe: 5 years).
- Time scale compilation of aquatic and wetland fauna. (Suggested actors: Government, scientists, NGOs, any other reputable resource person; timeframe: at an interval of 10 years).
- Preparation of herbaria /museum with scanned images for documentation (Suggested actors: government, scientists, NGOs; timeframe: 5 years).
- Preparation of an inventory of important wetlands having avifaunal importance. (Suggested actors: government, scientists; timeframe: 3 years).
- Identification of invasive species in the aquatic ecosystem for better management (Suggested actors: government, scientists; timeframe: 2 years).
- Preparation of an inventory of river flora and fauna of West Bengal. (Suggested actors: government, scientists; timeframe: 5 years)
- Preparation of inventory of the exotic and poisonous plants in an aquatic ecosystem. (Suggested actors: government, scientists; timeframe: 5 years)
- Survey of the status of freshwater otters in wetlands. (Suggested actors: government, scientists; timeframe: 2 years)

- Studies on the impact of pollution on the diversity of river flora and fauna (Suggested actors: government, scientists; timeframe: 5 years). Time-series studies needed.
- Inventorying wetland plants exploited for traditional practices. (Suggested actors: government, scientists; timeframe: 5 years)
- Identify and conserve amphibian diversity of the state through wider protected area network (Suggested actors: State Biodiversity Board, scientists, other resource persons; timeframe: 5 years).
- Reintroduce species (like *Aldrovanda vesiculosa*) those are reported earlier in the locality. (Suggested actors: government, scientists; timeframe: 5 years)
- Promote conservation of salamander habitat in the state. (Suggested actors: government, scientists; timeframe: 5 years)
- Preparation of an inventory of wild fish in different districts of West Bengal. (Suggested actors: government, scientists; timeframe: 3 years)
- Time scale computation of the loss in species diversity in wetlands following pesticide application. (Suggested actors: government, scientists; timeframe: 5 years)
- Identification of communities involved in traditional practices and study their role in the conservation of biodiversity. (Suggested actors: government, scientists; timeframe: 5 years)
- Threat identification in the aquatic ecosystem and ecotones (Suggested actors: government, NGOs; timeframe: 3 years)
- Promote biodiversity Festival more and more in the concerned areas involving stakeholders and students of school, colleges and varsities for awareness and conservation purpose.
- Integration of aquatic plant diversity in the Peoples Biodiversity Register (PBR).
- Participation of common people, as well as their initiative, action and traditional community rights in wetland management and conservation, should be assured.

Actors: State Biodiversity Board and specific communities surviving on wetland resources. (Time: 5 years).

Wetlands may store as much as 40% of the global terrestrial carbon, wetlands dominated by trees as well as peatlands are significant carbon sources. Conversion of these wetlands either for agriculture or for human settlement purpose will release a huge amount of carbon dioxide that may result in enhancement of more than 60% of the global warming effect. Forested and larger and deeper wetlands are too some extent safe, however, conservation of small and medium-sized wetlands should be our priority in the environmental management programme.

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state of environment report-II

WEST BENGAL

Chapter 12

East Kolkata Wetlands – An Innovation in Urban Environment Management in West Bengal

Chapter 12

East Kolkata Wetlands – An Innovation in Urban Environment Management in West Bengal

East Kolkata Wetlands (EKW) is a unique ecosystem, which exists in the eastern part of the city of Kolkata, West Bengal, India. The city of Kolkata is one of the four major urban metropolises of India. Kolkata, a densely populated city (population is 4.5 million as per last Census in 2011), is facing many challenges in managing its urban environment like many other Asian cities. The East Kolkata Wetlands system has evolved through trial and practices of about a hundred years and is an excellent example of wise use of marshy land at the city fringes. On-field implementation of traditional wisdom by the community residing in EKW teaches how to live creatively with nature and how to provide goods and services to a big city like Kolkata. Existence of EKW is helping Kolkata in many ways. At present, EKW is playing a key role in

- sewage treatment of 900 MLD wastewater,
- providing fish to the platter of Kolkatans by providing fish in the range of 22000 MT per year in this era of dwindling fish reserve nutrient recovery,
- waste disposal and garbage fed agriculture (150 MT vegetable and 16000 MT paddy per year),
- acting as a carbon sink and keeping the net GHG emission from Kolkata at a lower level,
- reducing urban heat island effect,
- providing livelihood to 50000 people,
- drainage,
- harvesting rainwater in its vast water bodies and recharging the groundwater,
- creating diverse habitats for a wide range of plant and animal species to survive.

Brief Description of EKW and Its Role In Sanitation and Fresh Fish Supply in Kolkata

The East Kolkata Wetland (EKW) at the eastern fringes of the city of Kolkata is historically sprawled over 12500 ha with inter-tributary marshes in the deltaic region of Hugli River (Figure 12.1 & 12.2). Earliest known accounts (1748) of wetland describe this area as marshy salt lakes. Observations of river scientist suggest that this area is an incomplete morphogenesis, where fluvial and marine land building process was juxtaposed during the British era. In course of time, with changes in land use in and around this region, the saline marshy area has been gradually changed into waste recycling region. EKW comprises of sewage canals and sewage farms, intertidal marshes, oxidation basins, dumping ground, green zone and cultivable land and even villages. Water area is spread over more than one-third area of the EKW. The ponds are used for pisciculture while the land area is used for garbage dumping and garbage farming and most expansively for the cultivation of rice. This place is thus an excellent example of conversion of waste to resources through traditional resources recovery practices. The wetland is not only contributing to urban cooling but also is a rare example of wise use of resource recovery through the treatment of wastewater. EKW is so located that it acts as the spill basin of Kolkata in terms of urban runoff and overflow.

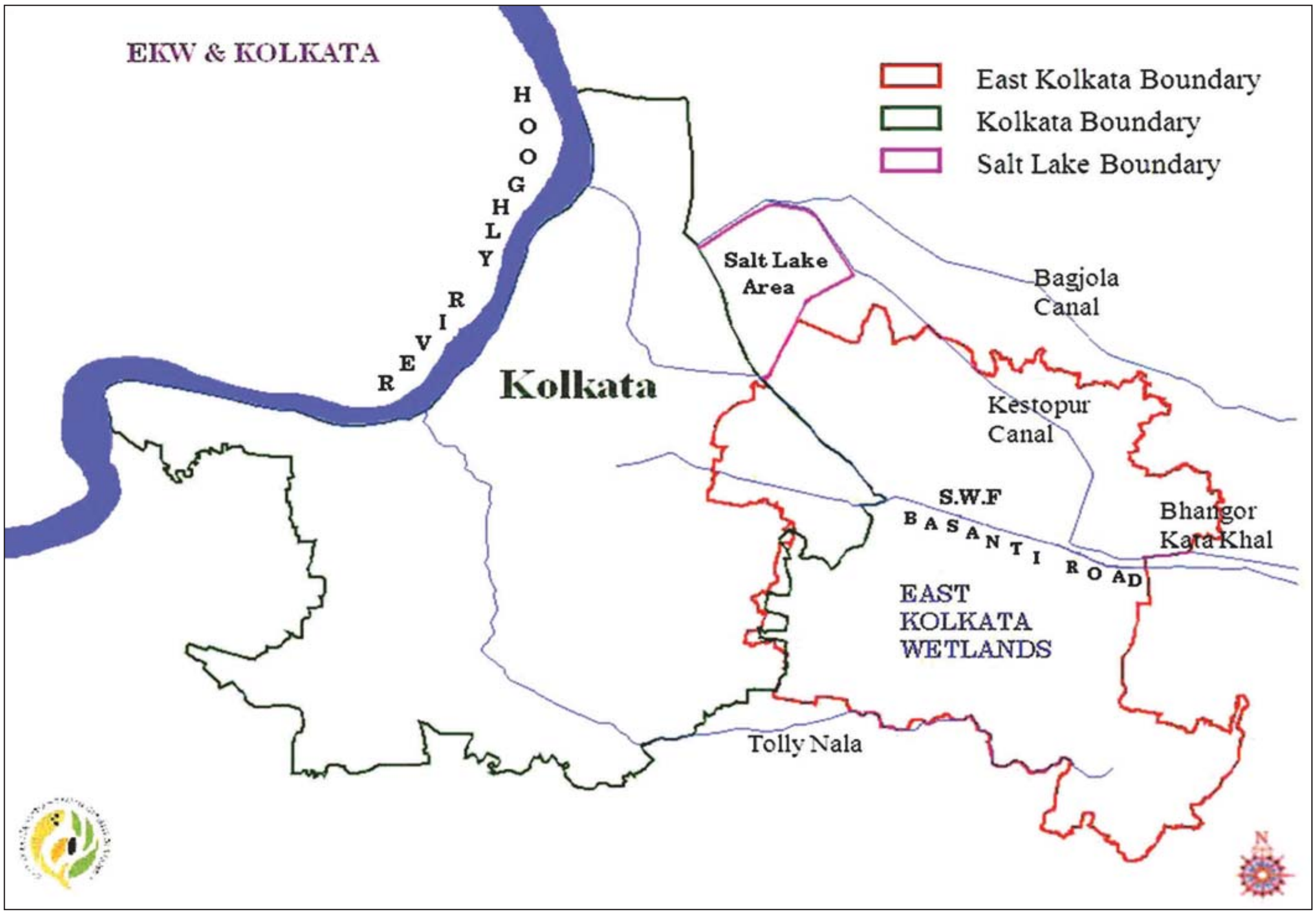

Figure 12.1: Location of East Kolkata Wetlands

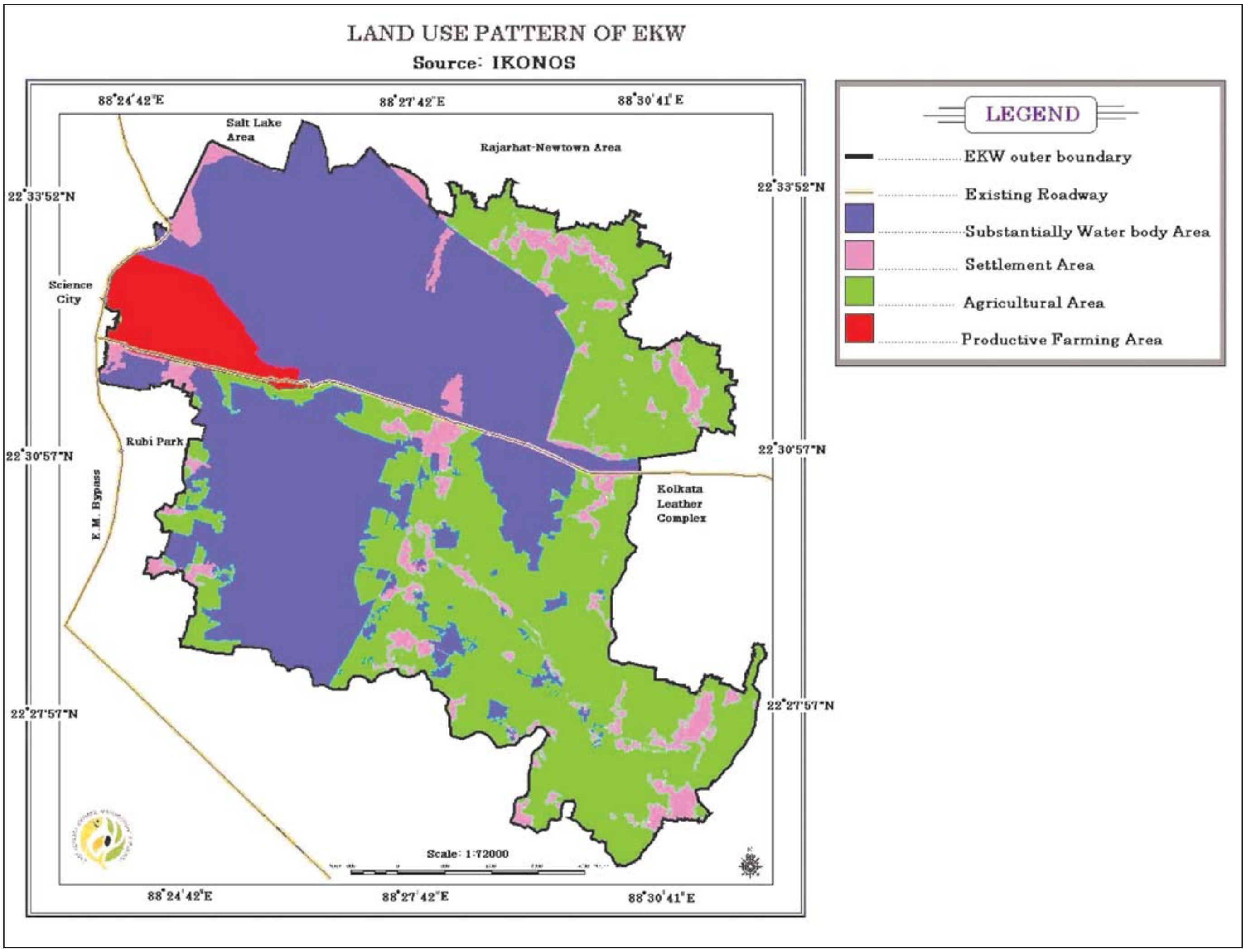

Figure 12.2: Land Use Patterns in EKW

A major portion of city sewage (900 million litres per day) loaded with organic mass, pathogens are received by EKW. The wastewater from the city of Kolkata is being treated in EKW fishponds since 1940. No conventional sewage treatment plant is needed as EKW treats the sewage and returns fish and vegetable to the city markets. Numerous studies corroborated that wastewater (mostly sewage) is being "cleaned" at the wetland. Untreated and partially treated sewage enters the EKW through Bantala Lock-gate (Figure 12.3). Organic loading rate in these fishponds varies between 20 to 70 kgs per hectare per day (in form of Biochemical Oxygen Demand). There is a network of channels that are used to supply untreated sewage and to drain out spent water. Canal systems that flow through the EKW and carry sewage as fish feed to over 260 ponds are shown in Figure 12.4. Phytoplankton and microbial profiling have revealed many interesting underlying bio remedial activities, which are taking place at EKW. Presence of appropriate microbial community, plankton, water hyacinth and ample sunshine in shallow ponds help in removal of pollutants in its fish ponds and facultative ponds of EKW. The symbiotic relationship between the two primary producers, the microbes or bacteria and algae are utilized in these ponds for treating the wastewater. The bacteria break down the sewage and, in the process, consume Oxygen. However, while decomposing the organic matter, carbon-di-oxide (CO_2) and ammonia (NH_3) are produced, which is consumed by the algae for their growth (Figure 12.5). Many studies have shown that the EKW system undertakes the wastewater treatment by removing BOD by about 80% and coliform bacteria by 99.99 %. The EKW systems can remove 237 kg of BOD per day. The shallow ponds with water hyacinth absorb heavy metals, sunlight penetration also help in bioremediation. It is unmatched by Sewage Treatment Plant (STP) results in India. One estimate shows that the EKW reduces 330 TPD of CO_2 emission from the city of Kolkata by acting as an alternative to any energy-consuming conventional Sewage Treatment Plant.

Figure 12.3: Bantala Lockgate, where the sewage enters EKW

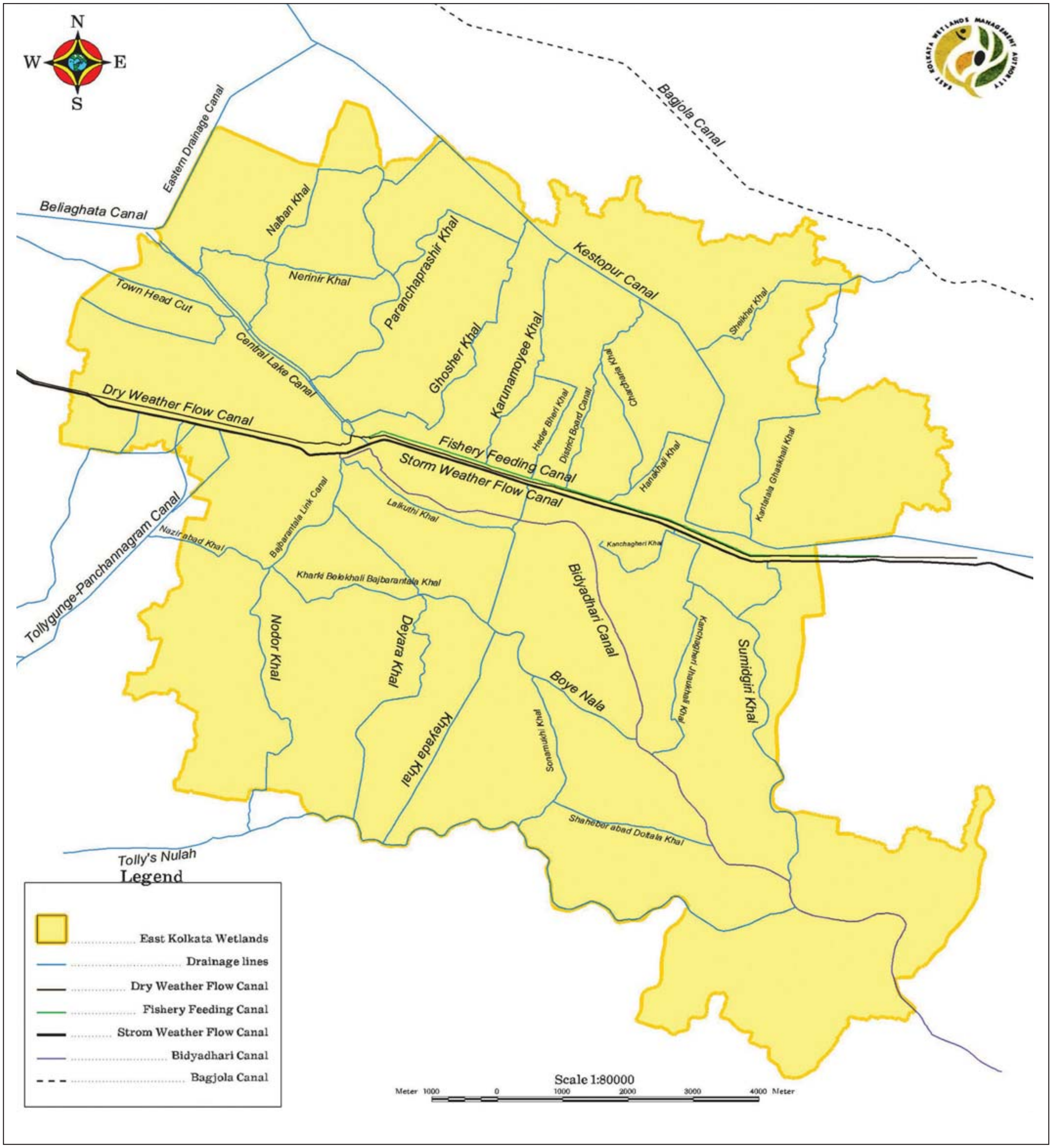

Figure 12.4: Canal system in East Kolkata Wetland

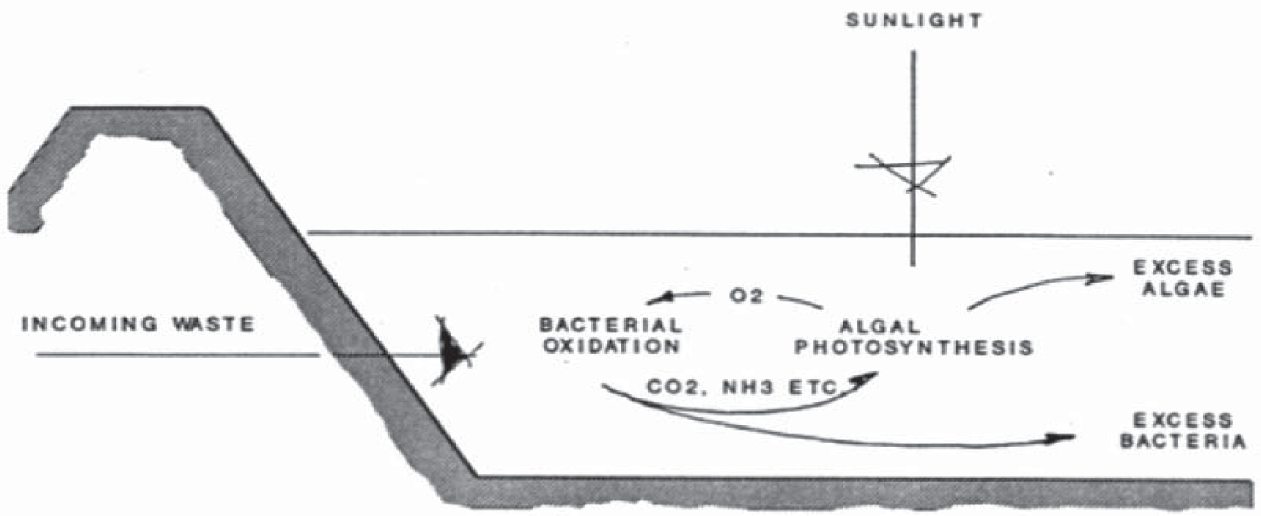

Fig. ii : Algae-Bacteria Symbiosis (Ghosh, 1995)

Figure 12.5: Algae-Bacteria Symbiosis

Source: Ghosh, D., (1995) Integrated Wetland System for Wastewater Treatment and Recycling for The Poorer Parts of the World with Ample Sunshine - Basic Manual, Regional Housing and Urban Development Office, New Delhi, US Agency for International Development.

The traditional wisdom of fish farmers taught them to appropriately sequence the wastewater ingress, retentions, and drainage. The solar radiation is about 250 langleys per day and is adequate for photosynthesis to take place. The sewage-fed fishery ponds act as solar power-based treatment units. The solar energy is tapped by dense planktons. Local farmers used their innovative and indigenous techniques in the construction of embankments along the pond banks to prevent erosion. Bamboo poles are fixed at a distance of 4 meters from pond bank tied with one another with Galvanized wires. A 3-4-meter-wide band of Water hyacinth is placed between pond bank and river, which provide shelter to fish during summer, absorb the heavy metals, and is a good breeding ground for fishes. Water hyacinth prevents erosion. Traditional wisdom in wastewater utilization for growing fish is used for sequencing feeding of untreated wastewater into the fish ponds. Planktons help in reducing pollution. The fishes graze the planktons and maintain a balance in the plankton density in the pond. The ponds are of shallow depth with 1-1.5 m and oxidation takes place. Fish is an integral part of the food chain, the nutrients are recovered by the production of new fish and are out back into the food chain by fish consumption. EKW provide fish to the platter of Kolkatans by providing fish in the range of 22000 MT per year in this era of dwindling fish reserve nutrient recovery. This fish produce in EKW contributes 2% of the inland fish production and 65% of the total sewage-fed fisheries production of the state. Fish produced in EKW caters to a large share of demand of freshwater fish in Kolkata and adjacent areas.

Figure 12.6: Fishing Activities in East Kolkata Wetland System

Waste Disposal in EKW and Garbage fed Agriculture

The Kolkata Municipal Corporation (KMC) disposes the solid waste in the dumping ground at "Dhapa" within EKW. The waste is segregated by the rag pickers into a biodegradable, recyclable and non-recyclable part. The biodegradable part is used for the generation of compost. The compost is used for farming. The ponds are used for pisciculture while the land area is used for garbage dumping and garbage farming and cultivation of rice (Figure 12.7)

Figure 12.7: Garbage-fed Agriculture

Paddy is the major crop cultivated thrice in a year in EKW. The monsoon crop (locally called aman) and winter crop (locally called boro) are the two major varieties of paddy in a year, while the third paddy variety (locally called aus) cultivated during summer constitutes the rest. Individually, the average yield is highest in boro paddy (5 MT/ha), followed by aman (3 MT/ha) and aus (2.5 MT/ha). Use of organic waste makes the land extremely fertile. It is a common practice for the farmers to crop 3-5 different varieties of vegetables on the same land. 55% of the area is used for double cropping, while the rest is used for three crops in a year. Around 15 different types of vegetables are grown in EKW production. These vegetables are sold in local and city markers, supporting small and marginal farmers. Major vegetable crops of EKW are cauliflower, maize, and ridge guard. This production meets nearly 20% of the vegetable requirement of the Kolkata city.

Figure 12.8: Paddy cultivation- end-use of sewage

Level of contamination in EKW grown fish and other food products

A study on genotoxic effects on mice by feeding vegetable extracts containing heavy metals from EKW concluded that vegetables produced in EKW are safe for humans in prevailing conditions. Results of another study by the Jadavpur University of Kolkata in 2007 indicated that presence of Zinc, Chromium, Lead and Cadmium in fish were within tolerable limits according to per capita per day consumption. Other similar studies again confirmed about the safe consumption of EKW products. It is also found that a considerable amount of metals are released out from fish during cutting, dressing and washing. Studies have been carried out on the toxic levels of Phosphorus, Chlorine, Potassium, Calcium, Chromium, and Manganese in vegetables which are produced in the EKW system. Monitoring records of WBPCB do not indicate the presence of heavy metals in the wastewater sample collected over a long period of time. These studies indicated that net consumption of all mentioned elements per capita per day is much below the recommended daily dietary levels.

Biodiversity at EKW

EKW hosts a wide range of both flora and fauna. At least 380 taxa under major flora including 93 plant families, 10 amphibians, 29 reptiles, 260 bird (of which 160 consistently sighted), 79 fish, 11 prawns, 3 molluscs and 13 mammal species have been recorded from these wetlands. Studies showed that EKW has a variety of the microbial population with diverse genetic characters, which includes spore formation for stress adaptation, versatile enzymatic and metabolic activities, high pH and temperature tolerance, nitrogen-fixing abilities and the capacity of bioremediation of different toxins, heavy metals and pollutants. Plant roots grown in these areas release compounds including simple sugars, amino acids, aliphatic, aromatics that can stimulate the growth and metabolism of specific microbial communities which accelerate the bioremediation processes.

Acting as a carbon sink and mirco cooling of the urban environment

Kolkata, like any other big cities of the world, emits a huge amount of CO_2. EKW acts as a huge carbon sink. Its fishes and plants store a considerable amount of CO_2. In the aquatic system, the highest amount of carbon is stored in fish. In EKW ponds, the estimated carbon content in primary producer level (phytoplankton) is 2040 mg per m^3 per day, in primary consumer level (zooplankton) it is 307 mg per m^3 per day and in secondary consumer level (fish) it is 11532 mg per m^3 per day. At present, a study has been taken up to obtain total CO_2 intake by EKW. The vast open land and the water bodies of EKW are also contributing to micro-cooling of the eastern part of the city. The cooler breeze from the EKW side reduces the heat island effects of the newly established IT hub at the boundaries of EKW and city of Kolkata as well.

Providing livelihood

Fish farming, vegetable and paddy farming, waste segregation provides livelihood to about 50000 people in EKW. The distribution chain of fish and vegetables provides livelihood to a larger community in the downstream. EKW system is providing direct employment for thousands of men and women in catching fish, weeding, carrying fish to market, cultivating vegetables, rice and is providing indirect employment in supply and distribution networks, e.g., fish seed traders, market vendors and rag-pickers.

Drainage and rainwater harvesting

The EKW is acting as a spill basin between Kolkata and its Kulti estuary and its vast water bodies hold a considerable amount of rainwater during monsoon months and help in rejuvenation of groundwater regime.

Ecosystem services by EKW – Living Creatively with Nature

The fishponds, paddy fields and recycling garbage farms of EKW provide three basic needs of human life: food, sanitation, and livelihoods.

EKW system is providing ecosystem services directly by providing wastewater treatment facilities, sewage feed to fishponds and water facilities to the paddy cultivation and vegetable cultivation. EKW system is also providing ecosystem services indirectly by contributing to flood control, livelihood support and carbon sequestration. The ingenious but innovative practices followed by the people of EKW have evolved through traditional practices and intense interactions between humans and their surrounding nature. This is described as Living Creatively with Nature.

Community-based water conservation good practices are quite common but not community-based management of wastewater treatment and that too for a densely populated city like Kolkata. Wastewater treatment predominantly falls in the domain of qualified engineers and concepts of tertiary treatments and resources recovery are being encouraged as an essential step in sewage treatment systems. But fishermen at EKW did it much before the concept of sustainable living or resource recovery gained its momentum in the international arena.

Another exemplary measure taken by the fishermen in EKW is the protection of the banks of the fishing ponds. The local fish farmers do not have the capital to construct the costly dykes and therefore develop a three-meter wide water hyacinth lacing which breaks the surface waves and protect the banks. Again the same water hyacinth margin is used as an umbrella by the fish in summer. Bamboo screens are provided to prevent the entry of solid waste into fish farms.
(Figure 12.9).

Figure 12.9: Bamboo screens used for filtering solids from sewage before entry into ponds

The innovative locally developed and replicated ecological practices led to the recognition of EKW as a Ramsar site and got the attention of international conservationists.

Declaration of EKW as a Ramsar site

The year 2002 was a momentous time when EKW was recognized as a **Ramsar site no 1208** – a wetland of international ecological importance.

Legal framework and institutional setup

EKW is playing a key role in sustaining Kolkata. However, with growing population pressure, demand for land is also growing in and around Kolkata. The State Government of West Bengal has taken measures for conservation of EKW. In 2006, the State Government promulgated East Kolkata Wetlands (Conservation &Management) Act and constituted the East Kolkata Wetlands Management Authority for the conservation of this unique process. This authority was the first of its kind in India constituted to protect a wetland.

According to the EKW (C&M) (Amendment) Act, 2017, the EKWMA is now a thirteen (13) member body with the Chief Secretary and Secretaries of different departments of State Govt. as well as four experts each in the areas of wetland ecology, hydrology, fisheries and socio-economic under the chairmanship of Minister-in-Charge, Department of Environment, Government of West Bengal.

The EKWMA functions under the aegis of the Department of Environment, Government of West Bengal. This has reduced the growing pressure from real estate groups for land use change and destruction of ecological reserves. The activities like development of inventory, mapping of catchments and land use pattern have resulted in the better management of EKW area. Constant regulatory watch to keep encroachment at bay is one of the major challenges faced by EKWMA. State Government provides funds to EKW (Figure 12.10) for regular activities, which includes de-silting of sewage canals, demolitions of illegal constructions, monitoring and research, wetland delineation, and communication and research.

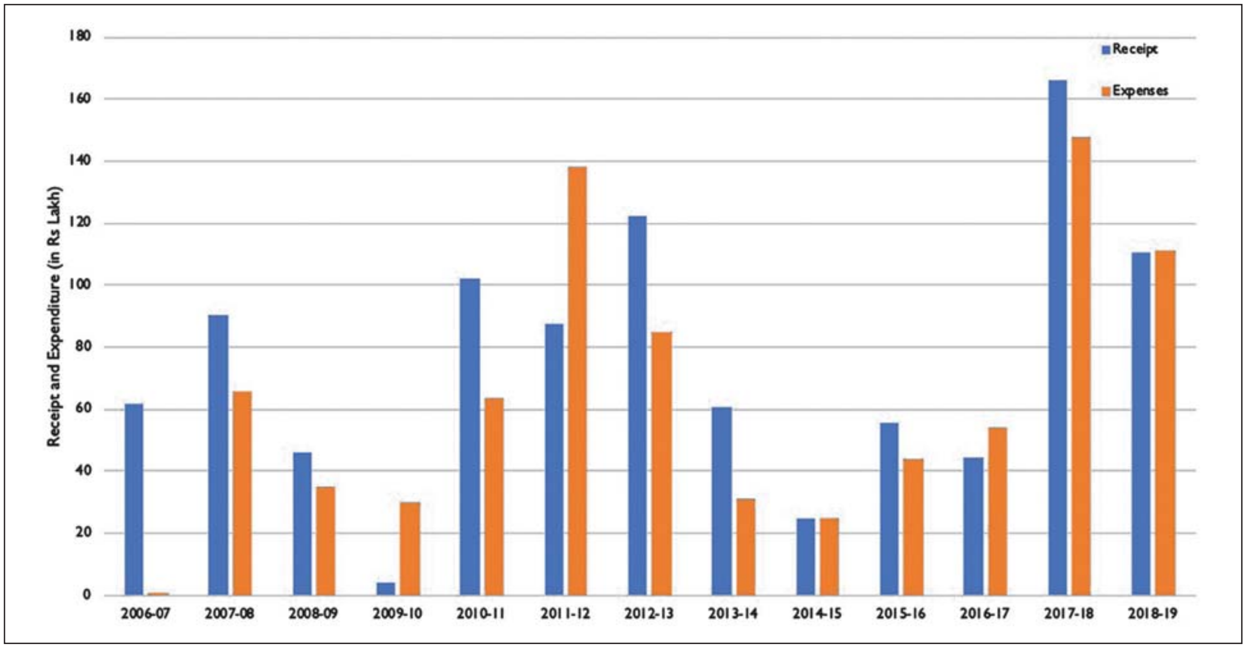

Figure 12. 10: Fund Flow in EKWMA

Besides the East Kolkata Wetlands (Conservation and Management) Act, 2006 and as amended from time to time and Rules made thereunder, the EKWMA is also guided by the Wetlands (Conservation and Management) Rules, 2017 notified by the Ministry of Environment, Forest and Climate Change, Government of India. The efforts of state government have been augmented by the positive role played by the NGOs and wetland communities of fish and agriculture farmers.

It is a multifaceted treasure that needs to be preserved with great dedication. It was a traditional knowledge that was passed across generations for nearly 100 years in this wetland and the State Government is exactly doing the same. EKW is a site identified as a tutorial ecosystem for the understanding of wise use of wetlands. Many publications by different researchers in peer-reviewed journals also showed how a traditional knowledge-based system contributed to a better understanding of the scientific community in sustaining the urban environment. The example of EKW also shows how an adaptation measure also contributes to the reduction of GHG through intelligent governance and contributes to a sustainable urban ecosystem. The aquaculture-based system of EKW is contributing to managing the urban environment and reducing carbon footprints.

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state of environment report-II

WEST BENGAL

Chapter 13

The Sundarban and its Impact

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The Sundarban and its Impact

Introduction

Sundarban is an extensive mangrove forest on the coast of West Bengal and East Bengal (Bangladesh), encompassing a total area of 10435 sq km. This World Heritage site is divided by the international border between the two countries, India and Bangladesh having 4266 sq km and 6169 sq km of forest respectively.

In West Bengal Sundarban extends over 13 blocks of South 24 Parganas district, namely Sagar, Kakdwip, Namkhana, Patharpratima, Mathurapur-I, Mathurapur -II, Jaynagar -I, Jayanagar -II, Kultali, Basanti, Canning -I, Canning-II, Gosaba and 6 blocks of North 24 Parganas district — Haora, Minakha, Sandeshkhali-I, Sandeshkhali –II, Hasnabad and Hingalganj.

The protected areas of the Indian Sundarban are divided into six parts— Sundarban National park, Sajanekhali Wildlife Sanctuary, Lothian Wildlife Sanctuary, Haliday Wildlife Sanctuary, Sundarban Biosphere Reserve and Tiger Conservation Area.

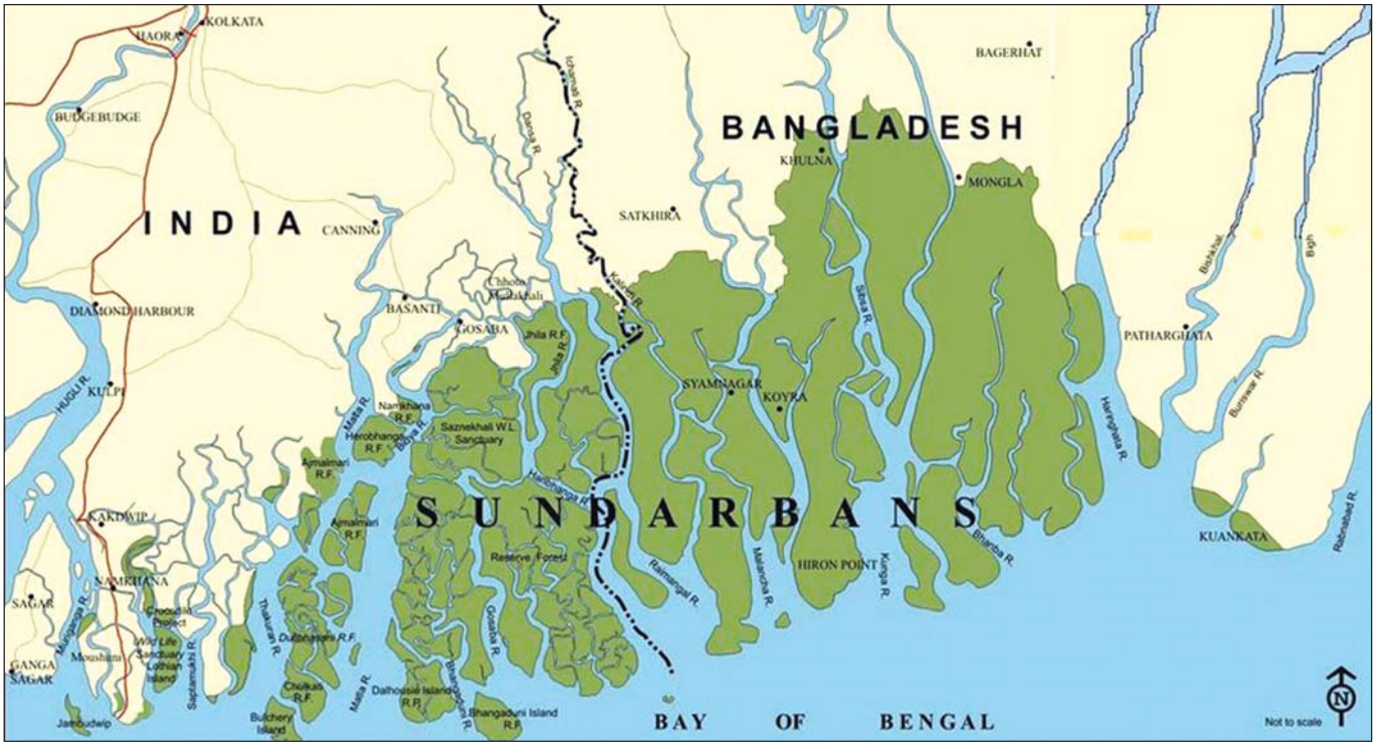


Figure 13.1: Map of Sundarban Area

Mr Dampier and Mr Hodges surveyed the Sundarban in 1830 to determine its northern boundary and a map of the Sundarban was published in 1875 based upon these results. The line that defines the northern boundary of the Sundarban is known as the 'Dampier-Hodges line'.

There are different opinions about the origin of the name 'Sundarban', it may have been derived from the word 'Sundari tree' or ' sundar bon' ('beautiful forest') or 'sudur bon' ('far away forest'). There are at least 79 species of mangrove plants in this region. This delicate ecosystem of Sundarban is formed by a mixture of upstream freshwater and saline seawater.

Figure 13.2: The Royal Bengal Tiger.
Proto credit- Arnab Nandi.

Arguably the most infamous wildlife of this religion is the "Royal Bengal Tiger". The Sundarban is unique in the fact that no other mangrove forest in the entire world boasts of the presence of this big cat. Many of these tigers were killed during the reclamation of the deltaic island. In 1852, the reward for hunting tigers was increased from 5 rupees to 10 rupees and again in 1860 to 20 rupees. In 1914 there were a total of 1556 tigers in the Sundarban, but the number has been reduced to 110 in the Indian Sundarban. Experts agree that the number is not more than 250 in India and Bangladesh altogether.

The clearing of forest and reclamation of premature land in Sundarban started in the late 18th century continued till the 1970s, when very strict laws were enacted to protect forest along river channels and creeks. During this period, almost 9654 square kilometres of mangroves had already been destroyed for agricultural land or human habitation. This area is still called 'Sundarban' in India; in Bangladesh, this region is called the 'Sundarban Impact Zone'. This area is one of the most densely populated regions, with almost 5 million people living in the Indian Sundarban and another 3 million people in Bangladesh. The settlement has its origins in the colonial period but the history of the human settlements dates back to ancient times. Several archaeological pieces of evidence of ancient civilizations have been found in the deep jungles of Sundarban. Although these artefacts are considered to be traces of past human settlements, there is a difference in opinion among historians as to their exact age. Historians have suggested that this civilization was created and destroyed between 300 BC and 1200 AD. The cause of the decline of the early civilization in Sundarban was not conclusively proved.

Flora and Fauna

Figure 13.3: Stilt Roots.
Proto credit- Sudhu Sundarban Charcha.

The Sundarban are the world's largest mangrove forest. Most of the sediment that is deposited in this delta is in the form of mud, due to the coastal saline or brackish water. This saline and oxygen-deficient soil doesn't support the growth of any plants, except the mangroves. The mangroves have specialised root structures that help them to survive such conditions— the pneumatophores or breathing roots which rise vertically above the soil surface, these have lenticels (pores) through which oxygen enters the underground tissues; stilt roots which arise from the lower nodes of the main axis and enter the soil obliquely to which prop up the plant during the daily rise and fall of tides.

Figure 13.4: Pneumatophores or Breathing Roots. ***Proto credit- Sudhu Sundarban Charcha.***

In some species of mangroves, the seeds germinate into plants while still being attached to the parent plant. Seedlings of some species are dispersed by currents if they drop into the water, but others develop a heavy, straight tap-root that commonly penetrates mud when the seedling drops, thereby effectively planting the saplings.

Figure 13.5: Viviparous Germination.
Proto credit- Shuvadip Adhikari.

The major flora of Sundarban can be divided into the following categories based on salinity influences, freshwater supply and geographical location:-

Geographical features	Plants
An area that is submerged in tidal water for a long duration, where salinity is more pronounced	*Avicennia officinalis(Jaat Bain), Avicennia marina(Peyara Bain), Avicennia alba (Black Bain), Kandelia candel(Garia), Lumnitzera racemose (Kripa), Aegialitis rotundifola(Tora)*, etc.
An area where water is less saline and the land is occasionally flooded by tides	*Rhizophora apiculata (Garjan), Ceriops decandra (Garan), Ceriops tagal (Math Garanh), Sonneratia apetala (Keora*)etc.
An area where the water is only slightly brackish and where the freshwater flows	*Excoecaria agallocha (Gemoya) , Bruguiera gymnorrhiza(kakra),Aegiceras corniculatum(khalasi), Sonneratia caseolaris(ora),Pheonix paludosa(hemtala)*, Heritiera fomes (*Sundari*), etc.

This region is also home to 2,626 species of animals. This includes 50 species of mammals, 360 species of birds, 12 species of tortoises, 13 species of chameleons, 37 species of snakes, 10 species of frogs, 350 species of fishes, 173 species of snails, 753 species of insects, 334 species of crabs, 119 species of spiders, 48 species of earthworms and 140 species of unicellular organisms as identified by the Zoological Survey of India (ZSI).

Clearing of Forest

The motive governing the English East India Company's indiscriminate deforestation in the Sundarban was the collection of revenue. The British tactfully distributed the land under various laws; the peasants never got any real ownership. The zamindars or *latdars* were the permanent masters of their holdings. People under them (*Chakdar, Jotdar*) cleared the forests to make it cultivable. In the hopes of owning a smallholding, those poor people risked their lives to clear the dense forest. Even after India achieved independence (1947), the condition of the peasants did not change much. After the Tevhaga movement, the demands of the farmers and agricultural labourers were given minimal consideration. The Tebhaga movement forced the Cabinet of the then West Bengal government to enact land reforms and the abolition of zamindari law. The zamindari system was abolished on 12 February 1954.

The farmers of the Sundarban acquired the ownership of their lands. While the cultivators acquired ownership rights, they also started inhabiting in the western islands of the Indian Sundarban— leaving very little place for the survival of the mangroves.

Riverine System of the Sundarban

Sundarban is drained by an intricate network of many channels. The Ganges-Brahmaputra-Meghna delta has thirteen major rivers opening into the Bay of Bengal. The major rivers flowing in the Indian part, are Hooghly, Saptamukhi, Thakuran (Jamira), Matla, Vidya, Gosaba, and Haribhanga. These are all tidal creeks which widen during high tide shrink during low tide. A brief description of these rivers is noted below:

1. Hugli - The Hooghly River enters the Sundarban and branches into two— one towards Ghoramara Island and the other towards northern Sagardwip. The eastern branch flows South-East through Kakdwip, Namkhana, Mausuni, and the western part of Bakkhali and ends in the Bay of Bengal. This branch is known as Battala, Bartala, or Muriganga. The other branch is flanked on the east by Sagardwip, and on the west by the west coast of East Midnapore. This part is called the Gabtala river. The union of these two rivers forms a funnel-shaped estuary in the west of the Sundarban.

2. Saptamukhi - The old course of the Adiganga is Saptamukhi. The source of the river is presently near Sultanpur. The Thikara, Banshtala, and Ghughudanga canals flow into this river. The river is connected to Battala or Muriganga river via Hatania-Doania.

3. Thakuran- The present source of Thakuran is near Joynagar-Mathurapur. The river then flows southwards for about eighty kilometres. In the northern part, it is connected with Matla and Saptamukhi. The Jagaddal river flows along the west side of the main river. Sometimes this river is also referred to as Jamira while joining the Bay of Bengal.

4.Matla - The Matla River forms the second widest estuary in the Sundarban after the Hooghly River. This river originates at the confluence of Bidyadhari, Khuratya, and the Rampur Khal close to Canning Town. The length of this river from Canning to the estuary is about one hundred and twenty kilometres. Canning, one of the entrances to the Sundarban, is located on the banks of the river Matla. Canning was once known as Matla village. In 1853, The British Government proposed the setting up of an alternative port of Kolkata, on the Matla river bank, so that sea-going ships would reach Canning through the Matla river. Railways were also built from Calcutta to Canning. As a result of huge silt accumulation, the Matla river rapidly lost its navigability. Natural disasters, especially cyclones, forced the British government to cancel plans to build a port in Canning within a decade.

5. Bidya – The Huta Khal and Durgamangal canals together created the river, Vidya. It is joined on the right by Pathankhali creek, Radhanagar creek, Duldul Khal, Khair creek, Mokamberia creek, Moukhali Khal, and Kartal Gung. Melmel Khal, Gumdi Khal, Durgadowani, Nabanki, and Netidhopani creeks join in from the left. Vidya river joins the Matla river near Jhorkhali, after flowing for about 55km through the Gosaba and Basanti blocks of the Indian Sundarban.

6.Gosaba - The two tributaries of the Jhila river are Gosaba in the west and Haribhanga to the east. Many small creeks from Rayamangal and Matla have joined the Gosaba river. After flowing for about 30km through the Sundarban, this river has reached the Bay of Bengal.

7.Haribhanga - The Ichhamati river is divided into two parts in Hingalaganj. The name of the western branch is Sahebkhali and the eastern part is Kalindi, both of which flow southwards. This stream called Kalindi later carries water through the

Haribhanga-Rayamangal river. It is connected with Barakalagachhi and Terbanki Khals. Haribhanga and Rayamangal merge before entering into the Bay of Bengal. This is the easternmost river and serves to demarcate the Indian and Bangladeshi territories of the Sundarban.

The course and extent of rivers in the Sundarban are fast changing. These flowing streams of water and silt have been beheaded from their feeder, the Ganga or the Padma due to eastward tilt of the delta.

A unique feature of the rivers of the Sundarban is their rapid widening at high tide and becoming narrow at low tide. For the last few centuries, the bulk of discharge of the Ganga has been flowing eastwards through the Padma towards Bangladesh. As a result, the flow of freshwater along the rivers Hughli, Bhairab, Jalangi, Mathabhanga, Ichchamati, etc., which used to maintain the ecological balance of the Sundarban, is now weak. Freshwater does not flow into the western Sundarban except through the Hooghly River. The rivers along the coast of West Bengal are now largely dominated by the tides. Since many rivers in Sundarban were embanked, the process of sediment dispersal on the inter-tidal space was largely interrupted. The sediment load deposited between the embankments has caused a gradual reduction of the water-holding capacity.

River Embankment

Figure 13.6: Lifeline of the Sundarban. ***Proto credit- Koushik Chatterjee.***

The term 'embankment' is almost intrinsically associated with the Sundarban. Though some may consider the usage of it a cliché, embankments are still referred to as the "lifeline of the Sundarban". According to the State Irrigation Department, the total length of the embankments in the Sundarban runs 3,500 km. However, recent satellite imagery has shown that the length of the effective embankments in the area is at the most 2,000 km. At present, the embankments constructed in the Indian Sundarban can be divided into various categories. The embankments along the bank of the rivers are called "river embankments". The embankments built on the seafront are referred to as "sea embankments". Secondly, they can be classified based on the materials used for construction. In ancient times "earthen embankments" were made and that is still going on in many parts of the Sundarban. Attempts to maintain and fortify those in various ways are still visible. Bamboo fences, sandbags, and bamboo poles, among other miscellaneous materials, are used to strengthen the earthen embankments. The practice of repairing the earthen embankment has been a task of the State Irrigation Department. On the other hand, the construction of embankments also reflects various technological advances over time. The embankment, originally made of brick, sand, and cement, is known as "concrete embankments". The synthetic sheets such as Geo-jute or Geo- poly-poplin filters are being used to ensure the durability of the embankments.


Figure 13.7: Earthen Embankment and Concrete Embankment.
Proto credit- Sudu Sundarban Charcha.

The shores of the Sundarban, are being eroded due to global warming. The water level is rising, the frequency of cyclones is also increasing. Efforts have been made to arrest the encroaching Sea by the construction of sea-front embankments or the plantation of mangroves. But the wondrous beauty of the Sundarban cannot be saved in this way. There are two challenges: one, how can the coast be protected; and two, how can the settlements that have been built for so long be protected? People and nature should not be considered as rivals. The dynamics of rivers must be understood and they must be allowed to widen during high tide.

In view of combating the challenge of sea-level rise and increasing storm surge over the Bay of Bengal, a holistic management plan is important. We have to think about river governance with the experience from the past. There is no other way to implement some long-term safeguards, except via general publicity and public awareness. Technology alone cannot save both the embankments of the Sundarban, as well as its people- this is a harsh reality. The realignment of the embankment may be a sustainable solution. We need to understand the river and explain it to the people.

Livelihood

Figure 13.8: A traditional paddy field in Gosaba with a small pond for the retention of rainwater.
Proto credit- Sudhu Sundarban Charcha.

It has been 200 years since the British have occupied the Sundarban. The primary aim was to make the land salt free and initiate farming. The primary livelihood of this forest drilling settlement was agriculture, catching fish and crab in the surrounding water or collecting honey or wood from the forest. The settlements adjacent to the jungles of Sundarban have faced various adversities repeatedly. Strong natural disasters have time and again questioned the existence of the people near the sea and forest areas. They had to build up their life over again in search of greater security, despite all these the lives of these people largely depend on the land, forest and water since its inception.

Figure 13.9: Fish and Crab Collectors. *Proto credit- Sudhu Sundarban Charcha.*

From time to time a catastrophic disaster has disrupted the human habitation, saline water has entered the farmlands and agriculture has brought to a standstill. People then rely more on the surrounding water and jungles. Gradually after the disaster saline water slowly drains out, embankments are repaired and the land again becomes suitable for cultivation. The people of Sundarban have built up their lives from amongst the ruins again and again.

People of Sundarban have always been dependent on land, water and forest but there is a significant change noticed in the last 10 years. After the catastrophic cyclone Aila in 2009 caused severe damage, wrecked embankments, thereby demolishing standing crops and rendering the agricultural lands unproductive, many people from the affected islands had to move to different parts of the state or the country in search of alternative means of living. During 2009 to 2012, there was a marked change in the social life of Sundarban, which had not been noted in the last 200 years. Such a large scale migration had never been observed in this forest-surrounded delta. The migrants have shown very less interest in coming back to their native land, but this change remains unnoticed in the government records. This is because some of the family members of the migrant still live in this region. This has made a difference in the daily life of the Sundarban. As a result, many families have become financially independent, but on the other hand, there has been a decline in competent men. Due to this the rural community is now more dependent on women. Active participation of women in almost every activity is a remarkable attribute of today's Sundarban.

Figure 13.10: Active Participation of Women in Almost Every Activity is a Remarkable Attribute of Today's Sundarban. *Proto credit- Sudu Sundarban Charcha*.

Though, all men have not left for the cities. Their livelihoods still depend on the forest and the surrounding water. People venture deep into these forests despite the imminent danger. Tiger attacks have become more frequent, but lack of an alternative profession forces people to resort to this risky line of work.

Even today, there is no adequate infrastructure for agricultural systems in the Sundarban. This is the root cause of the livelihood crisis of the people. Being surrounded by brackish water, an intrusion of this water in the agricultural lands due to natural disasters makes the farmland unfit for cultivation in a very short period. However, this is not the case for the entire region. In the village of Baliyara on the southernmost tip of Mousuni Island, green paddy fields can be seen on some part of the island while the adjacent areas have turned into saline fish farms. The reason for this disparity is a weak earthen embankment which luckily has not been destroyed. Some part of this embankment could not bear the pressure of the Bay of Bengal and was destroyed, causing those lands to turn into fish farms. The man who was a farmer in the previous high tide became a fisherman in the next one. This is an unbelievable world.

It must also be brought to notice that the scenario isn't similar all across the region. In the northern block saline water rarely enters the farmland, whereas, in the southern region close to the sea in Kakdwip, Namkhana, Kutali, Patharpratima, Gosaba and Hingalganj blocks submergence of agricultural lands is a common event.

The major reasons that people are facing in regards to agriculture are the intrusion of saline water and inadequate irrigation facility. The practice of retention of rainwater by digging ponds in some part of the agricultural land is very common and effective to meet the need of freshwater. But it's not possible to retain water in this way in the dry season making the land reliant on one crop. Extraction of groundwater is both difficult and not economically viable as the water level is very low.

Nevertheless, the production of various green vegetables and betel leaf is doing well in several blocks of Sundarban. It's very difficult for people to be solely dependent on agriculture, so the permanent residents have to turn to the forest in search of subsistence.

Figure 13.11: Plantation of Betel Plant in Patharpratima Block.
Proto credit- Abhijit Chakroborty.

The marketing of perishable goods is also a serious challenge, most of the time the farmers suffer losses because the product cannot reach the market due to lack of proper infrastructure. The brokers acting as middleman make unfair profits and describe the farmers of their share. Raw vegetables like chilli, brinjal and tomatoes are produced in huge quantities in some areas of Sundarban and are highly demanded in Kolkata for their good quality. The demand for construction of cold storages remains unresolved due to the absence of electrical grids in those areas. Currently, the government-run "*Kisan Mandi*" at the block level is helping farmers get the right price for their crops.

A lot of discussions has been undertaken in the last few decades regarding healthcare, education, communication but irrigation demands a top priority in this planning. More than 20 % of the land in Sundarban cannot be irrigated, leaving most of the land dependent on a single crop. The main restriction of installing mechanical pumps was the non-availability of grid-connected electricity. Recently grid-current has started reaching the remote areas of Sundarban.

People dwelling on the coastal Islands of the southern Sundarban survive on catching fish. The biggest challenges faced along with other adversities are fighting natural disasters in mid-sea.

There has been an increase in the number of women as permanent residents of Sundarban. They are seen to play a much more active role in fulfilling their domestic responsibilities. They collect fish and crabs in the rivers or work as agricultural labourers. There are specific government guidelines for female participation in the panchayat or any other government infrastructure development plans. Following that directive, many gram panchayats have women representatives at different levels.

Man Animal Conflict

Figure 13.12: Royal Bengal Tiger
Proto credit-World Wide Fund for Nature.

Many people live near the forested part of the Sundarban. On taking a close look at this part of the region on a map, it can be understood that the Namkhana, Patharpratima, Kultali, Canning-I, Basanti, Gosaba and Hingalganj blocks are very close to the forest. Many people living there have to venture into the neighbouring forests in search of their livelihoods. Even though they are not as close to forested areas as the other blocks, many people in Sagar, Kakdwip, Mathurapur-II, Joynagar-II, Hasnabad, Sandeshkhali-I and Sandeshkhali-II Block have to depend on the forest for survival. This dependence on jungles is the main cause of man-animal conflict in the Sundarban. The Sundarban are unique in the fact that tigers are not found in any other mangrove forest. It's not possible to access the forest without a manually operated boat. While it is possible to fish from the boat, catching crab often requires one to get off the boat. Tiger may attack such people. The people who go deep into the forest of the collection of honey often run into these animals.

There are no fixed entrance and exits like other forests as it is surrounded by rivers and creeks. Although permits are issued by the government for the people who enter this forest, it is almost impossible for the government to keep a record of the people entering the jungle illegally. The risk of facing a dangerous animal in the jungle is equal, for both.

'Crocodile in the water and tiger on the land', is a phrase that holds relevance not metaphorically but literally in the Sundarban. There are numerous venomous snakes all over the jungle floor, along with crocodiles and dangerous sharks in the water.

Another aspect of the human-animal conflict in the Sundarban is the infiltration of forest animals into human-inhabited islands. In the last ten years, tigers have invaded many human-inhabited islands in the I Sundarban, but the latest example of a tiger attack is the abduction of a teenage girl, Rupali Bauri, from Baule Para, adjacent to the Jhingekhali forest in the southern Samshernagar of Hingalganj block.

The idea that tigers in the Sundarban often kill people when they enter the locality is not correct. Only four out of 100 incidents in the last 25 years have killed villagers in the Indian Sundarban. These four incidents took place in January and February 1990 in the Shamshernagar village, proving only one particular Tiger was responsible for the series of events. The Shamshernagar village separated from the Jhingekhali forest by a narrow river named Kurekhali has now shrunk to a small channel due to silt deposition. There is almost no water at some places during the low tide, and it's not surprising that cattle like goat and cow roaming on the river bank attract the forest tigers. Scientists believe that tigers hide their newborn cubs in the paddy fields to keep them away from the view of other male tigers. It's also believed that tigers often confused and fail to distinguish between the dhani grass growing along the river bank from the paddy fields. Another reason might be that the territory-indicating pheromone-markings spread on the tree trunk or roots get periodically erased by the tides and tiger is unable to find any sign of its domain, so they come back to re-establish them.

There are various opinions as to why tigers often chose humans as prey. Hunting in the muddy mangrove forest is no easy task for the tigers. Their main diet comprises deer and wild boar in the forest, the Sundarban tiger is even seen catching forest snakes, fishes or crabs for food, which has never been observed in any other forest of the world. So for the tigers, humans venturing deep in the forest are much easier prey.

People who venture into the forest can be categorised into three groups: honey collectors, fish collectors and crab collectors. Fish and crab collectors are often indistinguishable since a fisherman collecting crabs and crab collectors catching fish is very common. The number of people going deep into the Jungle to collect timber has drastically gone down, mainly due to the strict penalties imposed by the government. Government surveillance and the use of cleaner fuel and alternative construction materials has greatly reduced this trend.

People going into permitted areas with government permission receive compensation from the authorities if they are attacked by any wild animal. But the actual picture of man and animal conflict in Sundarban cannot be understood from the statistics available in the government officers, because most of the incidents are not reported by the media. Families of people illegally entering the jungle often do not report such events to avoid legal complications.

To the people of Sundarban especially those who catch shrimp's larva ('*min*'), crocodiles and kamats pose a huge risk. Crocodiles are often seen in creeks and rivers of Sundarban and many people have been injured by these beasts, in most cases, the bodies are not recovered. The author has made a woman who was attacked by a crocodile while trying to catch '*min*'. She sat on the back of the crocodile and poked its eye with a finger, and lived to tell the tale.

Kamat is a type of shark, which amputes limbs especially legs, of such 'min' catchers. However, over the past decade, this number has drastically dropped, the main reason being that the catch of 'min' from the river has decreased a lot and the main business has gone the drastic change with a decrease in demand. Increase of motorized vessels has also contributed to the cause.

Venomous snakes pose a huge threat to the people, with snake-bites reported quite often. types of venomous names are found in the Sundarban the sankhachur(*Ophiophagus hannah*), keute(*Naja kaouthia*),gokhro(*Naja naja*), shankhamuti(*Bungarus fasciatus*), kalaj(*Bungarus caeruleus*), chandra bora(*Daboia russelii*), gach bora (*Trimeresurus albolabris*)and jol keral (*Enhydrina schistosa*). Among them, shankhachur mainly live in the forest. Shakhamuti snakes are venomous but naturally innocuous in character. Deaths from kalaj, keute and chandrabora more common. In many cases, the deaths from non-venomous snakes are psychosomatic, induced only by fear and ignorance.

Honey collectors and people who go fishing in the Jungle gain quite a lot financially, but people of Sundarban should be encouraged to cultivate box-honey as an alternative. Most of the box honey collectors are non-natives. Interests in the safer method can be generated among the locals by training them. The search for sustainable alternative livelihoods can reduce the tendency of people going into the jungle. Human-animal conflict needs to be minimised as much as possible to ensure a healthy, comfortable, and minimally dangerous life for thousands of people living in this littoral tract.

State of Environment Report-II

WEST BENGAL

Chapter 14

Coastal Zone Management

Chapter 14

Coastal Zone Management

The coastal stretches are the first line of defense for the protection of landmass from natural calamities emanating from the sea. Hence, proper management of the coastline is necessary to protect the integrity of the coast which in turn helps the protection of natural resources ensuring livelihood security to the fisher and other local communities, living in the coastal areas.

Therefore, in exercise of the powers conferred under sub-section (1) and clause (v) of sub-section (2) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986), and clause (d) of sub-rule (3) of Rule 5 of Environment (Protection) Rules, 1986, the Central Government, with a view to ensure livelihood security to the fisher and other local communities, living in the coastal areas, through conservation of biodiversity and protection of coastal stretches, its unique environment and its marine area and to promote development through sustainable manner based on scientific principles taking into account the dangers of natural hazards in the coastal areas, sea level rise due to global warming etc., declared the coastal stretches of the country and the water area upto its territorial water limit as Coastal Regulation Zone (hereinafter referred to as the CRZ) on 19.02.1991 [S.O. 114(E)] and restricted the setting up and expansion of any industry, operations or processes and manufacture or handling or storage or disposal of hazardous substances in the aforesaid CRZ. The notification was subsequently amended on 6th January 2011[S.O. 19(E)].

As per the CRZ Notification, 2011, the High Tide Line (hereinafter referred to as the HTL) means the line on the land up to which the highest water line reaches during the spring tide and shall be demarcated uniformly in all parts of the country by the demarcating authority(s) so authorized by the Ministry of Environment, Forests and Climate Change (MoEF&CC) following the general guidelines issued and finally vetted by National Centre for Sustainable Coastal Management (NCSCM).

The extent of CRZ would be the land area from HTL to 500 metres on the landward side along the seafront and the land area between HTL to 100 mts or width of the creek whichever is less on the landward side along the tidal influenced water bodies that are connected to the sea (the distance upto which development along such tidal influenced water bodies to be regulated shall be governed by the distance upto which the tidal effects are experienced which shall be determined based on salinity concentration of 5 parts per thousand (ppt) measured during the driest period of the year). The expression tidal influenced water bodies means the water bodies influenced by tidal effects from the sea, in the bays, estuaries, rivers, creeks, backwaters, lagoons, ponds connected to the sea or creeks and the like. To designate the zones, the following parameters were prescribed:

- The area between the HTL and upto 500 meters on the landward side along the seafront would be designated as CRZ III [with the first 200mts from HTL are to be designated as "No Development Zone (NDZ)"] in areas that are rural (developed and undeveloped) and also areas within municipal limits or in other legally designated urban areas, which are not substantially built up. The stretch of land extending upto100 meters or width of the creek whichever is less from HTL on the landward side along the tidal influenced water bodies that are connected to the sea are also to be designated as NDZ with an exception in such area falling within any notified port limits.
- The areas within the existing municipal limits or in other existing legally designated urban areas that have been developed upto or close to the shoreline with proper infrastructure facilities such as drainage, road, water supply and sewerage mains etc., would come under CRZ II.
- The land area between HTL and Low Tide Line (hereinafter referred to as the LTL) which will be termed as the intertidal zone and designated as CRZ I (CRZ IA : The areas that are ecologically sensitive areas and having geomorphological features which play a role in the maintaining the integrity of the coast & CRZ IB: The area between Low Tide Line and High Tide Line i.e. intertidal).
- The water and the bed area between the LTL to the territorial water limit (12 Nm) in case of the sea (CRZ IVA) and the water and the bed area between LTL at the bank to the LTL on the opposite side of the bank, of tidal influenced water bodies (CRZ IVB) are designated as CRZ IV.

Based on the above presumptions as well as the geomorphology and land use of the area, the States were directed to prepare draft Coastal Zone Management Plan (CZMP) of the State through any organization designated by MoEF&CC. It was also stated in the said notification that a "hazard line" would be demarcated by MoEF&CC through the Survey of India (SoI) taking into account tides, waves, and sea-level rise and shoreline changes to depict the flooding due to tides, waves and sea-level rise in the next fifty and hundred years.

Based on the criteria of the initial notification, the first approved CZMP for the state was in operation from 1996. The detailed final methodology for demarcation of HTL & LTL approved by MoEF&CC as per CRZ Notification, 2011 was received in June 2015. The CZMP for West Bengal as per CRZ Notification, 2011 was prepared on Geographical Information System Platform and submitted to MoEF&CC in April 2018 fulfilling all the formalities and finally approved on 22.06.2020 after thorough scrutiny by the Technical Scrutiny Committee of MoEF&CC.

The total shoreline of West Bengal of about 220 km, covering mainly two districts viz. Purba Medinipur (from bordering Orissa State in the west which is towards the east of the mouth of Subarnarekha River to River Hugli and along the western bank of river Hugli) and South 24 Parganas (from the southern limit of Diamond Harbour Municipality on the eastern bank of river Hugli in the west including Gangasagar Island to river Harinbhanga in the east adjoining Bangladesh). Though the North 24 Parganas is also considered as a coastal district, as it faces tidal effect upto the Dampier-Hodges line, it does not have a sea face. The Purba Medinipur District has important beaches like Digha, Sankarpur, Mandarmoni etc. replenished through the sediment cell from River Subarnarekha upto the south of Rasulpur River which is predominantly sandy. This stretch is meso-tidal in nature. The rest area of the coast is replenished by sediments from River Hugli and Matla which is predominantly clayey in nature, macrotidal and have important areas like Ganga Sagar Island, Bakkhali, Frezargaunge etc. and the mangrove forests of Sundarbans which is a World Heritage Site containing several sanctuaries and a National Park. The rivers in this region drain towards the east due to the geotectonic movement of the Bengal basin gradually tilting towards the east. Hence, the coastline of West Bengal may be viewed in three distinct physiographic characters (i) along the river Hugli, (ii) on the east of river Hugli, (iii) on the west of river Hugli. Based on above, it is evident that in Purba Medinipur District the shores have predominantly sandy beaches, which extends upto Sagar in South 24 Parganas but the coastal areas of South and North 24 Parganas are predominantly clayey and congenial for the mangroves.

As per CRZ Notification, 2011, the distance upto which development along such tidal influenced water bodies to be regulated shall be governed by the distance upto which the tidal effects are experienced which shall be determined based on salinity concentration of 5 parts per thousand (ppt) measured during the driest period of the year. With this characteristic in view, the upper limit of CRZ along river Hugli was freshly examined during the high tide on the advent of the cyclonic storm Bulbul. The samples from different spots and depths along river Hugli were collected from areas below the southern limit of Diamond Harbour Municipality upstream upto the junction where river Rupnarayan meets river Hugli with support from Kolkata Port Trust (KoPT) and analyzed by West Bengal Pollution Control Board (WBPCB). It was found that the salinity was far below 5 ppt. The data also corroborated with the regular salinity measurement data of KoPT. The data taken by an Expert Committee set up by the State Government comprising of Jadavpur University, Zoological Survey of India, Geological Survey of India, Department of Science and Technology under the State Government, Central Pollution Control Board and Centre for Studies of Man and Environment for preparation of CZMP of 1996 also was of the view that coastal processes virtually becomes inoperative beyond Kulpi point where the river widens. Report of Marine Science Department of Calcutta University also confirms the same. Proceedings of National Institute of Oceanography in 1987 also stated that “penetration of salt front never extends beyond Diamond Harbour”. Based on the present result and earlier findings referred above, the upper limit of CRZ was fixed safely at the southern limit of Diamond Harbour Municipality on the Eastern Bank and the point on the same latitude on the western bank. While on the eastern side of Hugli River, it was kept along the Dampier-Hodges line extending upto Bangladesh.

After finalization of the extent of CRZ as referred above, the zonations [CRZ I(A), CRZ I(B), CRZ II, CRZ III with NDZ, CRZ IV(A) and CRZIV (B)] were done as depicted under CRZ Notification, 2011. The first part of mapping that was completed was of Purba Medinipur District. The mappings of South 24 Parganas and North 24 Parganas District took time as it construed of Sundarban Biosphere Reserve which covers the land area from the Dampier-Hodges Line towards the south upto Kakdwip and below upto Sagar Island. This area comprises of numerous tributaries, distributaries, deltas including the National Park, Sanctuaries and other Notified Forest areas covered under World Heritage Sites and hence ecologically sensitive. The Sundarban Biosphere Reserve has three different regions. (i) Core Zone, (ii) Buffer Zone and (iii) Transition Zone. The Core Zone and Buffer Zone comprises of the Ecologically Sensitive Areas (ESA) and is under active protection of the Forest Department through their Tiger Conservation Plan, Management Plan and Working Plan. The Transition Zone is the Human habitated areas and part of these areas comes under Critically Vulnerable Coastal Areas (CVCA) as per CRZ Notification, 2011.

The Coastal Zone of West Bengal is having geomorphology which has low load-bearing capacity, the area is partially meso-tidal (Orissa border to river Hugli) and macrotidal with a high incidence of tidal surge with velocity even upto 7 knots (Hugli river to Bangladesh border covering Sagar Island), the sea is very rough and prone to several severe cyclones during two cyclone seasons in a year – pre-monsoon and post-monsoon cyclone seasons during April-May and September-December. The above mentioned natural phenomenon added to the man-made problems such as the reduction in the flow of sand from river Subarnarekha of Orissa which previously used to replenish the Digha and associated beaches along with the unplanned development of different areas along the coast, high population density and climate change have accelerated the erosion process along the coastline. For identifying coastal areas likely to be affected over the long term, the hazard line delineated by the MoEF&CC through the Survey of India (SoI), taking into account tides, waves, sea-level rise and shoreline changes has been incorporated. The hazard line delineates land areas that are at risk from coastal erosion and coastal flooding. The “Composite Hazard Line” showing the most landward of (i) the flood and (ii) the erosion lines.

Thus the Coastal Zone Management Plan of West Bengal was prepared by Institute of Environmental Studies and Wetland Management (IESWM) for the entire coastal area of West Bengal through active co-operation and involvement of the Department of Environment, West Bengal State Coastal Zone Management Authority (WBSCZMA) and the Working Committee made for the purpose under active guidance from the Steering Committee made for the purpose involving all line departmental heads and the Chief Secretary for merging the CZMP with the policy and local issues of West Bengal.

Meanwhile, a new Coastal Regulation Zone Notification has been published by MoEF&CC in 2019 for up-gradation of the CZMP as per the new policy decisions taken by the Central Government. The work of the new CZMP is under progress.

Table 14.1: District wise Blocks and Number of Mouzas under CRZ

District	Blocks	Nos. of Mouzas under CRZ
South 24 Parganas	Basanti	48
	Canning - I	15
	Canning - II	19
	Gosaba	44
	Kakdwip	36
	Sagar	39
	Namkhana	37
	Patharpratima	84
	Mathurapur - I	7
	Mathurapur - II	21
	Jaynagar - II	8
	Kultali	37
	Kulpi	20
	Diamond Harbour - I	1
North 24 Parganas	Haroa	19
	Hasnabad	14
	Hingalganj	38
	Minakhan	21
	Sandeshkhali - I	20
	Sandeshkhali - II	23
Purba Medinipur	Contai - I	17
	Deshopran	41
	Haldia	2
	Khajuri - I	22
	Khajuri - II	50
	Nandigram - I	20
	Nandigram - II	9
	Ramnagar - I	43
	Ramnagar - II	18
	Sutahata	13
	Mahishadal	5
	Haldia Municipality	--
	Bhagwanpur	6
	Contai - III	4
	Nandigram - III	1

Figure 14.1: Sample Map of a Portion of Sagar Block with Maximum Possible CRZ Features.

Reference:

Coastal Regulation Zone Notification, 18th January, 2019 and amendments

state of environment report-II

WEST BENGAL

Chapter 15

Agriculture

Chapter 15

Agriculture

The Indian Council of Agricultural Research (ICAR) has divided the country into 13 major and 127 micro-level agro-climatic zones. Out of these, 3 regions are represented by the state of West Bengal; though the entire State has been divided into 6 agro-climatic zones, viz Hill Zone, Terai Zone, Old Alluvial Zone, New Alluvial Zone, Red Lateritic Zone and Coastal Saline Zone based on climatic factors, soil structure, texture, type, topography *vis-a-vis* groundwater availability etc. An overview of these agro-climatic zones has been depicted in Table 15.1. Out of these six agro-climatic zones Hill Zone, Terai Zone, Red Lateritic Zone and Coastal Saline Zone are identified to be stressed zones.

Table 15.1: Agro-Climatic Zones of West Bengal-An Overview

Sl. No.	Agro-climatic zone	Area (ha)	Districts	Main Crops
1.	Hill Zone	2,42,779 (2.79%)	Darjiling (except Siliguri subdivision) and Northern part of Jalpaiguri	Maize, rice, different vegetables, potato, soybean, cardamom, ginger, medicinal plants, tea, orange etc.
2.	Terai Zone	12,14,880 (13.99%)	Darjiling (only Siliguri subdivision), Jalpaiguri, Alipurduar, Koch Bihar, Uttar Dinajpur (only Islamur subdivision)	Rice, jute, tea, pineapple, potato, pulses, oilseeds etc.
3.	Old Alluvial Zone	17,53,757 (20.20)	Dakshin Dinajpur and Part of Murshidabad, Bankura, Haora, Hugli, Barddhaman(undivided), Birbhum, Paschim Medinipur and Purba Medinipur.	Rice, wheat, maize, jute, mustard, niger, groundnut, sesame, linseed, lentil, black gram, green gram, pigeon pea, vegetables etc.
4.	Gangetic Flood Plain	15,30,415 (17.62)	Nadia, Murshidabad, Maldah, Uttar Dinajpur, Barddhaman(undivided), Hoogly, North 24 Parganas and Haora.	Rice, wheat, maize, jute, green gram, black gram, pigeon pea, lentil, rapeseed, mustard, groundnut, sesame, linseed, niger, vegetables etc.
5.	Lateritic Zone	24,84,244 (28.61)	Entire Puruliya and part of Barddhaman(undivided), Birbhum, Bankura, Purba Medinipur and Paschim Medinipur.	Rice, maize, millets, vegetables, niger, toria, safflower, mustard, sesame, pulses, potato, vetiver, sabai etc.
6.	Coastal Zone	14,56,879 (16.77)	Entire South 24 Parganas and part of North 24 Parganas, Haora and Purba Medinipur.	Rice, chilli, vegetables, sunflower, sesame, watermelon, *Lathyrus* etc.

Data in parenthesis indicate the percentage of land under the concerned agro-climatic zones.

Sources: 1. *Principles of Agronomy. S R Reddy (2010). Kalyani publishers. Ludhiana.*
2. *NARP status reports for different Agro-climatic Zones (1991). Bidhan Chandra Krishi Viswavidyalaya.*
3. *Sahaj kathaybijnanbhittikchashbas. GosthtoNayban (2008). Ananda Agency, Kolkata.*

Agriculture is undoubtedly the backbone of the state of West Bengal, as the lion's share of the State's mammoth population depends directly or indirectly on it. It may not be irrelevant to mention that Agriculture in West Bengal is the livelihood of 65 per cent of the State's population living in the villages, with 95.4 per cent as small and marginal farmers who, besides sustaining their own families, are still feeding the rest Thirty five percent of the population of our State having the second-highest population density in the country and consequently minimum per capita share of land, being only 0.07 ha (700 square meters), for all material activities. The small and marginal farmers own 84 per cent of the land. Land reforms measures, as well as modern agro-techniques *vis-à-vis* inputs and extensive use of major and minor irrigation systems, had a specific impact on the agricultural production of the State.

Since many decades, the State occupies a prestigious position in the country. People get their food from agriculture in various forms *e.g.* cereals, pulses, fruits, vegetables etc. Many large- and small-scale industries depend on agriculture for their raw materials. Foreign trade also depends on it as it supplies a lot for exports. Thus, in brief, the fact is that the development of agriculture is the backbone of the State's economy. The importance of agriculture and allied sectors in the State's economy is reflected in its contribution of around 20 per cent in the Net State Domestic Product (NSDP) at constant (2013-2014) prices. The employment support from the sector is nearly 39 per cent of total force and about 70 per cent are dependent on agriculture for their livelihood.

Agro-climatic Regions of West Bengal is presented in Figure 15.1.

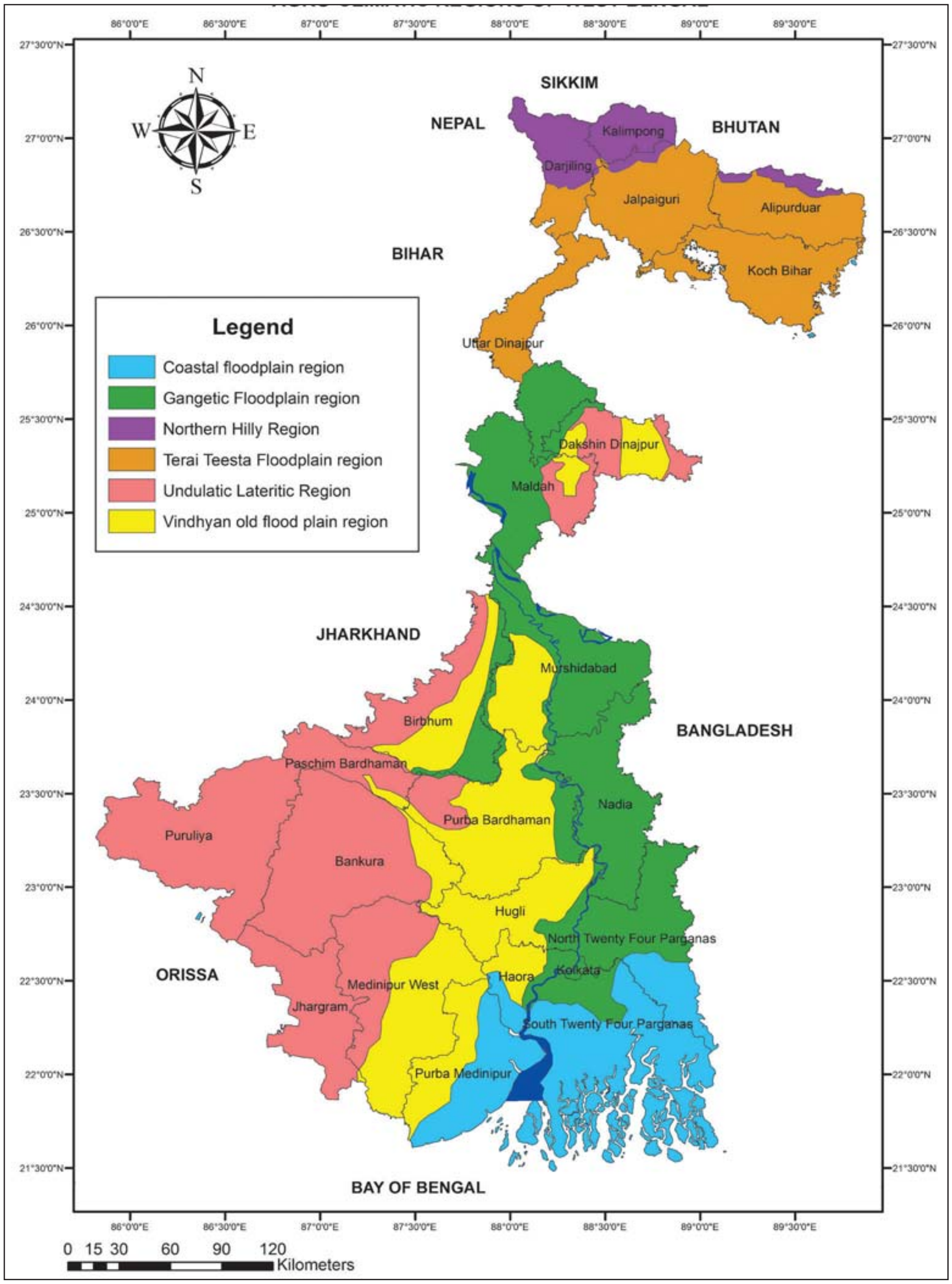


Figure 15.1: Agro-climatic Regions of West Bengal

The average growth in different sectors during the period of last three five years plans is depicted below in Table 15.2.

Table 15.2: Average Growth in Five-Year Plan Period

Growth in plan periods (%)			
Sectors	Ninth plan (1997-2002)	Tenth plan (2002-2007)	Eleventh plan (2007-2012)
Agriculture and allied	3.29	1.63	2.76
Industry	6.64	8.01	5.08
Services	8.62	7.79	9.65
Total	6.53	6.19	7.32

Source: *Bureau of Applied Economics and Statistics (BAE&S), Government of West Bengal, 2013*

The State achieved significant growth in agricultural production over the past few years. It is now among the Country's top producers in a variety of agricultural produces like rice, jute, potato etc. The State produced 6.1 per cent of the total food grains in the country (State Economic Review, 2011-12). The Compounded Annualized Growth Rate (CAGR) of food grains production over the period 2001-02 to 2010-11 was 0.7 per cent. This indicates that foodgrains production is reaching a plateau. Total cultivable land in the State is 5.6 million hectares which are about 65.25 per cent of the total geographical area of the State.

Land Reforms and Utilization of Lands/Land Resource Mapping

Land reforms system implemented in the State of West Bengal for past years has vitalized the rural economy to such an apex that it has attracted attention not only at national but also at the international level. Distribution of ceiling surplus land to the landless and near landless people by the State Government with the active help of the Panchayati Raj institutions, recording Bargadars or sharecroppers providing them with the security of tenure with inheritance rights *vis-à-vis* providing small and marginal farmers with crucial non-land inputs like irrigation facilities, fertilizers, seeds, plant protection chemicals, soil and water conservation measures, credit facilities enormously changed the rural scenario of the State.

Diversified Crop Production/Crop Resource Mapping

The state of West Bengal is endowed with an enormous range of agro-climates and soil types to support diversified agriculture *vis-à-vis* multidisciplinary farming systems. In this context, intensive rather multiple cropping assumed great importance. It became an effective tool in increasing total production from a single piece of land as it increases net cropped area indirectly. Crop diversification in a cropping sequence on the same piece of land has been a very important tool in increasing per hectare net production from that very land.

The cropping intensity which is the ratio of gross cropped area to net sown area along with the gross cropped area and net sown area of different district of West Bengal are presented in Table 15.3.

Table 15.3: Gross Cropped Area, Net Sown Area and Cropping Intensity in the Districts of West Bengal during 2015-16

Sl. No	District	Cultivable Area* (ha)	Gross Cropped Area (ha)	Net Cropped Area (ha)	Cropping Intensity (Per cent)
1.	Darjiling	156811	199279	134854	147.77
2.	Jalpaiguri	349998	567258	337046	168.30
3.	Koch Bihar	263189	519681	255742	203.21
4.	Uttar Dinajpur	277113	528618	274473	192.59
5.	Dakshin Dinajpur	189457	319004	188424	169.30
6.	Maldah	286902	469800	236903	198.31
7.	Murshidabad	400838	1007102	397917	253.09
8.	Nadia	299196	708258	293448	241.36
9.	North 24 Parganas	257339	485488	231400	209.80
10.	South 24 Parganas	376538	564381	362103	155.86
11.	Haora	87975	169799	82755	205.18
12.	Hugli	214202	546824	211502	258.54
13.	Barddhaman (undivided)	462098	792753	457374	173.33
14.	Birbhum	332951	590644	327629	180.28
15.	Bankura	373390	506602	337769	149.98
16.	Puruliya	436785	342492	309158	110.78
17.	Paschim Medinipur	592911	1024820	517267	198.12
18.	Purba Medinipur	290139	538551	287624	187.24
West Bengal		**5647832**	**9881354**	**5243388**	**188.45**

*Cultivable area includes Net Area Sown, Current Fallow, Fallow Land other than Current Fallow, Culturable Waste Land, Land under Misc. Tree Crops and Groves.

Source: Economic Review, Department of Agriculture, GoWB (2018).

State of Agriculture in West Bengal

The total food grain production of West Bengal has increased from 4,788 thousand tonnes in 1950-51 to 17,276 thousand tonnes in the year 2018-19. It is reflected from Figure 15.2 that the State achieved to produce 3.45 times more cereals and pulses in the post-independence decades.

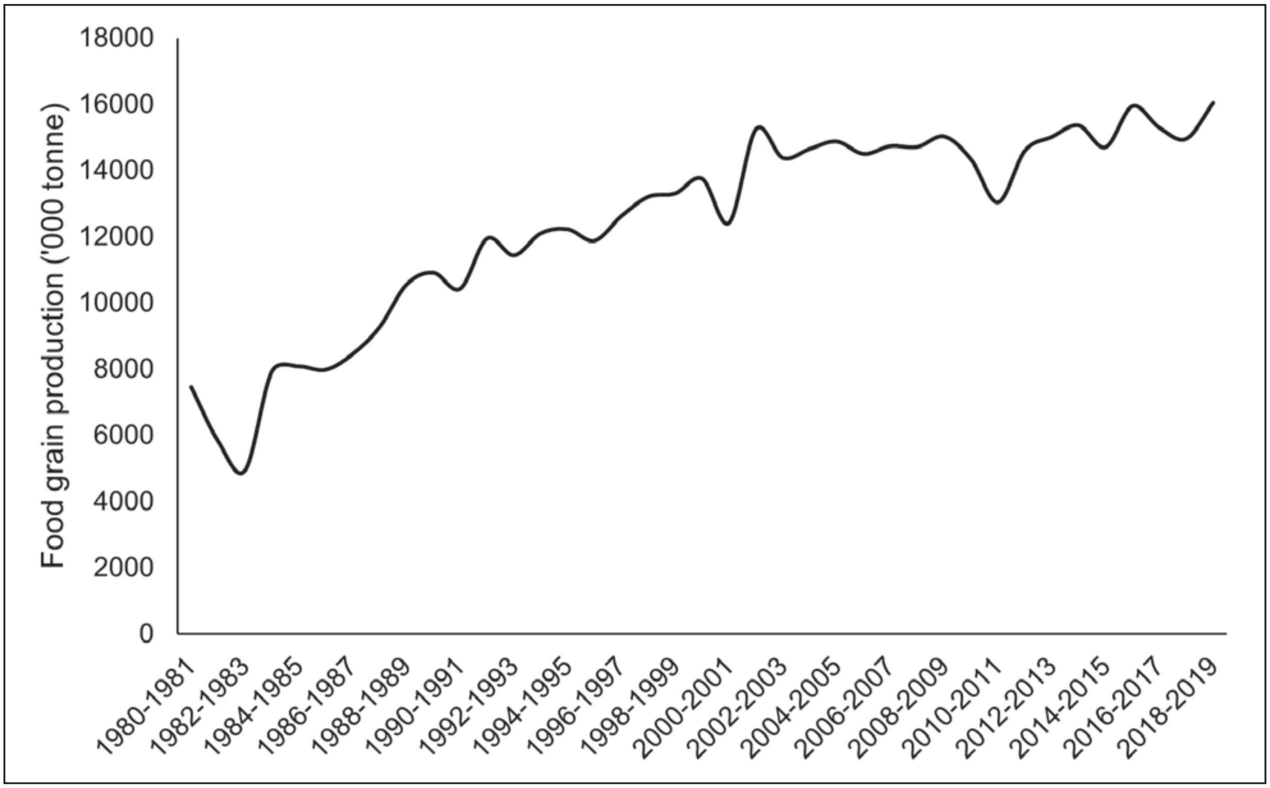
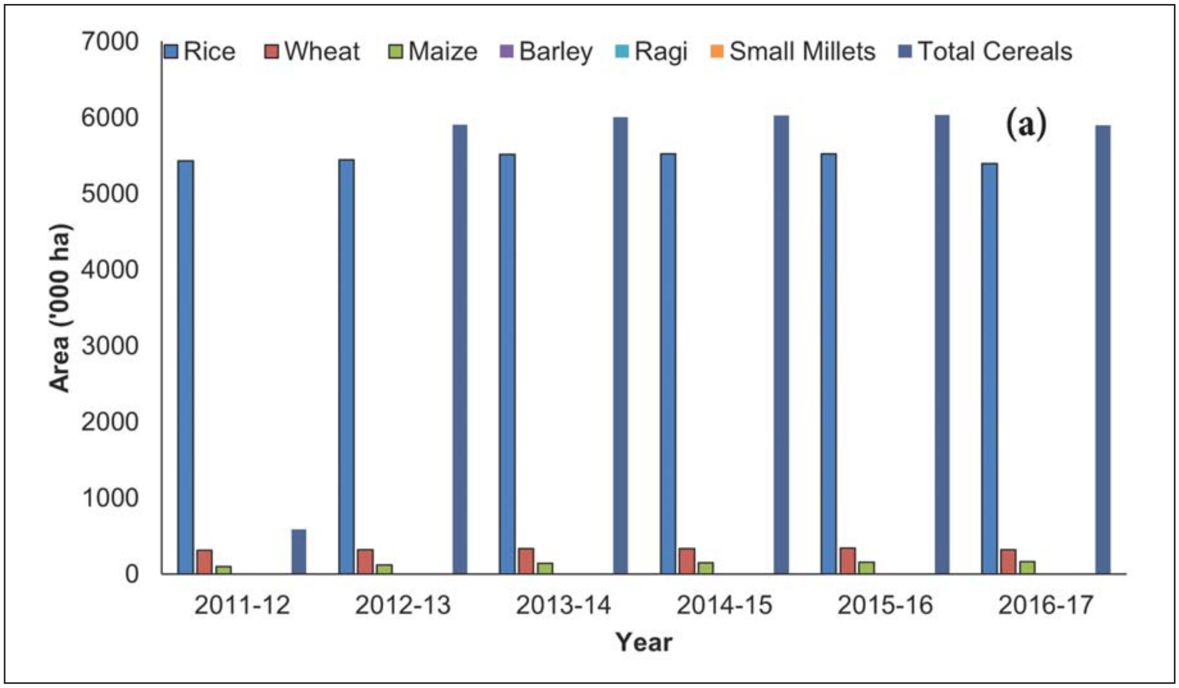


Figure 15.2: Total food grains (cereals and pulses) production of West Bengal ('000 tonnes)

Source: *Agricultural Statistics at a glance- 2019. Directorate of Economics and Statistics(2019). Govt. of India*

The cropping pattern in the State is changing steadily. While the acreage under pulses, oilseeds, vegetables and fruits have escalated significantly these crops as well as strengthen and broaden the value-added chain by promoting food processing industries. The State Government is implementing a centrally sponsored scheme "Integrated Scheme of Oilseed, Pulses, Oil Palm and Maize" (ISOPOM) in recent years. Cultivation of crops other than rice, like wheat, oilseed, maize, pulses etc. would help to meet the growing demand in the State for to increase the area and yield rate of these crops since 2004-05. From the year 2010-11 Pulses Development Programme has been dropped from ISOPOM as it was included under the National Food Security Mission (NFSM) scheme.



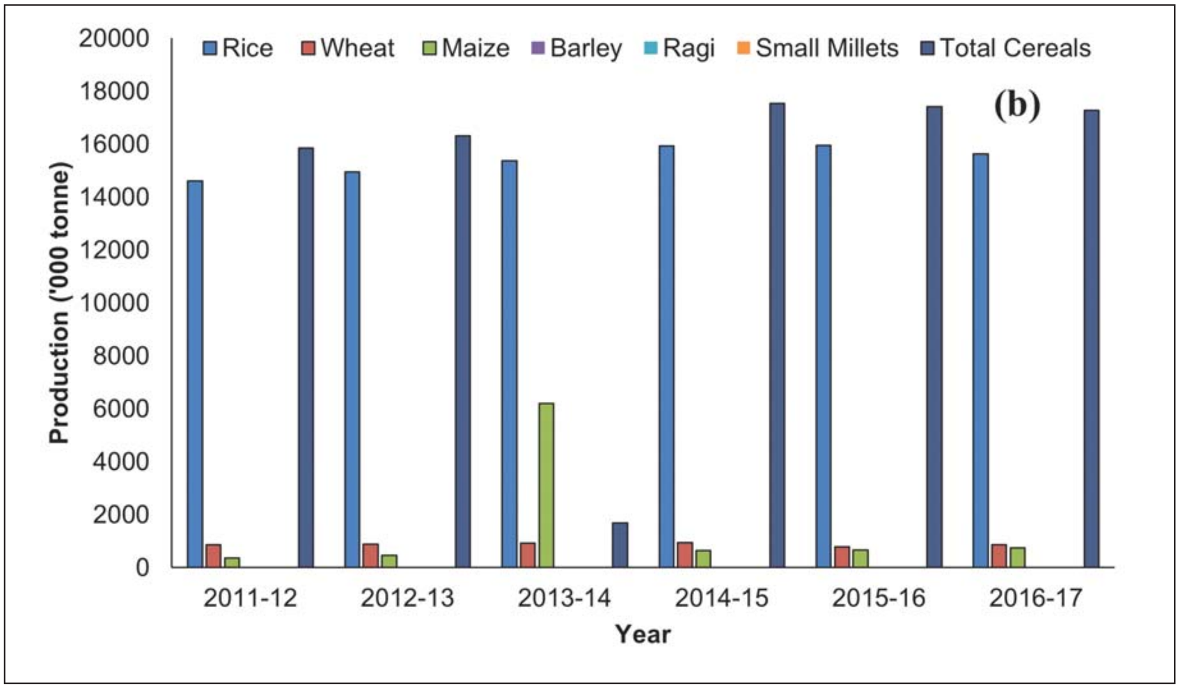
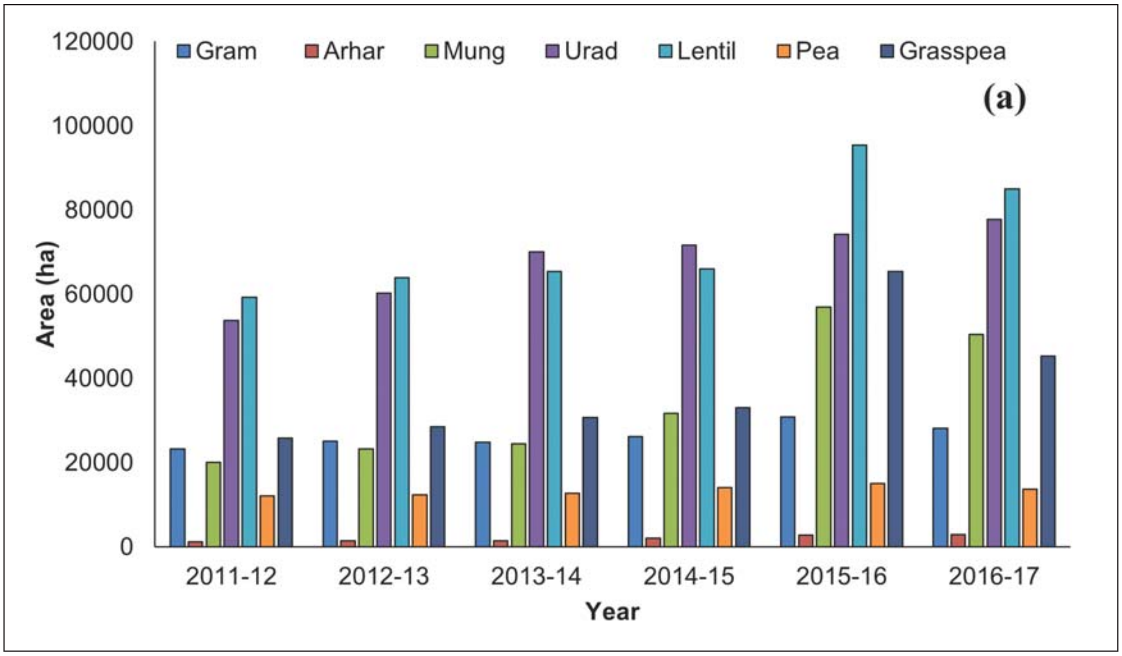


Figure 15.3 (a & b): Area ('000 ha) and production ('000 tonnes) of different cereals in West Bengal

Source: *Estimates of Area, Yield Rate & Production of Principal Crops in West Bengal, 2018, Evaluation Wings, Directorate of Agriculture, Govt. of West Bengal*



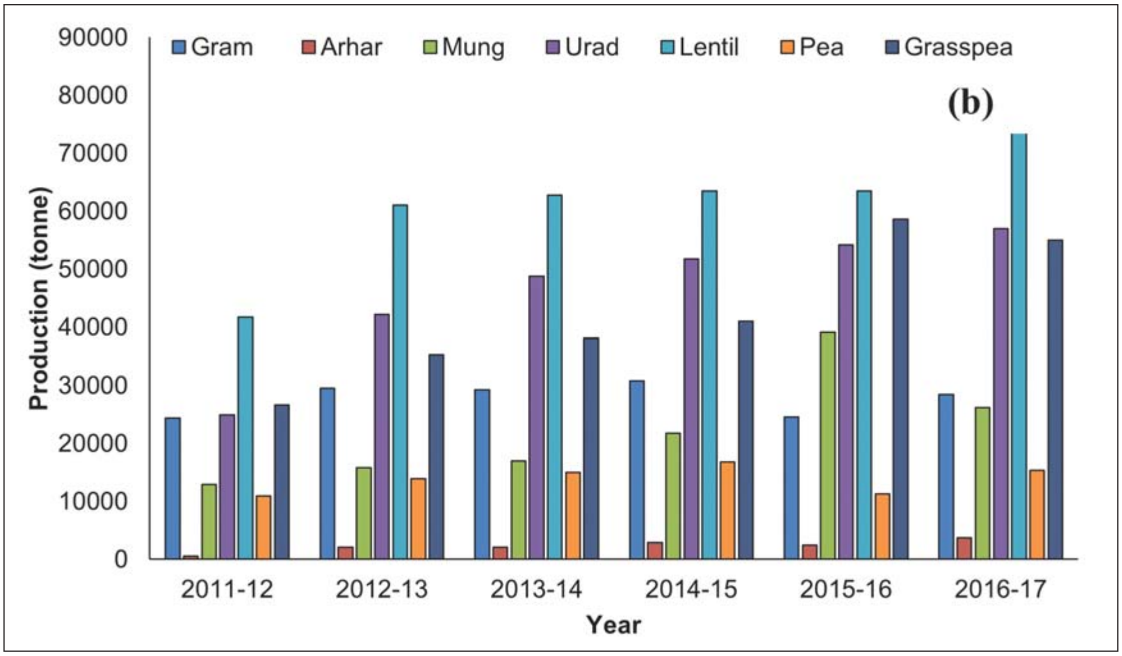


Figure 15.4 (a & b): Area ('000 ha) and production ('000 tonnes) of different pulses in West Bengal

Source: Estimates of Area, Yield Rate & Production of Principal Crops in West Bengal, 2018, Evaluation Wings, Directorate of Agriculture, Govt. of West Bengal

Within the period of 1980-81 to 2016-17 the total oilseed production of the State has augmented about by 5.6 times. The corresponding production values are 150.4 thousand tonnes and 854 thousand tonnes. Different developmental schemes such as National Oilseed Development Project (NDOP), Oilseed Production Thrust Programme (OPTP), Integrated Scheme on Oilseed, Pulses, Oil-palm and Maize (ISOPOM), Oilseed Production Programme (OPP) etc. have contributed a lot in this aspect.

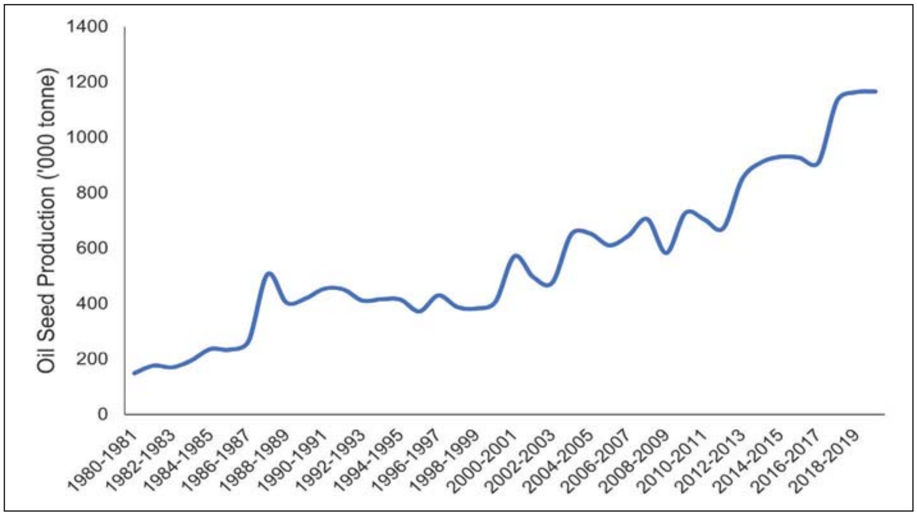
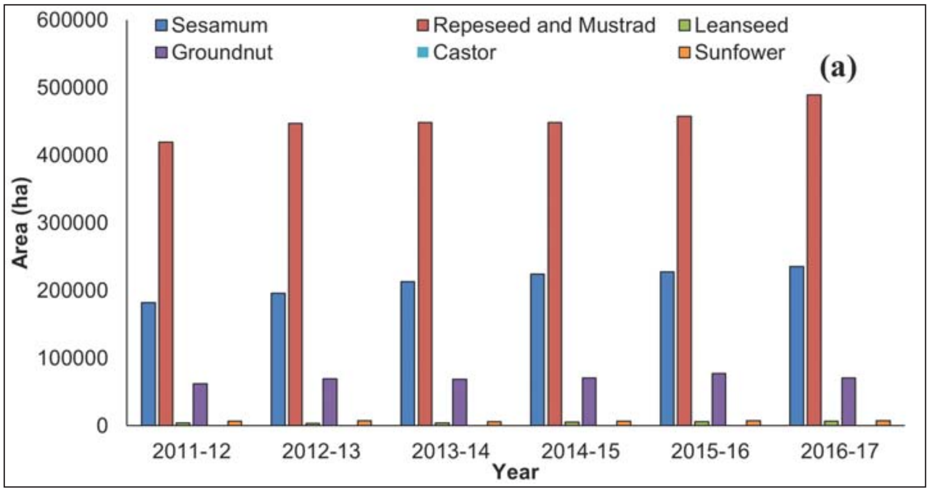


Figure 15.5: Total Oilseeds Production of West Bengal ('000 tonnes)

Source: Estimates of Area, Yield Rate & Production of Principal Crops in West Bengal, 2018, Evaluation Wings, Directorate of Agriculture, Govt. of West Bengal



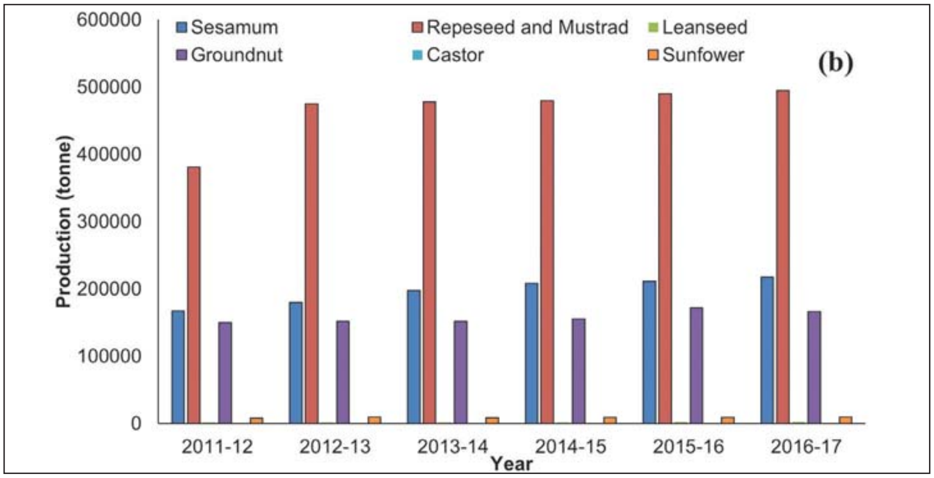


Figure 15.6 (a & b) Area (ha) and production (tonnes) of different oilseeds in West Bengal

Source: Estimates of Area, Yield Rate & Production of Principal Crops in West Bengal, 2018, Evaluation Wings, Directorate of Agriculture, Govt. of West Bengal

The increase in area, yield rate and production of rice, wheat, maize, coarse cereals, oilseeds etc. are attributable to the interventions by the schemes like ISOPOM, NFSM etc. The dissemination of latest technologies by carrying out a vast number of demonstrations and successful farmers' training programmes, bringing new potential crop varieties through Minikit scheme in ISOPOM and distribution of agri-inputs like Plant Protection Chemicals (PPC), Plant Protection Equipment (PPE), seed bins, manual and power-driven implements, Rhizobium/PSBs, NPV, micronutrients etc. are the key factors behind such success in the recent past.

The name of the schemes like "Diversified cropping programme under Dryland/Rainfed condition" under State Plan, being implemented in drought-prone/rainfed mono-cropped 59 Blocks of 5 districts *viz.* Puruliya, Bankura, Paschim Medinipur, Barddhaman and Birbhum located in the Red Lateritic agro-climatic region of the State, having low rainfall and low soil fertility, should also be mentioned. Multiple crop demonstration programme has been taken up under this scheme through a demonstration on hybrid maize, groundnut, pigeon pea and other pulses during Kharif (rainy) season in demonstration centres of 0.13 ha (1,333 sq m) each. The scheme like "Agricultural Development in Special problem Areas like Kanksa, Budbud, Ausgram, Gopiballlavpur, Ayodhya Hills etc." is going on in 20 underdeveloped tribal blocks of four major districts in the dry region *i.e.* resource-poor areas of the State *viz.* Puruliya, Bankura, Paschim Medinipur and Barddhaman.

NFSM was launched in 13 districts of the State with the objective of 4 per cent enhancement in production by the end of the 11th Five year plan period by dint of replacement of old seeds by new HYV and hybrid seeds; restoring soil fertility by applying soil correcting chemicals (ameliorants), micronutrients, organic manures and biofertilizers; proliferating productive technology through demonstrations. The ultimate goal is to create rural employment and hence uplift of the farm economy.

Focal objective of the flagship programme of the Additional Central Assistance Scheme e.g. Rashtriya Krishi Vikash Yojana (RKVY), launched in the State of West Bengal, was to incentivize the State to attain 4 per cent annual growth rate in agriculture and allied sectors. In "Bringing Green Revolution in Eastern India" (BGREI), the sub-scheme under RKVY, 64 Block Demonstration Centres (1,000 ha each year for HYV and Hybrid paddy) and 3 Block Demonstration Centres (1,000 ha each for wheat) was allotted to the State. For holistic socio-economic development of the farm sector and sustainable use of natural resources, the Government of India has introduced the Macro Mode Work Plan in agriculture.

State of Horticulture in West Bengal

The Horticulture sector in West Bengal holds tremendous potential for larger production, area expansion, generation of self-employment, processing, packaging, transportation, marketing and above all export. The State produces a considerable quantity of vegetables (13,875.51, fruits (3,172.5 thousand tonnes), flowers, spices, plantation crops (coconuts, cashew nuts) etc. A stringent growth in total fruits and vegetables production of West Bengal during 1997-98 and 2014-15 is depicted in Figure 15.7 and Figure 15.8 respectively.

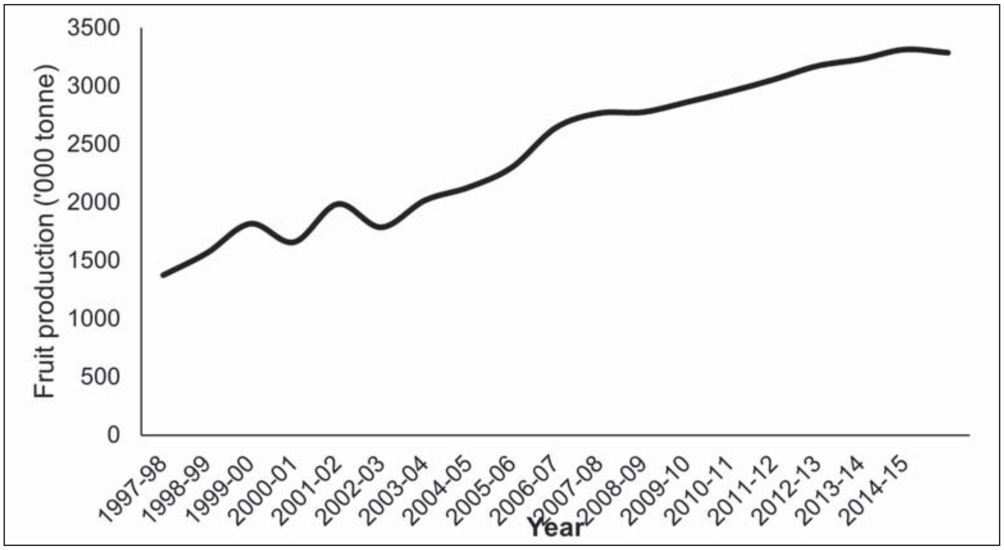


Figure 15.7: Total Fruits production of West Bengal ('000 tonnes)

Source: Estimates of Area, Yield Rate & Production of Principal Crops in West Bengal, 2018, Evaluation Wings, Directorate of Agriculture, Govt. of West Bengal

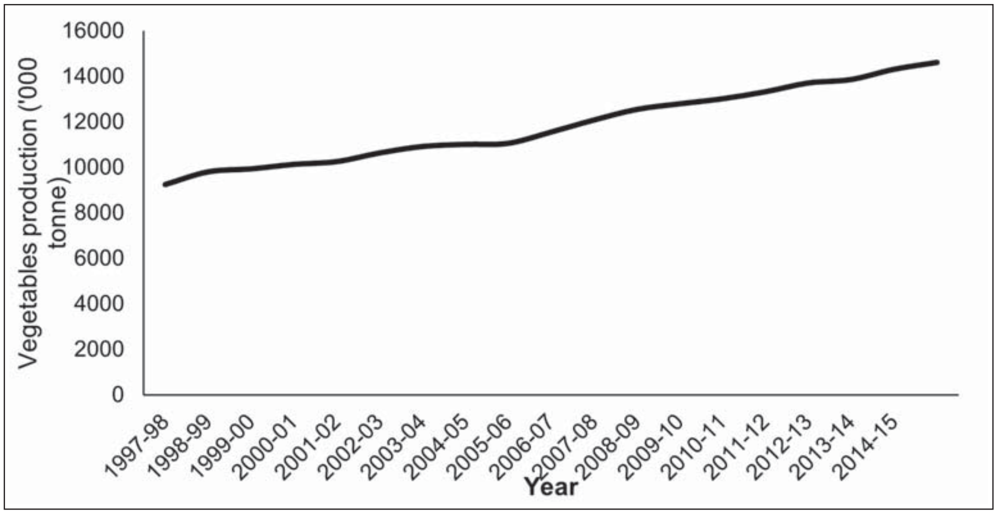


Figure 15.8: Total Vegetables production of West Bengal ('000 tonnes)

Source: Horticulture Statistics Division (2018). Department of Agriculture and Cooperation, Govt. of India.

The schemes under State Plan, National Horticulture Mission, National Bamboo Mission, National Mission on Medicinal Plants, RKVY, Micro Irrigation, National Vegetable Initiative in Urban Clusters and above all mandates taken up by the Food Processing Industry and Horticulture Department as well as Directorate of Cinchona and other Medicinal Plants are showing enlightened horizon in this domain.

The major fruits are mango, pineapple, banana, litchi, orange, guava and papaya. Apart from those jackfruit, sapota, water chestnut, jamrul, pomegranate, ber, wood apple, java plum is also very important for their cultivation to meet the local demand. The Statistics of 2013 -14 regarding the acreage, production and productivity of the major fruits is given below in Table 15.4.

Table 15.4: Area, Production and Yield of Major Fruits in West Bengal

Sl. No	District	2014-15			2015-16		
		Area in hectares	Yield rate in kg/ha	Production in tonnes	Area in hectares	Yield rate in Kg/ ha	Production in tonnes
1.	Darjiling	12135	18730	227289	12258	18800	230450
2.	Jalpaiguri	5643	23213	130990	5656	23184	131131
3.	Alipurduar	4356	19676	85709	4368	19659	85869
4.	Koch Bihar	6598	17284	114042	6665	17308	115355
5.	Uttar Dinajpur	9951	16264	161839	10341	17119	177025
6.	Dakshin Dinajpur	4547	10583	48121	4580	10628	48678
7.	Maldah	34352	12530	430445	35128	9385	329689
8.	Murshidabad	28570	10872	310610	29745	11562	343899
9.	Nadia	22373	23769	531789	22592	23654	534380
10.	North 24 Parganas	22689	16236	368369	23065	16312	376227
11.	South 24 Parganas	11652	15543	181105	12108	15485	187490
12.	Haora	2269	9556	21683	2477	9623	23835
13.	Hugli	13476	14662	197591	13500	14647	197730
14.	Barddhaman (undivided)	8214	9931	81575	8305	9178	76224
15.	Birbhum	6126	11707	71716	6286	11577	72773
16.	Bankura	7897	8468	66871	7972	8594	68515
17.	Puruliya	5647	8457	47758	5780	8623	49843
18.	Paschim Medinipur	12582	8345	105003	12618	8353	105395
19.	Purba Medinipur	9173	14302	131190	9243	14307	132237
Total		**228250**	**14518**	**3313695**	**232687**	**14125**	**3286745**

Source: *Horticulture Statistics Division (2018). Department of Agriculture and Cooperation, Govt. of India.*

West Bengal occupies 9th position (Horticulture Division, Department of Agriculture and Cooperation) amongst the fruit-producing states of the country having an acreage of 220.6 thousand ha it produced 3,172.5 thousand tonnes fruits (average yield being 14.13 tonnes/ ha) during 2015-16. It must be mentioned that even the marginal farmers of the State are now inclined to produce short duration fruits like papaya and banana. Some are getting good profit by producing strawberry in their fields. 'Lakshmanbhog', an elite mango variety of this State has secured the place in the list of exportable mango in the country. A considerable share of the farmers of Nadia, North and South 24 Parganas and Hugli have switched over from rice farming to orchard development for growing fruits especially banana, guava, ber (varied types), sapota, star apple etc. in the upland and medium upland situations.

Healthy liaison amongst the fruit growers and exporters and offering a special package including subsidy and technical supports for fruit orchard development from the Government sector is an essential need at this moment. At the same time, special emphasis should be given on the overall uplift of Food Processing units, Agri-export zones and Agro-Food parks. All these issues if properly addressed may contribute successfully to bring the

State at the top of the list of fruit growing states of India.

From the point of total vegetable production (including potato) the State occupies the 1st position amongst the vegetable producing states of India. But in the matter of productivity, it occupied the 8th position (16.7 tonnes/ha being less than the national average yield of 17.34 tonnes/ha). Table 15.5 shows the estimated demand for vegetables in West Bengal during 2019-2021. Table 15.6 represents the districts producing vegetables (2015-16). The major vegetables produced in the State are tomato, brinjal, green chilli, lady's finger, garden pea, cucurbits, watermelon, cabbage, cauliflower, onion, garlic, pointed gourd, carrot, beet etc. Table 15.7 depicts some improved varieties of vegetable ideal for processing.

Table 15.5: Estimated Demand for Vegetables in West Bengal

Time period	Population (crore)	Annual demand for vegetables (crore tonnes)
2005-06	8.18	0.88
2011-12	8.34	0.72
2020-21	10.34	1.04

Source: AdhunikUddyanBijnanPrajukti (2016), faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya

Table 15.6: Statistics of Leading Vegetable Producing Districts of West Bengal

Sl. No	District	2014-15			2015-16		
		Area in hectares	Yield rate in Kg/ ha	Production in tonnes	Area in hectares	Yield rate in Kg/ ha	Production in tonnes
1.	Darjiling	22595	11258	254377	22697	11274	255883
2.	Jalpaiguri	30014	14165	425141	30081	14198	427079
3.	Alipurduar	23718	19167	454596	23792	19172	456131
4.	Koch Bihar	54890	17845	979489	54941	17833	979763
5.	Uttar Dinajpur	36526	13907	507956	36698	14085	516881
6.	Dakshin Dinajpur	44251	12227	541035	44220	12228	540731
7.	Maldah	58325	13103	764210	58460	13208	772130
8.	Murshidabad	88482	17127	1515472	92443	18908	1747956
9.	Nadia	85461	16034	1370281	85598	16346	1399153
10.	North 24 Parganas	72792	15674	1140965	72982	15739	1148691
11.	South 24 Parganas	77810	14772	1145506	78128	14767	1153726
12.	Haora	15428	12869	198538	15548	12943	201223
13.	Hugli	55748	13237	734363	55525	13254	735940
14.	Barddhaman (undivided)	60970	13123	800084	61255	12843	786668
15.	Birbhum	53924	11886	640953	54083	11920	644641
16.	Bankura	55462	16320	905140	55535	16321	906392
17.	Puruliya	36017	14942	538176	36114	14984	541124
18.	Paschim Medinipur	59294	14655	868938	59206	14724	871727
19.	Purba Medinipur	43559	12452	542385	43667	12433	542889
Total		**974996**	**14695**	**14327605**	**980973**	**14912**	**14628738**

Source: Estimates of Area, Yield Rate & Production of Principal Crops in West Bengal, 2018, Evaluation Wings, Directorate of Agriculture, Govt. of West Bengal

Table 15.7: List of Vegetables with their Varieties

Vegetable	Processed products	Improved/ Hybrid varieties
Tomato	Sauce, Ketchup, Chutney	Pusa Gourav, PusaUpahar, Roma, Arka Sourav, Hybrid 2 & 4, Punjab Chauhara
Cauliflower	Pickles, Dried cauliflower	Pusa Snowball (KT-1 & KT-25)
Potato	Chips, Flakes, Fries	KufriChipsona 1&2
Chilli	Sauce	PusaSadabahar, Punjab Red, Pant C-1
Pumpkin	Sauce	Pusa Bikash
Carrot	Halua	Pusa Kesar, PusaMekhali
Onion	Flakes, Powder	Pusa Red, Pusa White Round/Flat
Bitter gourd	Pickle	PusaBisesh, Pusa Hybrid-1
Garden pea	Canned variety/Frozen variety	Pusa Pragati, Arkel
Ash gourd	Sweets/Pie	Pusa Shakti, Co-1

Source: Annual Report (2015).All India Coordinated Research Project on Vegetable crops, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal

Table 15.8 and Table 15.9 depict the fruits, flowers and spices having potentiality to be grown on a commercial basis in different agro-climatic zones of West Bengal and different leading districts growing flowers in West Bengal.

Table 15.8: Potential Fruits, Flowers and Spices of Different Agro-Climatic Zones

Agro-climatic Zones of WB	Fruits	Flowers	Spices
Hill Zone	Orange, Strawberry etc.	Orchid, Gladiolus, Gerbera, Anthurium, Foliages, Cactus, Succulents, Different flowers	Black cumin, Fenugreek, Coriander, Chilli, Turmeric, Ginger, Large cardamom
Terai Zone	Pineapple, Jackfruit, Coconut, Arecanut, Banana etc.	Marigold, Tuberose, Foliages, fern, Gerbera in polyhouse etc.	Fennel, Coriander, Chilli, Turmeric, Ginger, Black pepper
New& Old Alluvial Zone	Mango, Guava, Papaya, Litchi, Banana etc.	Tuberose, Marigold, Roses, Jasmines, Dahlia, Gerbera, Anthurium, Gladiolus etc.	Black cumin, Fenugreek, Fennel, Coriander, Garlic, Black pepper, Chilli, Turmeric, Ginger
Red Lateritic Zone	Mandarins, Ber, Mango, Pomegranate, Guava, Grapes, Cashewnut etc.	Hibiscus, Roses, Marigold, Cactus, Succulents, Chrysanthemum, Gerbera in poly house, Anthurium etc.	Black cumin, Fenugreek, Coriander, Chilli, Turmeric, Ginger
Coastal Saline Zone	Coconut, Cashewnut, Sapota, Carambola, Karamcha etc.	Hibiscus, Marigold etc.	Black cumin, Fenugreek, Fennel, Coriander, Garlic, Chilli, Turmeric, Ginger

Source: Adhunik Uddyan Bijnan Prajukti (2016), faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya

Table 15.9: District Wise estimates of Area, Yield Rate & Production of Flowers in West Bengal during 2014-15 and 2015-16

Sl. No	District	2014-15			2015-16		
		Area in '000 hectares	Loose flower (Production in '000 tonnes)	Cut flower (Crore Sticks)	Area in '000 hectares	Loose flower (Production in '000 tonnes)	Cut flower (Crore Sticks)
1.	Darjiling	1694	549	25.188	1709	550	25.462
2.	Jalpaiguri	176	236	1.356	178	236	1.382
3.	Alipurduar	129	219	0.590	130	221	0.596
4.	Koch Bihar	197	523	0.833	211	534	0.975
5.	Uttar Dinajpur	253	733	1.302	257	729	1.346
6.	Dakshin Dinajpur	42	141	0.416	47	157	0.167
7.	Maldah	130	594	0.295	138	606	0.338
8.	Murshidabad	273	1608	0.711	339	1641	2.138
9.	Nadia	6820	19664	73.498	6878	19732	75.337
10.	North 24 Parganas	2050	7263	15.506	2070	8253	15.131
11.	South 24 Parganas	2297	7990	16.119	2339	8136	16.398
12.	Haora	1362	3516	4.889	1370	3547	4.892
13.	Hugli	156	171	0.932	161	192	1.008
14.	Barddhaman (undivided)	161	429	0.230	167	448	0.333
15.	Birbhum	156	450	0.223	162	479	0.229
16.	Bankura	91	205	0.331	106	246	0.390
17.	Puruliya	46	73	0.131	48	78	0.139
18.	Paschim Medinipur	3864	8550	59.145	3832	8518	58.893
19.	Purba Medinipur	5423	15236	65.025	5494	15325	66.286
Total		**25320**	**68150**	**266.450**	**25636**	**69628**	**271.439**

Source: Estimates of Area, Yield Rate & Production of Principal Crops in West Bengal, 2018, Evaluation Wings, Directorate of Agriculture, Govt. of West Bengal

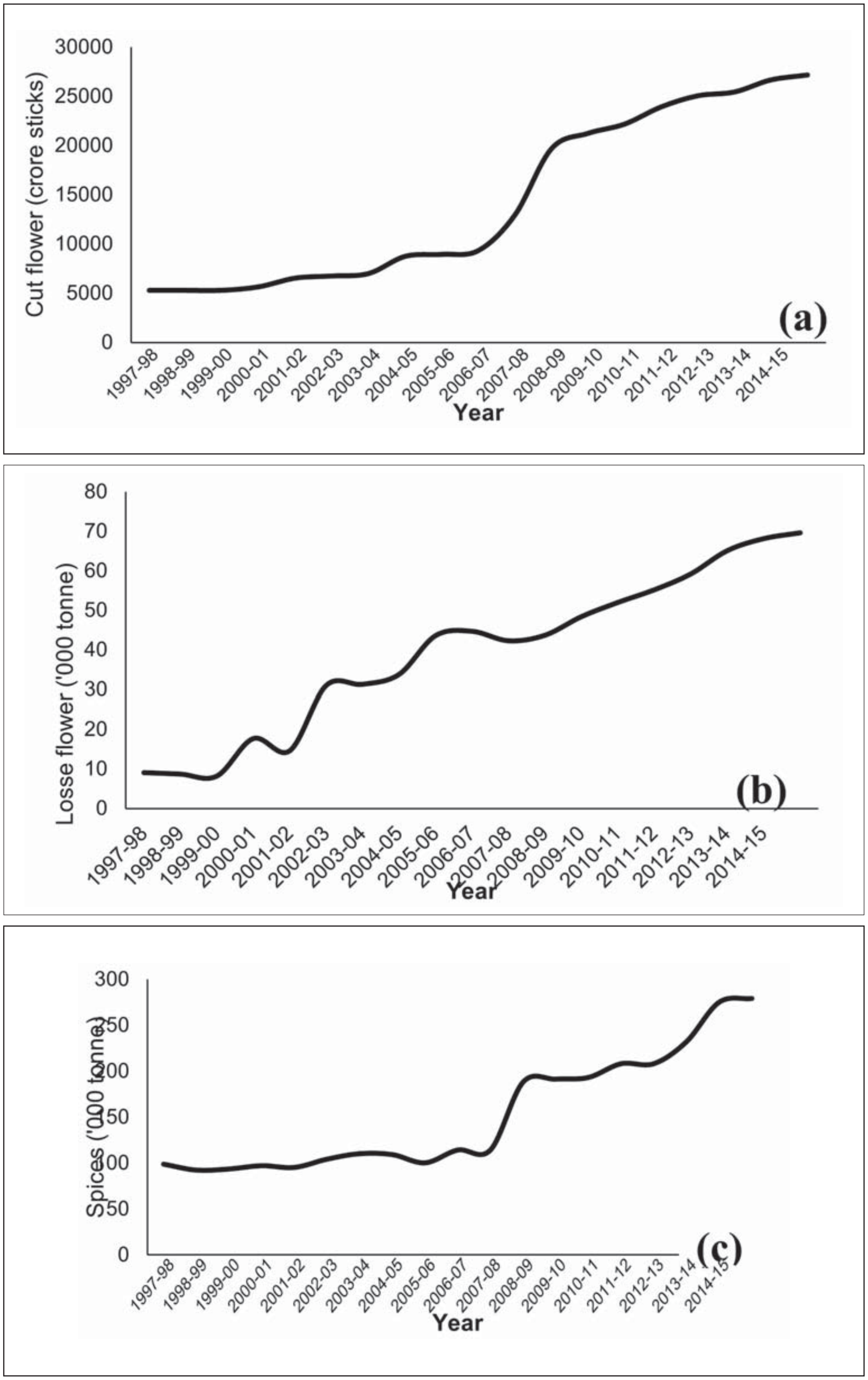


Figure 15.9 (a, b and c): Production of Cut Flower, Loose Flower and Spices of West Bengal

Source: Estimates of Area, Yield Rate & Production of Principal Crops in West Bengal, 2018, Evaluation Wings, Directorate of Agriculture, Govt. of West Bengal

Animal Resources: Past, Present and Future

The crop-livestock system is one of the most important characteristics of Indian agrarian economy and livestock sector is an integral part of India's agriculture sector. Indian livestock sector provides sustainability and stability to the national economy by contributing to farm energy and food security. Livestock sector not only provides essential protein and nutrition to the human diet through milk, eggs, meat and by-products such as hides and skin, blood, bone and fat etc. but also plays an important role in the utilization of non-edible agricultural by-products. During the last decade, the annual growth rate of livestock production has maintained a steady growth of 4.8-6.6 per cent with a compounded growth rate of more than 5.0 per cent. In contrast, crop production remained either stagnant or increased marginally. Therefore, the livestock sector has emerged as one of the key components of agricultural growth in India.

Animal husbandry is a vital sector of the agricultural economy in the State also, which supports small and marginal farmers both economically and nutritionally and plays a crucial role in the generation of employment and augmentation of rural incomes. Concerted efforts combined with well-planned schemes have strengthened this sector to a great extent. Combating the challenge of development of the poor quality, low productive non-descript livestock and poultry breeds of the State, on one hand, generating rural employment in the primary sector along with the creation of income opportunities in secondary and tertiary sectors in rural, semi-urban and urban areas, on the other have been successfully carried out. For this, the Animal Resources Development Department of Govt of West Bengal is pursuing an elaborate, dynamic and scientific policy in association with the State’s unique three-tier panchayat system and municipal bodies. Increased production of milk, meat and eggs shows an improvement upon those of the previous years.

However, despite a significant increase in the production of milk, meat and egg in the State in the last three decades, there is still a considerable gap between demand and supply of products of animal origin. To achieve a high level of productivity from the bovine livestock in the State, constant care for genetic up-gradation is being pursued. Since 2001-02 a comprehensive centrally sponsored National Project for Cattle and Buffalo Breeding (NPCB) has been launched in the State with Paschim Banga Go-Sampad Bikash Sanstha as the State implementing agency.

The main achievement in this respect so far is an extension of facilities like artificial insemination, veterinary first aid, deworming, vaccination of livestock and birds etc. to farmers' doorsteps through active and effective involvement of private workers named 'Prani-Bandhu’. This programme of engaging ‘Prani-Bandhu’ has created a remarkable step-up in self-employment for the rural unemployed youths. At present nearly three thousand numbers of ‘Prani-Bandhu’ are working at Gram Panchayat level in the State. Consequently, the target is to double the number of ‘Prani-Bandhu’ who are private workers bestowed with the responsibility of reaching intensive vet care to farmers’ doorsteps so that per 800 breedable bovines at least one 'Prani-Bandhu’ is at work. The achievements of the ‘Prani-Bandhu’ in West Bengal can undoubtedly usher in an unbeatable example of successful self -employment not only in our State but also in India, at large.

Nationally, West Bengal holds the second position in fish production after Andhra Pradesh amongst leading fish producing states. With the expansion of fishery areas and development of management policy, fish production has increased from 370 thousand tonnes in the year 1980-81 to 1,490 thousand tonnes in the year 2015-16. South 24 Parganas is the leading district in fish production (Figure 15.10).

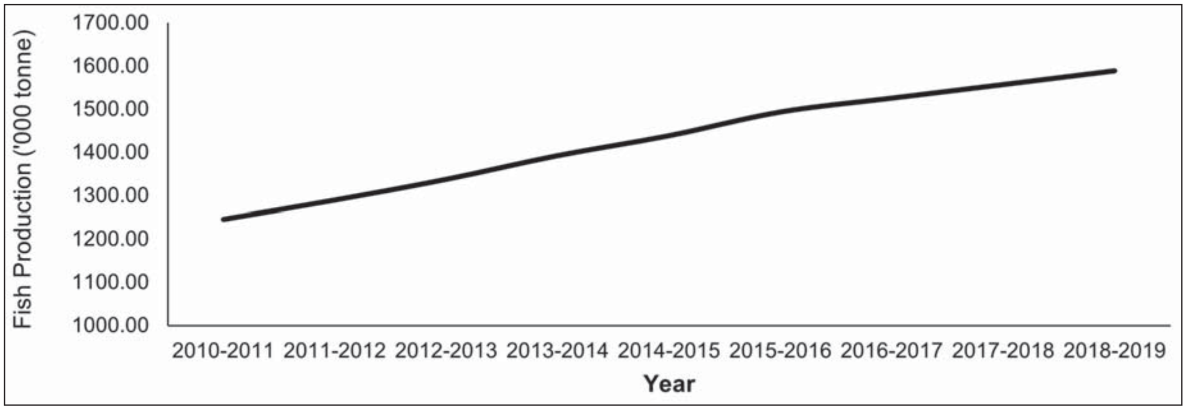


Figure 15.10: Total Fish Production of West Bengal

Source: *Agricultural Statistics at a Glance- 2019. Directorate of Economics and Statistics (2019). Govt. of India (Assessed from https://www.indiastat.com/table/agriculture-data/2/fish-production/450250/38469/data.aspx)*

Over the last few years, egg production of West Bengal has increased remarkably (Figure 15.11). The State produced 4,711 million eggs during the year 2012 -13. It was about 2.06 times more than the egg production in the year 1990- 91 (2,279 million eggs). South 24 Parganas ranks first in egg production followed by Murshidabad.

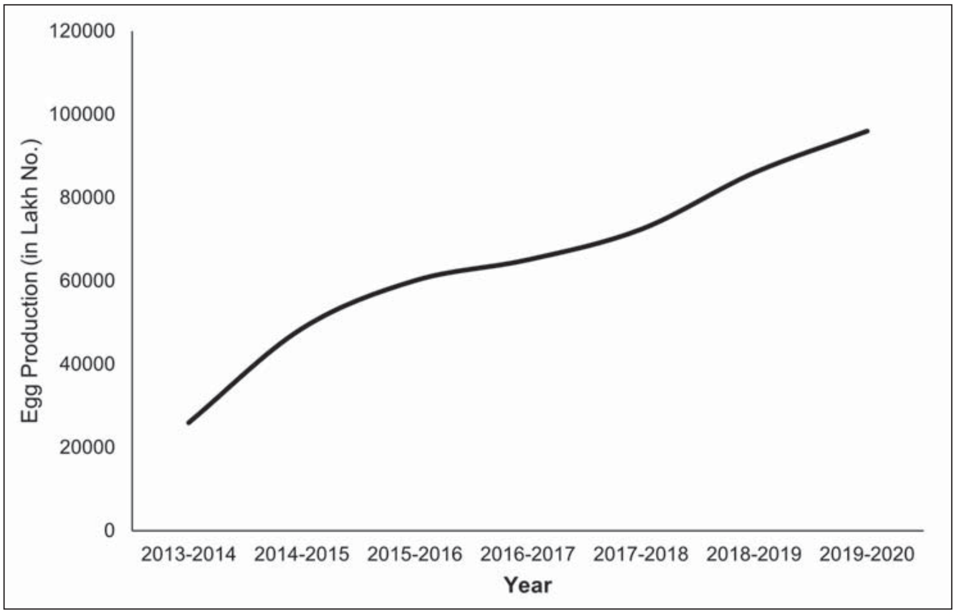


Figure 15.11: Total Egg production of West Bengal

Source: Agricultural Statistics at a glance- 2020. Directorate of Economics and Statistics (2020). Govt. of India (Assessed from https://www.indiastat.com/table/agriculture-data/2/total-egg-production/449295/789085/data.aspx)

Meat production in the year 1990-91 was 695.7 thousand tonnes and 649.36 tonnes in the year 2012-13. The production declined enormously in the mid-'90s; after that, it increased gradually (Figure 15.12).

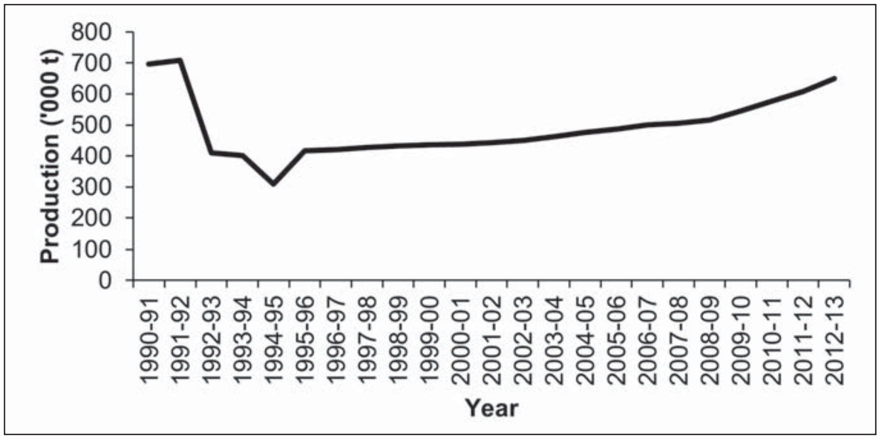


Figure 15.12: Total Meat Production of West Bengal ('000 tonnes)

Source: *Agricultural Statistics at a glance- 2014. Directorate of Economics and Statistics (2014). Govt. of India*

Dairy Development

A network of the three-tier co-operative system - Village Level Primary Milk Co-operatives, District Level Milk Unions and State Level Milk Confederation - under the overall guidance and control of the West Bengal Co-operative Milk Producers Federation Limited has been constituted to facilitate rural development by providing opportunities for self-employment at the village level, prevent migration to urban areas, introducing cash economy and opportunity for steady income. Inspired by the scope of self-employment till now more than three thousand primary milk co-operatives have been set up with a total membership of more than 0.2 million persons. The milk production pattern of West Bengal during the last 20 years is given in Figure 15.13.

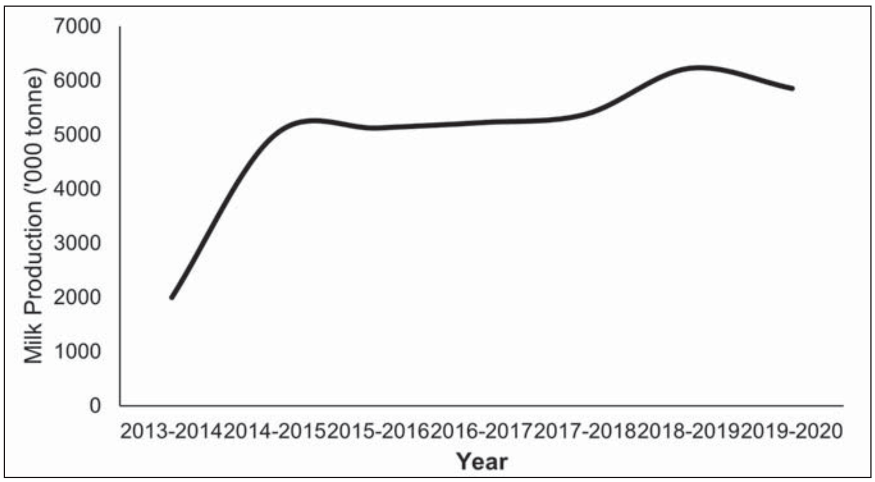


Figure 15.13 Total Milk Production of West Bengal ('000 tonnes)

Source: *Agricultural Statistics at a Glance- 2020. Directorate of Economics and Statistics (2020). Govt. of India (Assessed from https://www.indiastat.com/table/agriculture-data/2/milk-production/279003/788675/data.aspx)*

Self-Employment for Women Development

The Federation is also implementing Women Dairy Cooperative Project funded by the Ministry of HRD, Government of India and thus empowering women economically and socially. Nearly six hundred societies have been formed with the membership of fifty-five thousand women members.

Poultry development

To augment egg and poultry meat production in the State for bridging the gap between requirement and supply, the State Government has taken up a two-pronged approach to increase egg production through promotion of large layer farms and secondly by promoting backyard poultry. To increase egg production in the organized sector, the State Government has introduced a subsidy scheme for the development of layer farms in cage system. A 10 per cent subsidy on the capital investment for 10 thousand commercial layers subject to a limit of Rs. 0.5 million has been introduced. In the unorganized sector, the State Government has introduced a scheme to encourage backyard poultry amongst women members of self-help groups (SHGs). The State Government had distributed a huge number of chicks amongst women members of SHGs.

The potential of the food processing industry is explored in the State depending on certain pockets of agro-commodity exuberance. Infrastructural amenities like agri-marketing zone, cold-chain management system, multipurpose godown etc. are being provided accordingly. The three-tier panchayat system has been largely instrumental in bringing about success in all these aspects.

At present West Bengal is not self-sufficient State regarding the production of milk, egg and meat. The present per capita production of milk is only 137 g daily and eggs 45 numbers in a year (2010 -11). On the other hand, the respective figures in India are 281 g milk and 53 eggs. The National Committee of Human Nutrition recommended that we should consume at least 250 g milk daily and 180 eggs yearly per head. So, there is a big gap between demand and availability of these animal products in the State.

Prioritization of Government Interventions in Animal Husbandry in the State

Breed improvement through artificial insemination (AI), introduction/supply of quality animals;

Calf rearing as part of animal quality upgradation; Promotion of green fodder cultivation on common lands, preservation of grazing land, through crop diversification and the simultaneous strengthening of fodder seed production facilities;

Milk processing and marketing through dairy cooperatives and supply chain management through milk societies;

Promotion of low input technology poultry/duckery for the benefit of marginal farmers/landless rural poor/tribal habitations and also to meet the increasing local demand;

Prani-Bandhus (private AI worker) has done pioneering work in providing doorstep AI services in rural areas. Promotion of more number of Prani-Bandhus (at least one in every gram panchayat);

Awareness among farmers, especially in North Bengal to grow maize to meet the ever-increasing demand for feed.

Agri-Marketing Infrastructure of the State

There is a three-tier marketing system in West Bengal. It includes 3,260 primary rural haats/ markets, 182 secondary markets, 34 secondary-cum -terminal markets and 12 large terminal markets and 279 wholesale markets. Most of the markets are privately owned. Besides these, there are haats and bazaars supervised by Panchayat Samiti and Regulated Market Committees. There are 43 regulated principal markets and 641 submarkets/ yards in the State. The network of these haats and Agricultural Produce Market Committee (APMC) markets play a vital role in the marketing of agricultural produce in the State. (Directorate of Agriculture Marketing, Govt of West Bengal, 2011-12)

The Government of West Bengal has initiated the administrative action to reform the APMC Act. Post-implementation, it is expected to draw the interest of large players in food processing who are keen to enter in direct arrangements with growers for sourcing of raw material.

Status of Logistics and Warehousing Facilities

At present West Bengal State Warehousing Corporation is functioning with a network of 28 warehouses throughout the state of West Bengal. Out of those warehouses 11 nos. are hired and 17 nos. are own constructed in different Districts including one in Kolkata with a total capacity of 6.64 lakh MT. The total effective storage capacity under Food Corporation of India (FCI) (owned and hired) in West Bengal as on February 2013 was 854,000 MT (including Sikkim) - out of this 94,000 MT was hired from Central Warehousing Corporation (CWC) and 19,000 MT from State Government.

Cold storages

The state has total 510 cold storage and out of which 431are potato cold storages with a total capacity of approximately 5,914,000MT, 15 potato multi-commodity combo cold storage in WestBengalwithanestimatedcapacityof180,000 MT. Besides, there are about 64 multipurpose cold storages with estimatedcapacityof45000 million MT (Department of Agricultural Marketing, W.B, 2012-13). Out of these, about 413 cold storages belong to the private sector and about 50 belong to the cooperative sector. In terms of products, more than 95 per cent of the cold storage capacity is utilized for potato.

Cold chain projects being implemented under MoFPI assistance

Under the Scheme for Cold Chain, Value Addition and Preservation Infrastructure, the Ministry of Food Processing Industries, GoI has approved five cold chain projects in the State which are in different stages of implementation.

Abattoirs/ Slaughter-Houses

The Ministry of Food Processing Industries has approved one abattoir project at Tangra, Kolkata with a total project cost of Rs. 284.5 million and with a capacity of 400- 450 bovine per day. As per the Agricultural and Processed Food Products Export Development Authority (APEDA), there are no approved abattoirs-cum -meat processing/ meat processing plant in West Bengal.

Table 15.10: Total Number of Livestock and Poultry in West Bengal

State/UT	Cattle	Buffalo	Sheep	Goat	Pig	Yak	Mithun	Total Live-stock[1]	Total Poultry[1]
West Bengal	16514239	597379	1076115	11505950	648111	1089	0	30348280	52837576
India	190904105	108702122	65069189	135173093	10293695	76662	298264	512057301	729209320

[1] Total livestock covers cattle, buffalo, sheep, goat, pig, Horses & Ponies, donkeys, camels, yak and mithun, and total poultry includes chicken, duck, turkey, quail, emu and other poultry species.

Source: *19th All India Livestock Census, 2012, Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture, Govt. of India.*

Status of West Bengal's Food Processing Industry

Food processing units: Despite being a large producer of horticultural crops, the food processing in the State is still underdeveloped. The main processed products in the fruits and vegetable category are jams, jellies, pickles, sauce, canned sliced fruits and squash. The total employment in the sector was more than 250,000 during 2010- 11. As per WBIDC, 1,009 number of food processing units are in the pipeline.

Agri-Export Zones: Six agri-exports zones(AEZ) of West Bengal are mentioned in Table 15.11. The AEZs, though operational, are in a nascent stage with potential to increase exports from the region.

Table 15.11: Agri-Export Zones of West Bengal

Crop	Agri Export Zones
Pineapple	Jalpaiguri, Siliguri, Koch Bihar, Uttar Dinajpur
Mango	Maldah, Murshidabad
Litchi	Maldah, Murshidabad, Nadia, North 24 Parganas
Vegetables	North 24 Parganas, Nadia, South 24 Parganas, Howrah
Potato	Hugli, Barddhaman(undivided), Haora, Purba Medinipur
Flowers	Purba Medinipur, Siliguri, Jalpaiguri, Nadia

Source: Adhunik Uddyan Bijnan Prajukti (2016), faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya

Agro Food Parks: Agro-food parks are being developed in the State to provide support to small and medium entrepreneurs by assisting them (financially) in setting up capital intensive facilities like cold storages, warehouses, quality control labs, effluent treatment plants etc. The following food parks (Table 15.12) are present in the State.

Table 15.12: Agro Food Parks of West Bengal

Sl. No.	Name of the Food Park	Location	No. of Units set up/ to be set up	Project Cost (Million Rs.)	Status	Items
1	Maldah	Maldah	25	160.8	Complete	Fruits & Veg. Processing
2	Sudharas	Sankrail, Haora	11	189.3	Complete	Potato chips, Kurkure, Ice cream, Biscuits, Ware House for Agro products, Packaging items for storage of food prod.
3	Haldia	Haldia, Purba Medinipur.	40	188.0	Under Implementation	Under implementation
4	Siliguri	Siliguri	20	142.1	Nearing Complete	Biscuits, F & VP
5	Kandua	Kandua, Haora	5	165.7	Complete	Biscuit, Cake, Dal, Kurkure, Pkg. of oil, Warehouse
6	Sultanpur	Sultanpur, South 24 Parganas.	40	80.1	Complete	Preservation & Marketing of fish
7	Kakdwip	Kakdwip, South 24 Parganas.	80	92.4	Complete	Preservation & Marketing of fish
8	Chakgaria	Chakgaria, South 24 Parganas.	10	80.1	Complete	Preservation & Marketing of prawn

Source: Adhunik Uddyan Bijnan Prajukti (2016), faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya

Taxation Policy of the State Government

The Central Government levies direct taxes such as personal income tax, corporate tax and wealth tax, as well as a comprehensive, multistage, destination-based indirect tax GST.

GST: Goods and Services Tax (GST) is an indirect tax (or consumption tax) used in India on the supply of goods and services. It is a comprehensive, multistage, destination-based tax. Goods and services are divided into five different tax slabs for collection of tax - 0%, 5%, 12%, 18% and 28%. GST for agricultural products in West Bengal is portrayed in Table 15.13 The tax came into effect from 1 July 2017 through the implementation of the One Hundred and First Amendment of the Constitution of India by the Indian government. The GST replaced existing multiple taxes levied by the central and state governments

Table 15.13: Goods and Services Taxes for Different Agro Products

GST Rate (in Per Cent)	Items
0	Fresh milk, Curd, Lassi, buttermilk, separated milk, Paneer, Bread except for pizza bread, fresh vegetables & fruits, eggs, honey, meat, fish & Prawn (except cured or frozen).
5	Processed and preserved vegetables and fruits, Processed meat, poultry & fish products, skimmed milk powder, vegetable oil, fresh and dried nuts.
12	Fruit pulp or fruit juice-based drinks, snacks items, Beverages containing milk, medicinal & aromatic plant-based preparations.
28	Agri-based confectionaries (Pan masala, sweetening matter or flavoured items, Molasses), Caffeinated Beverages, Unmanufactured tobacco; tobacco refuse (other than tobacco leaves) etc.

Source: *Dept. of Commercial Taxes, Government of WB (2018)*

Electricity duty: Electricity duty is also levied by the State Government with slabs decided depending on nature and industry of usage.

Potential Areas for Investment

Based on raw material availability in the State and adjoining areas, the following (Table 15.14) processable activities hold potential in the State. The list is indicative and may not be treated as exhaustive.

Table 15.14: Potential Areas for Investment in Industries for Processed Products

Crop	Processed products that may be derived
Rice	Milled rice, bran oil, powder, poha, puffed rice, noodles, etc.
Potato	Chips, flakes, powder, fries, starch etc.
Cauliflower, Cabbage, Okra, Carrot, Brinjal	Fresh cut, frozen and assorted products
Tomato	Puree, Juice, concentrate, ketchup, sauce etc.
Guava	Juice, concentrate, fruit drinks, frozen halves, candies, Jam, Jelly
Citrus Fruits (Aonla)	Juice, candy, powder
Pineapple	Juice, candy, pulp, concentrate, jam, jelly etc.
Mango	Pickle, Aam Papad, Chutney, Candy, dried mango powder, Jam, Jelly etc.
Raw Milk	Butter, crème, ghee, cottage cheese, flavoured milk, spreads, milk powder, ice-cream, curd, buttermilk
Fish	Fresh and frozen processed, Dry fish
Meat	Fresh and frozen processed

Source: Adhunik Uddyan Bijnan Prajukti (2016), faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya

Alarming issues

India inherited stagnant agriculture at the time of its independence in 1947. Thus, the first task of the National Government in the post-independence session was to initiate the growth process in the agricultural sector. When we look back to review these growth processes of Indian agriculture during the last seven post-independence decades, we find several success stories which have transformed the country from the image with "begging bowl" to not only "self-sufficient" one in food grains but also to be a leading exporter of some agricultural produces in the global market. In this laborious long journey, the country has added several gems to her crown by impressive revolutions in the agricultural sector - Green (from 51 to 253 million tonnes food grains), White (from 17 to 146.3 million tonnes milk), Blue (from 0.7 to 6.1 million tonnes fish) and Yellow (from 5.2 to 26.7 million tonnes oilseeds). The green revolution in mid-sixties, steered by research-based new technological development involving new materials, methods and ways of organizing farm inputs like the seed of high yielding varieties, water, fertilizer, plant protection chemicals etc. and the Government policy transformed the agriculture dramatically. As a result, the output exhibited a manifold increase in production and productivity.

Despite this magnificent progress during the last few decades, we cannot ignore the grim side of the story as well. The country, as well as the State of

West Bengal, occupies dismally a low position in respect of yield levels in comparison to many other countries. Planners, agricultural scientists and agricultural economists are badly worried about the slow growth rate of agricultural production in recent years. The population has been escalating at an alarming rate, while the average growth rate of total food grain production is not at all satisfactory. So, there is no other option except to produce more and more. It is also a fact that in a country like India augmenting crop production by increasing the area under cultivation is almost next to impossible. It is more true with the state of West Bengal. The dismal situation regarding the low position in respect of yield levels is attributed to poor input use efficiency, degradation of resources like soil and water and deceleration of total factor productivity. There is, therefore, an urgent need for massive well-planned action programme for enhancing input use efficiency and crop productivity to sustain the tempo of agricultural growth in both irrigated and rainfed areas of our state as a whole.

The following issues must be brought into light for keeping the pace of agricultural growth of the State in future mitigating the evil impacts of its varied operations and modern technologies/tools on biodiversity, water, air, soil and socio-economy as a whole:

The apathy of peasants to farming - social issue

The aberrant weather changed climatic condition regarding rainfall pattern, temperature and humidity and havoc crop pest occurrence; the increasing cost of inputs (seeds, fertilizers, pesticides etc.); reduction in holding size due to excessive fragmentation of land; absence of minimum support price (MSP) for most of the agricultural produces; inadequate market infrastructure and uncertain prices of agricultural produces, especially of highly perishable products; and above all resultant less return received from rice and many other crops, make the farmers' apathy in growing rice and in many cases other crops also. The small farmers from the remote areas are often forced to accept distressed sell of their products of hard labour. Management of farm animals is also becoming more difficult due to the high cost of feed and less rather rare availability of fodder *vis-à-vis* lack of remunerative marketing facilities. All these issues have created frustration in the mind of a large section of the farming community making them decide for an alternative remunerative profession like masonry, jewellery, hosiery or garment-making works and agricultural labours, in other districts of the native state and cities of other states like Odisha, Bihar, Jharkhand, Kerala, Andhra Pradesh etc. Practically, they are trying to come out from "high-tension agriculture" to "low tension" one. Landless classes are switching over from lease -in peasants to wage-earning field labourers. At present, this type of change in occupation is very common in the stress tracts like Coastal and Red Lateritic zones. As a result of this, different districts of the entire State are facing an acute crisis of labourers during the prime period of cultivation (usually at the time of sowing/ transplanting/ harvest/ post-harvest operations like cleaning, grading, packaging and warehousing etc) of almost all the crops. Moreover, leasing the land to others by the landowner results in ill maintenance of land avoiding thinking of the sustainability and soil health issues as land is considered as nothing but money earning machine to them.

Water issues

Water is the basic need for the sustenance of all living beings. It is obvious that nature is the key source of water and sweet water is the only permissible drinking water. About 97.5 per cent of the water available in the world is almost undrinkable and unsuitable for any purpose. 70 per cent of the drinkable water i.e. sweet water (2.5% of the total water) comes from glaciers and the rest amount remains as the groundwater. The source of this groundwater is rapidly getting reduced owing to escalating demand for irrigation purpose, rapid industrialization and urbanization as well as indiscriminate use of water in all the domestic and non-domestic spheres. Statistics show that every half to two-thirds of the world population will have to face the acute scarcity of water in the coming 20-25 years. Overexploitation of groundwater, cultivation of high water-requiring crops like rice in all the agricultural seasons (pre-Kharif or summer, Kharif or rainy and Rabi or winter and boro exclusively for dry season), overdependence on groundwater, reluctance to water-saving technologies are the key causes behind water crisis (quantity factor) and water quality (quality factor like arsenic, fluoride and heavy metal poisoning etc.).

At this moment about 280 crore people of almost all the continents of the world fall in the grip of this alarming water crisis for at least one month in a year. 120 crore people do not get uncontaminated good quality water. The main cause of death of the children below 5 years is water-borne diseases and at any moment, 50 per cent of the beds in the hospitals around the world are occupied by the patients suffering from such type of diseases.

Eutrophication, the ecosystem's response to the addition of artificial or natural nutrients, mainly phosphates, through detergents, fertilizers or sewage to an aquatic system results in an explosive growth of some aquatic plants and algae. It ultimately hampers the growth of the aquatic flora and fauna, resists penetration of solar radiation inside the water body and creates hypoxia.

Soil erosion issues

The land is the most vital basic natural resource. It is a dynamic and complex combination of geology, topography, hydrology, soil and flora as well as fauna and has an impact on every sphere of human activity. Different sectors including agriculture, industries, infrastructure and power projects have demand for land. Intensive farming practices accelerated soil and water erosion, erratic rainfall, increasing human population and livestock population also have contributed to unsustainable land use leading to degradation of this valuable resource in West Bengal. Measures should be taken to check erosion through conserving soil by utilizing these lands through growing different medicinal and aromatic plants, biodiesel crops and even grasses like vetiver and sabai. Promising results are found in checking riverbank erosion through vetiver plantation. Both the grasses are highly remunerative and have shown their potentiality in employment generation and livelihood development aspects in the adjoining villages of the rivers. Agro-forestry is also an outstanding choice for these eroded areas.

Chemical fertilizer and pesticide issues

Chemical pesticides and fertilizers played a significant role in the improvement of crop yields all over the world along with India as well as the state of West Bengal during the last five decades. Use of fertilizers along with pesticides, high fertilizer responsive dwarf crop varieties with high yield potential, providing and utilizing of surface *vis-à-vis* groundwater resources, intensive cropping and versatile chemical pest management practices played the pivotal part in bringing the green revolution of the late sixties in India. The trend of fertilizer consumption of West Bengal during the last twenty years is represented in Figure 15.14.

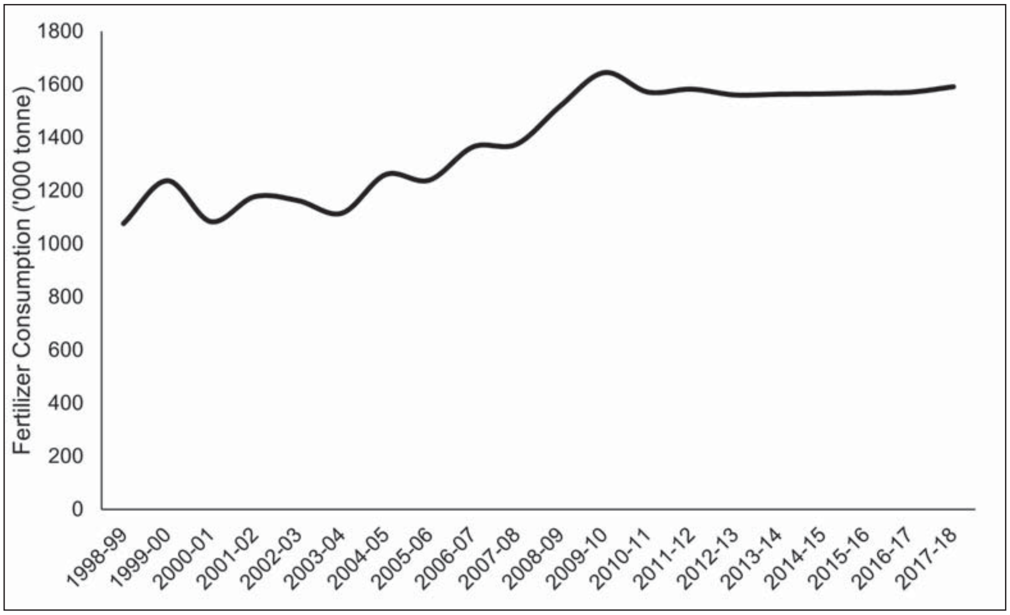


Figure 15.14: Total Fertilizer consumption of West Bengal

Source: *Ministry of Chemical and Fertilizers, Govt. of India., Govt. of India. (Assessed from https://www.indiastat.com/table/agriculture-data/2/consumption-of-pesticides/206872/1135962/data.aspx)*

Insect pests play a major role in crop damage and yield reduction. Jassid, whitefly, thrips, bollworms, aphids, and mites are posing a serious threat to several high-value cash crops. About 70 insect pests are reported to attack paddy crop and cause 20-25 per cent losses on a recurrent basis. Insects on many instances practically reduced the food availability by over 50 per cent. The pesticide consumption pattern of West Bengal during the last twenty years has been depicted in Figure 15.15.

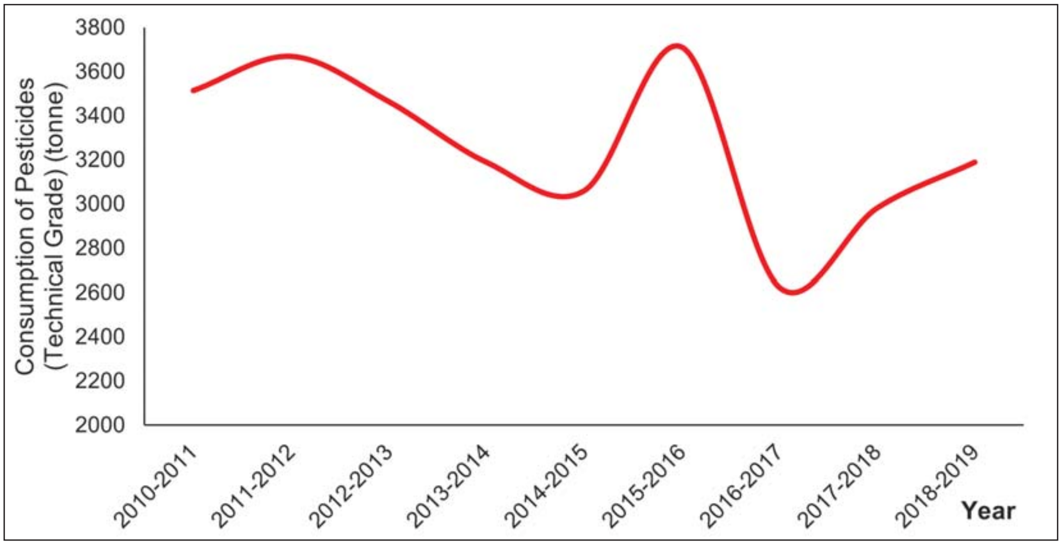


Figure 15.15: Total Pesticide consumption of West Bengal

Source: *Ministry of Chemical and Fertilizers, Govt. of India., Govt. of India. (Assessed from https://www.indiastat.com/table/agriculture-data/2/consumption-of-pesticides/206872/1135962/data.aspx)*

The main causes of environmental pollution due to indiscriminate use of pesticides and chemical fertilizers may be focused largely on:

- Farmers ignorance about fertilizers and pesticides application (method, time and quantity);
- Lack of awareness about integrated nutrient, water and pest (insect, disease, weed, rodents etc.) management.
- Improper storage and mishandling of such chemicals
- Improper disposal of empty containers

Reluctance vis-à-vis lack of awareness amongst farm families and common people regarding pesticides pollution in their daily food and water.

So, the following measures should be kept in mind to mitigate the ill impacts on the below-mentioned sectors.

Environment

- Harmful pesticides and chemical fertilizer create pollution in the environment if they are used indiscriminately. So, their judicious use reduces the pollution load;
- Careful use of pesticides and chemical fertilizers offers benefits to the soil-
- water-plant -animal-human being continuum.
- Integrated approach in pest management at the initial stage and in the long run switching over from chemical farming towards organic farming via integrated management systems should be advocated.

Farmers/ common people/ domestic animals/ birds etc.

- The farmers are directly affected by the ill effects of pesticides and different other chemicals during spraying or application to the field crops. Proper protection adopted during such spray/ application may save them from the direct bad impacts of these chemicals;
- The farmers, common people, domestic animal, birds etc are indirectly affected by the bad effects of these chemicals through consuming polluted food products as well as water etc. Proper measures taken in the agricultural field by the farmers during application and necessary precautionary steps adopted during consumption of food materials etc. by the common mass and feeding the animals and birds may save the entire living mass by reducing the pollution load in the food chain.

Industries

- There are a number of eco-friendly chemical pesticides, specifically graded fertilizers and a good number of organic manures, bio-pesticides, bio-fertilizers etc. prevailing in the market. The industries may come forward to survey on these aspects, promote these agricultural inputs to the farmers and produce such inputs as per the demand of the entire agricultural system for its betterment.
- Abiding by these mandates ultimately the national economy would be benefited through checking the degradation of soil, providing pure and safe water to the nation, reducing overall pollution load, protecting the bio-diversity, lesser import of agrochemicals saving valuable foreign exchange and making the human resource of the country healthy.

Biodiversity/seed issues

The seed is considered as a fundamental input for successful agricultural production. The State has achieved considerable progress in production and use of quality seeds. Seeds of different crops are multiplied in the Government Farms, West Bengal State Seed Corporation Ltd, State Agricultural Universities, West Bengal Comprehensive Area Development Corporation, Co-operatives and Private Agencies etc. West Bengal State Seed

Certification Agency is mainly associated with the production of certified seed in the State. As per the report of the Department of Agriculture, Government of West Bengal, 2011-12 the State produced 1626.6 t paddy, 49.98 t wheat, 9.35 t of jute, 61.35 t of pulses, 78.32 t oilseeds, 88.75 t potato, 82.8 t sugarcane, 19.5 t dhaincha and 10.66 t seeds of other crops. Seed village programme under Central Sector Scheme (CSS) is also in operation. Besides, production of hybrid seed paddy, maize as well as Varietal Replacement Programme (VRP) are also functioning in the state under Rashtriya Krishi Vikash Yojana (RKVY) scheme. Near about 7000 seed villages are under execution for the production of quality seeds of paddy, pulses, oilseeds etc. under CSS; more than 3500 seed villages have already been completed under Green Revolution Programme. Seed bank project for developing infrastructure on storage of seeds, data bank and information service related to seeds, quality control and management of seed bank is also in operation.

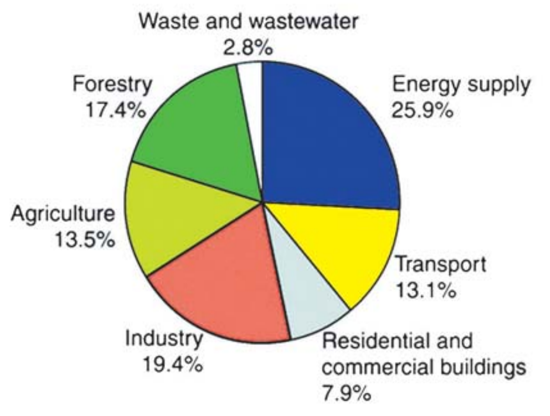
Biodiversity is the whole host of life forms within a particular ecosystem. It is often used for measuring the health of biological systems. Introduction of high yielding varieties in the intensified agricultural system has sharply diminished the area for traditional/indigenous varieties in the State resulting in the extinction of different local varieties/landraces. The trade and marketing policy of the national and multinational seed agencies and a parallel proclivity/inclination of the farmers towards HYVs of different crops during the green revolution as well as post green revolution eras are the key causes behind such phenomenon. Thus, at this phase, it is a crying need to protect and preserve all the landraces/local varieties of paddy, pulses, brinjal, chilly, amaranthus, tomato and different other vegetables; banana, mango and various other major and minor fruits having marvellous potentiality to survive in their respective stressed regions, combat with the versatile pest attack and acclimatize with the changed climatic conditions. Practically, they are the ores of special genes expressing their special features in distinct crop quality, taste, aroma and high nutritional value as well as in disease resistance, adaptation to poor soils, drought, waterlogging, cold temperatures etc. The indigenous technological knowledge (ITK) should also be addressed, validated and given priority, particularly in the stress areas. The age-old agricultural systems should also be offered priority- they should never be given up. The knowledge of the heritage agriculture should be intermingled with the modern ones for the sake of sustenance of the entire agrarian systems. Over-dependence on a very few HYVs, far divergence from the traditional ones and simultaneous use of large amounts of chemical fertilizers and pesticides resulted in the loss of varied biodiversities like fish, frogs, beneficial insects, birds, snakes and many other elements of the system.

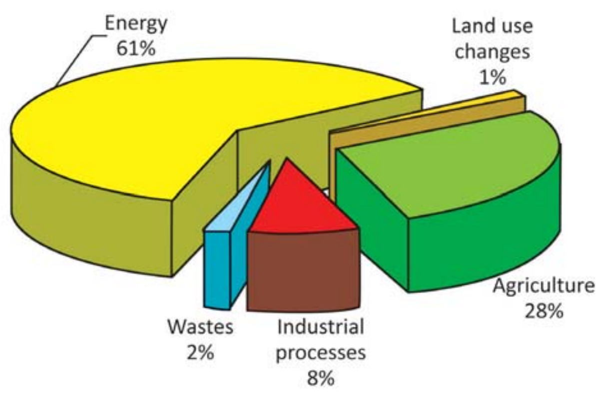
To protect valuable germplasms of different crops from contamination by genetically modified crops (GM crops) and pre-empt possible adverse effects on health and nutrition of the people of West Bengal, any open field trials and commercial cultivation of genetically modified crops should completely be banned in the State. The mutually exclusive nature of ecologically sustainable farming with the synthetic chemical-dominated conventional agriculture would be further vitiated by the introduction of GM technology.

Agriculture and Climate Change Issues

The Earth’s surface temperature has been slowly increasing for the last 15,000 years, since the last Ice age. Global warming refers to the increase in temperature of the Earth's surface. It is a natural process and without it, the temperature would be –18°C instead of the pleasant +15°C as it is today. The Greenhouse Gases influences the Earth's temperature. Increase in GHG in the atmosphere makes the earth atmosphere warmer that adversely affects life processes. Practically, global warming is the cause of climate change. Climate change is not a scientific debate but a real concern being not at all a state or country issue, it is a global issue having a trans-boundary effect (Naresh Kumar et al., 2011; Aryal et al., 2019):

- Global mean temperatures already increased by 0.74°C during last 100 years
- Likely to increase further by 1.8-6.4°C by 2100 AD
- Snow cover is projected to contract
- Sea level rise to be 0.18 - 0.59 m
- More natural disasters - frequent hot & cold extremes, heavy precipitations, flash flood, frequent drought, storms and cyclones etc. would be the common phenomenon
- Eleven of the last twelve years (1995-2006) rank among the 12 warmest years.





World scenario **Indian scenario**

Figure 15.16: Contribution to Global Warming: World and Indian Scenario

Coastal Saline Zone (CSZ) and Red lateritic zone (RLZ) are the most venerable agro-climatic zones of West Bengal as affected by the ill impact of the climate changes. Apart from different central and state government-sponsored projects, Bidhan Chandra Krishi Viswavidyalaya is working since long for overall livelihood development of this zone. The University has conducted research and extension actives related to cropping system intensification *vis-a-vis* nutritional security awareness generation amongst the tribal families of Ayodhya Hill and surrounding areas of Puruliya district of West Bengal through the project on "Improving livelihood with innovative cropping systems on the east India plateau" funded by the Australian Centre for International Agricultural Research (ACIAR), Australia. BCKV is also conducting collaborative research on agricultural development in environmentally sensitive CSZ. Diversification of existing Cropping System and Farming Systems and On-farm evaluation of farming system modules are being conducted for improving profitability and livelihood of small and marginal farmers of problematic CSZ of West Bengal. The collaborative research has been initiated with Australian Centre for International Agricultural Research (ACIAR), Commonwealth Scientific and Industrial Research Organization (CSIRO, Australia), Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BRRI) and Central Soil Salinity Research Institute (ICAR) Canning Centre aimed at cropping system intensification, water conservation technology in respect of salinity dynamics and polder level water balance of Sundarban.

The potential impact of climate change on Agriculture

- Cereal productivity to decrease by 10-40% by 2100.
- Greater loss expected in *Rabi*. Every 1°C increase in temperature reduces wheat production by 4-5 million tons. The loss only 1-2 million tons if farmers could plant in time.
- Reduced frequency of frost damage: less damage to potato, peas, mustard
- Increased droughts and floods are likely to increase production variability.
- A shift in pest disease scenario

There is an effect of climate change in pest dynamics. The driving factors are an increase in temperature, increase in CO_2 concentration, increase in vapour pressure and natural disaster (drought, flood, cyclone etc.) and the resultant impacts may be hastened lifecycle of insect and pathogen, more generations in a season, minor pests becoming a major problem and migration and spread of insect and pathogens.

The total precipitation has a decreasing trend across all agro-climatic zones of the State, except for the hill region. The rainfall pattern shows that there is not much change in total rainfall - monsoon rain decreased, and pre-monsoon rain increased in Alluvial Zone. The onset of monsoon is getting delayed and precipitation has become very erratic. Both monsoon and pre-monsoon rain increased in Hills, Terai and Coastal Zones and rain became more erratic in Red Laterite Zone. Erratic distribution of rainfall is leading to run-off loss, flash floods, increased frequency of drought and flood and loss to Kharif seedbeds, summer vegetables, jute, betel vine, flowers, etc. very often. Increase in winter temperatures causes an adverse effect on Rabi crop. Special attention is needed for wheat, potato, winter pulses, oilseeds and vegetables. Duration of high temperatures during summer is extending resulting reduced production of late sown boro paddy. Besides, high night temperature is also reducing crop production in general.

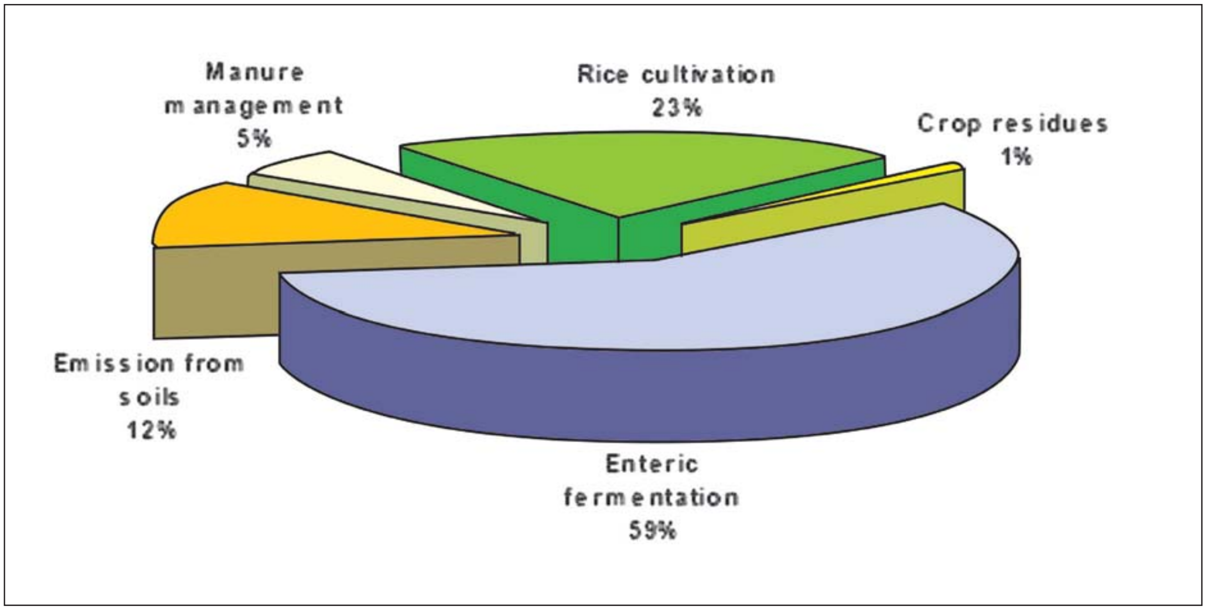


Figure 15.17: Contribution of Different Sectors of Agriculture to Global Warming

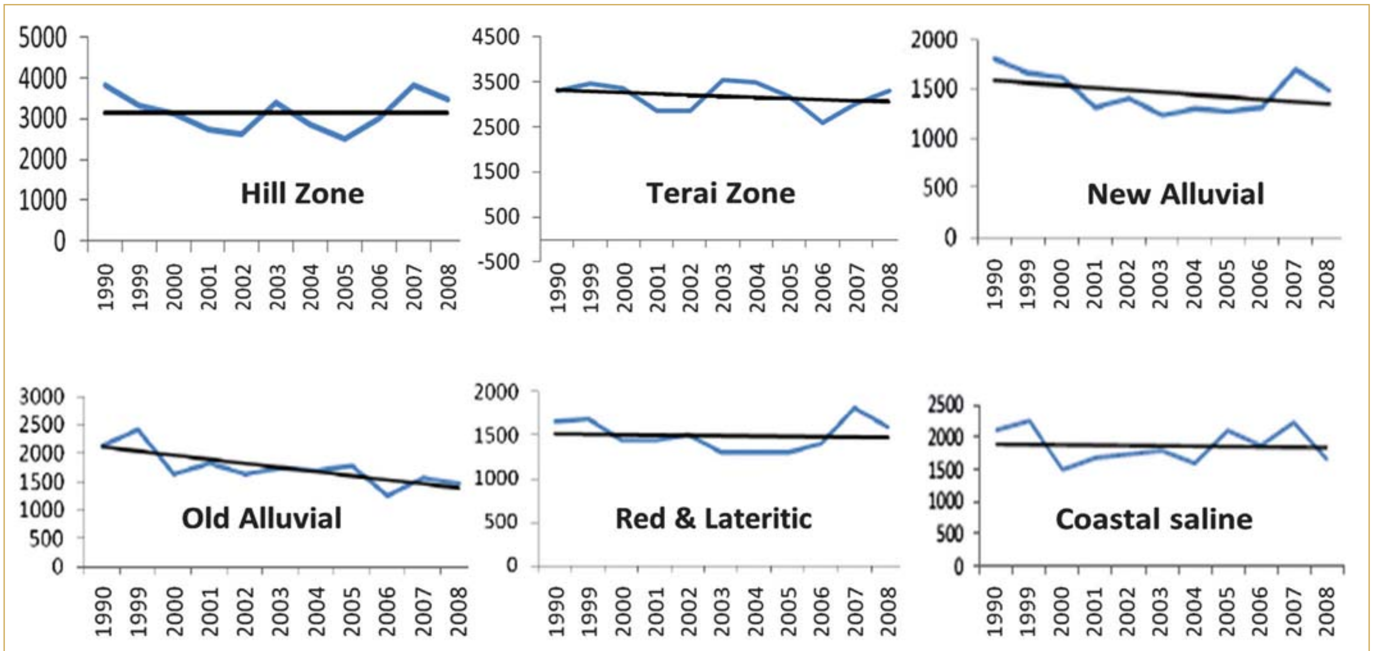


Figure 15.18: Annual Average Rainfall in mm in Different Parts of West Bengal

Source: West Bengal Statistical Handbook and District Handbook (2009)
http://wbplan.gov.in/htm/ReportPub/DistrictStatHandBook.htm

Other aspects of climate change are increasing intensity of extreme events such as cyclonic storms – Coastal zone is major sufferer; increase in foggy and cloudy days in winter resulting increase in pest and disease; widespread damage of Rabi crops (potato, mustard, vegetables); and decrease in carbon and moisture retention capacity of the soil.

Combating disaster, flexibility in crop/variety, conserving resources like water, fertilizer and chemicals, diversifying enterprise (Integrated Farming System) like livestock rearing, fishery and agroforestry are the ways to combat climatic stress.

Some Tips to Combat Climate Change

Strategies	Outcomes
Options: Utilizing the most profitable cropping window	
Staggered nursery Community Nursery	• To assure transplanting under erratic monsoon
Short duration crop	• Avoid dry spell and high-temperature spell
Crop diversification Variety diversification	• Fight against disease pest • Lessen risk
Using legume in crop rotation	• Additional return with minimum input • Benefit to soil
Relay /Paira cropping	• Using soil moisture and conserving carbon • Saving time

Strategies	Outcomes
Options : Nutrient management for crop & environment	
Adjusting application rates	• Based on soil test report & crop need
Use slow-release fertilizer forms or nitrification inhibitors	• Reduces nitrogen loss • Increase fertilizer use efficiency
Timing of application	• Application at a critical stage
Placement of fertilizer	• Placing the N more precisely into the soil to make it more accessible to crops roots
Options: Residue management for resource conservation	
Zero/Minimum tillage	• Save resource/energy • Save time • Protect beneficial microorganism
Residue incorporation	• Restores soil carbon • Maintains soil health
Avoiding burning of crop residue	• Checks carbon emission • Conserves moisture • Protects beneficial microorganism
Options: Manage the Manure for protection of the environment	
Covering the manure	• Reduce N_2O emission and carbon loss
Composting the manure	• Reduces GHG emission and • Conserves NPK
Separating solids from the slurry	• Reduces methane emission

And the most important thing is contingent planning for Natural disaster - Drought, Flood, heat wave etc.

Concern for different agro-climatic zones

Zone	Concern	Effects
Hill Zone	• Increased winter Temp • High intensity of rain	• Winter crops (wheat, potato) getting affected • Citrus size decrease • More landslide
Terai Zone	• Increased rain intensity • Increased winter span	• High nutrient loss by leaching • Favourable condition for wheat
Old alluvial & New alluvial	• Decreased monsoon rain • Increased temperature • Foggy weather	• Water stress to rice • More disease pest
Red lateritic	• Erratic rain • High temperature	• Increased water stress (drought) at different growth stages
Coastal	• More cyclonic storms • Increased sea level • High but erratic rainfall	• More salinity problem • Decreased water and nutrient use efficiency

The need for New Approach

Community Food Security System

Community food security system involves gene banking, seed banking grain banking and water banking to achieve the UN Millennium Development Goal of eradicating hunger and poverty.

Organic farming

Modern Agriculture and Horticulture with high yielding varieties, hybrids require heavy doses of synthetic chemicals such as fertilizers, insecticides, fungicides. However, the effect of indiscriminate use of fertilizer and pesticides without considering the future consequences started to show up and yields of crops have levelled off despite using higher doses of fertilizers. Resistance has developed among the pests against various pesticides. Environmental pollution is occurring at an alarming rate. With the increasing cost of cultivation in the conventional agricultural practices and no appreciable additional benefits in income, the farmers in general and small and marginal in particular are finding it extremely difficult to earn their livelihood and a large number of them are below the poverty line. The situation would further deteriorate with gradual fragmentation of holdings. To improve the socio-economic conditions of the farming community, soil health, productivity and production of crops at a lower cost in a sustainable farming system, it is considered essential to shift the production technology using organics. Organic farming is being mainly based on the utilization of local resources and is labour intensive, generates rural employment, avoids expensive inputs like synthetic fertilizers and pesticides, improves soil fertility and sustains productivity and also requires less financial involvement. Apart from the superiority in nutritional value necessary for health care and prevention of various ailments through intake of organic food, organic agriculture has convincingly proved to be eco-friendly and prevents environmental pollution and also increases tolerance to abiotic (drought, cold etc.) and biotic (pests and diseases) stresses ensuring crop production even under unfavourable environment.

Because of food safety, higher nutritive value, taste and better storage life organic products have a higher price premium both in domestic and export markets. Developing countries have also started realizing the advantages of organic farming and the movement is gaining momentum but at a slow pace. Conversion from conventional to organic agriculture is not an easy task particularly in developing countries because of reduced initial income and food insecurity, lack of technical awareness, support price, marketing and the adverse push-sale attitude of the input dealers in particular. Since organic agriculture is a technology of utmost priority for small and marginal farmers of West Bengal to survive and flourish with the sustainable farming system in crop production and animal husbandry, it needs to be introduced through the different extension methods at the farmers' level.

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State of Environment Report-II

WEST BENGAL

Chapter 16

Mineral Resources and Energy

Chapter 16

Mineral Resources and Energy

Mineral Resource

West Bengal is dominantly (75% of the total area) underlain by soft rocks and the rock formations vary in age from Pre-Cambrian to Tertiary. The major landmass is covered by Quaternary formation. West Bengal has mineral reserves for coal, apatite, china clay, fire clay, dolomite, feldspar, quartz, iron ore, granite, silica sand etc. West Bengal is a major apatite reserve of the country and apatite is available in Puruliya and Bankura districts. The State possess about 16 per cent china clay reserve of the country spread over Bankura, Birbhum and Barddhaman districts. Besides these two, coal is available in Barddhaman (undivided), Bankura, Birbhum, Puruliya and Darjiling districts and fireclay in Bankura, Birbhum, Barddhaman (undivided) and Puruliya districts, Other minerals available in the State are dolomite, feldspar, granite, lead-zinc, quartz, silica sand, limestone, barytes, manganese ore, copper, gold, kyanite, pyrite, titanium, dolomite, tungsten, vermiculite, sillimanite etc.

The royalty and cess collection from oil and gas, major minerals and minor minerals amounted to a total of Rupees 2151.26 Crores during 2018-19. (Mineral Prospects of West Bengal, Directorate of Mines and Minerals, Govt. of West Bengal). Total Mineral Production in West Bengal, 2015-16 to 2017-18 (Excluding Atomic Minerals) is given in Table 16.1.

Table 16.1: Mineral Production in West Bengal, 2015-16 to 2017-18 (Excluding Atomic Minerals) (Value in Rupees '000)

		2015-16			2016-17			2017-18		
Mineral	Unit	No. of Mines	Qty	Value$	No. of Mines	Qty	Value$	No. of Mines	Qty	Value$$
All Minerals		1		1455113	1		1455113	1		1455113
Coal	000 t	-	25751	-	-	27667	-	-	29241	-
Natural Gas	M cu m	-	392	-	-	564	-	-	735	-
Apatite	t	1	-	-	1	-	-	-	-	-
Sulphur#	t	-	46343	-	-	38580	-	-	40653	-
Minor Minerals@		-	-	1455113	-	-	1455113	-	-	1455113

Note: The number of mines excludes fuel minerals and minor minerals. $ Excludes the value of petroleum (crude) & natural gas (ut.).
$$ Excluding fuel minerals. + Coal-bed Methane, Includes Jharkhand and Madhya Pradesh.
#Recovered as by-product from oil refinery.
@ Figures for earlier years have been repeated as estimates because of non-receipt of data.
Source: Indian Minerals Yearbook 2018 (Part I) 57th Ed. Nov 2019

Energy Scenario

Thermal Power: Challenges Ahead

West Bengal, primarily being a centre of agriculture and with huge reserves of minerals, which constitutes one-tenth of the Indian context. Government of West Bengal had initiated power sector reforms in 2005 with the restructuring of West Bengal State Electricity Board into a distribution company and a transmission company in 2007. West Bengal shows certain promising signs for better energy situation in the state because of its financially viable power sector, energy surplus situation and its easy accessibility.

The Government has taken the '*Power For All*' initiative for 24x7 power supply to all households. This program envisages huge growth in demand for the power sector. The growth of energy sector in West Bengal is mainly driven by fossil fuel-based energy contributed by the State Power Generator West Bengal Power Development Corporation Limited (WBPDCL), Calcutta Electric Supply Corporation (CESC), National Thermal Power Corporation (NTPC), Haldia Energy, Damodar Valley Corporation (DVC), etc. Contributions from Hydel is mainly from Puruliya Pump Storage and North Bengal based hydel plants like Teesta, Jaldhaka and Rammam.

West Bengal, also has an estimated potential of generating 2,206 MW (excluding solar) of electricity from Renewable Energy sources. The West Bengal Electricity Regulatory Commission (WBERC) had mandated 4% of total procurement of electricity from RE sources as Renewable Purchase Obligation (RPO) by 2012-13. Government of West Bengal has formulated the Policy - "West Bengal Policy on Co-generation and Generation of Electricity from

Renewable Sources of Energy, 2012" for accelerating development initiatives for the promotion of alternate energy sources in the State.

The contribution of renewable energy projected to be around 20% of the total Indian demand by 2022. Most of the increased demand will be driven from East and North-East India as most of the development in the coming days will be from this region. The target for East India itself is 13 GW of solar capacity. Scalability, ease of deployment, and abundant availability of sunshine across East India have positioned the region as a bright region to focus on for this sunshine sector.

Solar energy is also likely to reach grid parity sooner than anticipated and become competitive with conventional energy sources, in light of increasing coal prices, decreasing module prices, technological innovations, and increasing installations. According to India Ratings and Research report, Solar power is likely to become cheaper than or equivalent to conventional thermal energy prices over the next two to three years.

In light of reducing solar costs, increasing grid tariffs, increased customer awareness, strong policy support, and on-ground net metering implementation across all over West Bengal, solar proves to be a massive market opportunity for investors, developers and manufacturers alike towards a renewed path crafted by green energy to shape a greener Bengal.

Energy Plan: A vision document is currently being prepared by the Power Department which will provide a roadmap of the Energy Plan for the state till the year 2040. This will provide a forecasting model envisioning the composition of different type of energy in the future. It will encompass the generating side of the energy spectrum and the consumption side as well. The Energy Plan will also identify the various actions points in different sectors of the state to make it effective and achievable.

Status of Thermal Power Sector

Table 16.2: Power Generation in West Bengal

Constituent	Station	IC(MW)	Utility Wise Total IC (MW)	State Share (MW)
WBPDCL	BTPS 1x215 + 2x60MW	335		
WBPDCL	STPS 2x250MW	500		
WBPDCL	KTPP 6x210MW	1260		
WBPDCL	BkTPP 5x210MW	1050		
WBPDCL	SgTPP 2x300 + 2x500MW	1600		
WBPDCL_Total		4745	4745	4745
WBSEDCL	Puruliya Pumped Storage Project	900		
WBSEDCL	Rammam Hydel Project, Stage – II	51		
WBSEDCL	Teesta Canal Fall Hydel Project	67.5		
WBSEDCL	Jaldhaka Hydel Project	44		

Constituent	Station	IC(MW)	Utility Wise Total IC (MW)	State Share (MW)
WBSEDCL	Teesta Canal Bank Ground Mounted Solar Project	10		
WBSEDCL	Mejia Bankura Ground Mounted Solar Project	10		
WBSEDCL	Charrah, Puruliya Ground Mounted Solar Project	9		
Mini-Micro HPS (6 NOS)				
WBSEDCL	Sidrapong SHP	0.4		
WBSEDCL	Little Rangit SHP	2		
WBSEDCL	Fazi SHP	1.2		
WBSEDCL	Rinchington SHP	2		
WBSEDCL	Mangpoo Kalikhola SHP	3		
WBSEDCL	Massanjore SHP	4		
Total Mini-Micro		12.6		
WBSEDCL_Total		1104.1	1104.1	1104.1
Private Mini-Micro	Lodhama SHP	3		
Private Mini-Micro	Neora SHP	3		
Mini-Micro Private Total		6	6	6
DPL	Unit 7	300		
DPL	Unit 8	250		
		550	550	550
CESC	Budge –Budge Thermal Power Station	750		
CESC	Southern Thermal Power Station	135		
CESC	Titagarh Thermal Power Station	240		
	TOTAL	1125	1125	1125
Haldia Energy Limited HEL (CESC Subsidiary)		600	600	600
IPC(H)L		150	150	150
IPP/CPP	Crescent Power Ltd. CPL	40		
IPP/CPP	Philips Carbon Black Ltd PCBL	30		
IPP/CPP	Tata Power Haldia	120		

Constituent	Station	IC(MW)	Utility Wise Total IC (MW)	State Share (MW)
IPP/CPP_TOTAL		190	190	190
Small IPP/CPP	Sri Renuka Sugar	15		
Small IPP/CPP	Concast Bengal	25		
Small IPP/CPP	Amrit Bio Energy	10		
Small IPP/CPP	BEL	40		
Small IPP/CPP	Himadri Chemical	20		
Small IPP/CPP	Reshmi Cement	18		
Small IPP/CPP	Ennore Coke	8		
Small IPP/CPP	Electro Steel	12		
Small IPP/CPP	Kamarhati Biomass	6		
	TOTAL	154	154	154
Small IPP/CPP	Hindustan Power (Solar)	5		
Small IPP/CPP	OCL(Solar)	5.5		
	TOTAL	10.5	10.5	10.5
NTPC Ltd	Farakka Unit#1-3	600		
NTPC Ltd	Farakka Unit#4-6	1500		
TOTAL NTPC Ltd		2100	2100	718
NSPCL	Durgapur JV of NTPC- SAIL	120	120	0
NHPC Ltd	TLDP-III	132		
NHPC Ltd	TLDP-IV	160		
TOTAL NHPC LTD		292	292	292
DVC (WB)	Mejia Thermal Power Station	2340		
DVC (WB)	Durgapur Thermal Power Station	210		
DVC (WB)	Durgapur Steel Thermal Power Station	1000		
DVC (WB)	Raghunathpur TPS	1200		
DVC (WB)	Maithon HPS	63.2		
Total DVC (WB)		4813.2	4813.2	50
Grand Total		16069.8	16070	9695

Constituent	Station	IC(MW)	Utility Wise Total IC (MW)	State Share (MW)
In addition to 96955 MW, the state also gets power from other ISGS located outside the state as follows-				
CONSTITUENT	STATION	IC (MW)	% ALLOCATION OF POWER	POWER ALLOCATION (MW)
NTPC Ltd.	TSTPP (NTPC)	1000	10.129117	101.29117
Ex-Bhutan	CHPC (Bhutan)	336	31.85	107.016
Ex-Bhutan	Kurichu (Bhutan)	60	50	30
Ex-Bhutan	Rangeet (Bhutan)	60	28.34	17.004
Ex-Bhutan	Tala (Bhutan)	1020	38.25	390.15
Ex-Bhutan	Testa (Bhutan)	510	23.98	122.298
Ex-Bhutan	KHSTPP (NTPC)	2340	7.908234	185.0526756
Jammu and Kashmir	Baghlier	450		100
	Adhunik Power	540		100
	Maithon Power Ltd	1050		282.75
Total Outside Power				1436

Ageing Fleet of WBPDCL

A glance of the WBPDCL shows that a majority of its units are more than 15 years old.

Table 16.3: Date of COD of Various Plants of WBPDCL

Plant	Date of COD
BTPS Unit-1 60MW	04.09.1965
BTPS Unit-2 60MW	15.10.1965
BTPS Unit-5 215MW	Initial COD 08.10.1982 EERM COD 24.11.1015
KTPS Unit-1 210MW	09.09.1990
KTPS Unit-2 210MW	09.03.1986
KTPS Unit-3 210MW	12.10.1984
KTPS Unit-4 210MW	01.04.1995
KTPS Unit-5 210MW	14.05.1991
KTPS Unit-6 210MW	01.01.1994

Plant	Date of COD
BKTPP Unit-1 210MW	29.11.2000
BKTPP Unit-2 210MW	01.04.2001
BKTPP Unit-3 210MW	11.10.2001
BKTPP Unit-4 210MW	08.03.2009
BKTPP Unit-5 210MW	27.06.2009
STPS Unit-5 250MW	01.04.2009
STPS Unit-6 250MW	30.09.2011
SGTPP Unit-1 300MW	07.09.2008
SGTPP Unit-2 300MW	06.11.2008
SGTPP Unit-3 500MW	01.07.2016
SGTPP Unit-4 500MW	20.12.2016

Similarly, the units of other generators in the state are also at different stages of their lifecycle.

Recent Development in the Power Sector

The Power sector has undergone many policy changes in the past few years. Starting with Electricity Act 2003 and subsequent opening of the sector to the Private sector has brought about a major change in terms of new investment for capacity addition. However, with more impetus on environment protection and human health-related issues arising out of pollution from Thermal Power plants in the form of GHG emission has forced the international community to decide on a Climatic Goal to curb Emission at COP21 at the Paris Summit in the year 2015. This has brought about two significant changes in the power sector, namely,

Department of MOEF &CC, Government of India came out with new emission norms in Dec'2015 which revised the emission limit for all Power plants based on their age, capacity and type of fuel. Government of India came out with a vision plan to add 175 GW of renewable capacity by the year 2022. This was subsequently scaled up further to 450 GW by the year 2030

Both these policy decisions have made huge ramifications on the power sector. The major impacts are mentioned in the following sections.

Climate Change and Environmental Norms

Recognizing the central role thermal power plays in worsening air quality, the Ministry of Environment, Forest & Climate Change (MoEF & CC) announced in December 2015 tighter standards for coal-based thermal power plants. The new standards aim to drastically cut emissions of particulate matter (PM), sulphur dioxide (SO_2), oxides of nitrogen (NOx) and mercury by 2022. Besides, the new norms also require power plants to sharply curtail freshwater use.

MoEF&CC has given a tight albeit achievable deadline to meet the new standards:

Standards (in mg/Nm³) Notified in 2015

	PM	SO_2	NOx	Mercury
Current standards	150–350	none	none	none
New standards				
Units installed till 2003	100	< 500MW-600 > = 500MW-200	600	> = 500MW-0.03
Units installed between 2004 and 2016	100	< 500MW-600 > = 500MW-200	300 300	0.03
Units installed after Jan 2017	30	100	100	0.03

Also, MOEF stipulates to bring the Specific Water Consumption within $3.5M^3/MWh$.

Financial Impact Under Environment Norms

Investment Required For Pollution-Control Technology

Technology required	Capacity in GW	Approx. cost (in Rs crores)
Electrostatic precipitator (ESP) upgradation	152.4	Rs 5–15 lakh/MW
Partial Flue gas desulphurization (FGD)	54.2	Rs 25–30 lakh/MW
Flue gas desulphurization (FGD)	98.2	Rs 50–60 lakh/MW
De-NOx	152.4	Rs 10–15 lakh/MW
Selective Catalyst Reduction (SCR) / Selective Non-Catalyst Reduction (SNCR)	Upcoming	Rs 20–25 lakh/MW

The time required to install different Pollution-Control Equipment

Technology	Construction time	Downtime
Electrostatic precipitator (ESP)	~ 3–6 months	~ 20–30 days
Flue gas desulphurization (FGD)	~ 18–24 months	~ 30–90 days
Selective Catalyst Reduction (SCR)	~ 5 months	~ 30 days
Selective Non-Catalyst Reduction (SNCR)	~ 4 months	~ 7 days
Low NOx burner, OFA etc.	~ 1 month	~ 15–20 days

The power producers argue that tariff increase could be in the range of Rs 0.5–0.75 per unit; however, an estimate by ICRA puts it Rs. 0.22 per unit, which would be a burden on the consumer. Tariff increases are politically challenging even if permitted under law. Regulators may need to devise a mechanism to stagger tariff increases. But, plants need an assured rate increase to help raise financing for the Capex and to avoid cash flow problems.

Additionally, the requirement to comply with the Specific Water Consumption(SWC) most of the plants have to go for major changes in respect of capex for implementation of ETP, STP, Closed Loop Water systems etc.

Sunshine Sector (Renewable Energy)

Given the growing impetus towards the generation of Renewable Energy with particular reference to solar energy generation in the national perspective, WBPDCL and WBSEDCL have in recent time started taking initiatives for the development of solar power projects.

Sagardighi Thermal Power Project (SgTPP)

10 MW AC Ground-mounted Solar PV project.
3.47 MWp Rooftop Solar PV Plant.
5 MW AC Floating Solar PV project is under execution which will be the highest capacity floating PV project in India. As on date, 3.4 MW has been commissioned.
There is a proposal for further expansion of 2X5 MW AC Floating Solar PV project

Bakreswar Thermal Power Station (BkTPS)

2.33 MWp Rooftop mounted Solar PV projects

Kolaghat Thermal Power Station (KTPS)

1.55 MWp Rooftop mounted Solar PV project

Bandel Thermal Power Station(BTPS)

1.78 MWp Rooftop mounted Solar PV project.

Santaldih Thermal Power Station (STPS)

0.70 MWp Rooftop mounted Solar PV project.

WBPDCL is gearing up to raise to the occasion and undertake extensive projects for implementation of large scale Solar Power Plants.

WBSEDCL

The canal bank solar power project (10 MW) near Teesta Canal Fall Hydro Electric Power Plant, Stage – II in Uttar Dinajpur district will be completed soon. Three numbers 10 MW solar power project in Puruliya and Bankura district has also been conceived and tender finalization would be done shortly.

Detailed Project Report for development of total 500 MW Solar Park in phases is being prepared for setting up in Purba & Paschim Medinipur and Bankura district. DPR of first phase having estimated capacity 210 MW at Dadanpatrabar of Purba Medinipur has been completed.

A scheme for setting up of a 900 MW (3 x 300 MW) Power Project has also been envisaged for providing clean pumping power to the existing and upcoming pumped storage projects in Puruliya district of West Bengal at Turga.

India's clean-energy initiatives have the wind at their back thanks to global advances in green technology—especially solar power, wind power, and energy storage. These technologies are progressing exponentially and have entered a virtuous cycle: As prices for these technologies fall, demand for them rises, and as production is expanded to meet demand, prices fall some more, all of which contributes to accelerating adoption.

The Indian electricity sector is undergoing rapid changes, among which the most important is the progress of solar power in the country. While this is helping increase competition in the sector and to fulfil India's obligations on climate change, it is also throwing up a lot of challenges like low and decreasing capacity utilization of the thermal power generating projects; this will add to the financial stress of the power sector. However, the challenges that the Indian electricity sector faces is part of global trends, and India must prepare for it.

Changing Operation Norms: Flexible Operation

Due to the law of nature, the renewable capacities (both Solar and Wind) will generate power during a specific period of the day unlike to the thermal capacities. The gradual addition of RE capacity will bring in variability in the Grid where RE generation will be available during the day. Therefore, to ensure Grid stability the thermal capacities has to change the generation. To survive that scenario CEA has mandated thermal plants to verify flexibilisation capability of thermal plants for 55% and 40% of MTL (Minimum Technical Limit). The Ministry of Power has set the targets of achieving the flexibility of operation of thermal power plants in a time-bound manner. The targets set by MOP are 20%, 30%, 40%, 50% and 60% of the total fleet of thermal power units compliant of 55% MTL during 2020-2024. Further, CERC vide IEGC regulation, 2016 has lowered and made mandatory the technical limit to 55% and provided compensation to the coal-based units on account of partial loading.

To implement the MTL at 55% as a directive of MOP, SERC has to consider the same and provide financial support to generating companies.

However, flexibilisation will have associated adverse impacts on the economics and life of the thermal assets. A few of them are as follows:

- Hot, Warm, and Cold Start Costs
- Forced Outage Rates (FOR) as a function of start type
- Load Following Costs (significant load follows)
- Start-up Costs – Fuel and (Aux. Power + Chemicals + Water)
- Heat Rate effects due to Power Plant Cycling
- Increase in APC due to more partial loading / start & stop
- Increase in Maintenance Costs
- Reduction of Useful Life Cycle of Plant
- Increase in Fuel, water and chemical consumption
- Environmental Impacts
- Loss of reliability
- Safety Concerns

The flexibilisation of units will further increase the cost of generation and transmission and finally increase the cost of electricity to the consumer.

Hence, reliability and cost-benefit analysis may throw up the long-term feasibility for an optimum solution for the sector as a whole. A lot of research and studies are being done in these areas. Few of the potential solutions could be as follows.

- Induction of Large-scale battery storage capacity
- Expansion of pump storage capacity
- Demand-side Management
- 100% use of battery storage with rooftop solar
- Utilization of gas-based thermal capacities

With an ambitious target to have 450 GW of RE capacity for the country by the year 2030 the problem likely to become even more challenging in the days to come.

Induction of Large-Scale Battery Storage Capacity

Induction of large-scale battery storage units will act as storage of Electricity when RE power is in generation mode and hence the thermal capacities may not have to reduce to load to the extent possible as envisaged for zero storage capacity. Hence, it will act as a shock absorber to the Grid in general and the thermal units in particular. In India, a single location battery storage capacity of 10 MW has already been installed. However, at the international level, in Australia and the USA larger capacity of RE with battery storage units have been built. Probably, the same trend will intensify further in the days to come to India as well.

Expansion of Pump Storage Capacity

In India, there are very few pump storage units with built-in hydel capacity despite blessed with large terrain and hills. WBSEDCL is having the largest pump storage capacity of 900 MW at Puruliya, West Bengal. The capacity is planned to be further augmented by 900 MW shorty. However, further exploration is required to be taken up at all states to augment this capacity further for the stability and reliability of the Grid.

Demand-side Management

In the demand side management approach, the effort will be to increase load demand during the day when RE capacities are ON. It could be achieved by rescheduling consumption pattern through incentivisation, large scale expansion of Electrical vehicle (EV) fleet, dis-incentivising use of diesel pump for agricultural use etc. All such steps may help in reducing the requirement of flexibilisation of the thermal capacities and facilitate stability of the Grid.

100% Use of Battery Storage With Rooftop Solar

India has a plan to add 40 GW of rooftop solar capacity by the year 2022. If such capacities are associated with battery units at the household level then it could play a positive role in stabilisation of the Grid. With favourable policy intervention, this could be implemented easily.

Utilization of Gas Based Thermal Capacities

India has about 25000 MW of gas-based thermal capacity. By nature, these units are having quick-start capabilities. However, due to lack of supply of adequate gas throughout the year, most of the capacities are remaining unutilised. With policy intervention, such capacities may also be utilised for the stability of the Grid and minimise flexibilisation requirement of the Coal based thermal units.

Way Forward

As solar panels and battery storage become cheaper and diffuse across the subcontinent, a major impediment to India's development and prosperity will be removed.

With India's energy costs already among the lowest in the world, it is at the cusp of an age of truly competitive, unsubsidized clean energy. When the price of solar panels and batteries falls another 50 percent, as is likely during the next three years, market forces will take over, and Indian consumers will take the clean-energy mantle from the government—something that still looks quite a way off in most developed countries.

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WEST BENGAL

Chapter 17

Industrial Pollution Management


COOLING
TOWER-1

Chapter 17

Industrial Pollution Management

Indian Industry had a global presence before the advent of British in India. The exports from India consisted of manufactured goods like cotton, silk, artistic ware, silk and woolen cloth and had a good repute. The impact of British Policies and the Industrial Revolution led to the decay of Indian handicraft industry and subsequently machine-made goods started flooding into the Indian markets. With the industrial revolution in the United Kingdom, Bengal also started receiving its fruit and experienced industrialisation in the banks of river Hugli. The industrial scenario of Bengal was dominated by jute producing industries and engineering industries.

In absence of any regulation on pollution management, rivers were the outlet of wastewater generated from such industries and served as the dumping ground of waste leading to degradation of ecological health of the river and environmental degradation. As industrialisation progressed in the state, the first iron and steel plant in Bengal was established at Burnpur and gradually various engineering and ancillary industries were set up in the Asansol-Ranigunj belt.

Post-independence, during the first 5-year plan period, West Bengal was the leading state in primary metallurgical and engineering industry. It was, apart from other reasons because of the locational advantage, particularly its proximity to coal and iron ore, the major input source for the industry. During this period, the establishment of the Damodar Valley Corporation (DVC) and a number of projects in the public sector helped industrialisation of the area. Subsequent to the establishment of the locomotive industry at Chittaranjan, the cable factory at Rupnarayanpur and small-scale Industries in different parts of the coal mining area, the Kulti-Burnpur industrial area developed fast. Located on the northern banks of the Damodar, Durgapur also developed into a major industrial complex and the industrialisation of the State took off. During the later part of the century, the Haldia region emerged as a petrochemical hub with companies like Haldia Petrochemicals and Mitsubishi Chemical Corporation setting up their units there.

India has the distinctive feature of being an agrarian economy coupled with industrialization and has been able to travel a long way on the industrial path since independence; this is expected to continue even more in the years to come due to liberalization of industrial policy.

While industrial development invariably creates more jobs in any region and leads to economic prosperity but possibilities of adverse effects on the environment also increases. Air Pollution in the form of dust, smoke, fumes and toxic gas emissions occur from potentially polluting industries like thermal power plants, coal mines, cement, sponge iron, steel & ferroalloys, petroleum and chemicals. Likewise, there are abundance of water polluting industries, which may cause adverse environmental impact on water quality in rivers, ponds, water bodies etc.

Though the economy of West Bengal is mainly dependent on agriculture and small & medium scale enterprises, it also has several major chemical and engineering industries in addition to small and medium scale industrial units. These include integrated iron & steel mills, ferrous & non-ferrous metallurgical units, drugs & pharmaceuticals, petrochemical complexes, fertilizer & pesticide plants, fermentation industries, thermal power plants, textiles, man-made fibres, pulp & paper, chlor-alkali units etc. These industries are characteristically polluting, the nature and extent of which vary with the production processes and pollution control technologies adopted. Hence it is imperative to comply with the regulatory norms for prevention and control of pollution. Alongside it is also essential to go beyond compliance through the adoption of clean technologies and improvement in environmental management practices. Therefore, commitment and voluntary initiatives of the industries for responsible care of the environment will help in the alleviation of the State's environmental scenario as a whole. As far as protection of the environment is concerned, control at source by adopting cleaner production methods is always a better option than end-of-the-pipe treatment, which goes by the old proverb 'prevention is better than cure'. Cleaner production methods reduce resource use at the input stage by using cleaner fuels and process, whereas end-of-the-pipe technologies curb the pollution generated at the tail-end by implementing add-on systems which require additional investment.

The adoption of control at source philosophy, however, is often hampered by barriers such as rudimentary mindset and lack of proper foresight and information. In addition to substantial initial investment costs in new technologies, additional obstacles arise due to the nature of the environmental problem and the type of regulations involved. Command and Control regulations frequently impose technology standards that can only be met through end-of-pipe abatement measures. Regarding diffusion of cleaner production technologies, question about the preference of several alternative policy approaches (viz. performance standards, voluntary measures or economic instruments) arises; thereby leaving decisions about the appropriate abatement technology up to the environmental consciousness of industrial establishments.

Traditionally, pollution control measures have been dependent on 'end-of-the-pipe' treatment technologies which allow wasteful use of resources and then consume further resources to deal with the environmental problems. With an increasing crunch of raw materials and energy coupled with tightening pollution control norms, the industries are being persuaded to look for cost-effective alternatives in terms of conservation of raw materials & energy and cleaner production technologies as well. Small scale Industries are a special feature of West Bengal's economy. Measures including scheme to encourage small scale industries' clusters to go for combined waste treatment facilities (for example, Common Effluent Treatment Plant) and giving subsidies for the same have been adopted.

Over the years, significant developments in pollution control technologies have taken place. However, the adoption of such technologies is yet far from adequate. Apart from hesitance to incur expenditure for pollution control equipment, the industries which are based on the old production process find it difficult to install pollution control systems due to technical as well as physical limitations. For instance, in some of the old thermal power generating stations, replacement of mechanical dust collectors with the electrostatic precipitators (ESPs) had been a difficult proposition primarily because of the reason that these plants have no space provision for installation of ESPs. Many industrial units need revamping and modernization of their production process for the adoption of low waste and efficient technologies. Production of steel based on traditional blast furnace technology is a case in point. Modernization of the steel industry with newer technologies will not only improve production efficiency but also reduce the nature and extent of pollution.

There is now a perceptible change in the policy and approach to pollution control through the encouragement of cleaner process technologies. Experience in some industries like the chlor-alkali and steel has shown that the switch-over to modern production technologies and environmental management systems help in conservation of resources and reduction of pollution. Also, the changeover to cleaner fuels (replacement of coal with oil or gas) in case of small boilers and other furnaces proved effective in the alleviation of ambient air quality throughout the state of West Bengal.

It is also necessary to sensitize the industries about the fact that though the add-on pollution control technologies involve some initial investment, such cost could be recovered to a great extent through recycling & reuse of waste as well as by-product recovery. Adoption of pollution control technologies could be successfully achieved through a coordinated approach in which industrial organisations and the stakeholders should work in tandem; it may be desirable to build a consortium of concerned organisations and establish a partnership for pollution control.

West Bengal is well endowed in terms of natural resources, which include various minerals. West Bengal has rich deposits of coal, rock phosphate, granite, manganese, silica, fire clay, road metal, quartz, apatite, dolomite, feldspar, limestone etc. West Bengal also has a prosperous hinterland of some extremely mineral-rich states like Jharkhand, Bihar and Orissa which is an added benefit for the industries of West Bengal. West Bengal is the 6th largest economy of the country and at current prices, Gross State Domestic Product (GSDP) of West Bengal is estimated at Rs 14.44 trillion (US$ 206.64 billion) in 2020-21. The annual GSDP growth rate on average is 12.62% approximately for the period 2015-16 to 2020-21. The state's strategic position in the eastern region makes it a natural gateway to the east.

West Bengal has an abundant pool of talented and skilled workforce that can cater to the requirements of the traditional industries as well as the needs of the new and emerging opportunities in areas such as Information Technology (IT) and IT-enabled services (ITeS), Biotech and Non-conventional energy. As per data of February 2020, West Bengal had 21 SEZs out of which 07 were in operation, 05 were notified, 07 were formally approved and 02 have in-principle approval.

The Government of West Bengal has initiated time-bound steps to modernize existing infrastructure facilities and to create new clusters and growth centres in certain focused sectors like Biotechnology, Cement, Chemicals, Food Processing, Gems & Jewelry, Iron & Steel, Information Technology Manufacturing and Textiles in addition to 59 multi-product industrial parks.

Several Intelligent Parks are being set up in the State for IT and ITeS companies. 21 IT parks are expected to operate in the state shortly. Total IT sector export of the state was estimated to be Rs. 22,897 crore (USD 3.28 billion) in 2018-19. West Bengal Information Technology & Electronics Policy, 2018 introduced by the State Government projects West Bengal as one of the pioneering states in the IT, ITES, ICT & ESDM sectors in the country.

The state focuses on conservation of critical environmental resources, securing a livelihood for the poor, judicious resource usage, integration of environmental concerns into policies, plans, projects for economic and social development, efficiency in the use of environmental resources, environmental good governance and finally partnerships with the civil society and communities to enhance resource flows. In short, the state government's policy is to strike a balance between the needs of development and the preservation and conservation of the environment and natural resources. Great effort is being made by the State Government in portraying West Bengal as a right destination for investment and has adopted 'Single Window Facility', called the 'State Investment Facilitation Centre' (SIFC), for project implementation & execution.

Apart from a supportive industrial infrastructure, West Bengal has been a pioneer in power development over the years. NASSCOM-Gartner ranks West Bengal's power infrastructure as the best in the country offering one of the lowest power tariffs in India. As per March 2020 data, the total installed power generation capacity of the State was 11026.5 MW, out of which 6497.95 MW was under State utilities, 2847.93 MW was private and 1,680.62 MW was under central utilities.

Apart from manufacturing and engineering industries, West Bengal is also a key producer of petroleum and petrochemicals. Natural gas production in West Bengal in the year 2018-19 reached 710.46 million cubic metres. West Bengal is also a flourishing exporter of leather products. The natural resources, policy incentives and infrastructure in the state support investments in major sectors such as iron and steel, engineering products, petroleum and petrochemicals, automobile and auto components, frigates, railway coaches and wagons, electronic and electrical equipment, coal, leather, textiles, jute products, tea, fisheries, IT, gems and jewelry, biotechnology and these sectors play a very important economic role. It is worth mentioning that many corporate giants have their center of operations in Kolkata and these include ITC Ltd., Exide Industries, CESC Ltd., Coal India Ltd., Haldia Petrochemicals, Damodar Valley Corporation, Price Waterhouse Coopers (India), Peerless Group, etc. Industries of this state are localised in the mineral-rich western highlands, the Haldia port region and Kolkata region. The Durgapur–Asansol colliery belt is also home to some major steel plants.

In the new area of clean energy, West Bengal has a large reserve of coal-bed methane gas and some private companies are already producing coal bed methane in West Bengal. The advancement of steel industry in the State is largely attributed to easy availability of raw materials & skilled manpower and proximity of port facilities & vast market for steel products. Given these locational advantages, several mini-integrated steel plants have been set up in the state manufacturing a wide range of products such as sponge iron, mild steel, iron pipes etc. West Bengal has traditionally been very strong in the engineering industries and has also been an important manufacturing base in the past.

Success Stories

Leather Industry: West Bengal accounts for about 25% of national leather exports which entails it as a leading State for finished leather goods export. A state-of-the-art integrated leather complex was set up on the eastern fringes of Kolkata by the State Government to relocate the existing old tanneries from the heart of the city as well as to create provisions for setting up new tanneries along with ancillary units related to leather goods manufacturing. The Complex has a capacity to process 1000 kg/day of raw hides and skins using 35 MLD (million litres/day) of water. More than 433 old tanneries have been allotted land in this complex. Some new tanneries have also come up in the complex. There are about 345 tanneries (both new and relocated) in the State which are registered with WBPCB. Entire liquid effluent (process as well as domestic) from tanneries is treated through a common effluent treatment plant (CETP) of 30 MLD planned capacity having six modules. Presently, four modules of the CETP (20 MLD) are in operation. The treated effluent is discharged to the Karaidanga Storm Water Flow (SWF) canal. The chromium-bearing effluent is separately treated, and chromium is recovered for reuse in the process. A modern Design Studio has been made operational within the integrated leather complex for providing global design capabilities and design solutions to the manufacturers. Since 2019, the 2nd phase of expansion of the Leather Complex and augmentation of the CETP with 4 additional treatment modules (Modules 5, 6, 7 & 8) with an investment of Rs.68 crores along with major overhauling of the existing 4 modules (Modules 1, 2, 3 & 4) is being undertaken. The state government, keen to promote new tanneries in this complex for ensuring employment generation as well as sustainable industrialization, has named it as "Karmadiganta".

Textile Industry: Textiles including jute manufacturing, is a prominent traditional industry in West Bengal due to availability of raw jute in the state. As per recent available data, West Bengal accounted for 82.5 % of India's total jute production and holds the 1st position in jute production. Important jute products are hessian, sacking, jute bags and other items produced from jute. Jute mills are majorly aligned along the banks of river Hoogly. The State envisages developing a competitive textile hub by increasing its share from the current 6% to at least 12% of GDP in next few years by initiating integrated textile development project of 13 Textile Parks (about 500 acres) under 4 broad categories, viz, Apparel & Garments; Dyeing & Processing; Power loom & Apparel and Technical Textiles. New industries investing in this sector are bound by new and more stringent environmental standards while the existing industries are being encouraged, guided and directed to incorporate and implement the new standards in their discharged effluents and gradually move towards zero discharge. Modern water-intensive textile units engaged in manufacturing of items like linen fabric and yarn, worsted yarn, wool tops etc. generate wastewater from equipment cleaning and process activities like the Flax Spinning Plant, Wool Combing Plant, Dye Houses etc. Treated effluent should be reused in the process after recycling through Reverse Osmosis (RO) Plant. Such units are encouraged to install Zero-Liquid Discharge (ZLD) plants to achieve zero discharge. These industries benefit from the erection of HRSCC units (High-Resolution Solid Contact Clarifier), Ultra Filtration Units, RO Plants followed by Multi-Effect Evaporators.

Ultrafiltration Plant

Reverse Osmosis Plant

Filtration and Softener Units

Chemical Dosing Units

Figure 17.1: Sample Facilities of Modern Textile Industry

Fermentation Industry: Water-intensive industries engaged in the production of baker's yeast are encouraged to install and maintain a zero liquid discharge system. Under the zero liquid discharge system the ETP has components of equalization, neutralization, clarification, filtration, reverse osmosis, multi-effect evaporation.

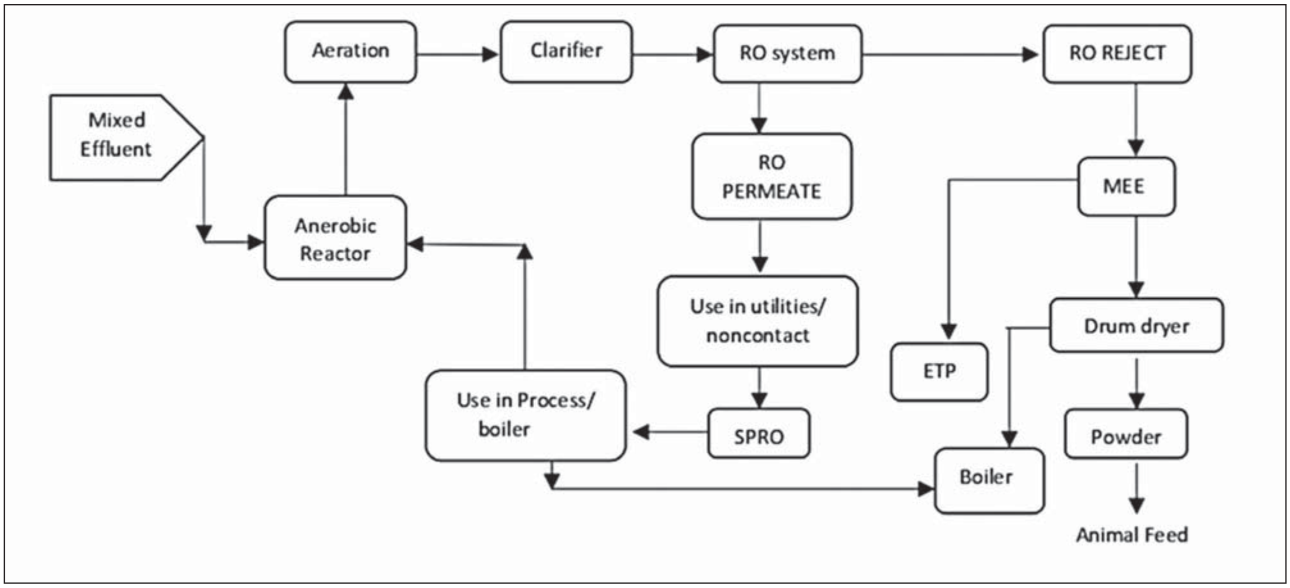

Figure 17.2: ETP Components of a Fermentation Industry Maintaining ZLD

In such industries, the effluent or liquid Vinasse from the process is stored in equalization tank and after proper neutralization, this effluent is fed to big volume fermenter (BVF). BVF is a type of anaerobic reactor which is designed for high COD effluent and effluent from its outlet is fed to aeration tank. Aeration tanks generally use a diffused aeration system and jet aerator system for maintaining dissolved oxygen (DO) level during aeration to treat incoming effluent. The aeration tank MLSS is further fed to clarifier to segregate supernatant from sludge and the clarifier sludge is recycled back to the aeration tank. Excess sludge can be drained to sludge holding tank which is later decanted at sludge decanter and the filtrate is transferred back to ETP and the non-hazardous sludge is used as manure.

The clarifier outlet effluent is later fed to plate tube reverse osmosis plant (PTRO) through multi-grade filter and cartridge filter. The product of PTRO, which is clear water, is stored in a reservoir and later fed to single-pass reverse osmosis plant (SPRO) to convert this PTRO product into potable water. The PTRO reject, with about 6% solids, is fed to the multi-effect evaporator (MEE) where steam is used to evaporate & concentrate liquid Vinasse. MEE outlet concentrate generally has 36% solids. This concentrate liquid Vinasse is non-hazardous and later fed to drum dryer to convert it into solid or dry Vinasse. The dry Vinasse is sold as raw material for the production of animal feed. Such industries need to ensure that production and effluent treatment is maintained in tandem for sustainable environmental management.

Brickfields Sector: Along the banks of the various rivers crisscrossing the state of West Bengal are several brickfields. They form the foundation of all construction activity. Over the past decades, the brickfields have been guided and coerced to change from traditional moving chimneys with high pollution potential to fixed chimneys with relatively lower pollution potential. Use of thermally low-efficient kilns, outdated technology such as Bull's Trench Kilns and inefficient firing technologies contributes to particulate and gaseous emissions both through the stack as well as fugitive sources. Presently, all brickfields in the state are required to change over to a cleaner and more efficient induced draft Zig-zag technology with rectangular kiln shape and zigzag arrangement of bricks for efficient heating and baking of bricks as well as for reducing the emission levels of particulate matter. Kilns with Zig-zag technology have air path about 03 times more than a straight line resulting in improved transfer of heat from flue gas to bricks. Also, better air-fuel mixing for complete combustion reduces consumption of coal to the extent of 20%. Side by side, the growth of fly ash based bricks and blocks in the state is also being encouraged and promoted. **DRI Industry Sector:** The DRI industry of West

Figure 17.3: Brick Kilns Shifting towards a Cleaner & Efficient Technology

Bengal has been a substantial contributor to the GDP of the State and the country as well. But such industry is, at the same time, a great contributor to air pollution levels by playing both active and passive roles. With time the industry has been able to develop itself in terms of air pollution control management both in the form of controlling pollution at source and end-of-the-pipe treatment. Among technologies adopted for controlling pollution at source, waste heat recovery boilers (WHRB) play a significant role.

The potential of generating electricity from an already existing resource like a Sponge Iron Plant and waste gas with a lot of sensible heat disposed to the atmosphere is immense. In sponge iron plant, a rotary kiln is used to manufacture sponge iron and a lot of heat energy is required. Waste flue gas emitted from the rotary kiln will have a temperature of 700°C and above. The energy content of these gases is effectively used to generate electricity as well as steam for meeting various process requirements.

Almost 50% of the total heat generated is exhausted as waste heat with a lot of sensible heat with around 700°C temperature. Plenty of heat energy is required for gas cooler which is used to cool the gas by mixing air with gas. Above waste energy is conserved by the installation of Waste Heat Recovery Boiler (WHRB) and it eliminates additional power required for the gas cooler. The generated steam is used in a steam turbine to generate electricity. A typical 100 TPD capacity coal-fired DRI kiln can produce steam upto 10 Tons/hour through its waste gas which can produce electricity upto 1.2 MW. Effective utilization of waste flue gas generated from rotary kilns to produce electricity eliminates the need for external fuel and subsequently reduces fossil fuel consumption thereby reducing pollution potential to a large extent.

Figure 17.4: A Typical DRI Industry

Gems and Jewelry Sector: Gems and jewelry making is a thriving industry of the state and West Bengal has had a rich and continuing tradition of craftsmanship for handmade gold jewelry. Jewelry from this region is famous throughout the world for its intricate designs and quality of workmanship. Artisans from the State are in high demand throughout the country and abroad as well. Jewelry exports from the Eastern Region have steadily grown over the past years. The State Government has taken several initiatives including setting up Manikanchan, the exclusive Gems & Jewelry SEZ at Salt Lake, Kolkata and Gems and Jewelry Park at Ankurhati, Haora with a CETP, CSTP, WTP, gas bank, back-up DG power, etc. The Gems & Jewelry Park set up at Ankurhati, Domjur in Haora district is set up on a 5.76 acres plot.

Real Estate Sector: Real estate is also a booming industry in the state of West Bengal and a lot of leading players have already set up their housing complexes in different parts of the state. The construction sector has been directed to follow all environmental norms and good practices during the construction-deconstruction phases, storage and handling of cement, bricks, fly ash etc.

It is needless to say that industrial development is an important constituent in our pursuit for economic growth, employment generation and betterment of the quality of life. On the other hand, industrial development, without proper precautionary measures for environmental protection leads to pollution and associated problems. The trend of increasing pollution levels is evident from deteriorating air & water quality and higher ambient noise levels. Realizing the urgent need for arresting the trend, the government adopted a policy which provides for several mechanisms in the form of regulations, legislation, agreements, fiscal incentives and other measures to prevent and abate pollution and aid in preserving of natural resources. Also, as end-of-the-pipe treatment approach to control pollution is not giving expected results, efforts are being made to adopt control-at-source measures like promoting use of cleaner fuels and low waste production technologies ensuring 'reduce-reuse-recycle' philosophy. To make the various policies effective, a multi-pronged approach (including natural resource accounting, environmental audit, stringent regulations, spatial environmental planning etc.) is being resorted to.

Depending upon the pollution potential of different industries, the West Bengal Pollution Control Board had classified the industrial units into five different categories: 'Red', 'Orange' 'Green'‘White' and 'Exempted'. The Red category units have maximum pollution potential, the Orange category units have moderate pollution potential and the Green units have the least pollution potential. Some industries which have negligible pollution potential have been identified and marked as 'White' and 'Exempted' Category which do not require any prior permission for setting up and operating within the state. Presently, 74 types of activities have been classified as ‘Red’, 93 as ‘Orange’, 67 as ‘Green’, 37 as ‘White’ and 51 as ‘Exempted. This classification has been implemented to harmonize the various types of industries across the country, in line with the directions and guidelines of the Central Pollution Control Board (CPCB) under the Ministry of Environment, Forests and Climate Change (MoEF & CC) based on the relative pollution indices of the industrial activities.

Table 17.1 and Figure 17.5 shows the district-wise distribution of various categories of industries in West Bengal which falls under the purview of ‘Consent’ administration.

Table 17.1: District-wise Distribution of Industries in West Bengal

District	Red	Orange	Green	Health Care Units (HCU)	Total
Alipurduar	13	44	101	256	**414**
Bankura	96	284	444	315	**1139**
Birbhum	37	406	554	396	**1393**
Barddhaman (undivided)	567	1623	1433	995	**4618**
Koch Bihar	14	77	127	216	**434**
Darjiling	26	230	475	266	**997**
Uttar Dinajpur	18	59	277	160	**514**
Dakshin Dinajpur	1	42	93	105	**241**
Hugli	362	1101	1091	766	**3320**
Haora	809	1257	768	404	**3238**
Jalpaiguri	62	302	292	144	**800**
Kolkata	466	2671	3574	817	**7528**
Maldah	21	118	494	203	**836**
Purba Medinipur	111	367	587	662	**1727**
Paschim Medinipur	136	235	507	546	**1424**
Murshidabad	21	139	210	456	**826**
Nadia	57	256	266	318	**897**
North 24 Parganas	333	1797	1465	788	**4383**
Puruliya	164	152	126	143	**585**
South 24 Parganas	620	1184	1404	837	**4045**
Total	**3934**	**12344**	**14288**	**8793**	**39359**

Source: EMIS, WBPCB

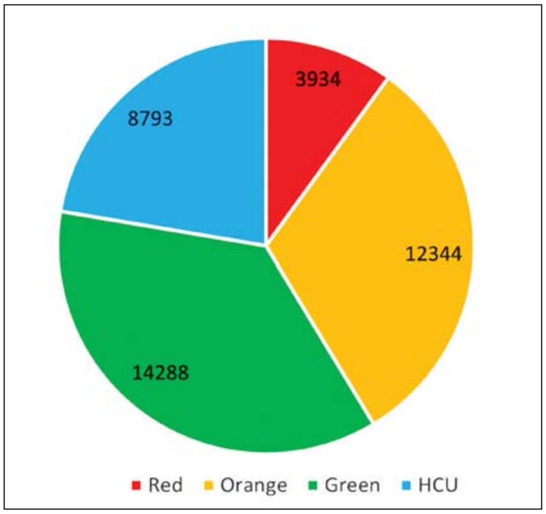

Figure 17.5: Category wise Distribution of Industries registered with the WBPCB

Source: EMIS, WBPCB

Table 17.2 illustrates the general profile of industries in West Bengal for the large and medium scale as well as the small-scale industries.

Table 17.2: Industries in West Bengal – General Profile

Large and Medium scale Industries		Small industries	
• Thermal power plants	• Fertilizer	• Foundry	• Rubber
• Oil Refinery	• Textile	• Rolling mill	• Ceramic
• Petrochemicals	• Paints	• Ferroalloy	• Tanneries
• Integrated Iron & Steel	• Bulk Drug	• Secondary Lead Smelting	• Plastic product manufacturing
• Sponge Iron	• Distillery etc.	• Galvanizing	• Printing etc.
• Paper & Pulp		• Dyeing Bleaching	

Table 17.3 shows the district-wise profile of industries scattered within the state:

Table 17.3: District–wise Profile of Industries

District	Key industries
Bankura	Cottage and Food-Processing, Cottage Textile Product, Iron & Steel, Layer Farms, Coal Mines, Thermal Power Plant, Particle Board etc.
Barddhaman	Thermal Power Plant, Iron & steel industries, Fertilizers Industries, Mining Industries, Equipment Manufacturing, Cement Industry, Rice and Oilseed Mills, Refractory and Ceramics etc.
Koch Bihar	Fertilizer Industries, Jute Twine and Weaving Industry, Electrical Component Industry, Mustard Oil Mill and Fruit Processing etc.
Darjiling & Kalimpong	Tea Industries and Tourism Industry
Hugli	Rice Mills, Rubber Factories, Chemical Factories etc.
Haora	Foundry, Re-Rolling Mills, Basic Metal & Metal Products, Bitumen Blowing, Coal tar Processing, Waste Oil Reprocessing, Transport Equipment & Spares, Rubber Moulded Goods Manufacturing industry etc.
Nadia	Food and Fruit Processing, Jute Diversified, Pipes & Tubes, Electronic and Computer Peripherals etc.
North 24 Parganas	Printing, Dyeing Bleaching, Metal Recovery, Chemical, Engineering Equipment, Food Processing, Oil Seed Milling, General Electrical Works etc.
Uttar Dinajpur	Agriculture and Allied Industries, Food Products, Hosiery and Garments, Chemical Industry, Engineering and Fabrication etc.
Puruliya & Jhargram	Thermal Power Plant, Sponge Iron Industry and Non-Metallic Mineral Product Industry, Quartz mine, Shellac Processing etc.
South 24 Parganas	Plywood Industry, Dyeing and Bleaching, Surface Treatment Industry, Waste Oil Reprocessing, Agro-Industry, Chemical Industry, Equipment Manufacturing Industry, FMCG Industry etc.
Dakshin Dinajpur	Agro Food-Based Industry, Mineral and Forest-Based Industry, Chemical Based Industry, Handicrafts, Engineering, Automobiles Servicing etc.

Table 17.4 shows the number of industries registered with the WBPCB (size-wise) under different categories of ‘Red’, ‘Orange’ and ‘Green’.

Table 17.4: Number of industries registered with the WBPCB (size-wise)

	Large	Medium	Micro	Small	Total
Red	668	136	693	2437	**3934**
Orange	277	286	3681	8100	**12344**
Green	121	186	4965	9016	**14288**
Total	**1066**	**608**	**9339**	**19553**	**30566**

Source: EMIS, WBPCB

Figure 17.6 and Figure 17.7 shows the number of industries registered with the WBPCB indicating both the category-wise (according to pollution potential) distribution as well as according to Large, Medium, Small, Micro-scale -wise distribution.

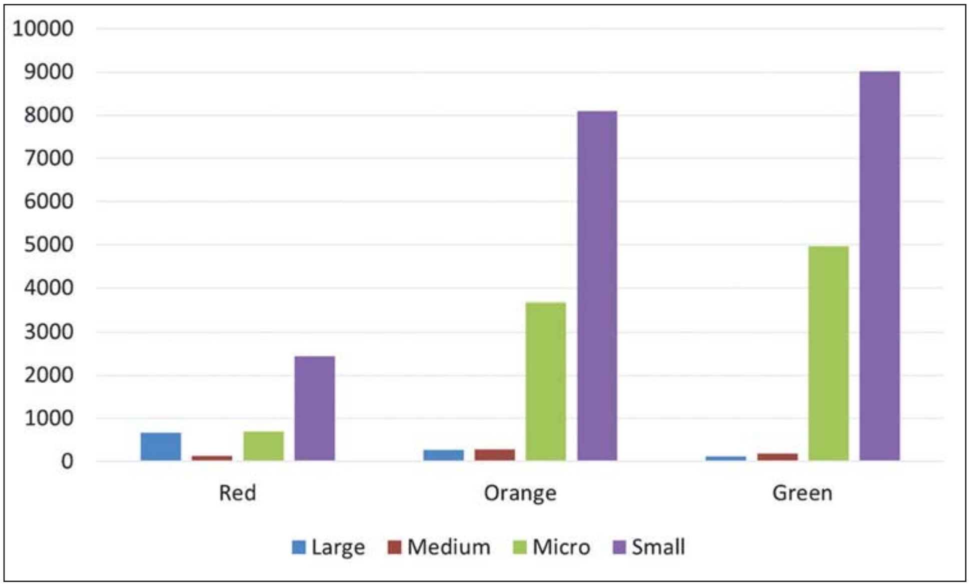

Figure 17.6: Size wise and Category-wise Distribution of Industries (Nos.) registered with WBPCB

Source: EMIS, WBPCB

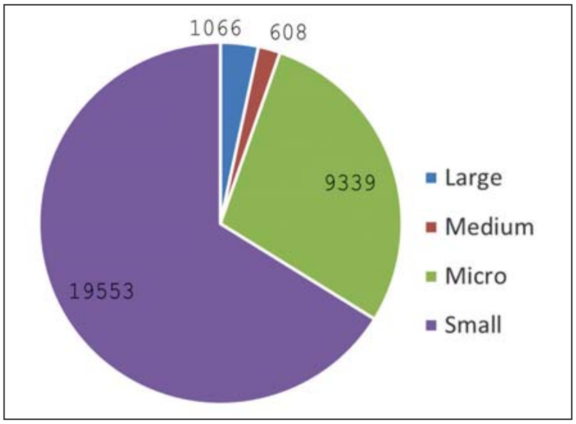

Figure 17.7: Distribution of Large, Medium, Small, Micro-scale Industries registered with WBPCB

Source: EMIS, WBPCB

As per the provisions of the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act, 1981, any industry, operation or process or an extension and addition thereto, which is likely to discharge sewage or trade effluent into the environment or likely to emit any air pollution into the atmosphere need to obtain consent from the State Pollution Control Board. The West Bengal Pollution Control Board aims to reduce industrial emission or effluent generation or any other form of pollution and to control the quality of the same within safe limits. The WBPCB issues two types of consent as mentioned in Table 17.5.

Table 17.5: Types of 'Consent' issued by WBPCB

Consent to Establish*	Consent to Operate
• To be obtained before the establishment of any new industry	• To be obtained for running any industry
• To be obtained before expansion or modification of the existing industrial process	• To be renewed periodically

Some activities attracting provisions of the EIA (Notification) 2006 dt.14/09/2006 as amended require* ***Environmental Clearance* *prior to obtaining Consent to Establish*

Certain types of industries which attract provisions of the EIA (Environmental Impact Assessment) notification (vide S.O. 1533 on September 14, 2006, and its subsequent amendments) are also required to obtain Environmental Clearance.

The Ministry of Environment, Forests and Climate Change (MoEF & CC) issued a notification on January 16, 1991, to ensure compliance of environmental standards in polluting industries. For a nation-wide drive to control industrial pollution, the Central Pollution Control Board (CPCB) enlisted 17 highly polluting categories of industries and also grossly polluting industries discharging their effluents into the rivers and lakes. The respective states are required to give special attention to these industries and regularly monitor these highly polluting natures of activities.

Table 17.6 and adjoining Figure 17.8 shows the 17 highly polluting category of industries identified by the MoEF & CC and their numbers in the state.

Table 17.6: 17 Category Industries in West Bengal (Nos.)

Aluminium Smelting	0
Basic Drugs & Pharmaceuticals Manufacturing	4
Cement (200TPD and above)	18
Chlor Alkali/ Caustic Soda	1
Copper Smelting	0
Dyes and Dye Intermediate	0
Fermentation (Distillery)	2
Fertilizer	4
Integrated Iron & Steel	58
Leather Processing including Tanneries	0

Oil Refinery	1
Pesticide Formulation & Manufacturing	2
Petrochemical	3
Pulp & Paper (30 TPD and above)	8
Sugar	2
Thermal Power Plants	18
Zinc Smelting	0

Source: WBPCB

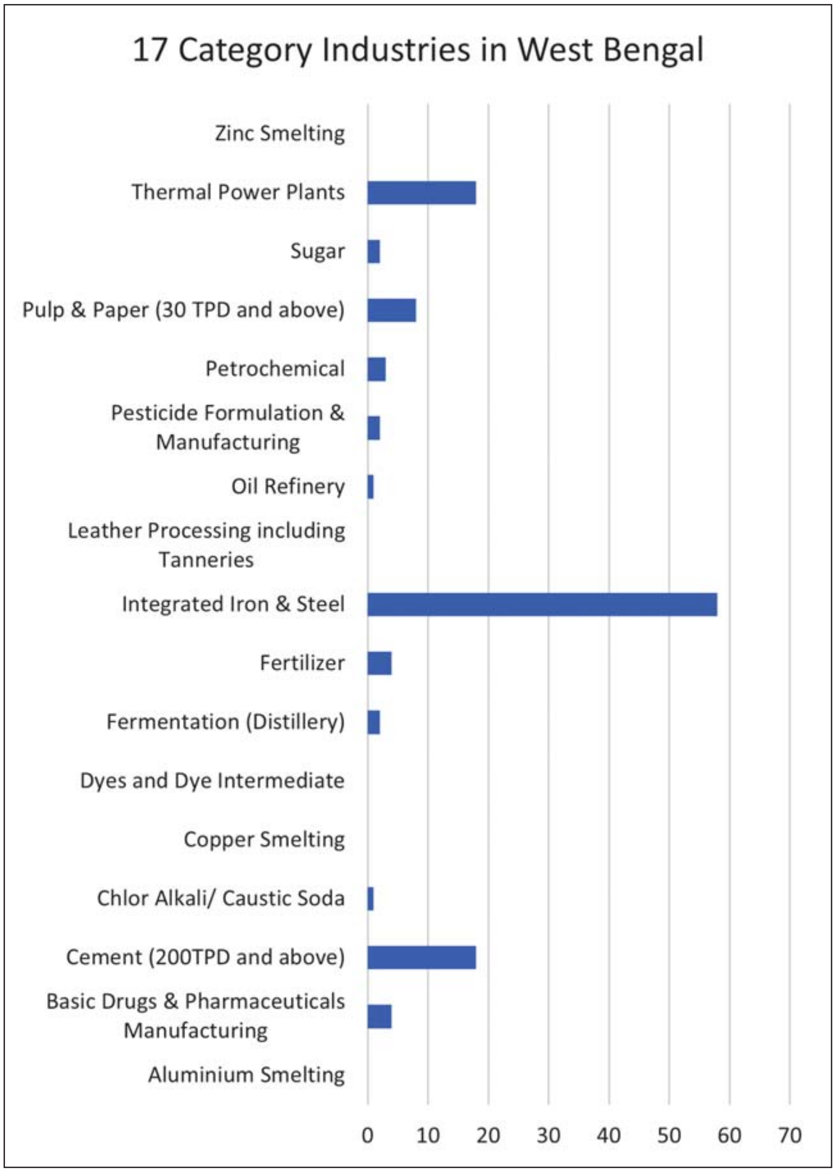

Figure 17.8: Seventeen Category Industries in West Bengal (Nos.)

Table 17.7 and Figure 17.9 shows the district-wise distribution of the 17 category industries and their numbers in the state.

Table 17.7: District-wise Distribution of 17 Category Industries in West Bengal

	District	Nos.
1	Bankura	12
2	Birbhum	1
3	Paschim Barddhaman	47
4	Purba Barddhaman	1
5	Purba Medinipur	10
6	Hugli	4
7	Haora	2
8	Kolkata	2
9	Murshidabad	3
10	Nadia	3
11	North 24 Parganas	5
12	Puruliya	20
13	South 24 Parganas	2
14	Paschim Medinipur	6
15	Jhargram	1
16	Jalpaiguri	1

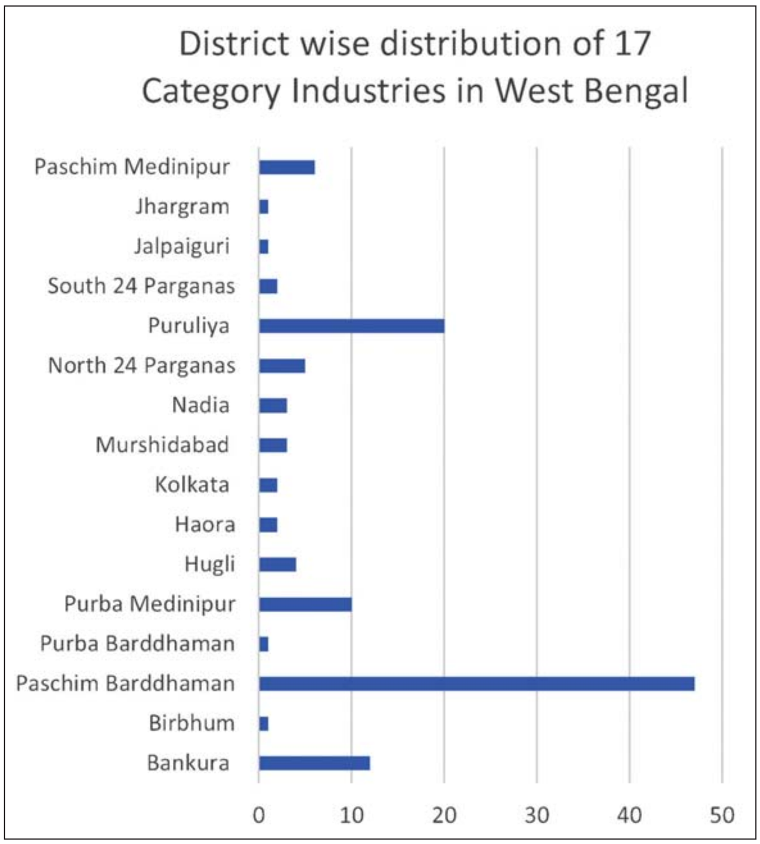

Figure 17.9: District wise distribution of 17 Category Industries in West Bengal

All of these identified 17 category industries have been directed to ensure online monitoring of effluent and emissions and are under regular surveillance of the Board.

The Grossly Polluting Industries (GPI) were earlier identified as industries discharging effluents into a watercourse and (a) handling hazardous substances, or (b) untreated effluent having BOD load of 100 Kg per day or more, or (c) a combination of (a) and (b). In 1993-94, the CPCB initiated identification of industries along the rivers to control industrial discharges into rivers. In July 1997, the National River Conservation Authority (NRCA) directed the industries located on the bank of water-bodies to install requisite effluent treatment systems. Subsequently, the action was initiated for inventorization of GPIs and ensuring compliance. Currently, there are 54 identified GPIs in the Ganga River Basin area of West Bengal. These industries are under strict surveillance. District-wise distribution of these industries is indicated in Table 17.8 and Figure 17.10.

Table 17.8: District-wise distribution of GPIs

District	*Number of GPI Industries*
Hugli	9
Paschim Medinipur	1
Purba Medinipur	10
Nadia	5
South 24 Parganas	3
North 24 Paragnas	2
Purba Barddhaman	3
Paschim Barddhaman	6
Maldah	2
Haora	5
Jalpaiguri	1
Darjiling	1
Kolkata	5
Jhargram	1
	54

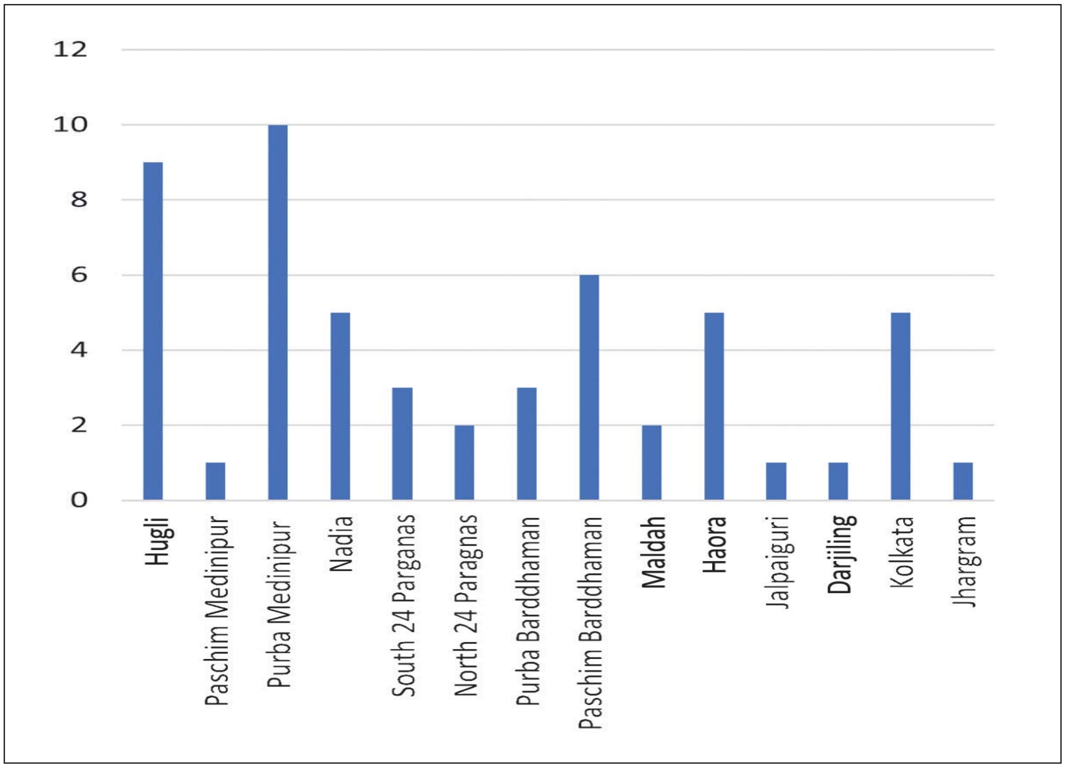

Figure 17.10: District wise breakup of GPIs

In recent times in connection with a matter before the Hon'ble National Green Tribunal (NGT), GPI was re-defined as industries discharging effluents into a watercourse and a) handling hazardous substances, or b) effluent having BOD load of 100 Kg per day or more, or c) a combination of (a) and (b). Such GPIs are now considered as Seriously Polluting Industries (SPI) and the CPCB has classified 33 sectors of industries as SPI sectors as indicated in Table 17.9.

Table 17.9: Sector-wise List of SPI

(Approved by the Principal Committee constituted by NGT vide original application no.196 of 2014 &ors. dated 17.11.2014)

Sl.No.	Sector
1	Distillery including Fermentation industry
2	Sugar
3	Tannery
4	Pulp and Paper (Paper manufacturing with or without pulping)
5	Slaughter Houses and meat processing industries.
6	Dyes and dye-Intermediates
7	Yarn/ textile processing involving bleaching, dyeing, printing and scouring etc.

Sl.No.	Sector
8	Thermal Power Plants
9	Milk Processing and Dairy Plants
10	Pesticides (Technical) (excluding formulation)
11	Pharmaceuticals (excluding formulation)
12	Petrochemicals (Manufacture of and not merely use of as raw material)
13	Aluminium Smelter
14	Chlor Alkali
15	Organic Chemicals manufacturing
16	Synthetic fibres including rayon, tyre cord, polyester filament yarn
17	Industry or process involving metal surface treatment or process such as pickling/ electroplating/ phosphating/ anodizing/ galvanizing etc.
18	Manufacturing of Paints, Varnishes, Pigments and intermediate (excluding blending/ mixing)
19	Automobiles Manufacturing (Integrated facilities)
20	Coal Washeries
21	Copper Smelter
22	Oil Refinery (Mineral Oil or Petrol Refineries)
23	Heavy engineering including Ship Building (with investment on Plant & Machineries more than 10 crores)
24	Hydrocyanic acid and its derivatives
25	Manufacturing of Lubricating oils, greases of petroleum-based products
26	Coke making, liquefaction, coal tar distillation or fuel gas making
27	Zinc Smelter
28	Chlorine, fluorine, bromine, iodine and their compounds
29	Chlorates, perchlorates and peroxides
30	Basic Chemicals and electro chemicals and its derivatives including the manufacture of acids
31	Food & Beverages (Alcoholic and non-alcoholic)
32	Photographic films and their chemicals
33	Industrial carbon including electrodes and graphite blocks, activated carbon, carbon black

There are currently 400 SPIs in the state of West Bengal and these are under surveillance of the Board.

To mitigate the menace of growing industrial pollution in the state, the government has taken several steps in its wake. Firstly, as described earlier, all industries of the state are required to go through a comprehensive consent mechanism prior to the establishment as well as prior to operation following the transparent "Industrial Siting Policy" prevalent in the state. Once the industries are established and are operational, they are subject to priority surveillance and monitoring by various regulatory organisations based on their pollution potential. All non-compliant industries are subjected to regulatory action as indicated in Figure 17.11.

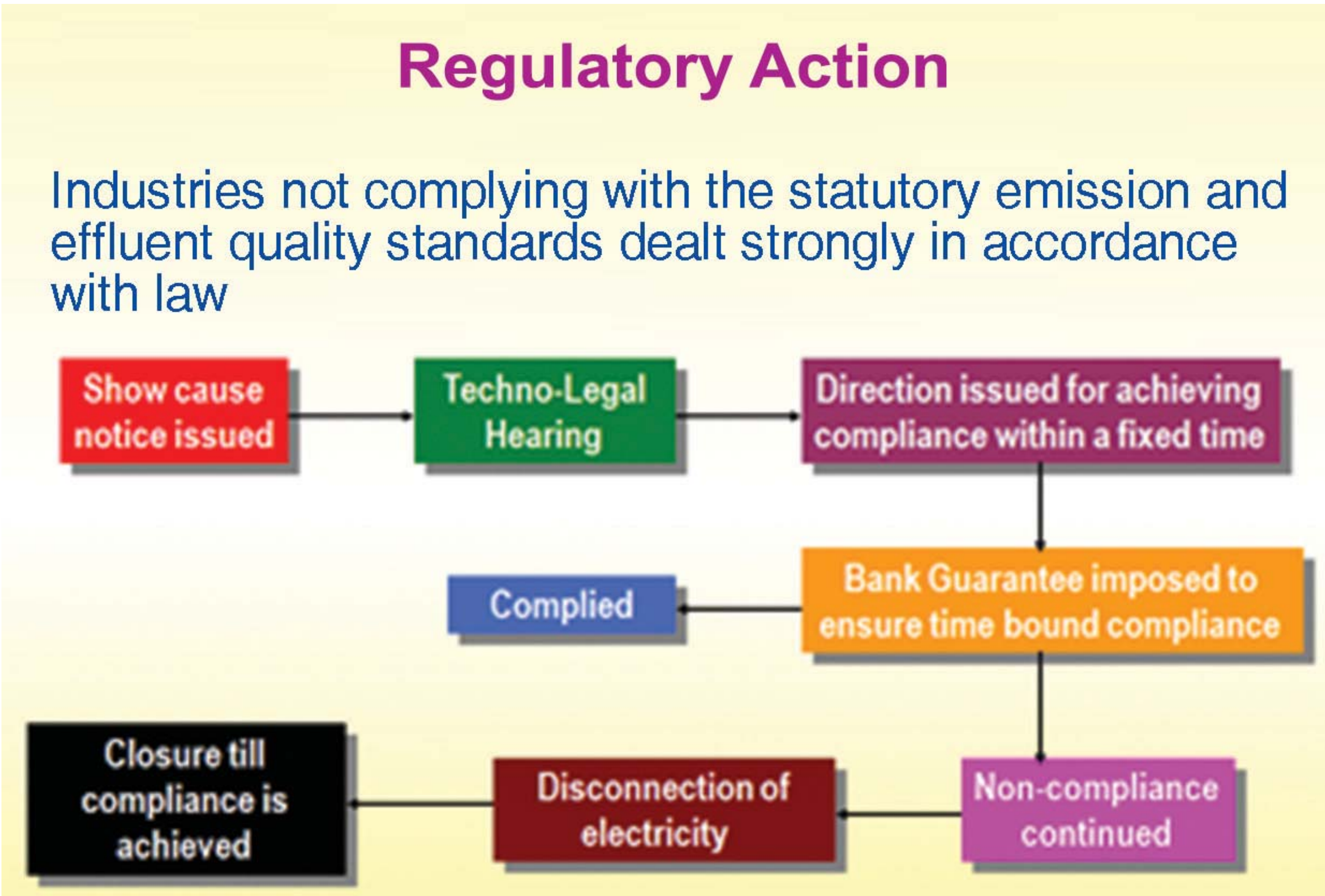

Figure 17.11: Regulatory Action for Non-complying Industries

Apart from the legislative and regulatory role, the government has tried to respond to the problems on a promotional note as well. The consent administration for small-scale industries was simplified and decentralised through General Managers of District Industries Centre, District Land and Land Reforms Officers and Regional Officers of the Board. Various government organisations work in close association with NGOs, academic institutions, chambers of commerce and industry associations for the betterment and support of industries within the state.

Ministry of Environment, Forests & Climate Change (MoEF &CC), Government of India had issued an Office Memorandum dated 13.01.2010 imposing a moratorium on setting up of new industries and also the expansion of existing industries requiring Environmental Clearance as per the EIA notification S. O. 1533(E) dated 14.09.2006 and its amendments thereof, located in critically polluted industrial areas (CPA) namely Haldia, Haora and Asansol based on Comprehensive Environmental Pollution Index (CEPI, based on evaluation of environmental parameters including ambient air, surface water and health-related statistics.)

Based on the environmental load-bearing capacity of sensitive areas like Haldia, Haora and Asansol which have many major industries, the West Bengal Pollution Control Board has taken elaborate action plan since 2010 involving the major industries and Local Bodies of the concerned areas. WBPCB submitted reports to CPCB on implementation of such action plans for the critically polluted areas in the State of West Bengal.

Reassessment of CEPI score during 2018 revealed that continuous efforts initiated by WBPCB for implementation of Pollution Abatement Action Plans for up-gradation of environmental quality in these critically polluted areas show decreasing trend in CEPI score for the Critically Polluted Areas as compared to CEPI score during 2010, calculated by CPCB, CEPI scores given in Table 17.10.

Table 17.10: CEPI Scores Calculated during 2010, 2013 and 2018

Name of the critically polluted area	CEPI Score during 2010	CEPI Score during 2013	CEPI Score during 2018
Asansol	70.20	56.01	55.09
Haldia	75.43	61.58	45.72
Haora	74.84	61.11	61.76

(Source: NGT Order Dated 10/07/2019 Original Application No. 1038/2018)

WBPCB engaged a third party in January 2019 for monitoring of environmental qualities in 5 Polluted Industrial Areas or PIAs (Durgapur and Bandel being the other two PIAs recently included) in West Bengal. Based on the monitoring report and as per the order of the Hon'ble NGT dated 13.12.2018 in the matter of OA no. 1038/2018, an action plan has been prepared for 5 PIAs in West Bengal in accordance with the revised norms laid down by CPCB. For the preparation of action plan large industries falling under 17 category, GPIs and highly polluting Red category have been considered. The action plan also includes various action points of the ULB and developmental authorities.

In connection with the order passed in July 2019, NGT directed the CPCB in coordination with all State PCBs (including WBPCB) to take steps in exercise of statutory powers to prohibit the operation of polluting activities in the critically polluted area (CPAs) and severely polluted area (SPAs). The WBPCB is undertaking an assessment of compensation to be recovered from the polluting units for the period of last 5 years, taking into account the cost of restoration and cost of damage to the public health and environment and the deterrence element. No further industrial activities or expansion are being allowed concerning 'Red' and 'Orange' category units till the said areas are brought within the prescribed parameters or till carrying capacity of the area is assessed and new units or expansion is found viable with regard to the carrying capacity of the area and environmental norms.

Conclusions

Industrialization has historically been degrading the Earth's environment both in terms of increasing pollution and natural resource depletion. But, on the other hand, economic growth will not take place without industrialization. Therefore, it calls for developing a resilient infrastructure based on the concept of 'sustainable development' for which the different stakeholders need to put a concerted effort. The State realizes the importance of necessary support for its industries for inclusive economic development. The State Government, therefore, proposes the following strategic interventions:-

(i) Creation of quality industrial infrastructure.

(ii) Facilitation of directed mega investments into sectors offering huge employment opportunities and having a domino effect on the development of downstream industries.

(iii) Adoption of a coordinated approach through the creation of sufficient land bank.

(iv) Adoption of 'single window clearance' system with the key objectives to achieve efficiency & transparency (online application & file tracking, time-bound clearance at each level, etc.).

(v) Create convergence of schemes for growth of MSMEs and provide financial, technological & other support.

(vi) Leveraging the industrial sectors having core competence (like agro-based industries, food processing, gems & jewelry, textiles, leather, metallurgical processing, IT & ITES, tourism, etc.).

(vii) Encouraging private sector participation through PPP model.

(viii) Development of industrial parks for a specific type of industry to effectively manage the environment.

The State intends to eliminate systemic bottlenecks and has kept 'Ease of Doing Business' (EODB) as one of the key components of this policy. Some components of EODB are:-

(i) Shilpa Sathi (e-enabled business portal)

(ii) Time-bound, process-driven & ICT enabled system

(iii) e-tendering & e-procurement

(iv) Optimum incentives for investors

(v) Reduction of 'red-tapism'

(vi) Ready land bank information in public domain

(vii) Transparency in allotment & sharing of public resources

(viii) Bringing best talent & knowledge in the private sector through Transaction Advisory Service from empanelled firms

All the departments, including WBPCB, have adopted this EODB for an industrial resurgence in the State.

Hence it is imperative and of utmost necessity to build resilient infrastructure, foster innovation and promote inclusive and viable industrialization. All the stakeholders including the government, local authorities, industrial managers as well as technical cooperation and collaborating agencies –need to come together at this juncture to help the organised industries of today to meet the burgeoning demands within the confines of constraints and pressures by harnessing resource efficiencies to the maximum. This can be achieved only with effective integration of the economic, social and environmental aspects of development and by reconciling all dimensions of sustainability.

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WEST BENGAL

Chapter 18

Waste Management


Coronavirus
COVID 19
YOUR DUTIES
AVOID CROWDED PLACES
WEAR A FACE MASK
Do's
MAINTAIN SOCIAL DISTANCING
WASH YOUR HANDS WITH SOAP AND WATER
DON'T SHAKE HANDS
AVOID TOUCHING YOUR EYES, NOSE AND MOUTH
Dont's
COVER YOUR NOSE AND MOUTH WHILE SNEEZING OR COUGHING
DO NOT USE CROWDED ELEVATORS

Chapter 18.I

Solid Waste Management

Waste management has emerged as a huge challenge in the country day to day with increasing population and urbanization. Characteristic of the waste has also changed continuously. Unscientific disposal of municipal solid waste has a serious impact on the environment and also on society. To overcome the challenges scientific disposal of Municipal Solid Waste through segregation at source, collection, treatment and disposal in an environmentally sound manner is the only solution to regulate the adverse impact on the environment.

To tackle this problem, the Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India framed Municipal Solid Waste (Management & Handling) Rules, 2000. These rules laid out a series of guidelines for scientific processing and disposal of waste.

The Municipal Solid Waste (Management & Handling) Rules, 2000 was revised in 2016 by MoEF&CC to regulate efficient management of Solid Waste in India and was further amended on 19th March 2020.

Table 18(I).1: Urban Scenario in West Bengal (As per Census 2011)

Total Statutory Towns	125 (2938 wards)
Total Census Towns	781
Total Urban Population	29093002
Total Population of Statutory Towns	21112134
Total Population of Census Towns	7980868
Total Urban Households	6611583

Source: Handbook on Solid Waste Management for urban local bodies of West Bengal by UD&MA Department, GoWB

Important Features of Solid Waste Management Rules, 2016

- Applicable beyond Municipal areas and extend to urban agglomerations, census towns, notified industrial townships, areas under the control of Indian Railways, airports, airbase, port and harbours, defence establishments, special economic zones, State and Central government organizations, places of pilgrims, religious & historical importance.
- Every household, event organizers, street vendors, resident welfare associations & market associations, the gated community having more than area 5000 sq.m, hotels & restaurants, etc. are the waste generators.
- The source segregation of waste has been mandated.
- Responsibilities of generators have been introduced to segregate waste into three streams, wet, dry and domestic hazardous wastes and handover segregated wastes to local bodies.
- All resident welfare and market associations, gated communities and institution with an area > 5,000 sq. m should segregate waste at source- into valuable dry waste like plastic, tin, glass, paper, etc. and handover recyclable material to either the authorized waste pickers or the authorized recyclers, or the urban local body.
- Used sanitary waste like diapers, sanitary pads etc. is to be wrapped securely in the pouches provided by the manufacturers or brand owners of these products or in a suitable wrapping material as instructed by the local authorities and shall place the same in the bin meant for dry waste or non- bio-degradable waste.
- Construction and demolition waste, as and when generated, is to be stored separately in his premises and shall dispose of as per the Construction and Demolition Waste Management Rules, 2016.
- The bio-degradable waste should be processed, treated and disposed of through composting or bio-methanation within the premises as far as possible. The residual waste shall be given to the waste collectors or agency as directed by the local authority.
- New townships and Group Housing Societies have been made responsible to develop in-house waste handling and processing arrangements for bio-degradable waste.
- No person should throw, burn, or bury the solid waste generated by him, on streets, open public spaces outside his premises, or in the drain, or water bodies.
- A generator will have to pay 'User Fee' to waste collector and for 'Spot Fine' for Littering and Non-segregation.

The Ministry of Environment Notifies Solid Waste Management (Amendment) Rules, 2020

- The Ministry of Environmental, Forest and climate change vide its notification dated 19th March 2020 has published the Solid Waste Management (Amendment) Rules, 2020.
- The Amended rule is now made applicable to every village where the population is more than 3000 and the duties of local authorities mentioned under section 15 have been amended as follows:
- The Local Authorities shall collect and transport bio-degradable, non-biodegradable and domestic hazardous waste from households including slums and informal settlements, commercial, institutional and other non-residential premises, multi-story buildings, large commercial complexes, malls, housing complexes and the like in compartmentalized and covered vehicle to the respective processing facility.

Status of Solid Waste Management following MSW Rule 2016 and its amendment

In line with Solid Waste Management Rules, 2016, "Duties of the State Pollution Control Board" is to enforce these rules in the State through local bodies, monitoring environmental standards, issuing authorization to the local bodies, operator as a facility etc. As far as management of Solid Waste is concerned, it is the duty and responsibility of the local authorities and Secretary-in-charge of UD&MA, as well as Secretary-in-charge of Gram Panchayats and Rural Development Department in a rural area in the State of West Bengal.

Duties of all ULBs as per Solid Waste Management Rules, 2016 and its amendment

For compliance of the direction issued by Hon'ble NGT, The West Bengal State Level Committee of Hon'ble NGT has resolved that the ULBs should take the following actions:

1. Source Segregation [Rule 15 (g) SWM Rule]:
    - Segregation of waste by households into biodegradable (green bins), non-biodegradable (blue bins) and domestic hazardous (black pouch of thickness more than 50 microns). As per the direction of State level Committee on SWM Rule, 2016 vide no Z-16025/6/2018 dated 21.01.2019, all the regional monitoring committee and State/UT/ULBs is to follow the two-bin system for storage of waste and separate storage for domestic hazardous waste.
2. Door to Door Collection [Rule 15 (b) SWM Rule]
    - Door to door collection of segregated solid waste from all households including slums and informal settlements, commercial, institutional and other non-residential premises. Transportation in covered vehicles to processing or disposal facilities.
3. Provision of Litter Bins & Waste Storage Bins [Rule 15 (h) SWM Rule]
    - Installation of Twin-bin/ segregated litter bins in commercial, public areas and strategic locations at every 50-100 meters.
    - Avoid indiscriminate dumping in important locations like a riverbank, roadside, near institutions, health care centres etc.
4. Transfer Stations
    - Installation of Transfer Stations instead of secondary storage bins in cities (mandatory for population above 5 lakhs).
5. Separate transportation [Rule 15 (q and r) SWM Rule]
    - Compartmentalization of vehicles (for biodegradable and non-biodegradable) for the collection of different fractions of waste.
    - Use of GPS in collection and transportation vehicles to be made mandatory at least in cities with a population above 5 lakh along with the publication of route map.

6. Public Sweeping [Rule 15 (n) SWM Rule]
    - All public and commercial areas to have twice daily sweeping, including night sweeping and residential areas to have daily sweeping.
7. Waste Processing (Wet Waste, Dry Waste, MRF Facility) [Rule 15 (h,v) SWM Rule]
    - Separate space for segregation, storage, decentralized processing of solid waste to be demarcated
    - Establishing systems for home/decentralized and centralized composting/generation of biogas.
    - Arrangement for Material Recovery Facilities (separation of recyclable material like PET bottle, soft drink can etc.)
    - Establishment of Refuse-derived fuel(RDF) plants/ waste to energy plants.
8. Scientific Landfill [Rule 15 (w) of SWM Rule]
    - Setting up common or regional sanitary landfills by all local bodies for the disposal of permitted waste under the rules.
    - Systems for the treatment of legacy waste to be established.
9. Bulk Waste Generators (BWGs) [Rule 4 (6 and 7) of SWM Rule]
    - Bulk waste generators (having an average waste generation rate exceeding 100kg per day) to set up decentralized waste processing facilities as per SWM Rules, 2016.
10. Preventing solid waste from entering into water bodies [Rule 4 (2) of SWM Rule]
    - Installation of suitable mechanisms such as screen mesh, grill, nets, etc. in water bodies such as nallahs, drains, to arrest solid waste from entering into water bodies.
11. User Fees [Rule 4 (3) of SWM Rule]
    - All Waste Generators shall pay a user fee for solid waste management, as will be determined by the bye-laws of the local bodies.
12. Penalty provision [Rule 15 (zf) of SWM Rule]
    - Impose / levy of spot fine for persons who litter or fails to comply with the provisions of these rules/ relevant act.
13. Notification of Bye Laws[Rule 15 (e) of SWM Rule]
    - Frame bye-laws incorporating the provisions of MSW Rules, 2016 and ensuring timely implementation.
14. C&D Waste (Rule 6(4) & 6(5) of C&D WM Rules)
    - Ensure separate storage, collection and transportation of construction and demolition wastes.
15. Plastic Waste (Rule 4(c) PWM Rules)
    - Implementation of a ban on plastics less than 50 microns thickness and single-use plastics.
16. Citizen Grievance Redressal:
    - Establish an effective grievance redressal mechanism for this purpose.
17. Monitoring mechanism
    - ULBs to update month-wise targets/action plans on the online format to the UD&MA dept.
    - The local body shall submit an annual report on solid waste management in Form-IV as specified in Solid Waste Management Rule, 2016 to WBPCB and UD & MA department before April in every year.

Table 18(I).2: Present Scenario of Urban Solid Waste Management of West Bengal

• Total number of Urban Local Bodies and their Population	125 (20905615)
• Current Municipal Solid Waste Generation	13709.412 (TPD)
• Number, installed capacity and utilization of existing MSW processing facilities in TPD (bifurcated by type of processing eg- Waste to Energy (Tonnage and Power Output), Compost Plants (Windrow, Vermi, decentralized pit composting), biomethanation, MRF etc	18 nos (1778 TPD)
• Action plan to bridge the gap between Installed Capacity and Current Utilization of processing facilities (if Gap > 20%)	11930 TPD
• No. and capacity of C&D waste processing plants in TPD (existing, proposed and under construction)	Setting up of one plant of capacity 1000 TPD is in progress.
• Total no. of wards, having a door to door collection service	2645 wards (90%)
• Total no. of wards practising segregation at source	588 wards (20%)
• Details of MSW treatment facilities proposed and under construction (no., capacity, and technology)	Cluster-1 Project. at Promod Nagar site. 450 TPD CP & RDF, 100 TPD bio methanation plant. At Kamarhati 180 TPD CP&RDF.
• No. and area (in acres) of uncontrolled garbage dumpsites and Sanitary Landfills.	107 nos for 92 ULBs (754.21 acres)
• No. and area (in acres) of legacy waste within 1km buffer of both side of the rivers	1 (3.2 acres) Naihati
• No. of drains falling into rivers and no. of drains having floating racks/screens installed to prevent solid waste from falling into the rivers	402 (400)

Source: Submission of U&D Dept, GoWB in the NGT Matter OA No. 673 of 2018 (in compliance to NGT order dated 24.09.2020)

Table 18(I).3: Present Status of ULB wise Management of Solid Waste

Sl. No.	Name of ULBs	Total MSW generation in TPD	Total MSW being Processed in TPD	Existing MSW Facilities	Utilization Capacity of the existing MSW facilities
1	Alipurduar	35.65			
2	Arambagh	30.25			
3	Asansol MC	654			
4	Ashoknagar-K_garh	79.65			
5	Baduria	13.62			
6	Baidyabati	68	48	CP	48
7	Balurghat	75			
8	Bankura	75			
9	Bansberia	39			
10	Baranagar	150			
11	Barasat	130			
12	Barddhaman	140			

Sl. No.	Name of ULBs	Total MSW generation in TPD	Total MSW being Processed in TPD	Existing MSW Facilities	Utilization Capacity of the existing MSW facilities
13	Barrackpore	50			
14	Baruipur	17			
15	Basirhat	29			
16	Beldanga	17.75			
17	Berhampore	90			
18	Bhadreswar	23			
19	Bhatpara	205	78	CP	78
20	Bidhan Nagar MC	400			
21	Birnagar	16.77			
22	Bishnupur	59.2			
23	Bolpur	45.44			
24	Bongaon	65			
25	Budge Budge	40			
26	Buniadpur	30			
27	Chakdah	54.12			
28	Champdany	19	19	CP	19
29	Chandannagore MC	55.5			
30	Chandrakona	7.8			
31	Contai	45			
32	Koch Bihar	45.69			
33	Cooper's Camp	13.86			
34	Dainhat	48.51			
35	Dalkhola	8.22			
36	Dankuni	25			
37	Darjiling	55.11			
38	Dhulian	46.42			
39	Dhupguri	11			
40	Diamond Harbour	18			
41	Dinhata	20			
42	Domkal	100			
43	Dubrajpur	47.87			
44	Dum Dum	62.1			
45	Durgapur MC	402.63			
46	Egra	19			
47	English Bazar	190			
48	Gangarampore	30.56			
49	Garulia	35			
50	Gayeshpur	60			
51	Ghatal	26.52			
52	Gobardanga	17.7			

Sl. No.	Name of ULBs	Total MSW generation in TPD	Total MSW being Processed in TPD	Existing MSW Facilities	Utilization Capacity of the existing MSW facilities
53	Gushkara	26			
54	Habra	72			
55	Haldia	80	70	CP + MRF	70
56	Haldibari	4			
57	Halisahar	52			
58	Haringhata	0.01			
59	Hugli Chinsurah	80			
60	Haora MC	910	60	CP	60
61	Islampur	21.73			
62	Jainagar-Mazilpur	18	6.2	WTE	6.2
63	Jalpaiguri	55			
64	Jangipur	40			
65	Jhalda	7.56			
66	Jhargram	44			
67	Jiaganj-Azimganj	20.53	3	MRF	3
68	Kaliaganj	59			
69	Kalimpong	38.085	16	MRF + BM	16
70	Kalna	27.72			
71	Kalyani	58			
72	Kamarhati	160			
73	Kanchrapara	56.71			
74	Kandi	25.34			
75	Katwa	40			
76	Kharagpur	114.6			
77	Kharar	4.1			
78	Khardah	64.5			
79	Khirpai	5.92			
80	Kolkata MC	4500	1207.7	CP + MRF	1207.7
81	Konnagar	32	5.5	CP + MRF	5.5
82	Krishnanagar	130	130	CP	130
83	Kurseong	11			
84	Madhyamgram	58			
85	Maheshtala	184	8.2	CP	8.2
86	Mal	14	0.5	CP	0.5
87	Mathabhanga	9.79			
88	Mekliganj	4.69			
89	Memari	14.53			
90	Midnapore	87.3			
91	Mirik	4.2			
92	Murshidabad	30			

Sl. No.	Name of ULBs	Total MSW generation in TPD	Total MSW being Processed in TPD	Existing MSW Facilities	Utilization Capacity of the existing MSW facilities
93	Nabadwip	53.98			
94	Naihati	100			
95	Nalhati	32			
96	New Barrackpore	29.8			
97	North Barrackpore	59			
98	North Dum Dum	165			
99	Old Malda	27.13			
100	Panihati	193			
101	Panskura	24.18			
102	Pujali	15.6			
103	Puruliya	60.6			
104	Raghunathpur	11.43			
105	Raiganj	90			
106	Rajpur-Sonarpur	170	1.1	MRF + BM	1.1
107	Ramjibanpur	7.55			
108	Rampurhat	105			
109	Ranaghat	25.89			
110	Rishra	50	5	CP	5
111	Sainthia	32			
112	Santipur	65.22			
113	Serampore	90	10	CP	10
114	Siliguri MC	380	70	CP	70
115	Sonamukhi	11.7			
116	South Dum Dum	372			
117	Suri	60			
118	Taherpur	0.45			
119	Taki	21.75			
120	Tamralipta	15			
121	Tarakeswar	13.16			
122	Titagarh	65			
123	Tufanganj	14.23			
124	Uluberia	50			
125	Uttarpara Kotrung	90.66	40	CP + MRF	40
TOTAL		**13708.585**	**1778.2**	**Total**	**1778.2**

CP-Compost Plant, **MRF** - Material Recovery Facility, **BM**- Bio methanation, **WTE-** Waste to Energy

In the State, setting up of Compost Plant (CP) / Bio methanation(BM)/ Material Recovery Facility (MRF)/ Sanitary Landfill (SLF) as per SWM Rules, 2016 are in progress

Source: Submission of U&D Dept, GoWB in the NGT Matter OA No. 673 of 2018 (in compliance to NGT order dated 24.09.2020)

Monitoring on Compliance of Solid Waste Management by Hon'ble National Green Tribunal

Municipal Solid Waste (MSW) remains one of the most serious challenges for environment protection in our state. Proper management of solid waste has become a burning issue to keep the environment clean, green and liveable. This issue has been highlighted and considered at all concerned levels. The Solid Waste Management Rules have been reframed in the year 2016 for implementation of proper management of Solid Waste and the compliance of the same has been extensively monitored by the Hon'ble National Green Tribunal through its Apex Committee and State Level Committee.

In compliance with Municipal Solid Waste Management Rules 2016, the Hon'ble National Green Tribunal *Suo Moto* initiated the case O.A. No.606 of 2018.

On 23.07.2018 the Hon'ble NGT considered the matter in the light of annual report prepared by the CPCB in April 2018 under Rule 24 of the MSW Rules and noticed serious deficiencies. In an order dated 31.08.2018, the Hon'ble Tribunal observed that municipal solid waste remained one of the most serious challenges of environmental protection. At the conclusion, the Tribunal declared that the mandatory provision of the Rules and directions should be implemented in a time-bound manner. In the State, the Monitoring Committees headed by the Secretary, Urban Development Department has been formed with the Secretary of Environment Department as Member and CPCB and West Bengal Pollution Control Board assisting the Committees. The Committees were to function for one year subject to further orders.

Then by an order dated 16.01.2019, the Hon'ble Tribunal gave a detailed direction about the compliance with Solid Waste Management Rules, 2016. By the said order the Hon'ble Tribunal was pleased to constitute the State Level Committee. In West Bengal, the Committee was constituted under the Chairmanship of Justice Jayanta Kumar Biswas, former Judge of the High Court at Calcutta. The Department of Environment notified the Committee (Notification No.257/3C-19/2019 dated 06.02.2019). State Level Committee has further co-opted two other members vide Notification No.EN/503/3C-19/2019 dated 12.03.2019.

Hon'ble NGT vide O.A No 606/2018 dated 02/04/2019 directed all the ULBs to take compliance of clause no 22 of SWM Rules 2016 for the following activities within six weeks:

- Enforcing waste generators to practice segregation of biodegradable, recyclable, combustible, sanitary waste domestic hazardous and inert solid wastes at source.
- Ensure door to door collection of segregated waste and its transportation in covered vehicles to processing or disposal facilities.
- Ensure separate storage, collection and transportation of construction and demolition waste.
- Setting up solid waste processing facilities by all local bodies and census town.
- Setting up common or standalone sanitary landfills for all local bodies and census town for the disposal of permitted waste under the rules.
- Bio-remediation or capping of old and abandoned dump sites.

Hon'ble NGT vide O.A No 606/2018 dated 02/04/2019 directed that at least three major cities and as many major towns as possible in the State and at least three Panchayats in every District may be notified on the website as model cities/towns/villages which will be made fully compliant with Solid Waste Management Rules 2016.

Accordingly, 3 model cities, 5 model towns and 69 Gram Panchayats from every District are notified on the website as model cities/towns/villages.

Table 18(I).4: Model cities/towns/villages to be made fully compliant with Solid Waste Management Rules 2016.

Sl No	Name of Model Cities
1	Asansol Municipal Corporation
2	Bidhannagar Municipal Corporation
3	Durgapur Municipal Corporation

Sl No	Name of Model Towns
1	Uttarpara Kotrang Municipality
2	Baidyabati Municipality
3	Rishra Municipality
4	Kalyani Municipality
5	Haldia Municipality

Names of Model Gram Panchayats

Sl. No	District	Block	Gram Panchayat
1	Alipurduar	Kumargram	Volka-Barobisha – I
2		Kumargram	Kamakhyaguri – II
3		Falakara	Parangerpar
4	Bankura	Rajpur	Rajpur
5		Rajpur	Motgoda
6		Jaypur	Hetia
7	Birbhum	Labpur	Labpur – I
8		Siuri – II	Abinashpur
9		Rampurhat – I	Kharun
10	Purba Barddhaman	Memari – II	Bohar – I
11		Aushgram – II	Kota
12		Aushgram – I	Guskara – II
13	Paschim Barddhaman	Salanpur	Alladi
14		Durgapur Faridpur	Pratappur
15		Raniganj	Jemari
16	Koch Bihar	Tufanganj – I	Natabari – II
17		Dinhata – II	Barasakdal
18		Mathabhanga – II	Unishbisha
19	Dakshin Dinajpur	Kushmandi	Maligaon
20		Hili	Dhalpara
21		Kumarganj	Ramkrishnapur
22	Uttar Dinajpur	Raijanj	Kamlabari – I
23		Hemtabad	Hemtabad
24		Kaliaganj	Bhander

Names of Model Gram Panchayats

Sl. No	District	Block	Gram Panchayat
25	Hugli	Jangipara	Rajbalhat – I
26		Chinsura Mogra	Chandrahati – I
27		Balagarh	Shripur – Balagarh
28	Haora	Shyampur – I	Radhapur
29		Uluberia – II	Basudevpur
30		Domjur	Dakshin Jhapardaha
31	Jalpaiguri	Jalpaiguri Sadar	Kharija Berubari – I
32		Maynaguri	Khagrabari – II
33		Nagrakata	Sulkapara
34	Jhargram	Binpur – I	Lalgarh
35		Binpur – II	Silda
36		Gopiballavpur	Tapsia
37	Kalimpong	Kalimpong – I	Yangamakum
38		Kalimpong – II	Gitabling
39		Gorubathan	Gorubathan – I
40	Maldah	English Bazar	Kotwali
41		Kaliachak – II	Uttar Panchanandapur-II
42		Gazole	Deotala
43	Murshidabad	Sagardighi	Patkeldanga
44		Msd-Jiaganj	Dahapara
45		Beldanga-II	Saktipur
46	Naida	Krishnagar – I	Rjpukur
47		Ranaghat – I	Anulia
48		Karimpur – I	Karimpur – I
49	North 24 Parganas	Bagda	Sindrani
50		Begda	Koniara – II
51		Barrackpore-I	Kapa Chakla
52	Paschim Medinipur	Garbeta – II	Sarbot
53		Daspur – II	Gochati
54		Keshpur	Golar
55	Purba Medinipur	Sahid Matangini	Raghunathpur – I
56		Mahisadal	Itamagra – II
57		Nandigram – I	Nandigram
58	Puruliya	Kashipur	Kashipur
59		Raghunathpur	Chellyama
60		Manbazar – I	Jitujuri
61	Darjiling	Darjeeling – Pulbazar	Pul-Bijanbari
62		Mirik	Chenga Panighata
63		Jorebunglow-Sukhiapokhri	Sukhia Simana
64	Siliguri Mahakumar Parishad	Naxalbari	Naxalbari
65		Kharibari	Buraganj
66		Phansidewa	Ghosh Pukur
67	South 24 Parganas	Kakdwip	Pratapadityanagar
68		Namkhana	Namkhana
69		Patharpratima	Digambarpur

Compliance Status in West Bengal: an overview

- ✓ State Policy and Strategy for SWM has been framed for the State.
- ✓ Solid Waste Management Cell has been created in the state.
- ✓ State Level Advisory Body (SLAB) has been constituted for the State.
- ✓ Implementation status of Action Plan has been uploaded on State Govt.'s website
- ✓ Department of Urban Development & Municipal Affairs, GoWB has notified 3 model cities Asansol Municipal Corporation, Durgapur Municipal Corporation & Bidhannagar Municipal Corporation & 5 towns Uttarpara-Kotrung, Baidyabati, Rishra, Kalyani & Haldia municipality to be developed as model city/ town complying all criteria of Solid Waste Management Rules, 2016 as per the direction of Hon'ble NGT (O.A. No.606/2018 dated 02/04/2019).
- ✓ Department of Panchayat and Rural Development, GoWB has notified 69 Gram Panchayet to develop as model GP complying all criteria of Solid Waste Management Rules, 2016 as per the direction of Hon'ble NGT (O.A. No.606/2018 dated 02/04/2019).
- ✓ Action Plan (Management & Disposal of Waste, Selection and Establishment of a Landfill site, Establishment and Operationalization of plants for plants) been framed.
- ✓ State Level Committee on solid waste management as per the order of the Hon'ble NGT dated 16/0/2019, O.A. No. 606/2018) has been constituted.
- ✓ Special Task Force (Four members nominated by DM, SP, RO SPCB & District Legal Services Authority) for Awareness has been created in 100% districts.
- ✓ Annual Report on SWM in Form-IV submitted by all ULBs for the Calendar year 2019 as well as 2020.

Source: *Monitoring Compliance Report submitted by Department of Urban Development & Municipal Affairs, GoWB w.r.t SWM Rules 2016 & Directions of Hon'ble NGT Dated 05-03-2019 (OA No.- 606/2018).*

Closure and Rehabilitation of Old Dumpsites-an overview and steps towards compliance

To comply with the clause 'J' of Schedule–I of SWM Rules, 2016, Hon'ble NGT directed CPCB to propose Standard Operating Processing (SOP) for implementation of bio-mining and bio-remediation of legacy solid waste. The guidelines were framed by CPCB on February 2019 which is very useful to Municipal Corporations, Councils & Waste Management Agencies which mandate that bio-mining and bio-remediation is the first option for clearing of legacy sites.

Methodology

Solid waste dumps which have reached their full capacity or those which will not receive additional waste after setting up new and properly designed landfills should be closed and rehabilitated by examining the following options:

(i) Reduction of waste by bio-mining and waste processing followed by placement of residues in new landfills or capping.

(ii) Capping with a solid waste cover or solid waste cover enhanced with a geomembrane to enable collection and flaring/utilisation of greenhouse gases.

(iii) Capping as in (ii) above with additional measures (in alluvial and other coarse-grained soils) such as cut-off walls and extraction wells for pumping and treating contaminated groundwater.

(iv) Any other method is suitable for reducing environmental impact to an acceptable level.

The treatment & disposal of Legacy MSW can be done by bio-remediation and bio-mining. It refers to the excavation of old dumped waste and making windrows of legacy waste thereafter stabilization of the waste through bio-remediation i.e. exposure of all the waste to air along with the use of composting bio-cultures, followed by its sustainable management through recycling, co-processing, road making etc.

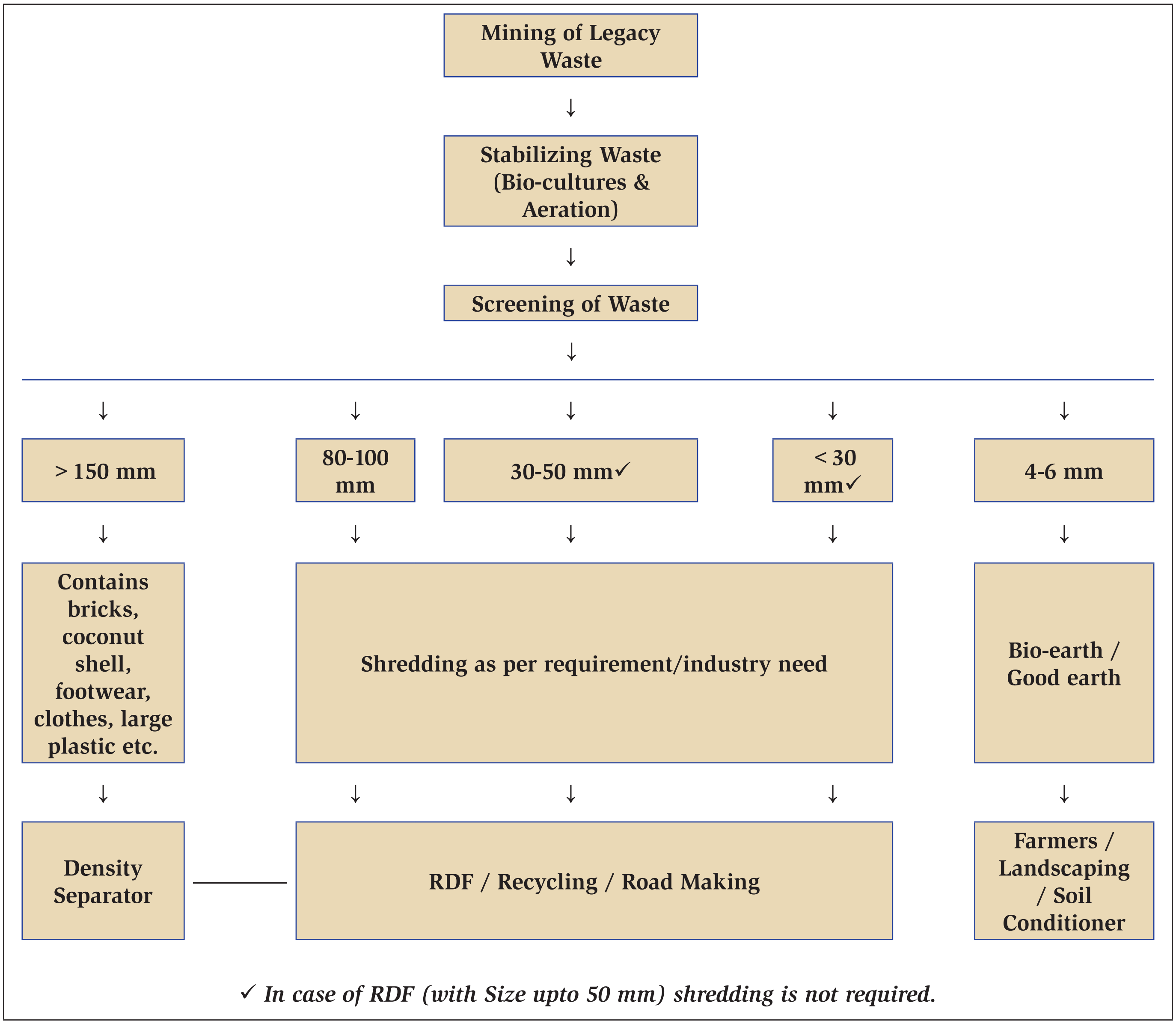

Figure 18(I).1: Overview of Bio-remediation & Bio-mining of Legacy Waste

Source: *Guidelines for Disposal of Legacy Waste (Old Municipal Solid Waste) by CPCB, published by February 2019*

Steps towards Compliance: Initiatives at Dhapa Legacy Waste Site, Kolkata

A portion of the existing Dhapa site was scientifically closed with all precautionary measure and the other site is still in use to receive Municipal Solid Waste. The details of closure and containment of old MSW dumpsite at Dhapa is discussed in the section "Success Stories on Environmental Issues".

Figure 18(I).2: Location of Active and Closed MSW Dumping Ground at Dhapa in Kolkata, India

Source: Google Earth

Biomining at Dhapa Active MSW Dumpsite

- ➢ West Bengal Pollution Control Board, in association with IIT Kharagpur has conducted a study at Dhapa active dumpsite to study the feasibility of bio-mining in June 2019.
- ➢ Kolkata Municipal Corporation has started biomining of legacy waste on and from 03rd January 2020.
  - ✓ Trommel with a capacity of 600 TPD installed for bio-mining.
  - ✓ Excavator, Backhoe loader and other supporting vehicles deployed.
  - ✓ A fraction of waste will be used as a soil conditioner in the nearby compost plant.
  - ✓ Moreover, Kolkata Municipal Corporation is already in the process of finalization for engagement of an agency to clear a total of 40,00,000 metric tons legacy from approximately 60 Acre land within the next 3 years.
  - ✓ 300 KLD leachate Treatment Plant is also set up at Dhapa to receive the leachate water from the landfill sites.

Figure 18(I).3:Trommel Installed for Bio-mining at Dhapa

Figure 18(I).4: Compost Plant at Dhapa

Bio-mining in the legacy waste site at Rajiv Nagar, North 24 Parganas

Rajiv Nagar site is under the jurisdiction of South Dum-Dum Municipality. The total area of the site is approximately 22 Acre land and the height of the waste is about 15 meters. The dumpsite is surrounded by the Residential area i.e, Adarsh Nagar, Mathkhol school and four-lane Belghoria Expressway and a pond. A key arterial road is linking the terminal junction points of NH19 and NH16 near Dankuni to Dakhineswar across Nivedita Setu and NH12 (Jessore Road) near Dum-Dum Airport. Presently the waste inflow is only from four ULBs i.e, Dum-Dum, South Dum-Dum, North Dum-Dum and Baranagar.

The Hon'ble National Green Tribunal *Suo Moto* initiated the case O.A. No. 70/2016/EZ on a report received from the Registry that a vast area of Mouza Rajiv Nagar, Ward No. 35 under Kamarhati Municipality was being used for dumping of garbage and municipal solid waste indiscriminately which had the potential of causing air and water pollution.

The NGT directed that all necessary actions for dealing with the issue should be completed following the Solid Waste Management Rules, 2016. The Chief Secretary, Government of West Bengal has to submit a report on the present status in respect of the implementation of the Solid Waste Management Rules, 2016 with particular reference to the present dumping ground.

The consequential status report filed by the Chief Secretary was taken up on 10.07.2020.

As per the direction of the Hon'ble Tribunal, the Urban Development & Municipal Affairs Department (UD&MA Deptt.) of Government of West Bengal has finalized the plan for processing of legacy waste at Rajiv Nagar. It is expected to take 27 months for processing the entire legacy waste and work is expected to be completed within 31st December 2022. The municipal solid waste will be processed through bio-mining, bio-remediation, compost, Material Recovery Facility (MRF), Refuse Derived Fuel (RDF) and Sanitary Landfill (SLF) to reclaim the land.

There is an existing legacy waste of approximately 8.54 lakh tonnes at Rajiv Nagar/Pramod Nagar Site as on 31st of July, 2020. An agency has been engaged with effect from 30th June 2020 for processing of legacy waste initially of 9000 MT scaled upto18,000 MT per month from 1st August 2020 and thereby 2.16 lakh MT annually. At present 600 MT of legacy waste is being transported from Rajiv Nagar to the Dhapa Dumping Ground every day. At Dhapa the agency has an existing compost processing plant to treat the legacy waste of KMC area. State Urban Development Agency (SUDA), as the implementing agency under the administrative control of the UD & MA Department, has issued a work order to M/S Eastern Organic Fertiliser Pvt Ltd.

It is targeted that entire legacy waste will be processed by December 2022 and from January 2023 onwards only fresh municipal solid waste will be processed @550 TPD by way of Windrows Composting (450 TPD), Bio-Methanation (100 TPD), MRF and production of RDF along with disposal of inert at the Sanitary Land Fill.

Figure 18(I).5: Preparation of Bio-mining at Rajiv Nagar

Figure 18(I).6: Legacy Waste Transported to Dhapa from Rajiv Nagar for Composting

Bio-mining in the legacy waste site at Mollar Bheri, North 24 Parganas

Mollar Bheri was the disposal site, where all unprocessed wastes from BMC, NKDA and NDITA, were getting regularly disposed of till December 2019. The total land area of the disposal site is about 55 acre, out of which around 45% area is covered by accumulated garbage.

The average height of dumped solid waste was about 12 ft. The incoming waste from Bidhannagar Municipal Corporation was around 350 TPD and from Nabadiganta Industrial area was around another 150 TPD.

Mollar bheri falls under two different Mouzas. Dhapa Manpur Mouza and Mahisbathan Mouza. The Dhapa Manpur Mouza falls within the ambit of an area characterized by wetlands. Whereas Mahisbatan Mouza is not characterized as a wetland. Several water bodies surround the site. On the northern side, Mollarbheri is surrounded by residential colonies, slum area as well as high rises.

The site is extremely vulnerable to environmental impacts because of :

- Uncontrolled waste dumping.
- The waste stream was of mixed type.
- Disposal was being done unscientifically.
- Aesthetics and health impact to the neighbourhood settlement due to odour and fumes from bio-degradation and open-burning.

That regarding the compliance of direction of Hon'ble National Green Tribunal in respect of Mollar Bheri, the present status is as follows:-

➢ The dumping of solid waste at Mollar Bheri has been stopped permanently from 16/12/2019.

➢ With the financial assistance from the Environment Department, Government of West Bengal, the Bidhannagar Municipal Corporation has completed fencing work of approx. 150 metres around the periphery of the Mollar Bheri dumping site, to prevent spillage of solid waste into the wetland.

➢ As per the decision in a meeting held on 26/06/2020 at State Urban Development Agency, the Bidhannagar Municipal Corporation has started the Bio-mining work at Mollar Bheri w.e.f. 12/07/2020 by setting up a dedicated Trommel.

➢ The Urban Development & Municipal Affairs Department has assessed that 15 (fifteen) months will be required for completion of the bio-mining work at Mollar Bheri; this includes 3(three) months for installation of machinery and the rest 12 (twelve) months for completion of bio-mining work. The work is expected to be started from October 2020 and be completed within December 2021.

Figure 18(I).7: BMC Dumping Site, Mollar Bheri -Preparation of Bio-mining is going on

Figure 18(I).8: BMC Dumping Site, Mollar Bheri - Legacy waste transported to Dhapa for Composting

Conclusion

Solid Waste Management is a serious challenge, West Bengal is no exception. In compliance with the order of Hon'ble NGT, a special initiative started at 8 model Towns and Cities and 69 Gram Panchayats, legacy dumpsites are also being taken care of through the process of Bio-mining. Awareness generation initiative from school level is one of the mandates of WBPCB. All Urban Local Bodies and Gram Panchayats are being motivated to segregate the waste and recycle it as far as possible.

Chapter 18.II

Bio-Medical Waste Management

With rapid civilization and growing population, there has been a significant increase in the generation of solid waste & threat of contamination of air, water and land resources. Medical waste generated from various health care facilities becomes a potential hazardous agent to the environment. Poor management of these wastes results in occupational health hazards, public health hazards. The indiscriminate disposal of BMW results in the spreading of infectious diseases. Apart from these, a part of BMW such as disposable syringes, saline bottles, I.V. fluid bottles etc. is picked up by the rag pickers and are recycled back into the market without any disinfection and treatment. It is essential, therefore, to adopt an appropriate system for safe management & disposal of medical wastes.

With this backdrop, Govt. of India had notified the Bio-Medical Waste (Management and Handling) Rules, 1998 vide notification number S.O. 630 (E) dated the 20th July 1998 providing a regulatory framework for the management of BMW generated in the country. To implement these rules more effectively and to improve the collection, segregation, processing, treatment and disposal of these bio-medical wastes in an environmentally sound manner thereby, reducing the biomedical waste generation and its impact on the environment, the Central Government reviewed the existing rules; and notified the Bio-medical Waste Management Rules, 2016 on 28th March 2016 in supersession of the Bio-Medical Waste (Management and Handling) Rules, 1998.

As per the Bio-medical Waste Management Rules, 2016, "bio-medical waste means any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or research activities pertaining thereto or in the production or testing of biological or in health camps, including the categories mentioned in Schedule I appended to these rules". The rules shall apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle biomedical waste in any form including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories, blood banks, Ayush hospitals, clinical establishments, research or educational institutions, health camps, medical or surgical camps, vaccination camps, blood donation camps, first aid rooms of schools, forensic laboratories and research labs defined as 'Occupier' in the rules.

'Operator' of a common bio-medical waste treatment facility" means Common Bio-medical Waste Treatment Facility (CBMWTF) for the collection, reception, storage, transport, treatment, disposal of BMW.

Table 18(II).1: Acts and Rules on Bio-medical Waste Management

	Law/Regulation Standard	Issued by	Date of issuance
Laws	The Air (Prevention & Control of Pollution) Act, The Water (Prevention & Control of Pollution) Act	GOI	1981, 1974
	Environment Protection Act	MoEF	1986
Regulations	Biomedical waste management and Handling Rules 1998	MoEF	July 20, 1998, Amendments: March 6, 2000, June 2, 2000 & Sept 17, 2003
	Biomedical waste management Rules 2016	MoEFCC	March 28, 2016, Amendments in March 28, 2018 & February 19, 2019
Standards and Technical Guidelines	Guidelines on "Design & Construction of Biomedical Waste Incinerator" and "Common Biomedical Waste Treatment Facility"	CPCB	2003
	Guidelines on safe disposal of Used Needles and Syringes in the Context of Targeted Intervention for Injecting Drug Users	NACO	2009
	Guidelines for disposal of Bio-Medical waste generated during the Universal Immunisation Programme	CPCB	November 2004
	Revised Guidelines for Common Bio-medical Waste Treatment and Disposal Facilities & Guidelines for Bar Code System	CPCB	December 21, 2016, April 2018

New rules specified the responsibilities of all the stakeholders right from Occupiers, Operators, to prescribed State Govt. & Central Govt. authorities.

The features upon which the new rules have emphasized are:

- Authorization to non-bedded Healthcare units.
- Categorization of BMW in four colour codes.
- Maintenance of records.
- Immunization of health care workers.
- Pre-treatment of laboratory waste/microbiological waste/blood samples & blood bags.
- Phasing out use of chlorinated plastic bags.
- Establishment of Bar-Code-System for bags or containers containing BMW&Global Positioning System.
- Development of website for displaying details of authorization, treatment, Monthly Report & Annual Report.
- Disposal of cytotoxic drugs, Disposal of a dead fetus.
- Installation of ETP.
- Up-gradation of an incinerator to achieve the standards for retention time in the secondary chamber and Dioxin and Furans.
- Training for all personnel involved in the handling of & management of biomedical waste.
- Constitution of State level Committee & District Level Committee for better monitoring.
- Inventorisation of Occupiers and data on bio-medical waste generation, treatment & disposal.
- Third-party audits of the common bio-medical waste treatment facilities.

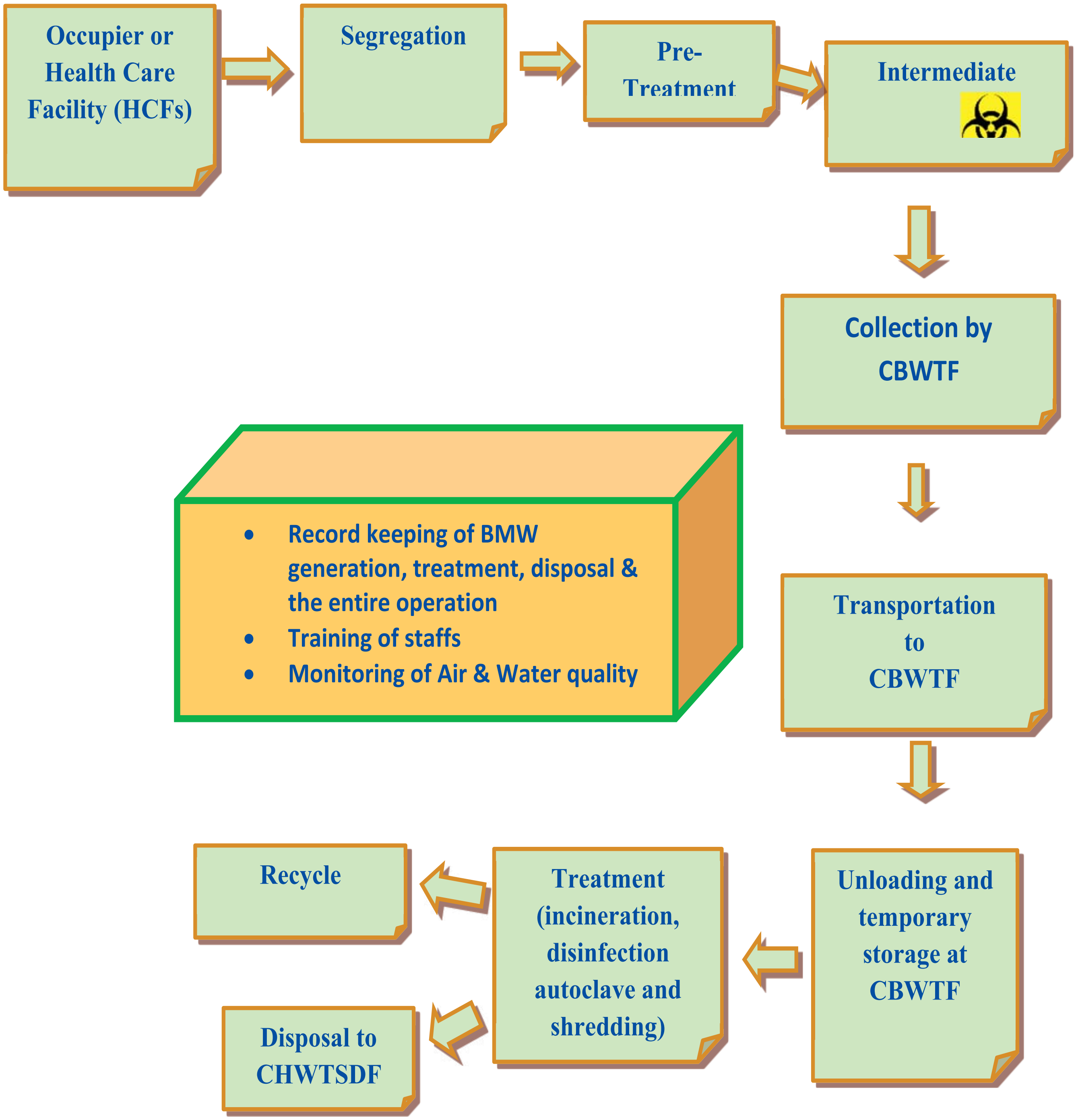

Figure 18(II).1: Biomedical Waste Management in West Bengal

Table 18(II).2: Colour Coding and Type of Container/ Bags to be used for Waste Segregation & Collection

S. No.	Category	Type of waste	Colour & Type of Container
1.	Yellow Category	▪ Human Anatomical Waste ▪ Animal Anatomical Waste ▪ Soiled Waste ▪ Discarded or Expired Medicine ▪ Microbiology, Biotechnology and other clinical laboratory waste ▪ Chemical Waste ▪ Chemical Liquid Waste	Yellow Coloured Non Chlorinated Plastic Bags **(having thickness equal to more than 50 μ) or containers**   **Note** ▪ Chemical liquid waste such as spent hypo of X-Ray should be stored in yellow container and sold to recycler authorised by SPCB/PCC. ▪ Infected secretions, aspired body fluids etc from laboratory should be disinfected before mixing with other wastewater from hospital. ▪ Liquid chemical wastes should be pre treated/neutralised before mixing with other wastewater from hospital.
2.		Contaminated Waste (Recyclable)	Red Coloured Non Chlorinated Plastic Bags (having thickness equal to more than 50 μ) and Containers  
3.	White Category	Waste Sharps including metals	White Coloured translucent, puncture proof, leak proof, Tamper Proof containers  
4.		Glassware Metallic Body Implants	Cardboard boxes with blue colored marking or blue colored puncture proof, tamper proof containers  

Source: Bio-medical Waste Management Rules, 2016 and amendments thereof

Table 18(II).3: CBWTFs Operating in the State

Name of the CBWTF & Address	Treatment Capacity (In no. of beds)	Area of Action	Bar/ QR code status	GPRS waste tracking system
Medicare Environmental Management Pvt. Ltd. 'F' Road, Belgachhia, Dist. Haora	30,000	Haora District, Kolkata, South Twenty Four Parganas	Exists	Exists
Medicare Environmental Management Pvt. Ltd. K-26, Phase – III, Growth Centre, (Behind IOCL LPG Bottling Plant), Kalyani, Nadia	30,000	Nadia, Murshidabad, North Twenty Four Parganas, Kolkata	Exists	Exists
Medicare Environmental Management Pvt. Ltd. Mouza: Mangalpur, P.O.: ShergarhPargana, P.S.: Raniganj, Paschim Barddhaman	30,000	Bankura, Birbhum, Puruliya, Purba & Paschim Barddhaman, Hugli	Exists	Exists
West Bengal Waste Management Ltd. PurbaSrikrishnapur, P.O.: Haldia, Purba Medinipur	15,000	Purba & Paschim Medinipur, Jhargram	Exists	Exists
Green Zen Bio Pvt. Ltd Mouza. Binnaguri, PO. Fulbari, PS. Bhaktinagar, Dist. Jalpaiguri, PIN - 734015	15,000	Entire North Bengal	Exists	Exists
Greentech Environ Management Pvt. Ltd. Dhamua Road, P.S.-Mograhat, P.O-Chakparan Kantakhali, Dist- South Twenty Four Parganas, Pin-743503.	20,000	South Twenty Four Parganas, Kolkata, Murshidabad	Exists	Exists

Source: WBPCB

Role of State Government Departments& West Bengal Pollution Control Board

- **Framing of policies & implementation strategies:** State Level Advisory Committee & District Level Monitoring Committee on implementation of Bio-Medical Waste Management Rules 2016 had been constituted for implementation of the provisions of these rules.

- **Authorization, Monitoring & Surveillance:** West Bengal Pollution Control Board plays its duty as a regulator. It issues ‘Authorization’ and ‘Consent to Operate’ to the Occupiers and the Operators. WBPCB monitors the compliance of various provisions and conditions of ‘Authorization’, ‘Consent to Operate’ through physical inspection, monitoring of air and water quality at both occupiers’ and operators’ facilities. Biomedical Waste tracking is done through GPS by West Bengal Pollution Control Board. Defaulting units are issued notices, hearings are conducted, Environmental Cost & Bank Guarantees imposed, and court cases are filed.

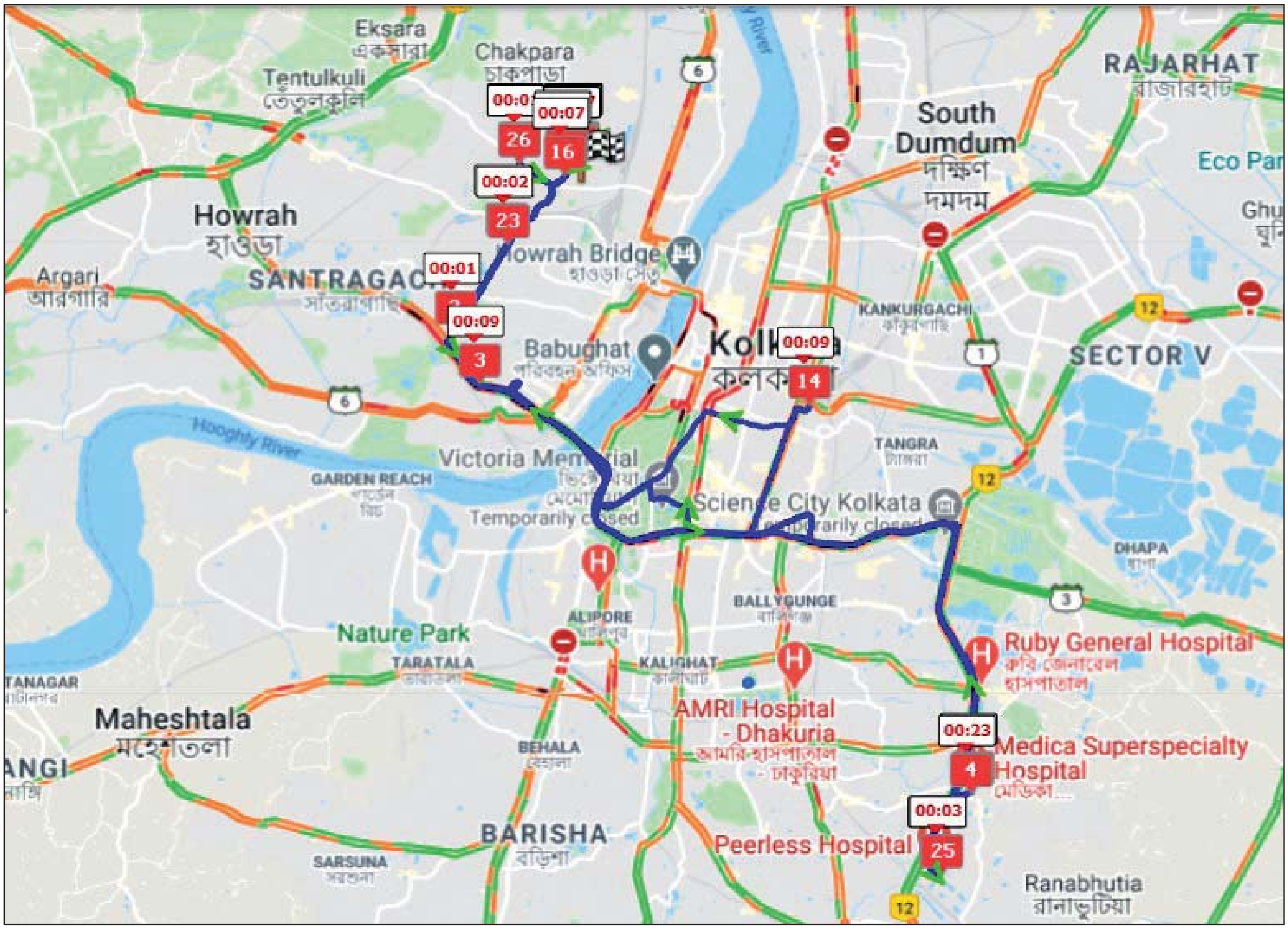

Figure 18(II).2: GPS Tracking of BMW

- **Inventorisation:** In 2010, in collaboration with a Kolkata based NGO, Society for Direct Initiative for Social and Health Action (DISHA), West Bengal Pollution Control Board carried out inventorisation of Health Care Facilities and Biomedical Waste generation, treatment and disposal in the State.

  In 2019-20 West Bengal Pollution Control Board once again carried out inventorisation of Health Care Facilities and Biomedical Waste generation engaging National Productivity Council (An institution under Ministry of Commerce & Industry, Govt. of India) to assess the current status of health care units and bio-medical waste generation, treatment and disposal in the State to ensure better management of biomedical waste and mitigating the gaps.

Key findings of the latest Inventorisation:

- **BMW generation:**

BMW generation is between 316 gm to 594 gm per bed per day. Details are given in Table 18(II).4

Table 18(II).4: Average BMW Generation (Kg/bed/day)

Category of HCU	Average BMW generation in Kg/bed/day
Govt. bedded	
Medical College & Hospital	0.431
District Hospital &Superspeciality hospitals	0.376
State General Hospital & PSUs Hospitals	0.364
Municipal Hospitals	0.345
Sub-Divisional Hospital	0.344
Rural Hospital	0.342
Block Primary Health Centre	0.323
Primary Health Centre	0.316
Pvt. bedded	
Private HCUs (> 200 beds)	0.594
Private HCUs (51-200 beds)	0.462
Private HCUs (50 beds)	0.361
Pvt. Non-bedded	
Diagnostic Centre & Pathological Lab	0.768

- **The proportion of BMW in total solid waste generation in hospital:** Out of total solid waste generated in the hospital BMW is 15% to 20%, rest is a municipal solid waste & other waste.
- **The proportion of Recyclable and Non-Recyclable BMW:** Generally plastic, glass and metal in BMW are recyclable items. 54% of the total BMW is recyclable.

Third-Party Audit of CBWTFs

West Bengal Pollution Control Board has conducted a third-party audit in 2019-20 engaging CSIR-NEERI, Nagpur for evaluation of the performance of the existing CBWTFs in West Bengal.

Key findings of the Audit

- All six CBWTFs have adequate capacity for treatment of BMW w.r.t. incinerator, autoclave, and shredder.
- All CBWTFs have Bar Code System & GPRS System for BMW tracking.
- CBWTFs are compliant with Revised Guidelines of CPCB for setting up of a CBWTF & BMWM Rules, 2016 for collection, transportation, treatment & disposal of BMW.
- CBWTFs are required to improve their overall housekeeping, systematic storage of BMW, incinerator ash, record keeping and personal protection of staffs engaged in handling & management of BMW.

Awareness & Training

Total no. of training conducted in 2019 by different stakeholders like Occupiers, Operators & prescribed authorities like Health & Family Welfare, GoWB & WBPCB is 3992. In the last 3 years, 7053 nos training programs were conducted by WBPCB & other stakeholders. Apart from this in 2019, WBPCB engaged National Productivity Council to conduct training programs on various waste management rules which covers biomedical waste.

Figure 18(II).3: Training Programme Conducted by WBPCB and other Stakeholders

Table 18(II).5: Present Scenario of BMW Management in West Bengal

Total No. health care units in the State: 8509
Total non-bedded units: 5501
Total Bedded unit: 3008
Total no. of beds: 126143
Total BMW generated, collected, treated & disposed in 2019: 41571.4 kg/day
BMW generation per bed per day: 330 gm

Source: Bio-medical Annual Report, 2019

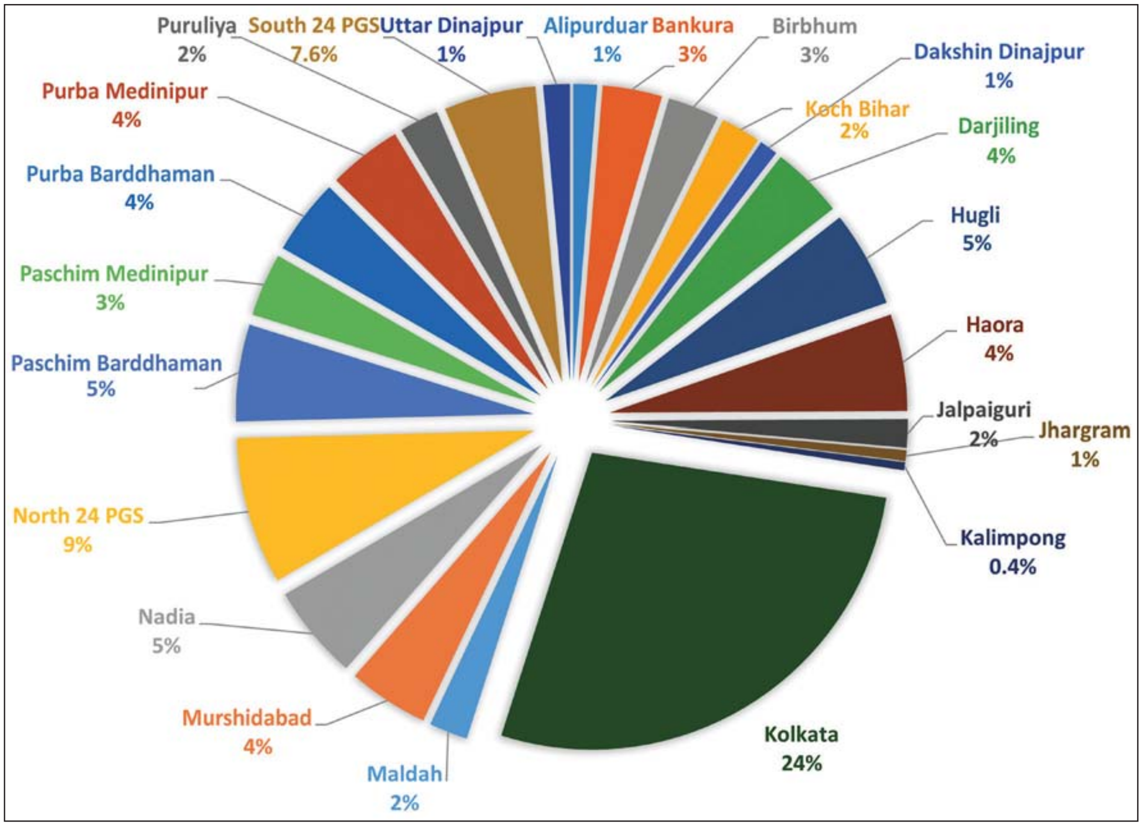

Figure 18(II).4: District Wise Distribution of BMW Generation

COVID 19 Waste Management in West Bengal

- Historic COVID 19 pandemic has struck India badly since March; 2020. COVID 19 pandemic was an unknown threat to the environment. Effective COVID 19 waste management was utmost important because of the infectious nature of COVID 19 waste. The greatest challenge ever faced by WBPCB is the Collection, Segregation, Transportation and Disposal of highly infectious COVID 19 waste. The Board is dedicated to playing its role as a regulator. To achieve the goal of providing safe handling of COVID 19 waste, WBPCB left no stone unturned. During the process, in the service of the people of State, many of the officials of WBPCB got infected but the journey continues.

The role played by WBPCB
• Circulated Guidelines of Hon'ble NGT, CPCB
• Meeting with Stakeholders
• Awareness Generation
• Worked as a Coordinating Agency involving the Civil Society Experts
• Monitoring &Surveillance using a digital platform
• Regulatory Actions, Imposing Environmental Compensation on non-compliant HCF
• Providing technical guidance & training to personnel engaged in COVID 19 Waste Management through digital mode, physical meeting
• Tracking COVID 19 waste online from generators, waste handlers/ collectors to CBWTFs
• Bridging the gaps quickly through phone calls, Video Conference &Whasapp message & emails
• Monitoring of water quality in the major rivers including the Ganga &Monitoring Air Quality

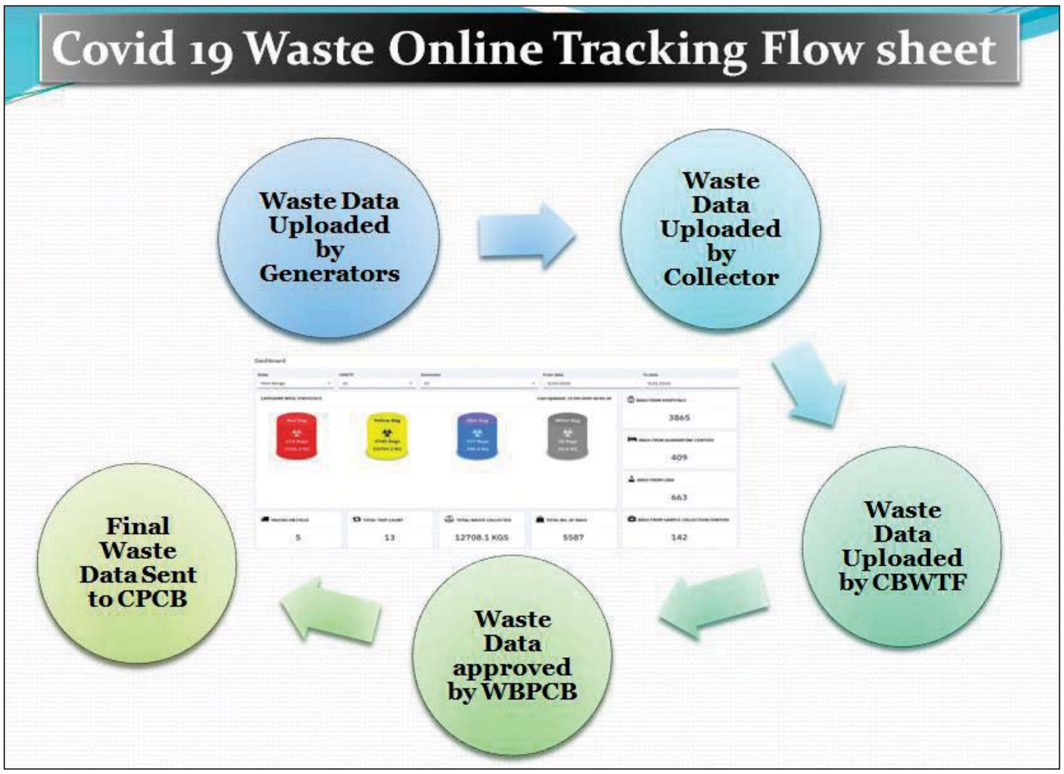

Figure 18(II).5: COVID 19 Online Tracking Flow Sheet

Figure 18(II).6: Awareness through Posters & Pamphlets & Media

Figure 18(II).7: Interaction with Housing Society through Webinar

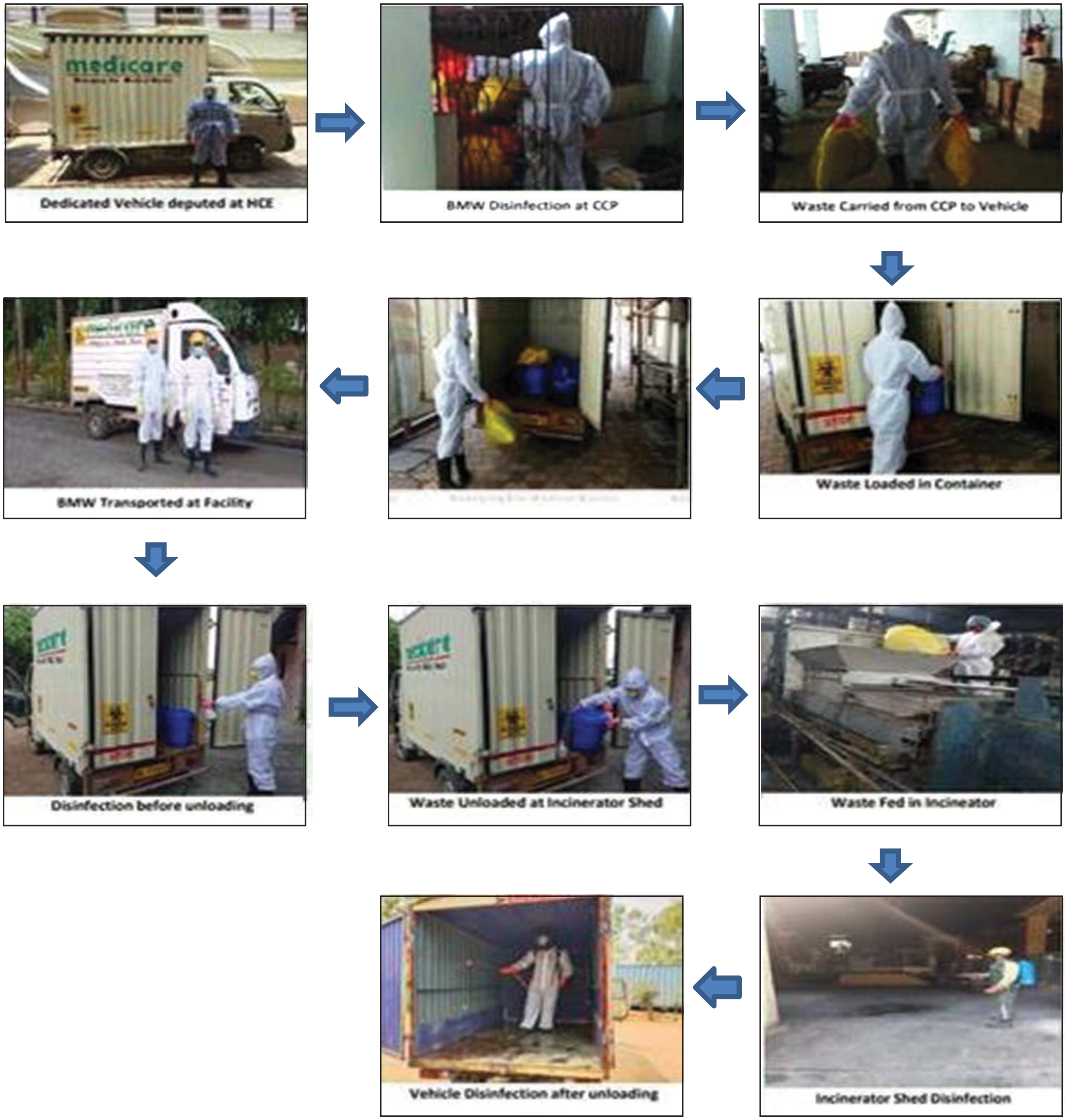

Figure 18(II).8: Pictorial Representation of COVID 19 Waste Management

Figure 18(II).9: COVID 19 Waste Collection from Home Quarantine

Challenges encountered in COVID 19 waste management by WBPCB:

- Overcoming the fear psychosis
- Cost of PPE, disinfection/sanitizing protocols along with cost involved for a dedicated vehicle for COVID 19 waste transportation were the addendums of expenditure to the service providers
- Shortage of human resources because of highly transmittable disease remained ever-challenging problems
- Prolonged lockdown and problem for the movement of human resources & technical resources
- Motivating Urban local bodies in COVID 19 waste management in policymaking & its implementation strategies because earlier ULBs were responsible for the management of solid waste only
- Interruption due to Super Cyclone AMPHAN
- Collection, Transportation, Treatment & Disposal of COVID 19 waste from home quarantine

Table 18(II).6: COVID 19 Waste Management as on 30.09.2020

A brief scenario of COVID 19 waste management as on 30.09.2020:	
Number of COVID 19 hospitals	92
Number of COVID 19 beds	12675
The number of govt. quarantine centres	2439
Qty of COVID 19 waste generated, treated & disposed from COVID hospitals/ quarantine centres up to April 2020	50 MT
In May 2020	170.5 MT
In June 2020	262.7 MT
In July 2020	276.7 MT
In August 2020	465.3 MT
In September 2020	434.8 MT
Qty of COVID 19 waste collected, treated & disposed from home quarantine up to 30.09.2020	30 MT

Source: Status Report of COVID 19 Waste Management up to 30.09.2020 as maintained by WBPCB.

West Bengal Pollution Control Board has won the SKOCH ORDER OF MERIT Award by qualifying in the Semifinal of SKOCH Award 2020 in COVID 19 Waste Management.

Figure 18(II).10: SKOCH ORDER OF MERIT Award

Chapter 18.III

Hazardous Waste Management

One of the prime mandates of the West Bengal Pollution Control Board (WBPCB) is to ensure safe collection, storage, treatment, disposal and transport of various types of hazardous waste from industries.

Hazardous waste is primarily generated from industrial activities and is required to be managed in an environmentally safe manner. The management of the hazardous waste is regulated as per the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 (HOWM Rules, 2016), notified by Ministry of Environment, Forest and Climate Change, Govt. of India under the Environment (Protection) Act, 1986. Thereafter the Rules were amended thrice in the years 2017, 2018 and 2019. First Amendments Rules, 06.07.2016, Second Amendments Rules, 28.02.2017, Third Amendments Rules, 11.06.2018 & Fourth Amendments Rules, 01.03.2019.

The HOWM Rules, 2016, lays down provisions concerning generation, packaging, storage, transportation, recycling/ reprocessing, utilization, treatment, disposal, etc. of hazardous waste and obtaining authorization from West Bengal State Pollution Control Board (WBPCB).

The HOWM Rules, 2016, also lays down the responsibility of the occupier of hazardous waste for their safe and environmentally sound management following the waste management hierarchy viz. prevention, minimization, reuse, recycle, recovery, utilization and lastly safe disposal. The recycling and utilization as a resource or energy recovery of hazardous waste are a preferential option over the disposal of hazardous waste since it conserves resources and leads to a reduction of the carbon footprint. Utilization of hazardous waste by co-processing in cement Kiln has proven a sustainable option because there is a dual benefit in terms of utilizing the waste as supplementary fuel as well as alternative raw material.

The HOWM Rules, 2016, stipulates provisions for maintaining records and filing annual returns on hazardous waste generation and their management. As per Rule 20(2) of the HOWM Rules, 2016, the occupier handling hazardous waste and operator of the disposal facility are required to submit the annual return (about hazardous wastes generation, storage, recycling, utilization, disposal, etc) in the prescribed Form (Form-4) to WBPCB by 30th June of every financial year. Based on this, WBPCB prepares an annual inventory of the waste generated, recycled, utilized, disposed of, etc. for the state of West Bengal and submits the same to CPCB by 30th September of every financial year following the provisions stipulated under Rule 20(3) of the HOWM Rules, 2016. And, as per Rule 20(4) of the HOWM Rules, 2016, CPCB is required to prepare a consolidated report on the management of hazardous wastes and submit the same to the Ministry of Environment, Forest and Climate Change before 30th December once in every year. This inventory report on hazardous waste generation and its management has accordingly been prepared for the financial year April 2019- March 2020.

The inventory report outlines state wise/ district wise generation of hazardous waste (i.e landfillable, incinerable, recyclable and utilisable) their recycling, utilization, disposal and storage including details of hazardous waste imported and exported from/to other parts of the country along with details on inter-state movement of hazardous waste within the country; availability of recycling/ utilization facilities and common/captive TSDFs.

Status of Hazardous Waste Management

There are 809 numbers of active hazardous waste generating units in West Bengal. Amongst the twenty-three districts of the state, one district (Dakshin Dinajpur) does not generate hazardous waste. The total quantum of hazardous waste generation from West Bengal is 1,48,798.35 metric tonnes per annum (MTPA) for 2019-20, out of which 22.57 per cent (33577.68 MTPA) is landfillable, 32.79 per cent (48791.16 MTPA) is recyclable, and the 14.43 per cent (21469.72 MTPA) is incinerable by nature. Interestingly, it was observed that the majority of hazardous waste generating units in the state is small and is generating a meagre quantity of waste, whereas the units generating a substantial amount of hazardous wastes are limited in number. The category-wise hazardous waste generation in the state is given in Figure 18(III).1.

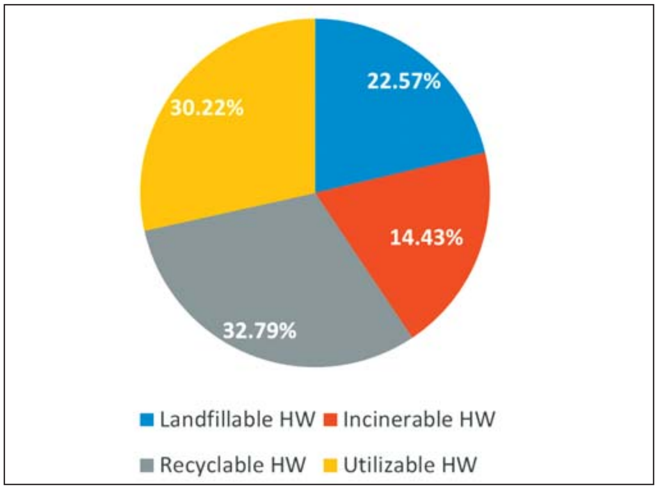

Figure 18(III).1: Category wise Hazardous Waste Generation in the State

As per the HOWM Rules, 2016 and rules made thereunder, WBPCB prepared an Annual Inventory for the financial year 2019-20 for submission to CPCB. Table 18(III).1 shows the inventory of hazardous waste generating units in West Bengal.

Table 18(III).1: Inventory of Hazardous Waste Generating Units in West Bengal

Total Number of Districts in West Bengal	23
Total Hazardous Waste Generation	**148798.35**
Districts having Hazardous Waste Generating Units	22
Total Number of Hazardous Waste Generating Units Identified	1049
Total Number of Operative Hazardous Waste Generating Units	809
Breakup of Total Quantity of Hazardous Waste Generation in West Bengal	
Incinerable Hazardous Waste (in MTA)	21469.72
Recyclable Hazardous Waste (in MTA)	48791.16
Disposable Hazardous Waste (in MTA)	33577.68
Utilizable Hazardous Waste (in MTA)	44959.79

District –wise HW generating industries as well as the quantity of hazardous wastes generated in West Bengal in the financial year 2019-20 is tabulated in Table 18(III).2.

Table 18(III).2: District –Wise Quantity of Hazardous Wastes Generated

Sl. No.	District	No. of Industries Submitted HW Annual Return FY 2019-20	HW Generated during the FY 2019-20 in MTA				
			Landfillable	Incinerable	Recyclable	Utilizable	Total
1	Darjiling	3	0.00	0.56	0.01	0.00	0.56
2	Jalpaiguri	7	0.52	75.62	39.15	0.00	115.28
3	Koch Bihar	1	0.10	0.00	0.00	0.00	0.10
4	Uttar Dinajpur	1	0.00	0.16	0.00	0.00	0.16
5	Dakshin Dinajpur	0	0.00	0.00	0.00	0.00	0.00
6	Maldah	3	0.00	3.20	200.40	0.00	203.60
7	Birbhum	2	0.05	4.00	8.02	0.00	12.07
8	Murshidabad	6	0.10	6.48	44.56	0.00	51.14
9	Purba Barddhaman	9	348.52	0.62	3.49	0.00	352.63
10	Nadia	17	253.24	2.37	524.09	0.00	779.70
11	Puruliya	2	0.07	0.19	18.25	0.00	18.51
12	Bankura	7	16.09	126.79	437.23	0.00	580.11
13	Hugli	33	5711.75	77.17	12319.96	0.00	27157.33
14	North 24 Parganas	55	1975.97	34.07	4457.80	279.79	6747.63
15	Paschim Medinipur	21	4070.01	13.27	801.53	44500.00	49384.81
16	Haora	143	11754.98	109.70	7582.22	0.00	19446.89
17	Kolkata	95	329.03	425.87	626.80	180.00	1561.70
18	South 24 Parganas	43	205.80	95.26	4711.30	0.00	5012.37
19	Purba Medinipur	24	6742.00	20426.24	7603.05	0.00	34771.29
20	Kalimpong	1	0.00	0.00	0.00	0.00	0.00
21	Alipurduar	1	0.00	0.00	0.00	0.00	0.00
22	Paschim Barddhaman	29	2167.66	68.13	9409.60	0.00	11645.40
23	Jhargram	5	1.80	0.03	3.70	0.00	5.53
	Total	**508**	**33577.68**	**21,439.01**	**48791.16**	**44959.79**	**148798.35**

Source: Annual Inventory of Hazardous Wastes for 2019-2020, WBPCB

Hazardous Waste Generating Industries

West Bengal Pollution Control Board has been conducting inventorisation of hazardous waste generating industries in West Bengal from time to time by engaging Institutions or reputed organization. The data obtained from the said inventorisation revealed that the number of active /operating hazardous waste generating industries have reduced in the last couple of years as observed from Figure 18(III).2. Moreover, the actual quantity of hazardous waste generation is less than the authorized quantity as shown in Figure 18(III).3.

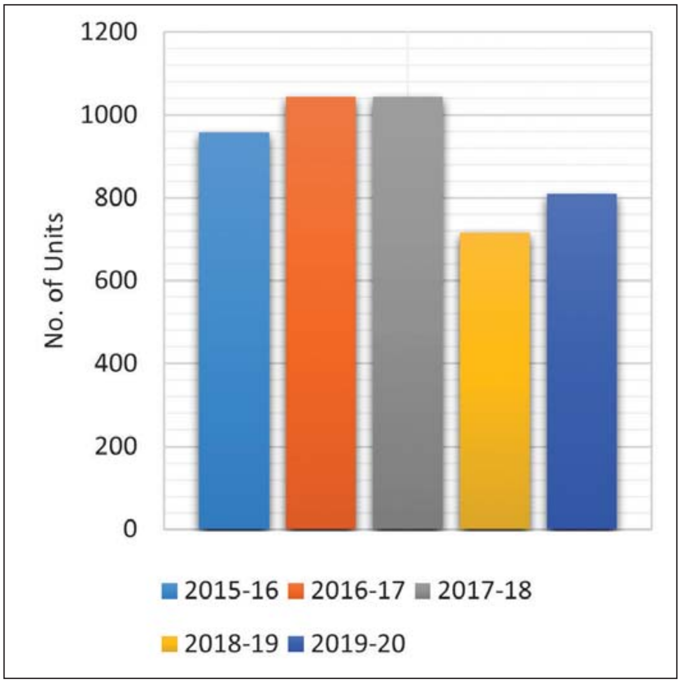

Figure 18(III).2: Number of Hazardous Waste Generating Industries

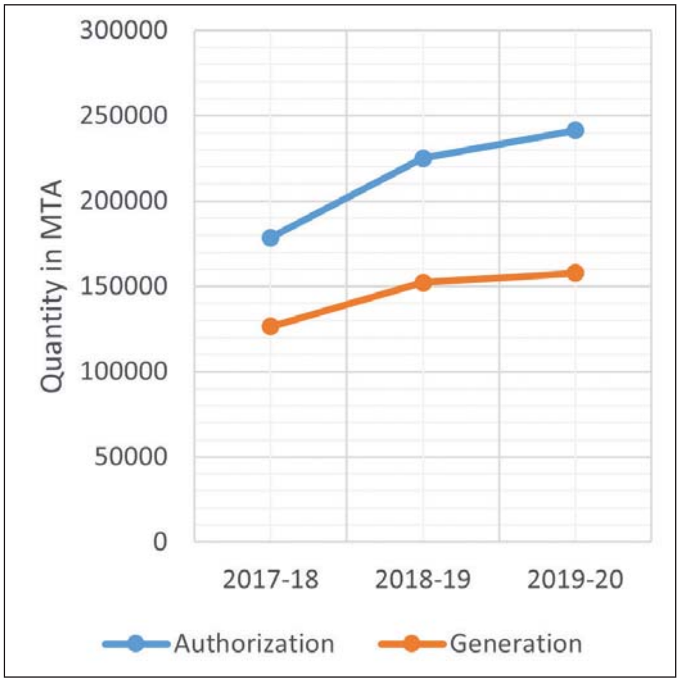

Figure 18(III).3: Status of HW Authorization & Generation

Source: WBPCB

Generation of Hazardous Waste during FY 2019-20

Based on inventorisation report with the assistance of IISWBM, hazardous waste authorization and annual report (Form-4), West Bengal Pollution Control Board has prepared an inventory wherein districts are classified on the basis of Hazardous Waste Generation Quantity as given in Table 18(III).3.

Table 18(III).3: Classification based on Hazardous Waste Generation

Generation Quantity in MTA	Class
> 1000	**A**
100-1000	**B**
10-100	**C**
< 10	**D**

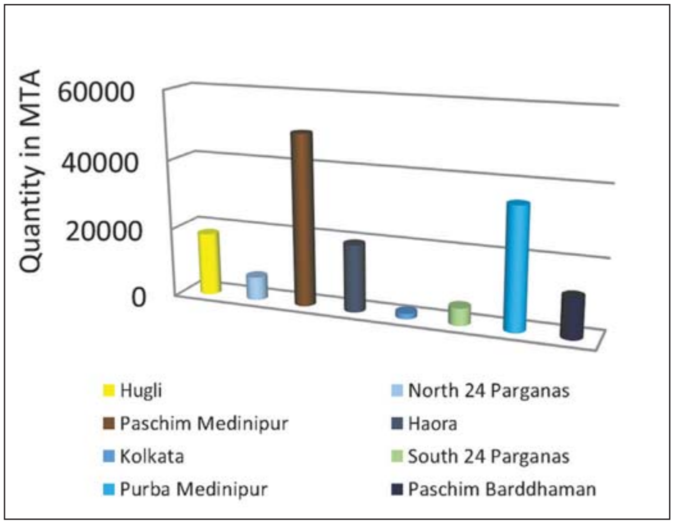

Figure 18(III).4: Status of Hazardous Waste Generation in Class A Districts (Generation More Than 1000 MTA)

Source: WBPCB

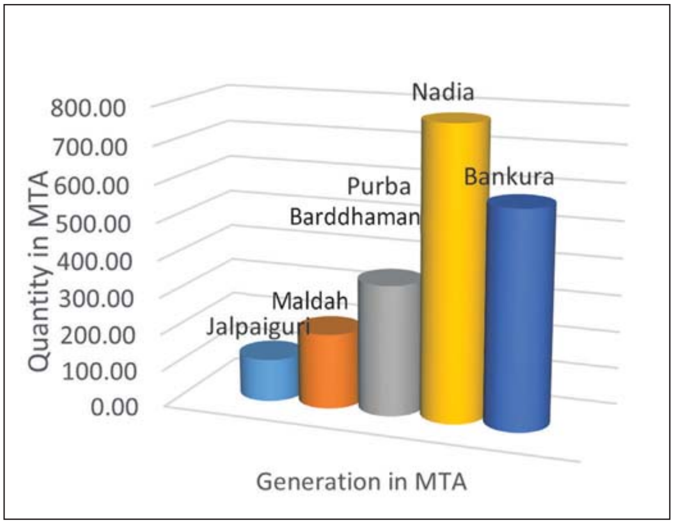

Figure 18(III).5: Status of Hazardous Waste Generation in Class B Districts (Generation 100 To 1000 MTA)

Source: WBPCB

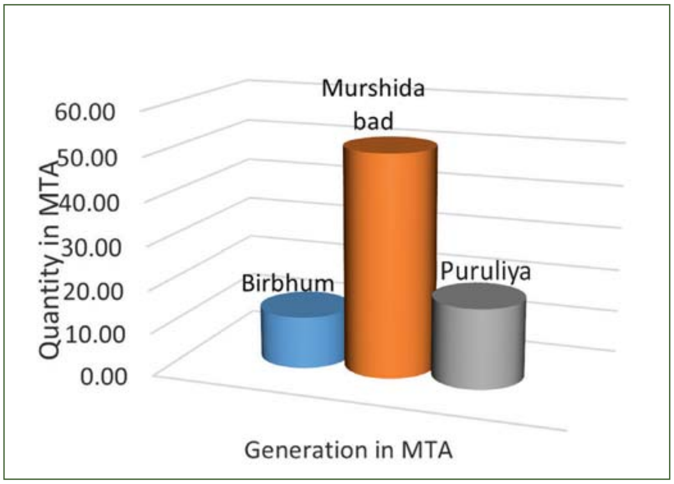

Figure 18(III).6 Status of Hazardous Waste Generation in Class C Districts (Generation 10 To 100 MTA)

Source: WBPCB

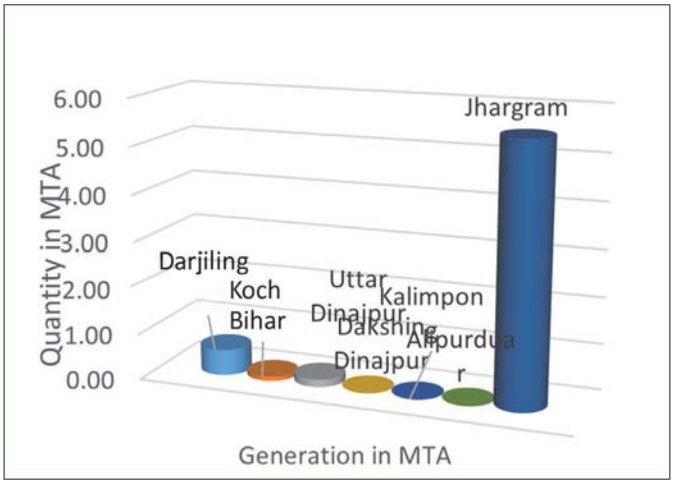

Figure 18(III).7: Status of Hazardous Waste Generation in Class D Districts (Generation Less Than 10 MTA)

Source: WBPCB

Common Hazardous Treatment Storage Disposal Facility (CHWTSDF)

The first Common Storage, Treatment and Disposal Facility (CSTDF) for hazardous waste under the Public-Private Partnership (PPP) have been developed in Haldia. It is a joint venture project of Haldia Development Authority (HDA) and M/s Ramky Enviro Engineers Limited. In April 2003, the Haldia Development Authority (HDA) and M/s Ramky Enviro Engineers Limited formed a joint venture company under the name and style of M/s West Bengal Waste Management Limited to develop and operate the integrated waste management complex for taking care of the industrial hazardous wastes from the entire state of West Bengal. The land for the Common Hazardous Waste Storage, Treatment and Disposal Facility (CHWSTDF) with an area of 70.46 acres is being developed at Mouza Purba Srikrishnapur, J.L. No. 103, P.S. Sutahata, Purba Medinipur. The total land requirement is 200 acres for Phase-I and II. Out of this, 70.46 acres has been acquired and is being utilised for the development of the landfill facility. The temporary storage facility, laboratory and other infrastructure are under Phase-I and installation of the incinerator is under Phase-II. The life of the landfill facility is 30 years. The first cell of the landfill facility with an area of 1.99 acres has been in operation since October 2006. Five such cells will be developed with a total area of 33 acres. Intermediate storage facility, waste stabilization facility and a full-fledged analytical laboratory are also in operation.

The Facility of M/s WBWM Ltd.

Phase -1 under Capping

Incinerator

Storage at Incinerator

Figure 18(III).8: Different facilities of M/s WBWM Ltd.

The WBPCB issued 'Consent to Establish' for the facility on April 28, 2004. After a public hearing on July 30, 2004, the Department of Environment, Government of West Bengal issued environmental clearance on October 18, 2004. Site notification was done by the Government of West Bengal on October 18, 2004.

Industrial Waste Management –Capacities

- ❖ Landfill Capacity - 1,20,000 MTPA
- ❖ Landfill after Treatment - 60,000 MTPA
- ❖ Incineration - 10, 800 MTPA
- ❖ Storage Area (Covered) - 30,000 MTPA
- ❖ Alternate Fuel & Resource Facility (AFRF) - 20000 MTPA

The total project cost for the CHWTSDF is INR 20.0 crores. Out of the financial assistance of Rs. 4 crores, the Ministry of Environment and Forests (MoEF), Government of India would grant Rs. 2 crores and the State Government would grant Rs. 2 crores. A Memorandum of Understanding was signed on January 31, 2006, between MoEF, WBPCB and M/s West Bengal Waste Management Limited. Accordingly, both the WBPCB and the MoEF had released Rs. 80 lakhs each to the West Bengal Waste Management Ltd. as the first instalment. Apart from industrial hazardous wastes M/s. WBWML has also been engaged in collection, treatment and storage of Municipal Solid Waste, Bio-medical wastes and Recycling of Plastic and Paper wastes.

Another CHWTSDF has been set up by the same group at Saltora, Bankura, W.B. This TSDF is yet to commissioned.

Hazardous Waste Received & Disposal

The incinerable and disposable hazardous wastes received by the CHWTSDF is shown in Fig 9 & Fig. 10

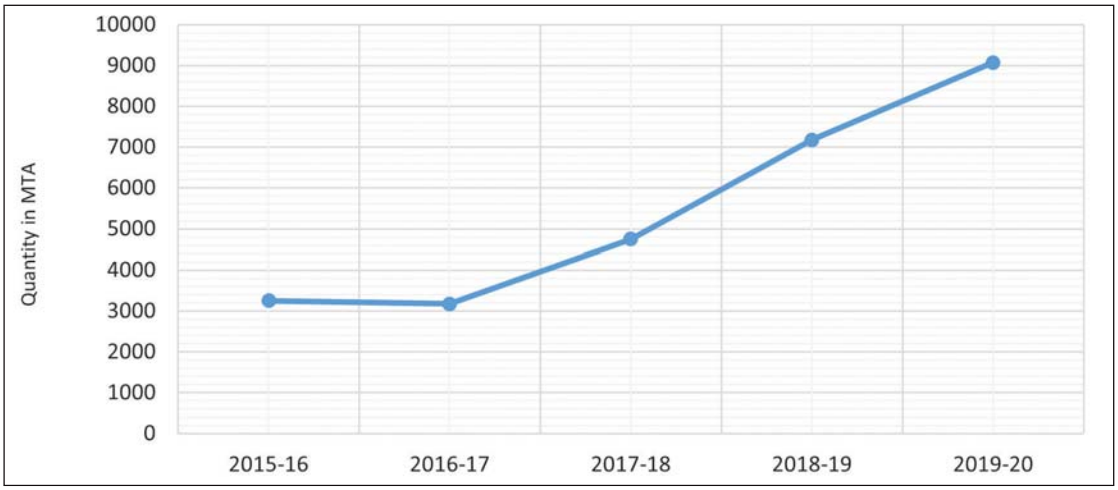

Figure 18(III).9: Status of Incinerable Hazardous Waste Received By CHWTSDF during 2015-2020

Source: WBPCB

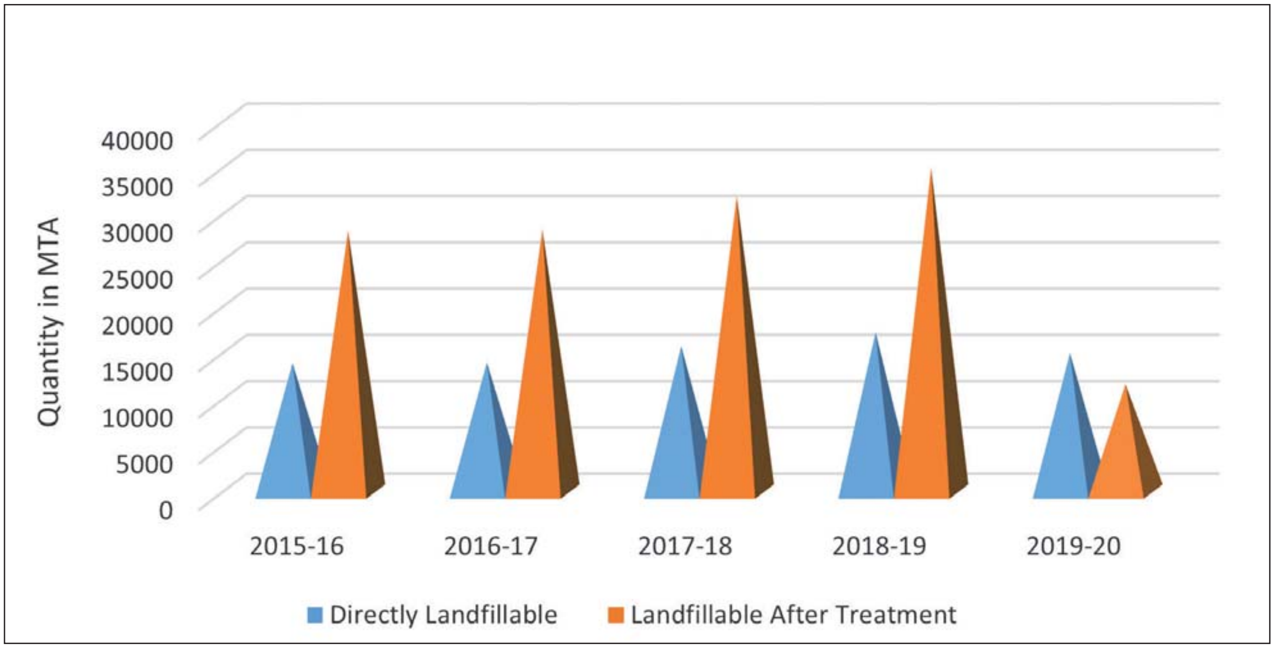

Figure 18(III).10: Status of Landfillable (Directly/ After Treatment) Hazardous Waste Received By CHWTSDF During 2015-2020

Source: WBPCB

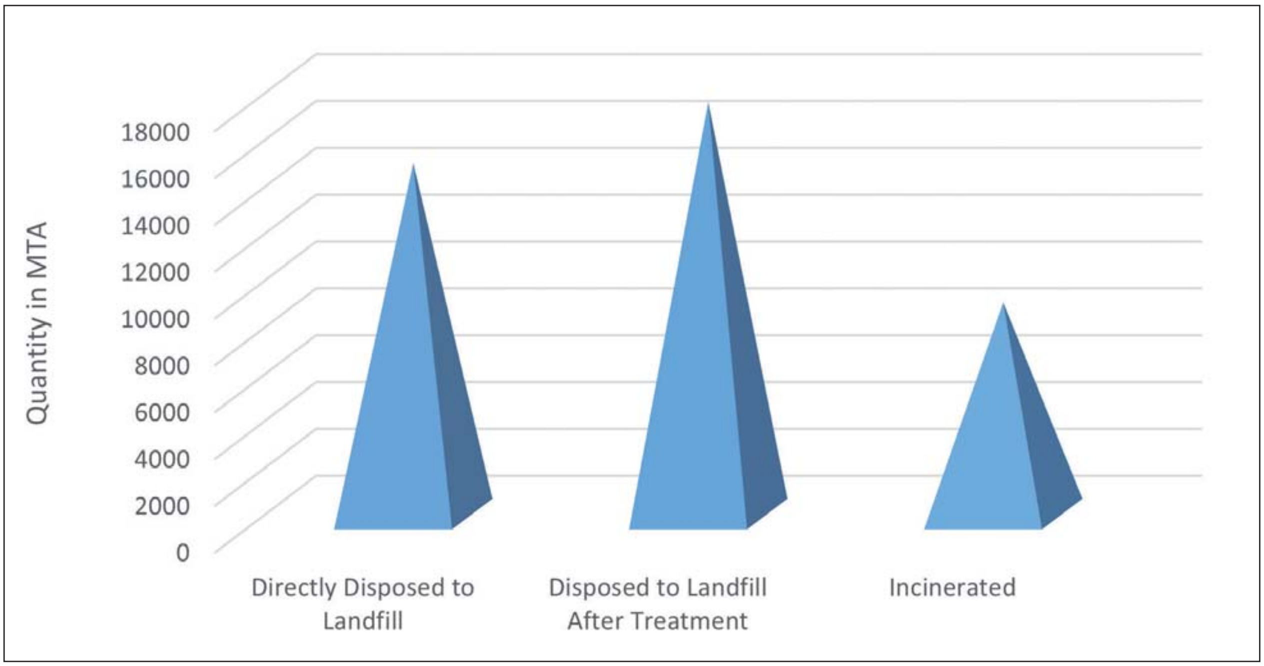

Figure 18(III).11: Quantum of Hazardous Waste Disposed during 2019-20 (Category-Wise)

Source: WBPCB

Escrow Account for Post Closure Monitoring

M/s West Bengal Waste Management Limited has opened Escrow account as per guidelines of CPCB on 3/18/2019 for post-closure monitoring of the closed facility and the total amount deposited in the Escrow account (i.e 5% of annual turnover as per MOEF&CC O.M dated) is Rs 390.76 Lakhs (As on 11.10.2019). The details are available at the WBPCB website; www.wbpcb.gov.in.

Sharing of Incinerator with Sikkim & Assam

As per the agreement, Sikkim State Pollution Control Board had sent incinerable hazardous waste generated in Sikkim to the Common Hazardous Waste Treatment Storage and Disposal facility in Haldia. at the cost of Rs. 2000.00 per ton. The said agreement is valid till 02/12/2021.

M/s. WBWML also requested WBPCB for sharing its Incinerator with Assam for disposal of incinerable hazardous wastes for a capacity 1000 MTA which is under process.

Capacity Building (Workshops/Training)

The Board conducted a good number of awareness programs cum workshops throughout the State involving the stakeholders at the regional level, district level and headquarter level. In the last financial year 2019-20, the Board has conducted 20 nos. of Awareness cum Training Programs at different regional levels with the assistance of the National Productivity Council (NPC).

Figure 18(III).12: Awareness cum Training Programmes Conducted by WBPCB and NPC

Inventorisation of Hazardous Waste in the State Conducted by the State Board

The Board has conducted an inventorisation on Hazardous Waste Generation and its Management in West Bengal with the assistance of Indian Institute of Social Welfare & Business Management (IISWBM), Kolkata in 2019-20. The report is available on our website (www.wbpcb.gov.in). The Board has also conducted Third-Party Audit for CBWTSDFs with the help of IISWBM. The report is available on our website (www.wbpcb.gov.in).

To estimate hazardous waste generation factors for predominant industrial sectors of the State of West Bengal, detailed studies were conducted for their raw material consumption, process, product manufactured and production efficiency to determine the process-specific Hazardous Waste Generation Factors (HWGF) concerning raw material or product quantity.

Keeping in view the variation, the minimum, maximum and average along with standard deviation of HWGFs for selected sectors are given in Table 18(III).4.

Table 18(III).4: Industrial Sectoral Hazardous Waste Generation Range*

S No	Sector	Hazardous Waste		Hazardous Waste Generation Factor (HWGF)*			
		Type	Category	Minimum	Maximum	Average	Standard Deviation
1	Galvanizing	Zinc Ash	6.2	0.00024	0.01126	0.00315	0.00302
		Zinc Dross	A71	0.00024	0.02936	0.00432	0.00683
		ETP Sludge	35.3	0.00003	0.03096	0.00523	0.00901
2	Fabric Dyeing	ETP Sludge	35.3	0.00111	0.02104	0.00609	0.00733
3	Secondary Lead Smelting	Lead Bearing Waste	9.1	0.02632	0.23899	0.10175	0.05707

**For further detail, please visit the website www.wbpcb.gov.in.*

Chapter 18.IV

Plastic Waste Management

Plastic, a marvel of polymer chemistry, are becoming omnipresent in our daily life through a variety of applications. Economic and environmental reasons have propelled increasing use of plastics and reprocessing of plastic waste. Yet indiscriminate use of plastics as well as reprocessing and disposal of the plastic waste, directly and indirectly, affects the ecosystem and living organisms with an increasingly high impact on marine life at a macro and micro level and create health hazards besides causing a public nuisance.

Current Situation in India

According to the FICCI report, the average per capita consumption of plastics in India is 11 kg and the consumption pattern varies one region to another. Per capita consumption will go upto 20 kg at the end of 2020. As per a study conducted by Central Pollution Control Board in collaboration with Central Institute of Plastics Engineering and Technology (CIPET), Ahmedabad on 'Quantification and Characterization of Plastic Waste Generation in 60 Major Cities (2010-12)' in the country, the percentage of plastic waste present in the Municipal Solid Waste (MSW) of the cities is ranging from 3.10% to 12.47%. According to the reports for the year 2017-18, CPCB has estimated that India generates approximately 9.4 Million tons per annum plastic waste (which amounts to 26,000 tons of waste per day), and out of this approximately 5.6 Million tons per annum, plastic waste is left uncollected or littered (9,400 tons of waste per day). Moreover, there is a constant increase in plastic waste generation and one of the major reasons for this is that 50% of plastic is discarded as waste after a single-use. This also adds to an increase in the carbon footprint since single-use plastic products increase the demand for virgin plastic products.

Rules by the Government of India for Management of Plastic Waste

- India's first attempt at tackling the menace of plastic waste came in 2011 when government notified the Plastic Waste (Management & Handling Rules), 2011 to provide a regulatory framework for the management of plastic waste generated in the country.

- To give thrust on plastic waste minimization, source segregation, recycling, involving waste pickers, recyclers and waste processors in the collection of plastic waste fraction either from households or any other source of its generation or intermediate material recovery facility and adopt polluter's pay principle for the sustainability of the waste management system the central government reviewed the existing rules and published Plastic Waste Management Rules, 2016 with specific obligations for every stakeholder in the plastic supply chain, including the extended producer responsibility (EPR) for producers, importers, brand owners. These Rules were further amended and named as "Plastic Waste Management (Amendment) Rules, 2018".

Current Scenario in West Bengal

Most of the plastic manufacturing, processing and recycling industries are medium and small scale and located in clusters in different urban or small town areas in West Bengal. The small scale units are mainly unorganized but adequate in numbers. Kolkata is the main hotspot of these small scale units. Waste scrap plastics are collected from other districts by primary secondary or tertiary handlers and finally transported to these manufacturing/processing units. Haora, Hugli, North 24 Parganas, South 24 Parganas, Purba Medinipur, Paschim Medinipur, Siliguri, Darjiling are the main collecting locations of the waste plastics.

A rapid study on the presence of plastic waste in Municipal Solid Waste in few municipalities by Municipal Engineering Directorate in North 24 Parganas, Jalpaiguri, Bankura and Puruliya municipalities suggest that percentage of plastic waste in MSW vary widely (4% to 24%) depending upon the extent of segregation of other recyclables like glass, metal etc. by rag pickers for selling to recyclers (Source: State Policy and Strategy of Plastics Waste Management for Urban areas of West Bengal).

An annual return submitted by 125 Urban Local Bodies (ULBs) for the year 2019-2020 shows an average of 2279.91 ton/year plastic waste generation in 124 ULBs other than Kolkata. As per annual return of Kolkata Municipal Corporation, during 2019-2020, 1131.84 MT recyclable waste has been collected from 7 Wards during 2019-2020.

West Bengal Pollution Control Board, in collaboration with Jadavpur University, has undertaken up a project in 2019 on inventorization of plastic waste in West Bengal to assess the actual scenario of plastic waste generation. It may help assess the scale of different types of plastic waste including single-use plastic and look for a clear alternative or better management of plastic waste within this State.

Preliminary study shows that plastic waste generation in Kolkata, Haora, Hugli, North 24

Parganas, South 24 Parganas, Purba Medinipur, Paschim Medinipur is 495 MT/day, 150 Mt/day, 72 MT/day, 220 MT/day, 30 MT/day, 8.5 MT/day and 14 MT/day respectively. The numbers of plastic manufacturing units running in these 7 districts have been estimated to be 1170, the number of plastic recycling units are 147 and the number of unorganized plastic waste collection centres/ plastic waste recycling units operating within these districts has been estimated to be 1094.

Critical Issues in Disposal of Plastic Waste

- No organized/systematic system has been developed by the local bodies for collection, segregation, transportation and disposal of plastic wastes. The so-called, rag pickers are not authorized by any agency or department, they work for their interest, pick-up only value-added plastic wastes. However, local body has no data that how much and what type of plastic wastes picked up by them and where it goes. Besides, the rag pickers leave the littered waste including non-recyclable and low-value plastic wastes. Indiscriminate littering, non-biodegradability of plastic waste raise several environmental issues, such as choking of drains, making land infertile and ingestion by cattle leading to death.

- Open burning of plastic waste is a very common phenomenon which generates toxic emissions, such as Carbon Monoxide, Chlorine, Hydrochloric Acid, Dioxin & Furans, Amines, Nitrides, Styrene, Benzene, 1,3-Butadiene, Carbon Tetra Chloride and Acetaldehyde which pollute the environment.

- Non–recyclable plastic wastes such as multilayered & metalized pouches/sachets and thermoset plastic-like SMC/FRP etc. pose several problems. Littered plastic waste, especially plastic carry bags/films give unesthetic look in the surrounding environment, choke the drain and may cause flood during monsoon.
- Sub-standard plastic carry bags, packaging films etc. pose several problems in collection and recycling and are ultimately dumped elsewhere.

- Garbage mixed with plastic waste interferes in recycling and solid waste processing facilities and also causes a problem in landfill operations.

Initiatives of West Bengal Pollution Control Board and Department of Environment since Plastic Waste Management Rules, 2016 came into effect

- Apart from the aforesaid inventorization project, WBPCB is working with the Indian Plastic Federation and State Urban Development Authority (SUDA) to ensure compliance of Extended Producers' Responsibility (EPR) Provisions.

- During the year 2019-2020 several workshops were carried out by the State Board in collaboration with National Productivity Council to generate awareness among different plastic waste generator, producer, brand-owner, manufacturer and recycler.

- The State Board organized an interactive meeting in March 2020 on Effective Implementation of Plastic Waste Management Rules, 2016 and its amendment to ensure effective implementation of EPR and also expedite the disposal of plastic wastes generated at dumpsite of ULBs, big housing complexes, producers and industrial houses.

- Initiatives have been taken to promote eco-friendly products as an alternative to plastic.

Conclusion

It is essential to understand that a plastic product cannot be recycled forever. As plastics are produced from hydrocarbons, at some point they have to be either incinerated in cement or power plants or used to recover oil or dumped in the landfill or used for producing some long-lasting products. Therefore, the plastic life cycle eventually is "from oil to oil" or "from oil to ash (incineration)." So, we will have to develop state-of-the-art facilities for energy recovery and conversion. We will have to do both: ban those products that are not required or have an alternative and improve recycling.

According to a UNEP report published on 5th June 2018, government levies and bans where properly planned and enforced have been among the most effective strategies to limit overuse of disposable plastic products. However, the report goes on to cite the fundamental need for broader cooperation from business and private sector stakeholders, offering a roadmap for upstream solutions, including extended producer responsibility and incentives for adoption of a more circular economy approach to plastic production and consumption.

state of environment report-II
WEST BENGAL

Chapter 18. V

E-waste Management

India is going through an exciting phase of development and economic transformation at an unprecedented pace. This growth has been supplemented with the exponential growth of the electronics sector. Electronic and appliances industry is expected to grow at US $ 400 billion in the domestic market by 2025.

Electronics usage and its growth are irreversible. Faster obsolescence with its technological up-gradation has reasoned the exponential growth of electronics waste (e-waste), which is the fastest growing waste stream in the world. It is also a global challenge due to the presence of hazardous contents.

According to the UN's Global E-waste Monitor 2020, the global quantity of e-waste reached 53.6 Mt (million tonnes) by 2019, an increase of 21 per cent in just five years. This report also predicts that global e-waste discarded products with a battery or plug - will reach 74 Mt by 2030, almost a doubling of e-waste in just 16 years. The said report has observed that India ranked as the third-largest generator of e-waste globally contributing about 6% to e-waste worldwide with 18% yearly growth. India has already generated 3.23 million metric tonnes of e-waste in 2019.

Categories of E-waste

The definition of the Waste Electrical and Electronic Equipment (WEEE)/ E-waste in European Union (EU) is more elaborate and exhaustive. EU defined that ''Electrical and electronic equipment' or 'EEE' means equipment which is dependent on electrical currents or electromagnetic fields to work properly and equipment for the generation, transfer and measurement of such currents and fields falling under the categories set out in Annex IA to Directive 2002/96/EC (WEEE) and designed for use with a voltage rating not exceeding 1000 volts for alternating current and 1500 volts for direct current.

European Union has categorized ten various groups of electrical and electronics products to embrace all categories of the EEE. However, E-Waste (Management) Rules, 2016 in India had defined only twenty-one products to be considered as electronics waste.

Table 18(V).1: Comparison of Categories of E&E Equipment in EU & India

		Items	
S. No	**Categories**	**EU**	**India**
1.	Large household appliances	• Large cooling appliances • Refrigerators • Freezers • Other large appliances used for refrigeration, conservation & storage of food • Washing machines • Clothes dryers • Dishwashing machines • Cooking • Electric hot plates • Microwaves • Other large appliances used for cooking and other processing of food • Electric heating appliances • Electric radiators • Other fanning, exhaust ventilation and conditioning equipment	Not Applicable

		Items	
S. No	Categories	EU	India
2.	Small household appliances	• Vacuum cleaners • Carpet sweepers • Other appliances for cleaning • Appliances used for sewing, knitting, weaving and other processing for textiles • Iron and other appliances for ironing, mangling and other care of clothing • Toasters • Fryers • Grinders, coffee machines and equipment for opening or sealing containers or packages • Electric knives • Appliances for hair-cutting, hair drying, tooth brushing, shaving, massage and other body care appliances • Clocks, watches and equipment for the purpose of measuring, indicating or registering time scales.	Not Applicable
3.	IT and telecommunications equipment	• Centralized data processing • Mainframes • Minicomputers • Printer units • Personal computing: • Personal computers-CPU mouse, screen & keyboard • Laptop computer- CPU, mouse, screen and keyboard included) • Notebook computers • Notepad computers • Printers • And other products or equipment of transmitting sound, images or other • information by telecommunications • Copying equipment • Electrical and electronic typewriters • Pocket and desk calculators • And other products and equipment for the collection, storage, processing, presentation or communication of information by electronic means • User terminals and systems • Facsimile • Telex • Telephones • Pay telephones • Cordless telephones • Cellular telephones • Answering systems	• Centralized data processing, Mainframes, • Minicomputers • Personal computing: Personal Computers (CPU with input and output devices) • Personal computing: Laptop computer (CPU with input and output devices) • Personal computing: Notebook • Personal computing: Notepad, • Printers including cartridges • Copying equipment, • Electrical and electronic typewriters • User terminals and systems • Facsimile, • Telex • Telephones • Pay telephones • Cordless-phones • Cellphones • Answering systems

S. No	Categories	Items EU	Items India
4.	Consumer equipment	• Radio sets • Television sets • Video cameras • Video recorders • Hi-fi recorders • Audio amplifiers • Musical instruments • Other products or equipment to record or reproduce sound or image, including signals or other technologies for the distribution of sound and image than by telecommunications	• Television sets including Liquid crystal display & Light-emitting diode technology • Refrigerator • Washing machine, • Air-conditioners excluding centralized air conditioning plants • Fluorescent & mercury-containing lamps
5.	Lighting equipment	• Luminaries for fluorescent lamps except for luminaries in households • Straight fluorescent lamps • Compact fluorescent lamps • High-intensity discharge lamps, including pressure sodium lamps and metal lamps • Low-pressure sodium lamps • Other lighting or equipment for the purpose of spreading or controlling light except for filament bulbs	Not Applicable
6.	Electrical and electronic tools (with the exception of large-scale stationary industrial tools)	• Drills • Saws • Sewing machines • Equipment for turning, milling, sanding, grinding, sawing, cutting, shearing, drilling, making, holes, punching, folding, bending or similar processing of wood, metal and other materials • Tools for riveting, nailing or screwing or removing rivets, nails, screws or similar uses • Tools for welding, soldering or similar use • Equipment for spraying, spreading, dispersing or other treatment of liquid or gaseous substances by other means • Tools for mowing or other gardening activities	Not Applicable
7.	Toys, leisure and sports equipment	• Electric trains or car racing sets • Hand-held video game consoles • Video games • Computers for biking, diving, running, rowing, etc. • Sports equipment with electric or electronic components • Coin slot machines	Not Applicable

		Items	
S. No	Categories	EU	India
8.	Medical devices (except for all implanted and infected products)	• Radiotherapy equipment • Cardiology • Dialysis • Pulmonary ventilators • Nuclear medicine • Laboratory equipment for in-vitro diagnosis • Analysers • Freezers • Fertilization tests • Other appliances for detecting, preventing, monitoring, treating, alleviating illness, injury or disability	Not Applicable
9.	Monitoring and control instruments	• Smoke detector • Heating regulators • Thermostats • Measuring, weighing or adjusting appliances for household or as laboratory equipment • Other monitoring and control instruments used in industrial installations (e.g. in control panels)	Not Applicable
10.	Automatic dispensers	• Automatic dispensers for hot drinks • Automatic dispensers for hot or cold bottles or cans • Automatic dispensers for solid products • Automatic dispensers for money • All appliances which deliver automatically all kind of products	Not Applicable

E-waste- Indian Scenario- Legislative Provision

Ministry of Environment, Forests and Climate Change (MoEF&CC), Government of India is the nodal agency responsible for policy, planning, promoting and coordinating the environmental programmes and is involved in enacting laws, guidelines referring to e-waste. MoEF&CC frames the regulations in the country for managing all waste materials including electronic waste.

MoEF&CC notified E-Waste (Management) Rules, 2016 on 1st October 2016 where environmentally sound dismantling and recycling through authorised dismantlers and recyclers have been prescribed.

The Central Pollution Control Board (CPCB) is implementing agency under MoEF&CC to implement the rules from central level and State Pollution Control Board (SPCB) or Pollution Control Board (PCB) under the State Governments is responsible from State Government level for implementation procedures to ensure proper management of rules set forth by the MoEF&CC.

The salient features of the E-Waste (Management) Rules, 2016 are reproduced below:

- E-waste is defined as "electrical and electronic equipment, whole or in part discarded as waste by the consumer or bulk consumer as well as rejects from manufacturing, refurbishment and repair processes". All manufacturers, dealers, and importers of electronic goods are responsible to manage their electronic products till their end-of-life.

- 'Electrical and electronic equipment' in turn has been defined to mean equipment which is dependent on the electric current or electromagnetic field in order to become functional.
- Manufacturers or importers or PROs to establish e-waste collection centres or employ take-back systems.
- Manufacturers to provide information to consumers on how to properly dispose of the electronics in order to prevent people from dumping their electronics with domestic waste.
- Specific responsibilities are defined for each stakeholder engaged in the management of electronic waste including producer, dealers, bulk consumer, collection centres, dismantlers, and recyclers disposal etc.
- Extended Producer Responsibility (EPR), a policy instrument for streaming e-waste to formal recyclers, has been further strengthened.
- Collection targets under EPR have been introduced from 10% during 2017–2018, enhancing 10% yearly to 70% during 2022–2023.
- Reduction of Hazardous Substances (RoHS) is also ensured to restrict using hazardous substances in the manufacture of electrical and electronic equipment and their components. Table 18(V).2 is providing a comparison of RoHS items and their limit in India and the EU.

Table 18(V).2: Comparison of Elements included in RoHS in EU & India

S. No	Items	
	EU	**India**
1	Lead (Pb) < 1000 ppm	Lead (Pb) < 1000 ppm
2	Mercury (Hg) < 100 ppm	Mercury (Hg) < 100 ppm
3	Cadmium (Cd) < 100 ppm	Cadmium (Cd) < 100 ppm
4	Hexavalent Chromium (Cr VI) < 1000 ppm	Hexavalent Chromium (Cr VI) < 1000 ppm
5	Polybrominated Biphenyls (PBB) <1000ppm	Polybrominated Biphenyls (PBB) <1000ppm
6	Polybrominated Diphenyl Ethers (PBDE) < 1000 ppm	Polybrominated Diphenyl Ethers (PBDE) < 1000 ppm
7	Bis(2-Ethylhexyl) phthalate (DEHP): < 1000 ppm	Not Applicable
8	Benzyl butyl phthalate (BBP): < 1000 ppm	Not Applicable
9	Dibutyl phthalate (DBP): < 1000 ppm	Not Applicable
10	Diisobutyl phthalate (DIBP): < 1000 ppm	Not Applicable

Table 18(V).3 is showing the commonly found Hazardous Materials in Electronics and Electrical Equipment (EEE).

Table 18(V).3: Commonly found RoHS in EEE

S. No	RoHS	Found in EEE
1.	Lead	• Solders (all non-exempted applications) • Leads, board finish, internal/external interconnects • PVC cables (UV/heat stabilizer) o Substitute: Ca and Sn-based stabilizers • Pigments, paints • Platings, coatings, lubricants • Detectors, fuses, photoconductors, glass • Metal parts, chassis, washers
2.	Cadmium	• PVC cables • Pigments (yellow), paints • Metal finishing/plating (low resistance corrosion or wear protection) o Connector/switch/ relay contacts o Fasteners • Phosphorescent coatings • CdS, CdTe detectors/devices/LEDs • Recycled plastic materials
3.	Mercury	• Switches • Lamps, bulbs, lighting o Displays, scanners, projectors o Exempted applications • Pigments, paints • Polyurethane materials o High gloss PU windows • PVC & rubber additives
4.	Hexavalent Chromium	• Metal finishing for corrosion protection (Example: yellow chromate) o Chassis, fasteners o Substitute: Trivalent chromate finishing • Pigments, paints • Aluminium conversion coatings, alloys o Residual Cr + 6 remain in the product
5.	Polybrominated Biphenyls & Diphenyl Ethers/Oxides	• Flame retardants are widely used o Plastics, housings (V0 rated) o Cables o PCBs, connectors, fans o Components (high power/heat) o Paints • Non-RoHS substitutes exist o Brominated: Allowable additive/reactive aromatic/aliphatics o Non-brominated: Inorganics (Aluminum, Magnesium, Phosphorus-based)

S. No	RoHS	Found in EEE
6.	Polybrominated Biphenyls & Diphenyl Ethers/Oxides	• 3 PBDE Flame retardants of concern: o Penta-bromodiphenyl Ether/Oxide (Penta-DBE) • Textiles, polyurethane foam • Not common in electronics o Octa-bromodiphenyl Ether/Oxide (octa-DBE) • Limited use: ABS, injection moulded plastics, PCBs • Substitutes: Brominated epoxy oligomer, • Tetrabromobisphenol A (TBBPA) o Deca-bromodiphenyl Ether/Oxide (deca-DBE) • Common: HIPS, PE, ABS, PBT, Epoxy, Nylon plastics • Substitute: Decabromodiphenyl ethane • Probably RoHS-allowed, but many OEM specs prohibit the use

E-waste Management Challenges

E-waste management is becoming a challenge in India due to lack of awareness among the stakeholders about the hazards associated in disposing of the end-of-life products in the informal sector, inadequate disposal facilities and infrastructure and implementation challenges of the E-waste Management Rules.

E-waste is considered as one of the priority areas in Circular Economy, as electronics products contain valuable resource materials, nearly 69 elements of the Periodic Table and those are depleting from the mother earth. End-of-life electrical and electronics products contain precious metals (copper, silver, gold, palladium etc.), rare earth metals (neodymium, europium, terbium lanthanum, cerium, dysprosium etc.), critical metals (antimony, beryllium, bismuth, cobalt, gallium, germanium, hafnium, indium, lithium, magnesium, niobium, tantalum, tungsten, titanium etc.).

Unless the society has a sound recycling facility and foolproof mechanism, the resource efficiency cannot be ensured and the critical raw materials will be difficult to save for future generation. E-waste also contains various hazardous materials including lead, cadmium, mercury, chromium (+6), and brominates flame retardant plastics, which require safe scientific disposal mechanism.

Majority of the e-waste in India is still being processed in the informal sector in primitive

Figure 18(V).1: Present Scenario in the Informal Sector methods, though EPR is implemented, which may be due to materials leakages in the value chain.

Informal operators are the best collectors, the majority of the e-waste from 'consumers' are channelized by them with a suitable remunerative price. Informal units spread in small clusters in the large cities provide services like collection, segregation, dismantling and recycling of e-waste. E-waste recycling is, however, not acceptable under the norms for Occupational Health and Standards (OH&S) or directives of Environmental Standards.

Electronics and Electrical Equipment (EEE) contain hazardous substances, usually heavy metals such as mercury, cadmium, or lead and chemicals such as chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and flame retardants. Nearly 71 kilotonnes of BFR plastic was generated from unaccounted e-waste in 2019 globally. Mostly, plastic containing PBDEs and PBBs should be incinerated under controlled conditions to avoid the release of dioxins and furans and subsequent health and environment hazards. Risk assessment studies found they are persistent, bioaccumulative and toxic and can damage kidney, skin, nervous and immune system.

Mercury used in fluorescent lamps, flat display panels and TVs, measure and control equipment, old switches, is extremely hazardous and should not be abandoned in open dumpsites and require appropriate recycling to avoid mercury entering to the food chain and accumulating in living organisms. A total of 50 tonnes of mercury are generated from unaccounted e-waste generated globally in 2019.

Chlorofluorocarbons (CFCs) and Hydrochlorofluorocarbons (HCFCs), used in refrigerant circuits and insulating foams of older generations of cooling and freezing equipment, such as refrigerators, freezers, and air-conditioning systems, are having long lifespan in the atmosphere. These molecules react with ozone molecules (O_3), generating molecular oxygen that thins the stratospheric ozone layer (ozone hole), which creates enhancement of UV radiation and may cause skin cancers, eye-related diseases, and a weakening of the immune system. The CFCs and HCFCs have high global warming potential (GWP) and are emited to the atmosphere during inappropriate handling during EEE recycling, which was globally estimated to ~ 98 Mt of CO_2 equivalents. It was estimated 73% CO_2 equivalents released to the atmosphere due to improper recycling of air conditioners and 27% were from fridges, which shows how refrigerants are contributing to high global warming.

Up-gradation of informal operation with affordable technology, safety tools and infrastructure, adequate capacity building and skill set development would be imperative to improve the irreparable environmental damages made in the last two decades. This will create environmental friendly eco-system, generate jobs in lower strata of the societies, inevitable health risks could be averted.

The authorised recyclers in India on the other hand, are, however, engaged in dismantling, dissembling, segregation and selling the materials as per their market demand. The most valuable parts of e-waste including printed circuit boards (PCBs), integrated circuits (ICs), spent magnet, rechargeable batteries etc. are, however, exported to foreign smelters, as state of art technologies are expensive and also not suited to the local needs. This inadequate facility has caused a significant loss of revenue, the country is losing precious resources materials and loss of employment.

E-waste Management in West Bengal

E-waste management is also facing similar implementing challenges in the State of West Bengal. E-waste (Management) Rules, 2016 as amended in 2018 provides the requisite enforcement for channelizing e-waste towards authorised dismantlers and recyclers to formalize the e-waste sector.

Accordingly, the West Bengal Pollution Control Board has authorised four Dismantlers/ Recyclers under E-Waste (M) Rules, 2016 in the state. The names are the following: -

1. M/s J. S. Pigments Pvt. Ltd, Delhi Road, Vill. + P.O.- Jarura, P.S.- Polba, Dist.- Hugli, Pin- 712138.
2. M/s P.U. Steel and Electro Process Pvt. Ltd, Vill. & P.O.-Patulia, P.S.- Khardah, Kolkata- 700119, Dist- North Twenty Four Parganas.
3. M/s Lubrina Recycling Pvt. Ltd, P.O.- Joychandipur, P.S.- Bishnupur, Dist.- South Twenty Four Parganas, Pin- 743377.
4. M/s Old N Furniture, 323, K.P. Mondal Road, P.O. & P.S.- Budge Budge, Dist.- South Twenty Four Parganas, Pin- 700137.

IT&E Department Government of West Bengal is in the process for setting up a pilot plant for e-waste collection, segregation, dismantling and recycling facility in a land (owned by IT&E Department, GoWB) at Sector V, Salt Lake with the financial assistance of West Bengal Pollution Control Board.

The informal operation, however, creates significant damages to the environment. West Bengal Pollution Control Board has carried out a study of the Ambient Air Quality in varied stations, the following table is showing the regular monitoring data.

Table 18(V).4: Ambient Air Quality at Recycling Site at West Bengal

S. No	Location	NAMP Station	PM10	$PM_{2.5}$	SO_2	NO_2
1.	Chandni Market	Moulali	72.86	27.46	6.45	48.34
2.	Princep street	Moulali	72.86	27.46	6.45	48.34
3.	Hazra Road	Gariahat	49.67	NA	3.50	39.70
4.	Bondel gate	Picnic Garden	58.32	NA	5.66	49.76
5.	Khidirpur- metiaburuz	Mominpur	54.54	NA	3.85	42.15
6.	Rifle Range road	Topsia	64.29	NA	4.99	48.66
7.	Keshabsen street	Moulali	72.86	27.46	6.45	48.34
8.	Tarak Pramanik Road	Ultadanga	73.81	NA	6.61	50.19
9.	Girish Park	Ultadanga	73.81	NA	6.61	50.19
10	Rajabazar	Ultadanga	73.81	NA	6.61	50.19
11	Topsia-Tiljala	Topsia	64.29	NA	4.99	48.66
12	Kakurgachi-Kadapara	Ultadanga	73.81	NA	6.61	50.19
		Beliaghata	57.43	NA	4.50	46.02
13	Haora-Ghusuri	Ghusuri	53.33	NA	8.94	38.58
14	Bajranbali	Bagnan	59.93	NA	8.91	38.62
15	Mograhat	Baruipur	88.54	NA	7.28	48.96
National Standard			**100.00**	**60.00**	**80**	**80**

Monthly Average of AUG 2020 UNIT: mcg/m³

Source: WBPCB

The Policy on Information & Communication Technology 2012 published by Government of West Bengal is also a forward-looking step to ensure green design for electronic and electrical products and sustainable management of end-of-life products.

Resource Efficiency and Circular Economy

Electronics and Electrical Equipment (EEE) requires numerous critical materials for desired functionality during their manufacturing. Nearly, 69 elements in the periodic table are used in EEE, including precious metals (e.g. gold, silver, copper, platinum, palladium, ruthenium, rhodium, iridium, and osmium), Critical Raw Materials (CRM) e.g. cobalt, palladium, indium, germanium, bismuth, and antimony, and noncritical metals, such as aluminium and iron. EEE is very complex from a material design perspective.

EEE has become an essential part of every day life. However, the way we produce, consume, and dispose of end-of-life equipment is unsustainable. Due to lack of collection and recycling, externalities –such as the consumption of resources, the emission of greenhouse gases, and the release of toxic substances during informal recycling procedures– illustrate the problem to remain within sustainable limits. The inadequately managed Waste Electrical and Electronics Equipment (WEEE) are a considerable challenge for the environment as well as human health. The formal e-waste management system has become ineffective due to high technology and machinery cost and insufficient input materials.

Within the paradigm of a circular economy, the mine of e-waste should be considered an important source of secondary raw materials. Due to issues relating to primary mining, market price fluctuations, material scarcity, availability, and access to resources, it has become necessary to improve the mining of secondary resources and reduce the pressure on virgin materials. By recycling e-waste, countries could at least mitigate their material demand in a secure and sustainable way.

The 53.6 Mt (million tonnes) of global e-waste generation in 2019 has witnessed 21% growth in the last 5 years and would reach 74 Mt by 2030. However, only 17.4% of e-waste is formally collected and recycled globally, which needs immediate attention. The cost of the recycling process is also not sustainable for recoveries of some materials like germanium and indium though they are indispensable for present-day products.

Products are neither designed nor assembled with consideration of recycling principle in mind. Base metals (e.g. gold) used in certain devices, such as mobile phones and PCs, have a relatively high level of concentration: 280 gm/T of e-waste. Separate collection and recycling for a few e-wastes are economically viable due to the presence of high contents of precious metals. The recycling rate of most CRMs is still very low and requires significant improvement with better collection and recovery.

The value of selected raw materials in e-waste was equal to USD 57 billion in 2019, which corresponded to a total of 25 Mt. The demand of similar raw materials for the production of new electronics in 2019 was ~ 39 Mt. Even in an ideal scenario of entire recovery of resource materials, the world would still require ~14 Mt of additional raw materials. With the present formal collection and recycling rate of 17.4%, a potential raw material value of USD 10 billion and 4 Mt of secondary raw materials can be recovered from e-waste.

Effective E-waste Management

Following are some of the measures that would be important for effective management:

(a) Awareness

The awareness creation to the citizen for safe disposal of end-of-life EEE is the prime and foremost objective for sustainable e-waste management. This will boost the channelization of e-waste to the formal channel for proper recycling and ensuring a system of accountability in its management. This will need greater awareness among all stakeholders. Ministry of Electronics and Information Technology (MeitY) had implemented a pan-India awareness programme on e-waste management during 2015-2020, wherein stakeholder wise specific contents, short films, posters etc. were created (www.greene.gov.in). The programme had also created trained experts (GreenE champions), whose contact details are available on the website. The resources materials (freely downloadable) and trained experts can be used for the future awareness programme. This programme has also created specific contents for 7th to 9th standard student for MOOCs, uploaded in the Ministry of Education's DIKSHA online learning platform. All these contents can be translated into the local language for the State population during an outreach programme for better effectiveness.

The social media platforms (Facebook, Twitter, WhatsApp etc.) should be utilised effectively for creation of awareness to sustain the outreach programme for a longer time. Short films, tutorial specific to targeted stakeholders should be prepared in local language for outreaching common people.

(b) Skillset development and common shared infrastructure

Informal operators are the most vulnerable section. Though they are the best collectors in the e-waste management eco-system, they lack awareness on health hazards, safety aspects associated, and environmental impact in engaging e-waste processing activities. They not only damage the environment, the recovery yield of valuable resource materials from valuable e-waste being significantly low they fail to achieve resources efficiency.

The majority of the informal e-waste recycling workforce needs upskilling, particularly for handling and dismantling hazardous materials and environmentally friendly recycling technologies. This important workforce needs to provide adequate skill sets and safety tools and equipment so that their skill and efficiency can be enhanced. They also require requisite knowledge on the components, parts in e-waste, which are hazardous materials and the primitive methods engaged in processing these components are extremely toxic for their health as well as the environment. This trained workforce will be a boon to the effective e-waste management for society.

Innovative short courses and training programmes could be specially designed for e-waste collectors, handlers and dismantlers by the combined expertise of the Electronics Sector to develop skilled manpower. The youth of the country also should be encouraged for setting up small cottage industries for segregation, dismantling, recycling of e-waste in a proper manner.

Table 18(V).5 is showing the parts, components, materials are typically available once e-waste is dismantled and segregated with their materials property.

Table 18(V).5: Possible Recycling Options

S No	Materials Recovered	Recycling Options	End-use
1.	Small & large structural metal parts, heat sinks, ferrous metal	Smelting	Secondary raw material
2.	Ferrite & ceramic components Nonferrous metal scrap mainly copper & aluminium	Smelting	
3.	Cables and wires	Striping + Smelting	
4.	Precious metal scrap, PCBs with IC Chips, electronic components and connectors	(i) Smelting + Hydro-metallurgy + Electro-chemical Process (ii) Mechanical shredding + screening + electrostatic separation + Falcon centrifugal separation + hydrometallurgy	Secondary raw material viz. Copper, silver, gold, palladium etc.
5.	Small and large structural plastic parts	(i) Chemical Recovery- plastics derived fuels (ii) Materials Recovery Recycled plastics viz. PC, ABS, PC- Energy Recovery (H2, steam)	Secondary raw material and energy source
6.	Glass components	Smelting	Secondary raw material
7.	Hazardous wastes like chlorofluorocarbon (CFC), Mercury (Hg) Switches, CRT, batteries and capacitor, flame retardants plastic	Recycling with due environmental care	Secondary raw material

Before dismantling of the collected end-of-life products, they should be trained on how to repair these products for the second-hand market and enhance the shelf-life of the products. Minimum testing skill and equipment also need to be provided for the quality of their repairing work. This is an important step in strengthening the resource efficiency. India is having a growing second-hand market.

Once the collected end-of-life products are beyond the scope of repairing, those products should be dismantled. The materials shown in Sr. No. 1, 2 and 6 in Table 18(V).5 can be sold to appropriate smelters in market price. The materials shown in Sr. No. 3, 4, 5 and 7 require technological intervention and are discussed in the next section.

The common infrastructure with minimum safety tools and equipment could be created with government support in identified hotspots of the state where e-waste are mostly generated. Informal operators could be placed in these common facilities, after improving their skill sets and registration process to formalize them.

Informal operators should be allowed to initially repair the collected products and sell them as per market price. Nonfunctional e-waste should be dismantled and segregated as per their material characterization. The materials shown in Sr. No. 1, 2 and 6 can be sold to appropriate smelters at market price. The materials shown in Sr. No. 3, 4, 5 and 7 require technological intervention and therefore should be recycled in formal recycling facilities. Informal operators need to hand over these components to formal recyclers with a remunerative price. Recycling of these items in the informal sector through primitive methods typically has yielded 30% of value materials. If the offer price of the formal recyclers is higher than the recovery price by the informal sector, they would handover these items for better profits. Since the activities would be carried in government created infrastructure, trust level among formal and informal could also be ensured. PROs can also be associated with these created clusters of the infrastructures for mobilizing more resource and materials.

(c) Common recycling infrastructure

The items indicated in Sr. No. 3, 4, 5 and 7 at Table 18(V).5 require technological intervention and appropriate machines, so investment would be required for creating those infrastructure and facilities.

The 'state of art' recycling facilities is available in developed countries and the plant and machinery and technology knowhow are expensive. Environmentally acceptable available technologies and affordable machinery should be explored.

In this direction, Ministry of Electronics and Information Technology (MeitY), has established environmental friendly, cost-effective technology for e-waste recycling to ensure minimum landfill and zero-emission to air, land and water under its R&D effort to create an economically profitable business.

E-waste contains various components like printed circuit boards (PCBs), plastic, metal, glass etc. A unique method for exclusively PCB processing was developed and demonstrated for 1000Kg capacity (35MT of e-waste/ day) and 100Kg capacity (3.5MT of e-waste/ batch). The method includes manual dismantling and segregation of e-waste till the PCB stage. PCB is then subjected to the process of depopulation of the boards, followed by pyrolysis, and calcination, smelting and electrolytic refining. The precious metals contained in anode slime are collected periodically and further processed for recovery of valuable gold, silver and palladium. The 100kg process technology has already been transferred to a formal recycler. E-waste contains nearly 27% of the plastics. Technology to convert e-waste plastics to a value-added product had also been developed and transferred for commercialization.

A Centre of Excellence on e-waste management has now been established in the country at C-MET Hyderabad engaging suitable end-user industries to create an eco-system in developing physical infrastructure and knowledge hub for the development of cost-effective technology for e-waste recycling and dissemination of e-waste solutions from dismantling to recycling and precious metal separation to potential recyclers.

The deliverable of the project includes providing affordable technologies (PCB, Li-ion batteries, phosphors/ spent magnets & PV modules) to SMEs, start-ups, assisting in creating recycling facilities, empowerment of informal units, manpower creation etc.

E-waste also contains nearly 27% of the plastics. Technology to convert the majority of the e-waste plastics to a value-added product had also been developed by CIPET, Bhubaneswar and transferred for commercialization.

The deployment of such affordable, environmentally acceptable, indigenous technologies should be preferred for creating recycling infrastructure in the States to ensure resource efficiency and empowering informal sector to engage in creating waste to wealth.

The State may subsequently invest in 'state of art' recycling facilities by setting up of Eco-Parks, as these are the successful model in various Asian countries. In such eco-parks, formal and informal units can be located in one designated place for better implementation of the E-waste Rules and also address the leakages of the resource materials.

(d) Some other policy measures

Apart from the measures indicated above the State may further notify State-Specific Policy paper, which would ensure few more additional policy measures apart from what CPCB already notified. This will create a requisite push for sustainable use and disposable of EEE in State Level.

Table 18(V).6: Possible Policy Measures

S No	Issues	Possible Solutions
1	No. of products identified under E-waste Rules are 21 (schedule-I), whereas EU Directives considered 642 EEE items, most of the products are being used in India as well.	• Encourage stakeholder to include all the products in the State
2.	Registration of the authorized recyclers (312nos.) requires a careful assessment based on their capabilities, infrastructure (tools, machinery) availability and adequate knowledgebase to recycle the products so that legally collected products should not be channelized to informal channel hand.	• Technical Audit by the third party would be required
3.	Mass balancing systems should be introduced to detect the leakages at each source.	• AI-based software solution to track the materials flow to be ensured • Manufacturers to provide information on composition materials
4.	Many of the end-of-life products may still have useable life, refurbishing is an important step towards ensuring a circular economy, formal refurbishing market is required.	• Standard safety rules, a protocol of refurbished products should be evolved to open up a refurbished legal market, and brand owners to be encouraged to sell refurbished products.
5.	Green design and sustainability to be promoted: i. Preference in Govt. schemes ii. Preference in Govt. procurement iii. Encouraging manufactures to use eco-level, CE mark to attract conscious buyers	• Suitable notification

Conclusion

The e-waste or WEEE are resource-rich products. Once they are in use or stocked after their usable life, do not cause any environmental harm. The hazardous materials in e-waste will only leach to the environment and harm human health once they are treated in an unscientific manner.

On the other hand, e-waste contains valuable materials, if processed in industrial scale, can create wealth and generate employment, especially in the lower strata of the society. The ever-increasing e-waste with our improved lifestyle, the associated threat due to lack of knowledge and awareness among the stakeholders will deepen further if a conducive ecosystem is not created.

The ecosystem should ensure the requisite awareness creation in the society, formalization of the informal workforce, and recovery of the resource materials in a sustainable manner. Hence the State will achieve the circular economy.

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Chapter 19

Urban Wastewater Management

Chapter 19

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Introduction

The strength of a nation depends upon its economic power and human resource. The gross difference between a developed and a developing country depends upon how that particular country managed its economy and resource to maximize its growth. Growth in economics parlance measured in terms of Gross Domestic Product (GDP). India is the fifth major economy of the world with a GDP growth estimated between 6-8 percent. Though in the environment of the recent prevalent pandemic the normal matrices have been upset to a great extent. A growing economy is fuelled by rapid industrial and infrastructural development. Huge investments in business and infrastructure can only sustain such growth. As in the case of developed countries (US, EU), such rapid growth often concentrates around major cities. Such economic centres drive major investments, infrastructural growth, the concentration of human resource and urbanization. Sustainable growth is the key to environmentally friendly development.

Economic/financial pressures often propel the rural population to migrate towards economic centres that promise better opportunities. It is reported by Ramakrishna Nallathiga that there is a non-uniform distribution of population in India. The Census 2001 showed that 28% of the Indian population live in cities and towns when compared to the figures of 11% in 1901. The World scenario is even more pronounced. As per the reports of the United Nation, almost 50% of the population is expected to live in urban centres by the year 2020. Such movement results in rapid population growth, which in turn alters the balance between growth and sustenance in such regions. Cities provide the economic, social and cultural environment to its inhabitants, but the ever-increasing population growth poses an enormous challenge to these growth centres. These urban centres face difficulties in managing limited resources amongst the growing population. The rate of increase in the population often leads to unplanned settlements. The change in the way of living often separates families and contribute to changes in family patterns. Mass exodus happens in India from rural regions towards urban centres in search of better economic prospects. Economically backward people cannot afford normal inhabitation resulting in slums and informal settlements. Unplanned settlements lack proper sanitation, contributing to environmental pollution. This poses a significant challenge to urban municipal bodies who are equipped to cater to a planned few. Rapid urbanization requires the development of housing at a fast pace. Basic amenities like water, power, waste management and efficient mass transport system can make an urban system sustainable and liveable.

India being the second populous country with 136 crore people constitutes over 17.7% of the world population. Figure 19.1 shows an estimated population graph of the most populous countries in 2018. The population density is 464 per Km^2 as compared to US (36/ Km^2 with 4.25% of the world population) and China (153/Km^2 with 18.47% of the world population). **The urban population of India is 34.5 % in 2019 and is ever-growing at an average annual rate of 1.14%.** In comparison with the United States of America, that has 82.5 % urban population in 2019 with an average annual growth rate of 0.23%. In the case of China, the figures for the urban population in 2019 is 61.4% whereas the growth rate is more than 2% on a year-to-year basis. Being the most populous democracy, India has progressed in terms of literacy, industrialization, science and technology while adopting the best international practices and trends in technology. Urban Indian population exceeds any developed country except China. However, trends predict that India will lead in terms of both overall as well as urban population.

Rapid growth in the urban population needs to be balanced with proportional and planned development. Planning may be easier in developing regions; however, there may be serious constraints when planning over already existing infrastructure. Planning is often constrained by a lack of financial support by the respective administration. This often leads to a lack of adequate infrastructure to support the expansion of the region. The influx of population is difficult to regulate in developing cities therefore planning often fails. Moreover, vertical development in large cities increases the population density as well as resource requirements necessary to support inhabitants.

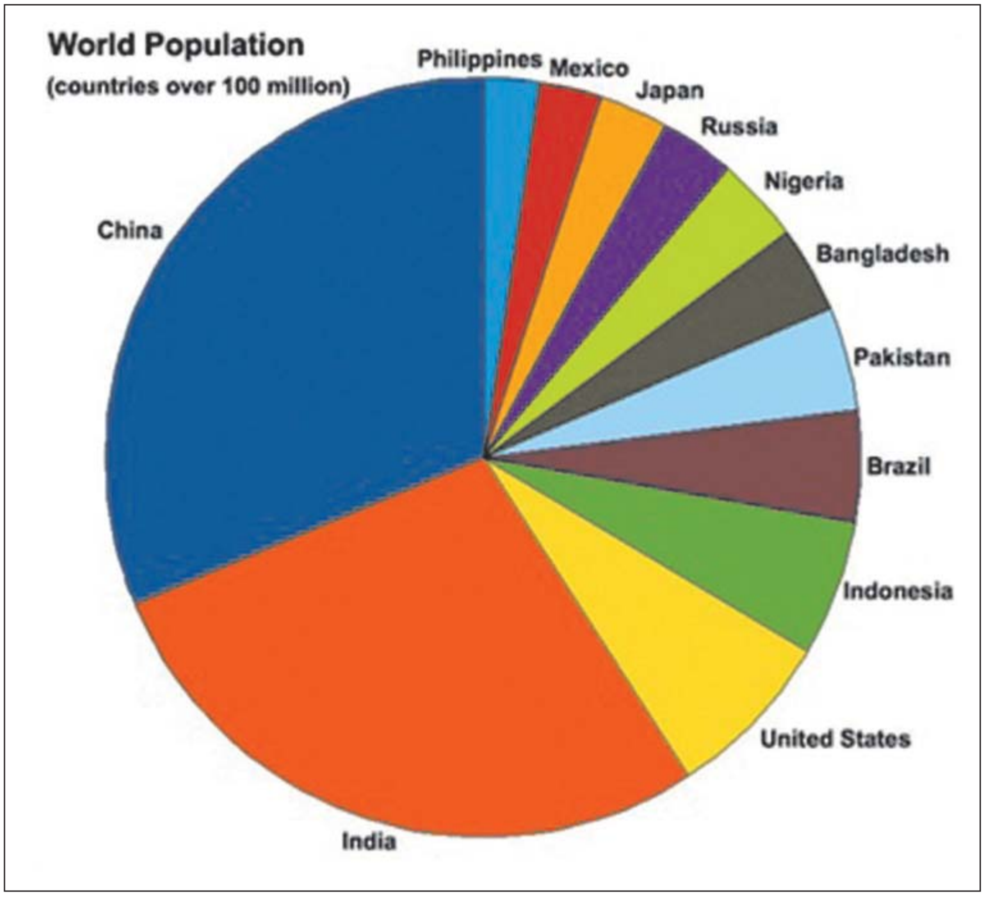

Figure 19.1: Population Graph of Countries with More Than 100 Million in 2018

The most significant fallout of rapid urbanization is the impact on the surrounding ecology system. Encroaching cities often engulf neighbouring eco-systems and bio-diversity. This in turn affects the quality of living as the natural resources are polluted. Most severe among them is air and water pollution. The natural purification system is removed due to rapid industrialization/infrastructure development. Artificial purification systems are needed to be put in place to make the region habitable. Moreover, the drainage of excess rainwater to different water bodies/groundwater or rainwater harvesting (water-scarce region) is important for the quality of urban life.

Pollution by human-generated waste adds to the degrading ecosystem (Figure 19.2). The removal of solid and liquid waste is of paramount importance for the health and wellbeing of the inhabitants. The amount of waste generated is proportional to the population density. Removal of waste and providing adequate sanitation by local civic bodies are the most necessary activities for a healthy urban life. The management of solid waste and wastewater that is generated due to human activities/habitation require significant planning and implementation. Providing effective drainage system and sanitation is a significant challenge faced by city planners and architects. The process of removal of human excreta, as well as wastewater, involves effective capture/ collection mechanism, storage of the same prior to transportation to areas where they will be treated/disinfected and will be disposed of finally to different water bodies. The treated wastewater is then culminated to other natural resources or reused. The latest trend towards wastewater management is eco-friendly sustainable solutions that will add to rather than harming the ecosystem.

Figure 19.2: Sewage and Solid Dumping in Water Channels

Therefore, to sustain growth, new habitats for the migrating population has to be designed with a focus on overall infrastructure (rather than building a housing complex only). This will support healthy, environment-friendly living conditions and add to the quality of sustainable urban life.

What is Wastewater?

Normal water is a solvent that carries surrounding particles it comes in contact with. The wastewater originates as a water solvent that carries harmful elements. The water in its pure form or in a form that can be utilized for normal consumption is useful to societal needs. However, any change in the physical, chemical and biological nature of the water may result in the water that is useless and harmful.

Apart from drinking water, there are several other requirements for pure/ potable water. The purity of water is defined by its quality. The qualitative requirements of the water vary with the targeted use of water.

Water is used for domestic uses like drinking of water, washing requirements of kitchen and laundry, bathing and general cleaning. In all the domestic uses of water, the highest quality requirement is for drinking water. Hence, drinking quality water has its standard that is possibly most superior to any other quality standard of water for domestic/ industrial use. Water is required for industrial requirements playing its ubiquitous role of solvent to industrial processes as well as washing and cleaning uses. A major requirement of water in the Indian context is its use in irrigation. Being an agricultural society, the farmers' dependence on irrigation water is foremost for crop production. Animal husbandry for food requirements like milk, meat or support for farming requirements is another requirement of good quality water. Breeding of aquatic fishes for human consumption requires water that is free from harmful chemicals as well as other pathogenic contaminants. Other requirements of water are mostly recreational or aesthetic in nature.

Water for domestic consumption is required for the highest potable quality. Such water should be free of any chemicals, organisms/micro-organisms that can cause harm to humans. Drinking water should be low in turbidity, colourless, odourless and without taste. Water for industrial supply should have similar characteristics if it is related to the food industry. However, the water supply used in other industrial process needs to possess specific characteristics as per the requirement of the particular process. Irrigation water is absorbed by the skin of the plants as well as absorbed by the ground. Therefore, the water should contain minimum chemicals and microbes. Saline water is harmful to food plants and horticulture; hence, the irrigation water must have minimum salinity. For feeding animals as well as an aquatic culture the water should contain minimum chemicals and microorganisms so that the animals are least affected. Fishes often carry harmful chemicals if they originate from a polluted habitat, causing illness on consumption. Water for recreational requirement or beautification may be of lesser quality, but free from faecal elements. Water is also required in power generation. Hydroelectric generation requires normal water but thermoelectric or cooling towers of nuclear reactors require high-quality water that is low on hardness.

Figure 19.3: Dumping of Collected Wastewater to Surrounding Waterbodies in Urban Regions

Consumption of water contributes to changing the nature of water. The change in the quality of water attributes to change in content it carries as solvent as well as suspended solids. The water cycle is also known as the hydrological cycle maintains the flow of water in the system. It feeds with a renewed water source and replenishes the resources from which the water is derived. The renewed sources of water may also result in contamination due to pollution. Apart from the generalized water cycle, there are other internal cycles as well as partial cycles in which water is present in the liquid state. However, each of these cycles may result in qualitative changes in the nature of water. It is of utmost importance that the environmental scientist and engineers devise effective measures to maintain and manage the quality of the water so that it can be used for its intended purpose. It is important to plan, design, build and implement mechanisms to ensure the purity of water at each partial cycles so that the desired quality of the water can be maintained for remote future use as the freshwater resource is extremely limited compared to total water quantity.

The water required for all activities is initially present as a raw water resource, obtained from rivers, freshwater lakes, underground aquifers/ groundwater table. This water has a basic quality. The water is collected and transported for the required activity. Before transport of the water, it is transformed into a suitable quality depending on the usage and is known as treated water. After the intended use of water, further transformation leads to degradation of quality resulting in raw wastewater. More often, the untreated wastewater drains to the primary water sources and pollutes the clean water source (Figure 19.3). In planned cities and industrial regions, the wastewater is treated to remove the harmful pollutants so that the waterbodies remain pristine state and unaffected. Treated wastewater is a further transformation of liquid water to upgrade it to its primary quality. Stormwater is the water collected after rain is mostly discharged directly to the receiving water bodies. This water, however, may contain some runoff pollutants which could not be treated. The receiving water bodies that receive the treated wastewater and stormwater have natural systems that further improves the water quality through dilution and self-purification mechanisms. In some developed countries, the stormwater is also ponded and treated before discharge in the water bodies.

Use of water in daily domestic activities introduce waste in the water. Human excretions in the form of faeces and urine are disposed from household along with other household effluents (Figure 19.4). The drainage from houses includes laundered wastewater, detergent, soap, shampoo, oils, fat, food wastes, fabric conditioners, toilet paper, chemicals, floor cleaners, dirt, micro-organisms and other biological wastes. Similar wastewater is added to the system by public institutions like hospitals. Industrial wastewater contains various chemicals that are used in the manufacturing process. Water is used for washing, cleaning or as a solvent for chemical processing. Stormwater dissolves dirt, pollution and other chemicals that it meets. Hence, urban systems lead to volumes of wastewater that is proportional to the volume of the city. The urban volume is in respect to the size in the area, population density and industrialization. Apart from urban wastewater, there are agricultural runoffs that also contributes to the wastewater and pollutes water bodies or the primary source.

Wastewater Management has been defined by authors Metcalf and Eddy as "handling of wastewater to protect the environment to ensure public health, economic, social and political soundness". There are other definitions attributed to wastewater. According to Corcoran et al., wastewater includes "domestic effluent consisting of blackwater (excreta, urine and faecal sludge) and greywater (kitchen and bathing wastewater); water from commercial establishments and institutions, including hospitals; industrial effluent, stormwater and other urban run-offs; agricultural, horticultural and aquaculture effluent, either dissolved or as suspended matter".

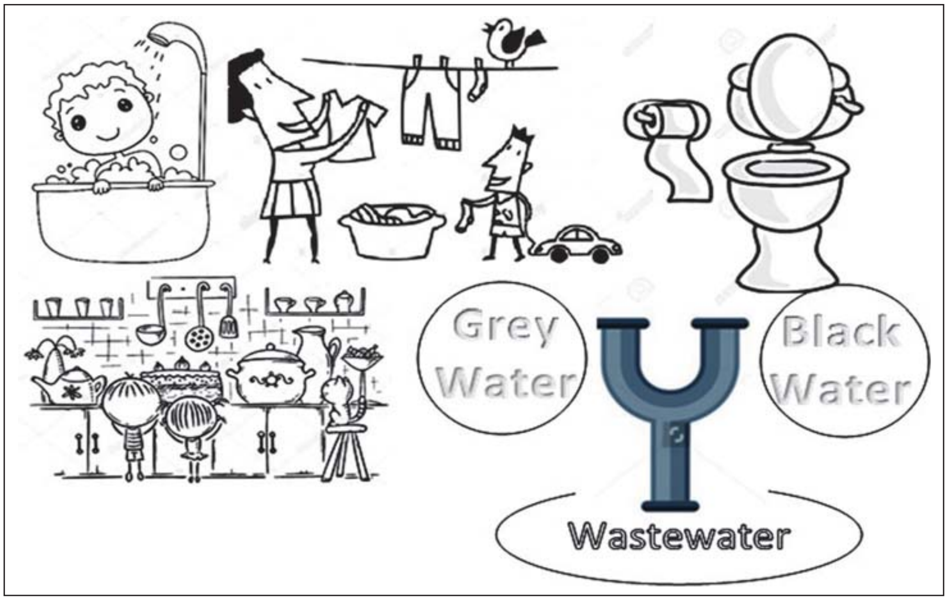

Figure 19.4: Household Wastewater in Urban Regions, Classified as Greywater (Generated Through Bathing And Washing) and Toilet Blackwater (Generated From Urine And Faecal Discharge)

Characteristics of Wastewater and Impact on Environment

Urban sewage contains almost 99.9% water and the remaining contains organic and inorganic elements that remain suspended and/or dissolved solids along with microorganisms. Only 0.1% of the wastewater needs to be treated. The composition of the wastewater varies depending on its origin. The nature of wastewater varies with climate, social and economic situation and civic habits. It is important to determine the constituents of wastewater so that treatment plants can be designed accordingly. It is difficult to identify all the constituents even after conducting several laboratory tests, so a general characterization of wastewater is done based on their physical, chemical and biological parameters (Table 19.1).

Table 19.1: Different Physical, Chemical and Biological Parameters of the Wastewater Characteristics.

Parameter		Description
Physical Characteristics		
Temperature		Slightly higher than drinking water but vary with the seasons. This influences microbial activity, the solubility of gases and viscosity of the liquid
Colour		Fresh sewage is slight grey and Septic sewage is dark grey or black
Odour		Fresh sewage is oily odour and relatively unpleasant. Septic sewage has foul odour due to hydrogen sulphide gas and other decomposed by-products. Industrial wastewater has characteristic odours depending on the refuse chemicals used.
Turbidity		Caused by different suspended solids. Fresh or concentrated sewage generally show greater turbidity
Chemical Characteristics		
Total Solids (Organic and inorganic)	Suspended	Part of organic and inorganic solids that are non-filterable
	Fixed	Mineral compounds, not oxidized by heat, inert, which are part of the suspended solids
	Volatile	Organic compounds, oxidized by heat, which are part of the suspended solids
	Dissolved	Part of organic and inorganic solids that are filterable. Normally considered having a dimension less than 10 – 3µm.
	Fixed	Mineral compounds of the dissolved solids
	Volatile	Organic compounds of the dissolved solids
	Settleable	Part of organic and inorganic solids that settle in 1 hour. An approximate indication of the settling in a sedimentation tank
Organic Matter (proteins, carbohydrates and lipids) - Indirect determination	Biochemical Oxygen Demand (BOD)	Associated with the biodegradable fraction of Carbonaceous organic compounds. A measure of the oxygen consumed after 5 days by the microorganisms in the biochemical stabilisation of the organic matter
	Chemical Oxygen Demand (COD)	Represents the quantity of oxygen required to chemically stabilize the carbonaceous organic matter. Uses strong oxidising agents under acidic conditions.
	Ultimate BOD	Represents the total oxygen consumed at the end of several days, by the microorganisms in the biochemical stabilisation of the organic matter
Organic Matter (proteins, carbohydrates and lipids) - Indirect determination	Total Organic Carbon (TOC)	A direct measure of the carbonaceous organic matter. Determined through the conversion of organic carbon into carbon dioxide

Parameter		Description
Total Nitrogen (an essential nutrient for microorganisms)	Organic nitrogen	Nitrogen in the form of proteins, amino acids and urea
	Ammonia	Produced in the first stage of the decomposition of organic Nitrogen
	Nitrite	An intermediate stage in the oxidation of ammonia. Practically absent in raw sewage
	Nitrate	The final product in the oxidation of ammonia. Practically absent in raw sewage
Total Phosphorus	Organic phosphorus	Combined with organic matter
	Inorganic phosphorus	Orthophosphates and polyphosphates
pH		Biological oxidation processes normally tend to reduce the pH.
Alkalinity		Indicator of the buffer capacity of the medium. Caused by the presence of bicarbonate, carbonate and hydroxyl ions.
Chlorides		Originating from drinking water and human and industrial wastes.
Oil and Grease		A fraction of organic matter that is soluble in hexane. In domestic sewage, the sources are oils and fats used in food.
Biological Characteristics		
Bacteria		Unicellular organisms, present in various forms and sizes. They are responsible for the stabilisation of organic matter. Though some bacteria are pathogenic, causing mainly intestinal diseases
Archaea		Similar to bacteria in size and basic cell components but differ in their cell wall material and RNA composition. They are important in anaerobic processes
Algae		Autotrophic photosynthetic organisms, containing chlorophyll and produce oxygen in water bodies but they can proliferate in excess, deteriorating the water quality
Fungi		Predominantly aerobic, multicellular, non-photosynthetic, heterotrophic organisms but are important in the decomposition of organic matter. They grow under low pH conditions
Protozoa		Usually unicellular organisms without a cell wall. A majority is aerobic or facultative. They feed themselves on bacteria, algae and other microorganisms maintaining equilibrium between the various groups. They are often pathogenic
Viruses		Parasitic organisms, difficult to remove in water or wastewater treatment
Helminths		Higher-order animals with eggs present in sewage can cause illnesses

Source: Adapted from Qasim Arceivala, Metcalf & Eddy, Tchobanoglous & Schroeder

The organic matter in water bodies consumes dissolved oxygen in the water during the stabilisation process. The bacteria use the oxygen available for their respiration. Depletion of oxygen has a detrimental effect on the water bodies, as they no longer can support life. This is the most damaging impact of organic matter on the ecosystem. This is caused by the respiration of microorganisms involved in the purification of the sewage. The organic matter present as suspended or particulate that settles down to form a sludge while the dissolved or soluble matter remains in the liquid. Bacteria convert organic matter to simple compounds of water and carbon dioxide under aerobic conditions. Other oxidation reaction by bacterium results in the nitrification process in which ammonia is converted to nitrite and further to nitrate. This consumption of oxygen happens at the second stage after oxidation of carbon compounds. However, the growth of some autotrophic organisms helps to synthesize organic matter through Photosynthesis process releasing oxygen to the system.

Another major influence of water pollution is the proliferation of water-borne diseases. The wastewater discharge is a carrier of a wide range of pathogens. They originate from the human and animal intestinal tract and released as excreta. Also released during bathing and irrigation. They thrive and multiply in the healthy substrate. Coliform bacteria found in human faeces are often taken as indicators of pathogen activity, their potential to contaminate the environment and transmit disease.

The release of heavy metals as industrial effluent in urban areas are of great concern. Such effluent mix with water bodies like rivers, lakes and underground water that serve as the primary water source for urban requirements. Contamination of primary source has a long-term effect on the health of inhabitants in the region and beyond. Such metal contamination is difficult to remove from the water system.

Water pollution by urban wastewater into pristine water source is of great concern across the globe. It is important to regulate and reverse the situation through awareness and adequate legislation. Protection of water resource is vital to the safety of the environment and public health. Such problems have been addressed by most developed nations. However, the problem exists among developing and underdeveloped countries due to lack of resource. These countries are unable to manage the infrastructural demand necessary to maintain adequate health, hygiene and sanitation. They are unable to install, implement and maintain sewage treatment facilities and keep up with international regulations and standards. In these regions, the concentration of pollutants in discharged wastewater is far higher than the discharge standards enforced through international conventions. Countries have developed National standards depending upon the nature of pollutants prevailing in the regions. Regional standards supporting the national standards form specific goals that are established to protect specific regions. World Health Organization (WHO), also provide guidelines and standards for the protection of public health. The established standards are based on sound, logical, scientific grounds and is aimed to obtain an estimated benefit or to minimize risk for a known cost.

Objectives of Wastewater Treatment

Wastewater causes a significant impact on the ecological system. It pollutes the surrounding environment and has a deep impact on both flora and fauna. Polluted water bodies can result in long-term damage to society. Such water bodies often serve as the primary water source for the sustenance of life in cities. The treatment of the collected wastewater, stormwater, industrial and agricultural runoff is necessary to protect the environment from harmful effects of water pollution. Treatment of wastewater before discharge to the waterbodies prevent further pollution of the primary water sources. Survival of large cities critically depends upon maintaining the balance of waste generation and effective disposal. Disposal without treatment will reduce primary resource quality. The wastewaters and faecal sludge discharged without any form of treatment into the environment will result in spreading disease. This will also destroy ecosystems such as coral reefs and natural fisheries. Dirty water results into de-oxygenated dead zones within large water bodies like natural lakes, seas and oceans. This has become a major global problem as urban populations are projected to double in 40 years to over six billion people. Most of the old cities lack adequate wastewater management due to ageing, absent or inadequate sewage infrastructure and unmanageable population explosion, according to reports of World Water Council, 2012. The primary objective of wastewater treatment is to remove harmful elements from water and restore the state of the water to the primary state. Figure 19.5 summarises the wastewater treatment objective.

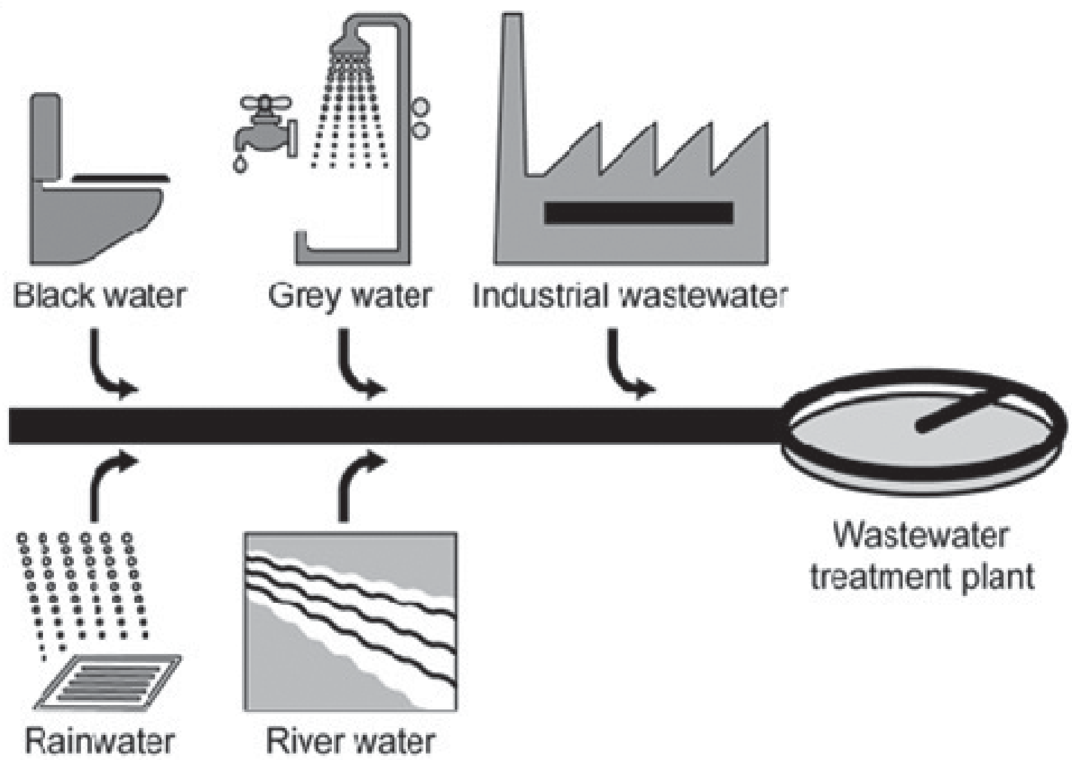

Figure 19.5: Showing the Origin of Wastewater and Treatment Plant that Cleans the Urban Wastewater

Most organic substances that are biodegradable, such as carbon, nitrogen, phosphorus, sulphur should be oxidised and released to the atmosphere. Presence of these substances helps the growth of aquatic plants like algae that depletes the oxygen content of water bodies and destroys other aquatic life. Several microorganisms like bacteria, virus, fungi, protozoa and helminths thrive in human/animal faeces. They find good habitat in wastewater and are ready to infect plants, animals and human that come in direct/indirect contact with these parasites. They can cause diseases like Cholera, Hepatitis, fungal infections, Amoebiasis, Giardia, ringworm, tapeworm infections.

Freshwater is precious but also a scarce resource.

Often this resource is taken for granted; although, there are cities that face acute shortage of water. Wherever there are rivers or lakes, or the presence of a high water table there is less scarcity of water but these sources are needed to be protected. In other places where the primary water source is limited, recycle and reuse of wastewater is necessary to fulfil water requirements. There is an increase in urban areas and slow decrease of agrarian characteristics of the region. Therefore, there is a change in the usage pattern of water, resulting in diminishing temporal and spatial distribution of water with groundwater resources being overdrawn. It has become imperative to devise means to recycle and reuse wastewater for sustainability. In India, pollution control boards have started to enforce zero discharge development of large complexes and industries.

Impact of Urbanization in India

Urbanization phenomenon is dependent upon the growth of physical infrastructure and distribution of resource and service to the public. The economic viability of a country is dependent on its infrastructural assets. The quality of urban life in turn is dependent on the efficiency of these infrastructures towards the welfare of its inhabitants. Infrastructure is collectively called "Public Works", with the basic objective to provide service to the citizen. The governmental agencies responsible to provide services like transportation, power generation, transmission and distribution, telecommunication, water supply, sewage disposal, irrigation, medical, educational and other similar functionality come under the public work. All these services accentuate the growth and quality of urban life. Rapid and uncontrolled urbanization can disturb the equilibrium between the growth of the population and services provided. This in turn affects the overall growth in terms of GDP and results in the degradation of the quality of life. India being an agrarian society resided mostly in rural regions. According to census data, in 2011 among 1.21 billion people 68.9% resided in rural regions. However, a country boasting 8% plus GDP growth annually is dependent on its industrial and infrastructural growth to sustain development. Though food security is important, to fuel this rapidly growing economy a good section of human resource need to be industry bound to sustain growth. Conversion of manual farming to mechanized farming contributes towards a lesser amount of labour required by the agricultural sector. Increase in literacy level further contributes to the addition of human resource to skilled labour and service industry.

The urbanization of India can be observed from the 2011 Census data. The 15th National census survey was the latest conducted. The national census survey covered all the 28 states of the country and 7 Union territories including 640 districts, 497 cities, 5767 tehsils & over 6 lakh villages. Table 19.2 shows the number and population of all Urban Agglomerations. The data shows that there is a steady increase in both numbers of UAs, population, urban population and increase in the percent of the urban population. There has been a constant migration from rural to urban areas since the early 20th century. Cities grew at an annual exponential rate. Table 19.3 obtained from the latest census data show that there is a steady growth of the urban population.

Table 19.2: Number and Population of Urban Agglomerations (UAs) and Towns in India

Year	Number of UAs/ Towns	Total Population	Urban Population	Urban Population as % of Total Population
1901	1,830	238,396,327	25,851,873	10.8
1911	1,815	252,093,390	25,941,633	10.3
1921	1,944	251,321,213	28,086,167	11.2
1931	2,066	278,977,238	33,455,989	12.0
1941	2,253	318,660,580	44,153,297	13.9
1951	2,822	361,088,090	62,443,934	17.3
1961	2,334	439,234,771	78,936,603	18.0
1971	2,567	548,159,652	109,113,977	19.9
1981	3,347	683,329,097	159,462,547	23.3
1991	3,769	846,387,888	217,551,812	25.7
2001	4,378	1,028,610,328	286,119,689	27.8
2011	6,171	1,210,854,977	377,106,125	31.1

Source: Census of India 2011

Table 19.3: Annual Average Growth of Population: 1901-2011

Census Decade	Average Annual Exponential Growth of Population		
	Total	Rural	Urban
1901-11	0.6	0.6	0.0
1911-21	0.0	-0.1	0.8
1921-31	1.0	1.0	1.7
1931-41	1.3	1.1	2.8
1941-51	1.2	0.8	3.5
1951-61	2.0	1.9	2.3
1961-71	2.2	2.0	3.2
1971-81	2.2	1.8	3.8
1981-91	2.1	1.8	3.1
1991-2001	1.9	1.7	2.7
2001-2011	1.6	1.2	2.8

Source: Census of India 2011

The Census data also categorizes towns as per the population strength. The data aggregates the number of towns, villages based on the population. Table 19.4, shows that there is a constant increase in the number of towns for the urban regions with a population of more than one lakh. However, there is a marginal decrease in towns with lesser population indicating that the smaller towns are constantly growing. Similarly, the share of the population against the total population in the various class of towns is shown in Table 19.5.

Table 19.4: Growth of Various Classes of Towns based on census data from 1961 -2011

	No. of Towns					
Census Decade	**1961**	**1971**	**1981**	**1991**	**2001**	**2011**
Class of Town						
> 100,000	113	148	216	300	433	468
50,000 - 99,999	138	183	270	345	493	474
20,000 - 49,999	484	582	739	947	1383	1373
10,000 - 19,999	748	874	1048	1167	1561	1683
5,000 - 9,999	761	678	742	740	1040	1749
Below 5,000	218	178	230	197	224	424
Unclassified					27	
All Classes	2,462	2,643	3,245	3,696	5,161	6,171

Source: Census data from 1961 -2011

Table 19.5: Growth of Various Classes of Towns based on Share of Urban Population

	Percentage of Urban Population to Total Population					
Census Decade	**1961**	**1971**	**1981**	**1991**	**2001**	**2011**
Class of Town						
> 100,000	9.22	11.28	14.04	16.44	17.20	21.86
50,000 - 99,999	1.97	2.20	2.66	2.79	3.32	2.66
20,000 - 49,999	2.99	3.12	3.11	3.42	4.08	3.45
10,000 - 19,999	2.26	2.10	2.13	2.02	2.20	1.98
5,000 - 9,999	1.20	0.88	0.79	0.67	0.77	1.05
Below 5,000	0.14	0.09	0.11	007	0.08	0.14
Unclassified	-	-	-	-	-	-
All Classes	17.98	19.92	23.39	25.71	27.82	31.14

Source: Census data from 1961 -2011

The exodus of human resource from rural India to the urban region can be easily seen from the Census records (Table 19.6). The number of cities having more than a million citizens was only one in 1901; however, there was a steady increase in the number of megacities 1951 onwards. The most significant rise happened from 1971 onwards. The number of cities was 35 in 2001 and the number increased to 46 in the last recorded census in 2011. Almost 40% of the urban dwellers reside in these mega centres of growth. Table 19.7 shows the population of the ten most populous cities of India and the percentage of growth in population from 2001 to 2011. Bangalore, Hyderabad, Surat, Ahmedabad have expanded significantly in ten years whereas, in contrast, only Kolkata showed negative growth.

Table 19.6: Growth in Number and Share of Urban Population of Million-Plus Cities in India

Census Year	Number	Population (in Million)	Population Per Million-Plus City (in Million)	Percentage of Urban Population
1901	1	1.51	1.51	5.84
1911	2	2.76	1.38	10.65
1921	2	3.13	1.56	11.14
1931	2	3.41	1.70	10.18
1941	2	5.31	2.65	12.23
1951	5	11.75	2.35	18.81
1961	7	18.10	2.58	22.93
1971	9	27.83	3.09	25.51
1981	12	42.12	3.51	26.41
1991	23	70.66	3.07	32.54
2001	35	107.88	3.08	38.60
2011	46	116.18	2.53	40.60

Table 19.7: Top Ten Urban Cities in India and the Growth Rate from 2001 to 2011

Rank	City	Population 2011	Population 2001	Percentage Growth
1	Mumbai	12,442,373	11,978,450	3.87
2	Delhi	11,007,835	9,879,172	11.42
3	Bangalore	8,436,675	4,301,326	96.14
4	Hyderabad	6,809,970	3,637,483	87.22
5	Ahmedabad	5,570,585	3,520,085	58.25
6	Chennai	4,681,087	4,343,645	7.77
7	Kolkata	4,486,679	4,572,876	-1.88
8	Surat	4,467,797	2,433,835	83.57
9	Pune	3,115,431	2,538,473	22.73
10	Jaipur	3,046,163	2,322,575	31.15

Source: Census of India 2011

Urban infrastructure plays a big role in the financial health of a country. The financial health of India is significantly affected by growing urban population, slums, lack of proper waste management, damage of the environment, pollution, and increase in the number of the vehicles, lack of adequate roads, parking space and transport. Infrastructure growth has been identified as a priority sector for investment. Consistently there has been an increase in spending in this sector, US$ 24 billion in 2005 to US$ 47 billion in 2009. Under the 11th, 5 year Plan of the Planning commission (2007-11), 350 Billion Euros was allocated for infrastructure development, a majority of which was allocated for urban development. Table 19.8 indicates the projected expenditure of the Indian government towards infrastructure.

Table 19.8: Estimated Urban Infrastructure Budget for 2012-2031

Type of Expenditure	Amount in INR Crores
Urban roads	1728941
Urban transport	449426
Renewal & redevelopment including slums	408955
Water supply	320908
Sewerage	242688
Stormwater drains	191031
Capacity buildings	101759
Traffic support infrastructure	97985
Solid waste management	48582
Street lighting	18580
Other sectors	309815
Total expenditure	**3918670**

Source: R. Shetty, Urban Infrastructure Development in India - An Overview, in: Int. Conf. Civil, Electr. Electron. Eng., Bangkok (Thailand), 2012.

After the economic liberalization policy in the last decade leading to the 21st century, there has been an onus in infrastructural development. Aggressive industrialization and shifting of focus from the rural economy led to the mass migration of people towards urban India. Only 28% of the population (286 million) was residing in urban India as per the census in 2001. This increased to 40% of the total population by the year 2011. A higher percentage of GDP was expected to be generated from urban India. However, to prevent the fallouts of overcrowded cities, certain urgent measures are needed to be taken. New cities are needed to be built with holistic planning to differentiate them from real estate development. Creation of durable civic systems to service city requirements and to include all the stakeholders for sustainable growth.

A large variation in population distribution reflects the spatial polarization in large economic zones. This is a nightmare scenario for civic administration. They exert undue pressure on existing civic infrastructure like drinking water, transportation, waste management (both solid and wastewater), open spaces like parks and recreational grounds. The infrastructure of older cities is unable to bear the population pressure as the existing systems are reduced to be inadequate. New settlements, however, are better planned but unable to handle the rate of influx. This situation culminates to unorganised infrastructure, excessive pollution, slums, traffic congestion, increase in crime and social unrest. Very few cities have adequate finance to meet the infrastructure requirements of the growing cities 14]. The unfortunate financial situation of urban bodies is due to its lowest position in the three-tiered government structure. The municipal bodies have a budgetary allocation that is least in contrast to State and Central government. Their accounts contribute to 1% of GDP whereas globally it is 5%. They also have limited scope to raise funds for the service and support provided by them.

The financial resource requirements of urban bodies are humongous for the development, management and maintenance of urban infrastructure. The India Infrastructure Report, also known as the Rakesh

Mohan Committee Report (1996), projected the fund requirements for infrastructure development to Rs. 79,300 to Rs. 94,000 crore for the period 1996-2001. For water supply and toilet facilities, it was estimated the fund requirements would be at Rs. 21,000 crore for 2001-2011 and subsequently Rs. 22,800 crore for 2011-21. The Central Public Health Engineering Organisation (CPHEO), Government of India targeted 100% coverage for safe drinking water and sanitation by 2021, at an estimated cost of Rs. 172,905 crore. The Development Research Group (DRG) in the Reserve Bank of India (RBI-DRG) did this estimation in 2008. Such a magnitude of funding requirement was difficult to arrange by any particular government, central, state or local. Resource sharing among all stakeholders was the only way possible to manage funding.

History of Wastewater Disposal

The use of water and sanitation has changed under the influence of cultural, social and religious factors over the ages Historically, wastewater was always considered as filthy. Public health was under least consideration and disposal of wastewater was done on the public streets. This created health hazards and damage to the environment. There were several epidemics reported that occurred throughout Europe before the nineteenth century. Wastewater management and sanitation did not improve even after suffering several epidemics.

Pre-historic humans were nomadic hunters who never settled down at any place. For small groups, waste was naturally decomposed by soil. Establishment of agrarian settlements started 10,000 years ago and the idea of community living commenced. Such small communities disposed of their wastes by making holes in the ground. Health hazards associated with such disposal techniques were not recorded. Pure water sources remained clean but the existence of public health issues remained in urban centres owing to lack of wastewater management. The Mesopotamian Empire (3500–2500 BC) addressed the community sanitation problem. Drainage system along with latrines and cesspits was reported from ruins of Babylonia. Garbage was, however, littered on the streets and covered with clay. The Indus valley civilization was more advanced in terms of wastewater management with Harappa and Mohenjo-Daro dated 2500 BCE, having the world's first urban sanitation systems discovered at Rakhigarhi (refer Figure 19.6). Drainage channels were connected with houses and wastewater underwent some treatment before entering the sewers. Bricks covered sewers and channels that was occasionally cleaned and maintained. Indus valley civilization exhibited urban planning with particular attention to public health and hygiene. In the Egyptian city of Herakopolis (B.C.E. 2100), there is a description of bathrooms and toilet seats. It was documented by Herodotus that wastewater was channelled to a vessel outside the house wall or directly to the desert.

The research study of Angelakis et al. indicated that the Greeks were pioneers of modern wastewater management. They constructed toilets, complete sewerage system with public latrines and mechanisms to manage storm-waters. They managed to use wastewater for irrigation that was transferred using brick-lined conduits and piping systems.

Figure 19.6: Images Showing Sewage Canal and Drainage System in Harappa and Mohenjo-daro dated 2500 BCE

The Roman engineers developed water supply systems that were comparable to the latest technology and are ancient marvels (Figure 19.7). The Assyrians developed sewerage systems in the Roman Empire. The Romans collected rainwater while they disposed of wastewater and stormwater. The Romans used recycled wastewater for flushing latrines before discharging to sewers and the Tiber River. The rich people had their own houses and toilets. The poor citizens littered wastes on the streets and used public latrines. They were responsible for fire and epidemics. However, the sewerage systems, aqueducts and sanitation systems failed due to lack of maintenance and were no longer usable.

After the collapse of the Roman Empire, the next thousand years are considered "sanitation dark ages" as the concept of sanitation was completely ignored. This period lasted until the start of the industrial revolution. During this period, freshwater was collected from rivers and lakes while untreated wastewater was allowed to flow to these primary water sources. This led to disease and epidemic outbreaks. The industrial revolution started in the eighteenth century but it was in the nineteenth century that development in the sanitation sector gained importance.

The progression of urbanization coupled with industrialization started in Britain in the eighteenth century. This led to the introduction of pollution and city planners started experimenting to prevent environmental degradation. The initial approach was based on the concept that "the solution of pollution is dilution". The Bazalgette sewer system was constructed in London in 1865 where a series of collection sewers with pumping stations gathered the wastewater and dumped it into the Thames. This wastewater was dumped without prior treatment. Similarly, it was unknown as to the capacity of pollution the river could assimilate. Such dumping happened throughout several centuries, eventually leading to "the great stench".

The Thames was popularly known as a "monster soup". The scenario in Germany was also changing in a similar pattern with a sewer system constructed in 1842 in Hamburg and several other projects in top cities. In France, restrictions were imposed on households through legislation to prevent pollution of Seine. There was a reorganization of existing sewerage channels so that untreated wastewater was emptied downstream. Even preliminary treatment was adopted on large fields that collected wastewater before they were discharged to the Seine. In modern Italy, construction of a pure water system started in 1870, where aqueducts transported drinking waters to major cities. Construction of sewers was the least priority. Upgradation and maintenance of already existing sewerage systems were done. Reports by Giovannini suggested that 69 cities in Italy boasted of sewerage system by 1899. In the United States, sewers were installed for stormwater runoff. Large cities had sewer systems with European influence in planning and construction.

Figure 19.7: Underground Drainage Systems in Rome and Aqueduct Structure Built in Ancient Times

The wastewater management systems construction, development and installations gathered pace in the twentieth century. There was an attitudinal change in society towards pollution. The Eighth Report of the Royal Commission on Sewage Disposal in 1912 introduced the concept of biochemical oxygen demand (BOD) and testing of sewage effluents. This was copied by several countries and before the First World War, almost all the major cities of Europe was performing wastewater treatment. Pollution of water sources increased during the Second World War. This was due to delay in the construction of wastewater treatment systems and rebuilding of the destroyed infrastructure. Later on, the focus shifted towards water quality standards and the relation between chemical water pollution and toxicity.

Historical Overview of Technology

Initially, wastewater treatment consisted of the removal of heavier solids by sedimentation. This is known as primary treatment, done with trenches and pits used for many centuries. L.H. Mouras designed a cesspit in the 1860s, in which inlet and outlet pipes are placed below the water surface, thus, sealing with water. The secondary treatment involves decomposition of organic components using naturally occurring microorganisms. This was done as either attached growth (biofilm) or suspended growth. The microorganisms attached to some surface like rocks in the former whereas in the latter the microorganisms present in the sludge. Edward Frankland introduced filtration technique in 1870 that was further improved to develop a trickling filter in 1893. Some moving/rotating cylinders made up of wooden slats or porous bricks was conceptualized initially as a rudimentary form of modern-day Rotating Biological Contactors (RBCs). Later on, metal disks were used in the 1950s instead of wood. Expanded polystyrene disks further replaced the metal disks in the 1960s. The use of activated sludge process for suspended growth is another method devised for aeration of wastewater and removal of pollutants. The process was experimented in Massachusetts and later patented in 1913 in the UK. The experiment used to draw-and-fill reactors where the sludge was activated due to the presence of microorganisms. The bioreactor broke down carbon compounds to release carbon dioxide, water and energy for rapid regrowth of microorganisms. This sort of treatment technique remained popular in America whereas trickling filtration was common in the UK and Europe.

Soon it was understood that more is needed to be done for wastewater treatment for the prevention of eutrophication. Removal of nitrogen and phosphorus from activated sludge was the next level of wastewater treatment required. The concept was introduced by Lutdzack and Ettinger in 1962, but the system was developed and patented by James Barnard. More advanced systems like the use of membrane filters were already being used in industrial processes. However, Smith et al. first conceptualized the use of membranes to filter out solids and microorganisms from secondary effluent. The widespread use of commercial aerobic membrane bioreactors (MBR) started in the US in the late 70s and later adopted by Japan and Europe in 1980s and 1990s.

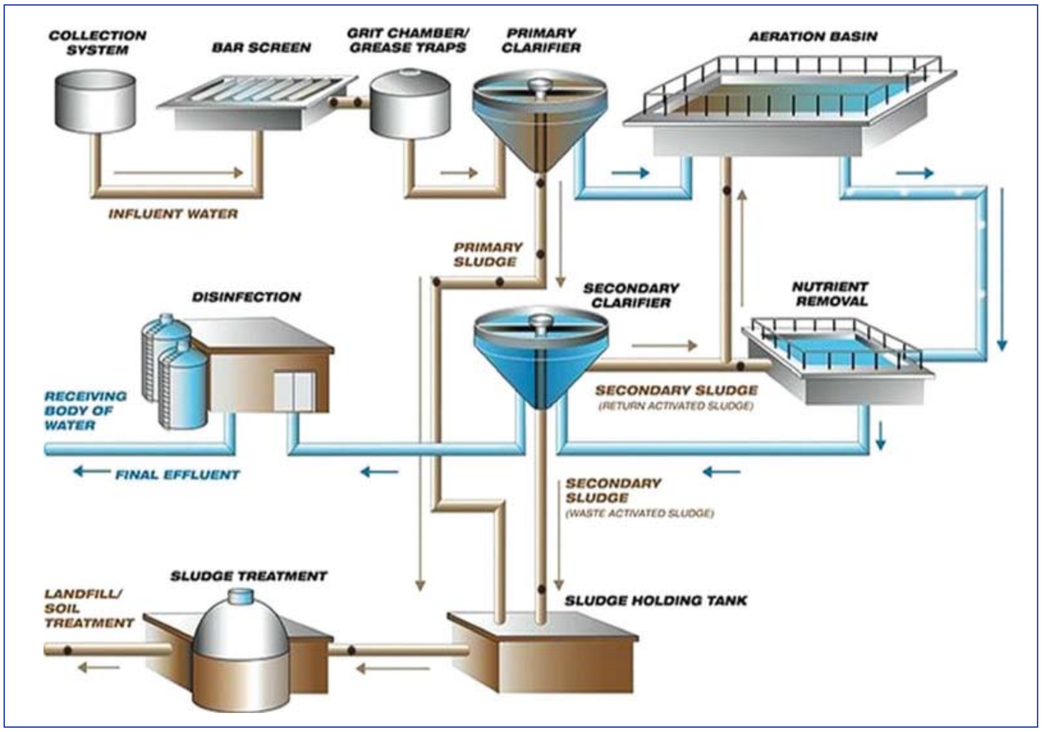

Figure 19.8: A Typical Wastewater Treatment System (Schematic Diagram)

In the early period of industrialization and urbanization, the odour emanating from wastewater was considered as the root cause of disease. Chlorine was commonly used as deodorants to remove the stench. Calcium Chloride was commonly used in London in the middle of the 19th century for deodorization and disinfection. During the late 19th and early 20th century, disease-causing microorganisms were being discovered and their relationship with wastewater was established. Chlorine for disinfection in different wastewater applications was used in diverse forms from late 19th century, however, became commonly practised since the 1960s as a residual controlled disinfection system. Use of Ultra-violet (UV) radiation for disinfection is considered latest technology and being adopted worldwide, though the effect of UV radiation is most efficient for neutralising the existing pathogens, but cannot neutralise further contamination downstream transmission. A typical wastewater treatment scheme is presented in Figure 19.8. A three-tier based treatment system is depicted in Figure 19.9.

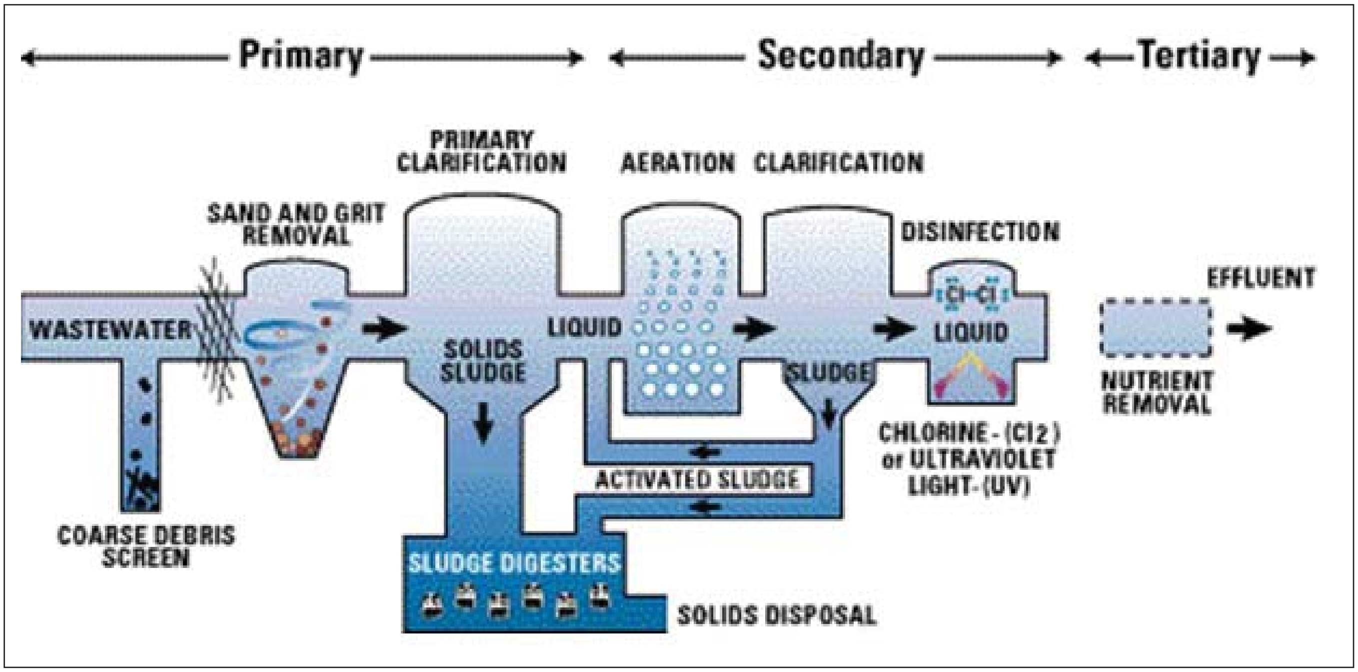

Figure 19.9: A Three-Tier based Wastewater Treatment Plant Schematic Diagram

Wastewater Disposal Schemes in India

The government of India identified the need for better urban management. Several missions/ programmes were launched to address the issues faced by the municipal bodies to manage urban resources. The government has emphasized on energy-efficient green technologies in wastewater treatment plants.

Modern cities focus on renewable resources like a reuse of treated wastewater. However, there are impediments, adequate finance to support such changes and mindset of people against change. Scarcity of water has shifted focus on resource renewal and reuse water. As per the world average, upper-middle-income countries treat 38%, lower-middle-income countries treat 28% and lower-income countries treat 8% of wastewater. In India, only 32% household is connected to a sewerage system and only 10% of the wastewater is treated. The wastewater treatment plants require lots of energy and untreated water is hazardous to society and climate. Hence, the treatment process has to be optimized so that the water-energy-food nexus equilibrium can be maintained. New approaches are considered to reduce the energy required for treatment of wastewater, reuse the water for horticulture, industry and agriculture. Re-engineering wastewater treatment plants to reduce energy cost and to use waste to generate energy like biogas and use it for wastewater treatment. Most of the newly built treatment plants generate 60% of its energy requirements through biogas heat and electricity. A company Veolia built the wastewater treatment at Nilothi in West Delhi with a capacity of 90,000 m^3 per day (Figure 19.10). It generates half of its energy requirements through biogas heat and electricity. It uses conventional biological treatment and uses technology to reduce sludge. The sludge is further converted to manure and sold off to farmers. The largest wastewater treatment plant in Nashik owned by the local municipal corporation (Figure 19.11). It uses up-flow anaerobic sludge blanket technology and produces biogas. The 21,000 m^3 methane generated is used to produce 32,000 kWh electricity and returned to the grid. The solid waste and black water is converted to an innovative waste-to-energy plant. This is the first of its kind of wastewater treatment plant in India. The treated effluent is dumped into Godavari River for indirect use of the wastewater in irrigation and downstream power plant uses.

Figure 19.10: Wastewater Treatment at Nilothi in West Delhi with a Capacity of 90,000 M^3 per day

The policy of the Indian government towards pollution control has contributed to the National Urban Sanitation Policy of 2008, which recommends 20% of wastewater to be reused in each city. Moreover, the National Water Policy of 2012, provide specific standards for treated wastewater and the reuse of the same. However, the reuse of wastewater is strictly followed in water-scarce cities. However, it is not considered a priority at national, state or municipal level. Our national capital faces severe water scarcity problem with very low groundwater level and have resorted to reuse wastewater for horticulture application and use in cooling towers of power plant (Pragati power plant). Almost 630,000 m^3 per day of recycled water is used for application in the government building, construction industry and all non-drinking use of water.

Figure 19.11: The Largest Wastewater Treatment Plant in Nashik

The 74th Constitutional Amendment Act 1992

The economic development centres are towns and cities. It is essential that the people of these places involved in the development of these regions. Though the power of legislation strongly held by the Parliament and State Legislatures, the devolution of power to the inhabitants of villages, towns and cities is important to determine their futures. The Constitution did not provide adequate legislation to make local self-governance in urban areas. There are Directive Principles that refer to Village

Panchayats, but a similar reference for devolution of power to the hands of local municipalities is not mentioned. The 74th constitutional amendment act provided the legislation for devolution of powers to Urban local bodies (ULBs) as the lowest level of government activity. This provides people power to control their fate via the local bodies (referred to as municipalities), namely Municipal Corporations, Councils and Nagar Panchayats. These have similar representatives, have elected members regularly and are given the power for local planning, provision and delivery of services to the area under their jurisdiction.

The constitutional amendment also provides provisions for setting up of Ward Committees, District Planning Committees and Metropolitan Planning Committees as well as State Election Commissions and State Financial Commissions. The ULB will play a major role in providing services like water, waste management, electricity etc. Municipal Corporations for cities whereas municipal council or municipalities for towns and Nagar-panchayat for lesser-populated regions. The act provides the power of legislation, to implement social and economic programmes, the power to collect specific taxes, duties, tolls to finance their activities.

Urban Reform Incentive Fund (URIF) 2002

This is a funding project of the Urban Development Ministry as an assistant to the states from the reform-linked Urban Reform Incentive Fund (URIF). Finance ministry proposed in the Budget for 2002-03 with an initial allocation of Rs 500 crore. The main areas addressed was linked to urban land development and control laws along with civic services. The City Challenge Fund (CCF) was initiated to fund municipal management. The Ministry of Urban Development further increased the fund to Rs 3,000 crore per year over the next three years during 2017-18. The International Bank for Reconstruction and Development (IBRD) cosponsored this funding with the Government of India.

Jawaharlal Nehru National Urban Renewal Mission (JnNURM) 2005

JnNURM was launched in 2005 for urban development. The specific aim of the Mission is to encourage reforms and planned development of identified cities (more than million population cities as per the 2001 census). JnNURM has two main components namely, Urban Infrastructure and Governance and Urban Infrastructure Development for Small and Medium Towns. The project commenced on 2005-06 and was supposed to complete by 2011-12. However, as the projects were extended until March 2014. The funds for JnNURM were provided as grants to the states directly from the centre. The 2012 Union Budget allocated Rs 12,522 crore for JnNURM. 554 projects at a total cost of Rs 62,253 crore was sanctioned under the Urban Infrastructure and Governance sub-mission of JnNURM. Table 19.9 shows the status of project completion. The project included the building of civic amenities like wastewater disposal systems and sanitation projects of big cities. The revamp of the age-old brick sewer system (developed pre-independence) with modern GRP liners retrofitted in situ done by Kolkata Municipal Corporation is shown in Figure 19.12.

Table 19.9: Project Status Report of JnNURM in 2012

Name of State	Total Allocation (Rs Cr.)	Number of sanctioned projects	Completed Projects
Andhra Pradesh	2118.5	52	18
Arunachal Pradesh	107.4	3	NA
Assam	273.2	2	NA
Bihar	592.4	8	NA
Chandigarh	270.9	3	NA
Chattisgarh	248	1	NA
Delhi	2823.2	23	4
Goa	120.9	2	NA
Gujarat	2578.8	72	40
Haryana	323.3	4	NA
Himachal Pradesh	130.7	5	NA
Jammu & Kashmir	488.4	5	NA
Jharkhand	941.2	5	NA
Karnataka	1524.6	47	22
Kerala	674.8	11	NA
Madhya Pradesh	1328.5	23	7
Maharashtra	5505.6	80	21
Manipur	152.9	3	NA
Meghalaya	156.7	2	NA
Mizoram	148.2	4	NA
Nagaland	116.3	3	NA
Orissa	322.4	5	NA
Punjab	707.8	6	1
Puducherry	206.8	2	NA
Rajasthan	748.7	13	2
Sikkim	106.1	2	NA
Tamil Nadu	2250.7	48	12
Tripura	140.2	2	NA
Uttar Pradesh	2769.4	33	4
Uttarakhand	405.3	14	NA
West Bengal	3218.4	69	15

National Urban Housing and Habitat Policy (NUHHP) 2007

This policy was formulated to support changing socio-economic parameters of the urban areas and increase in the requirement of shelter and related infrastructure. The Policy intends to augment the infrastructural requirements to achieve the goal of "Affordable Housing for All" with special emphasis on the urban poor. There is a huge budgetary constraint of funds for both the Central and State Governments. This policy intends to involve multiple stakeholders that include the private sector, the cooperative sector and the industrial sector for labour and employee housing.

Rajiv Awas Yojana (RAY) 2011

The project was announced by the President in 2009 and mainly focuses on slum dwellers and the urban poor. The project goal was to have a slum-free India in five years, which would grant property rights to slum dwellers. Apart from providing house, the project intends to provide civic facilities like water supply, sewerage, drainage, street lighting and other social infrastructure facilities in slums and houses of low-income group. The project provided subsidized credit facilities. An allocation of Rs. 150 Crore for 2009-10 was made in the union budget. The project was in tandem with JnNURM.

National Urban Livelihoods Mission (NULM) 2013

This mission is also known as Deendayal Antyodaya Yojana (NULM). The Ministry of Housing and Urban Poverty Alleviation was already having a project named Swarna Jayanti Shahari Rozgar Yojana (SJSRY) since 1997. This was rechristened as Deendayal Antyodaya Yojana - National Urban Livelihoods Mission in 2013. The project was being implemented in all district headquarters and all the cities with a population greater than one lakh. The project was aimed at providing self-employment and skilled wage employment opportunities.

Figure 19.12: The top left image shows the narrowing of the drainage pipes due to siltation. The right image shows the process of retrofitting done on the existing brick sewer using trenchless technology. The bottom left image shows the completed section of GRP liners.

Swachh Bharat Abhiyaan (Clean India Mission) 2014

This is one of the biggest and far-reaching programmes undertaken by the central government on Gandhi Jayanti to commemorate 150th birth anniversary of Mahatma Gandhi. The ideology of Gandhi of clean environment was the objective of this mission (Figure 19.13). SBM was implemented by the Ministry of Housing and Urban Affairs and by the Ministry of Drinking Water and Sanitation for urban and rural areas respectively. The salient feature of this mission was to prevent open defecation, eradication of manual scavenging, apply scientific and technological advance systems for Waste Management. The idea was to inculcate changes among citizens for better and healthy sanitation practices. Create awareness about cleanliness and sanitation for improved public health. The objective also included capacity building of lower civic bodies by bringing in private partnership in the creation and maintenance of public utility services. The Mission duration ended on 2nd October 2019.

SBM (Urban) will not allow any households to perform open defecation. The household sanitation and toilet facilities will be constructed and pit latrines to be converted to sanitary latrines. The target will be to achieve the conversion of 80% household engaged in open defecation or having insanitary latrines/ single-pit latrines. The rest 20% will be using community toilets due to space constraints. The household toilet will have pan/water closet and sewerage system connecting them to an outside sewerage system. The external sewerage will be made available within 30 metres of the household area. If a sewerage system is unavailable within 30 meters then an on-site treatment system (such as twin pits, septic tanks, bio-digesters, or bio-tanks) should be constructed. The household will maintain the sanitation costs inside the house whereas the urban local body (ULB) will maintain the sewerage system by carrying out periodic desludging of pits to minimize environmental and health problems to the community. The Central government provided an incentive of Rs. 4,000 for the construction of household toilets per household. For the construction and maintenance of the community toilets, the sole responsibility will lie on the ULB. The construction should ensure separate toilet and bathing facilities for men, women and the disabled (refer Figure 19.14).

Figure 19.13: The Swachh Bharat Mission

Under this scheme, the States and ULBs will build and maintain sufficient public toilets and Urinals covering the entire city with more number in prominent places. Separate facilities for men, women and physically challenged person. The ULBs must ensure that there is adequate water supply to the public toilets. The funding for SBM for public toilets in which the central government share is 40% and the rest by state and ULBs. All toilets constructed with sole discretionary power to the ULBs and maintenance for 5 years. Solid waste management to be done by ULBs. Tasks involved are waste segregation and storage at source, primary collection, secondary storage, transportation, secondary segregation, resource recovery, processing, treatment, and final disposal of solid waste. Change of behaviour towards healthy sanitation habits requires effective promotion and campaigning. The central share of funds was 15% and 12% for states for the total project outlay. The funds will be utilized for massive public awareness campaigns. Campaigning on national Newspaper and national TV not an admissible item under this component. There was an outlay of 3% for capacity building, administrative and office expenses of States and ULBs. Central governments allocation of 2% for the ministry expenses. The administration and monitoring of the project were done by the Programme Management Units (PMUs) at the State level, the Programme Implementation Units (PIUs) at the city level, and Independent Project Review & Monitoring Agencies (IPRMA).

Figure 19.14: Construction of Toilet Facilities under the Swachh Bharat Mission

The Smart Cities Mission - Development of 100 Smart Cities 2015

The objective of this mission was to upgrade the facilities of 100 selected cities from all over the country. This is another urban renewal program to modernize cities by ensuring infrastructure development to provide a decent quality of life to the citizens. The initiative supports a clean and sustainable environment with the implementation of 'Smart' Solutions. Initially, 20 cities got funding for converting them into smart cities. Later the remaining cities received project funding from the Ministry of Urban Development being an urban renewal fund the focus was on retrofitting and redevelopment of facilities. Concept of data and ICT for the smart initiative was key to this mission. The Centre, state, collaboratively did financing with local bodies and the involvement of private sector in Public-Private Partnerships model of financing. The major contribution of Rs. 48,000 crores over five years i.e. on an average Rs. 100 crore per city per year done by central funding. A similar contribution by both state and local bodies for funding the project.

Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

AMRUT was conceived for 500 cities with over one lakh population along with smart cities project. This was jointly planned and launched by the Central Government to alleviate urban living conditions through infrastructure upgradation. The project life was expected to be of five years. Ministry of Urban Development identified five hundred cities with the help of state governments. A fund of Rs 50,000 crore was allocated for this mission to be executed in five years. The Central Government committed 80% budgetary support to the mission. The primary objective was to ensure that every household gets a supply of filtered drinking water and sewage connection. Development of open spaces and parks for citizens to improve greenery. Provide transportation means that will not pollute the environment. The objective of providing 135litres per capita per day water supply and sewerage connections to all urban households. In the first phase, 90 cities were selected for the mission.

Pradhan Mantri Awas Yojana (Housing for All) 2015

This is an urban housing development programme launched by the Prime Minister to provide housing for all in urban areas by 2022. This centrally funded scheme assists States and Union Territories for constructing houses to all eligible sections by concentrating on urban slums and economically weaker sections. The main objective is to take care of slum dwellers in partnership with private developers. The fund also provided low-cost houses, credit facilities and subsidy to the eligible poor. This will enhance the sanitation, public health and hygiene of the cities.

Heritage City Development and Augmentation Yojana (HRIDAY) 2015

The HRIDAY scheme was launched for the holistic development of heritage cities. The aim was to preserve and maintain the unique character of heritage cities in India. The initial phase of the programme Rs 500 crore was allocated with full funding by the central government. Twelve cities—including Ajmer, Amaravati, Amritsar etc. were identified for the project.

RURBAN Mission 2016

This RURBAN mission was developed to preserve and nurture the essence of rural community life. The project focussed on justice, inclusiveness and facilities that are urban in nature, thus naming "Rurban Villages". The mission objective was to promote local economic development, enhance basic services and create well-planned Rurban clusters. The objective of bridging the socio-economic gap between rural and urban was the main concept of the mission.

Wastewater Disposal concerning Kolkata and West Bengal

The Hugli river flows through West Bengal for a stretch of 260 km until it reaches the Bay of Bengal. Some of the regions the river passes through are highly populated, urbanized and industrialized. A lot of household wastewater and industrial effluent is discharged to the river. The Central Pollution Control Board (CPCB) in its report in 2015 assessed that West Bengal dumped 49% of treated wastewater to the Ganges system. Since the river flows across the state, it is the main river basin for irrigation and drinking water source. Thus, pollution affects the inhabitants of Gangetic Bengal. This was due to the inefficient Sewage Treatment Plants (STP) adopted by the state to treat wastewater. Bengal generated 1,311 million litres a day (MLD) of wastewater and treated 214 MLD (though maximum capacity was 257 MLD with 34 STPs) where Kolkata being the top city to generate almost 47% of the effluent. When randomly tested some of the water samples had BOD and COD levels higher than the recommended standard. A few of the STPs were found non-operational. The report also indicated that few places in Bengal like, Dakshineshwar, Uluberia and Diamond Harbour had higher BOD, faecal coliform and pH. The National Green Tribunal (NGT) raised concern on West Bengals role in waste management and pollution of Ganga based on the report by CPCB. The tribunal also found that of the 341 blocks in West Bengal, 81 blocks had a high content of arsenic and 49 blocks had a high content of fluoride in groundwater.

CPCB in 2019 reported that unfiltered water of

Ganga is unfit for direct drinking with only seven spots (out of 86 spots being monitored) the water is good for drinking. Moreover, people take a holy dip in the river Ganga but that is harmful to bathing in the stretch from Uttar Pradesh to West Bengal. Only 18 spots are fit for bathing out of 78 areas monitored. Only water at Diamond Harbour is fit for drinking and four other spots in Bengal fit for bathing. The Central government is implementing Namami Gange programme initiated by the Ministry of Water Resources to make river Ganga pollution-free. The CPCB has adopted oxygen level (more than 6 mg/litre), BOD (less than 2 mg/litre), total coliform levels (5000 per 100 ml) and pH (range between 6.5 and 8.5) as standard for judging the quality of river water. Unfortunately, some samples reported 50,000 and above faecal coliform bacteria, rendering it harmful for drinking/bathing.

More than 70 million people are vulnerable to direct poisoning by Arsenic contamination in the groundwater system. Cases of Arsenic poisoning was reported from Punjab in the year 1976 and the state of West Bengal in the year 1982. Arsenic Task Force of the West Bengal government reported that the crisis was due to "geo-morphological reasons" as well as industrial effluent discharged to the Ganga without specific treatment for Arsenic. The World Health Organisation standard for safe level is 0.01 mg per litre. The Bureau of Indian Standards extended the safe level to 0.05 mg per litre. The scientist community have blamed the coal found in the region responsible, as the arsenic content is high. The fly ash dumped to the Ganga river is one of the causes apart from the rampant use of fertilisers, pesticides, herbicides and fungicides that are Arsenic rich. There was no reference made on this issue by the National Water Policy of 2012 and no action taken thereafter.

Figure 19.15: The accumulation of silt inside underground sewer channels (left image) and the cleaned sewer channel (right image). The bottom image shows the bricks dislodging off the sewer channel wall.

The maintenance of the sewage system is another big issue in terms of finance and infrastructure support. The sewer systems are old and need constant maintenance. Issue of silt settling down and blocking the sewers needed to be monitored. Sometimes these age-old brick sewer often caves in and result in failure of the drainage system. Figure 19.15 shows siltation blocking the sewer pipes and sewage tunnel collapse. Sometimes there is a complete collapse of the underground brick sewer channels (Figure 19.16). This results in complete damage to the sewer drainage system. The wastewater outfalls are needed to be cleaned so that the sewer wastewater flows to the treatment plants unobstructed. The wastewater canals often contain solid wastes and plant outgrowths that create hindrance for the flow of wastewater (refer Figure 19.17).

Figure 19.16: Complete Underground Brick Sewer Collapse and Damaged Drainage System in Kolkata

Figure 19.17: The Sewer Canals of the City of Kolkata, Clogged by Outgrowths and Solid Wastes

The facilities of sewage treatment present in the state of West Bengal and the capacity of wastewater the STPs can treat is documented in Table 19.10. The detailed capacity of each functional STP in the state is documented in Table 19.11. The effluents that arise from the industries in West Bengal, the amount of wastewater generated and the capacity of wastewater treatment is documented in Table 19.12. The alternative sewage treatment facilities that are working and are proposed across the state is documented in Table 19.13. The data is obtained from the recent report prepared by the State Pollution Control Board.

Table 19.10: Estimated Number of Sewage Treatment Plants and Capacity in West Bengal.

Total Population (Based on 2011 census) Estimated for Year 2020	10.09 crore	
	Urban	**Rural**
Estimated Population 2020	3.09 crore	7 crore
Estimated Sewage Generation (MLD)	2758	1400
Details of the Sewage Treatment Plant		
	Number	**Capacity in MLD**
Existing no. of STPs and Treatment Capacity (in MLD)	43	671
Capacity Utilization of existing STPs		526
MLD of sewage being treated through Alternate technology		8
Gap in Treatment Capacity in MLD		137
No. of Operational STPs	30	
No. of Complying STPs	7	
No. of Non-complying STPs	36	

Source - National Mission for Clean Ganga Format for submission of Monthly Progress Report in the NGT Matter O.A.No.673 of 2018 (in compliance to NGT order dated 24.09.2020)

Table 19.11: The Detailed Capacity of All the Sewage Treatment Plants in West Bengal.

Sl No.	Location	Existing STP Capacity (MLD)
1	Jagaddal Bhatpara New	31.00
2	Shyamnagar	10.00
3	Jagaddal Bhatpara old	9.50
4	Kankinara STP, Madrail, Bhatpara	10.00
5	STP Kalyani-I	11.00
6	STP Kalyani-II	10.00
7	Gayeshpur	8.33
8	Baidyabati	6.00
9	Bhadreswar	7.60
10	Chandannagar, Khalisani, Chinsurah- Hugli	18.16
11	Chandannagar, Khalisani, Chinsurah- Hugli	4.50
12	Bansberia	0.30
13	Konnagar	22.00
14	Naihati	11.56
15	Titagarh	4.50
16	Titagarh	4.50
17	Bandipur (Khardaha)	14
18	Champadani	1.00
19	Garulia	7.90
20	Naihati	6.50
21	Panihati	12
22	Serampore	18.60
23	Balli (Kona)- Kona, Chakpara (Anandanagar gram Panchayet)	62.00
24	Howrah-Arupara	65.00
25	Kamarhati - Baranagar -Kamarhati, Mathkol, near Belgachia Metro Car Shed	60.00
26	Bangur	52.00
27	Garden Reach	57.00
28	Keorapukur	45.00
29	Baghajatin	15.00
30	Hatisur	10.00
31	Durgapur Municipal Corporation	1.00
32	Durgapur Steel Plant	6.00
33	Durgapur Project Limited	5.00

Sl No.	Location	Existing STP Capacity (MLD)
34	ACC Babcock Limited	0.5
35	Damodar Valley Corporation	1.32
36	Nabadwip Municipality, Nadia	10.00
37	Katwa Municipality, Purba Burdwan	4.36
38	Diamond Harbour Municipality	2.03
39	Murshidabad Municipality	1.96
40	Berhampore Murshidabad	3.70
41	Jiagunj Azimgunj	1.39
42	Mahananda Left Bank, Siliguri	15.00
43	Jorapani & Fuleswari River, Siliguri	24.00

Source - National Mission for Clean Ganga Format for submission of Monthly Progress Report in the NGT Matter O.A.No.673 of 2018 (in compliance to NGT order dated 24.09.2020)

Table 19.12: Details of Industrial Pollution in The State of West Bengal.

No. of industries in the State	16259	
	Red Category	**Orange Category**
	3927	12332
No. of water-polluting industries in the State	454	
	GPI	**SPI**
	54	400
Number of industrial units having ETPs	54	400
	454	
Number of industrial units connected to CETP	345 Nos. tanneries	
Quantity of effluent generated from the industries in MLD	1360.60	
Quantity of Hazardous Sludge generated from the Industries in TPD	90	
Total capacity of ETPs in MLD	1360.60	
Number of CETPs (Existing)	1	
Total capacity of CETPs in MLD	20 (4 X 5 MLD)	
Location of Existing CETPs	Bantala Leather Complex Kolkata	
Number of CETPs (Proposed – Under Construction)	20 (4 X 5 MLD)	
Location of Proposed/ Under Construction CETPs	Bantala Leather Complex Kolkata	

Data Source - National Mission for Clean Ganga Format for submission of Monthly Progress Report in the NGT Matter O.A.No.673 of 2018 (in compliance to NGT order dated 24.09.2020)

Table 19.13: Alternative Sewage Treatment Plan (Adopted and Proposed systems) in West Bengal.

Existing Systems			
River name	**Polluting drain**	**In-situ treatment details**	**MLD treated**
Ganga	Jangipur	Bio / Phyto remediation treatment Necessary chemical dosing as per test result data	0.2
Churni	Basko Canal	Bio / Phyto remediation treatment	4.28
	Sreenathpur Drain	Bio / Phyto remediation treatment Necessary chemical dosing as per the test result data	2.79
Proposed Systems			
Kansi	2	Primary treatment providing screens, sedimentation tank, followed by disinfection by chlorination	21.41
Mayurakshi	12 (Suri) 14 (Sainthia)	Primary treatment providing screens, sedimentation tank, followed by disinfection by chlorination	4.04 (Suri) 2.68 (Sainthia)
Rupnarayan	4	Primary treatment providing screens, sedimentation tank, followed by disinfection by chlorination	8.37
Jalangi	8	Primary treatment providing screens, sedimentation tank, followed by disinfection by chlorination	17.45
Silabati	4	For Ghatal Primary treatment providing screens, sedimentation tank, followed by disinfection by chlorination	3.80
Dwarekeswar	13	For Bankura Primary treatment providing screens, sedimentation tank, followed by disinfection by chlorination	15.10
Kaljani	18	For Alipurduar Primary treatment providing screens, sedimentation tank, followed by disinfection by chlorination	9.33
Korala	47	For Jalpaiguri Primary treatment providing screens, sedimentation tank, followed by disinfection by chlorination	12.81
Ganga	22	S&SWM sector KMDA identify alternative treatment method where adoption of Bio / Phyto remediation is not possible as because they are situated in the tidal influence zone.	-

Data Source - National Mission for Clean Ganga Format for submission of Monthly Progress Report in the NGT Matter O.A.No.673 of 2018 (in compliance to NGT order dated 24.09.2020)

East Kolkata Wetland

Kolkata is a highly populated city with more than 45 lakh inhabitant and about 15 lakh floating population. There is a growing requirement for sewage, solid and wastewater treatment and disposal. In the eastern fringe of the city, there is a natural 125 km2 wide wetland known as East Kolkata Wetlands. This designated RAMSAR site consumes 78% of city wastewater. The wetlands are fed through an intricate system of canals that carry wastewater from the city. This site exhibit a symbiotic relation between wastewater treatment and wetland aquaculture. There are natural ponds/ lakes/tanks that have a healthy growth of sewage-fed fisheries. A potential site for wastewater reuse, maintaining an ecological balance as well as providing food and livelihood to local people. Such natural wetlands are living filters and act as transitional zones or ecotones, acting as buffer zones between wastewater and accepting waterbodies. Use of artificial wetland is low-cost system to clean wastewater, industrial effluent, agricultural effluents are popularly used worldwide.

The use of constructed wetlands for sewage treatment is emerging as low cost, efficient means to clean wastewater. The East Kolkata Wetlands is a synthetic ecosystem engaged in the resource recovery process that is environment friendly. The presence of humidity, sunlight, plants, microorganisms, soil nutrients and wastewater elements forms a complex mixture that aid growth of fish. Wastewater is judiciously channelled among five types of fish ponds namely, egg pond, nursery pond, rearing pond, stocking pond and harvesting pond. Apart from sewage-fed fisheries, paddy cultivation by utilizing fish-pond effluents, organic waste-based farming of vegetables and freshwater aquaculture support eco-friendly and sustainable wastewater management.

The eastbound growth of the city is a threat to this eco-system. The increase in the population of Salt Lake and Rajpur-Sonarpur municipalities, the construction of Eastern Metropolitan Bypass for north-south connectivity and development of Rajarhat/New Kolkata Township (on the north of the eco-system) is creating significant pressure on the eco-system. The problem of urban encroachment on the East Kolkata Wetlands was identified as a serious ecological problem in 1992. A pressure group called PUBLIC (People United for Better Living in Calcutta) successfully got favourable judgement after filing a writ petition in the High Court against encroachment. Subsequently, the West Bengal government passed East Kolkata Wetlands Conservation and Management Bill in 2006 to protect the wetland. All the stakeholders in Kolkata like KMC (Kolkata Municipal Corporation), KMDA (Kolkata Metropolitan Development Authority), WBHIDCO (West Bengal Housing Infrastructure Development Corporation), NGOs like PUBLIC, SAFE (South Asian Forum for Environment), Fishery cooperatives, residents, ecotourism resort owners, real estate developers and finally wetland institutes like IWMED, EKWMA are collaborating to protect this eco-system.

Figure 19.18: The East Kolkata Wetlands

Challenges for Implementing Effective Wastewater Management

Wastewater reuse happens mostly indirectly (mixing with primary water source) and unplanned way. Irrigation water often contaminated with poorly managed wastewater. It is essential to use wastewater in a planned manner, thus converting the wastewater problem to be eliminated to a potential resource. Again, we must change the attitude towards this resource.

Wastewater as a resource

Wastewater can be a source of nutrients in agriculture, act as a soil conditioner, source of energy and water for drought-resistant regions of the world. According to the research of Sato et al., wastewater differs according to geographical locations. More than 50 countries of the world use wastewater for irrigation. An estimated 20 million to 45 million hectares of land worldwide is irrigated with reclaimed water.

Wastewater being nutrient-rich contain 99% water and 1% suspended minerals and solids. Dissolved solids can be a potential resource of toxic minerals or pathogenic microorganisms. Wastewater can be treated to remove harmful elements and then can be directed to irrigate farmlands / non-agricultural recreational lands or flushing of toilets. This is useful in drought-affected regions of the world where water is much more scarce commodity. Wastewater can be a source of nutrients like phosphorus and nitrates that add on to the nutrient of the soil.

Faecal decomposition by bacteria can form biogas. Such biogas can be harvested for heat generation and energy requirements. The sludge can be collected from pits, sedimentation tanks and used to generate methane gas.
Faecal deposits are also good bio-solids, with proper analysis, can be collected and used as soil conditioners or fertilizers in gardens and farmlands.

Challenges Faced

The wastewater volume continuously increases with growing urbanization. With an increase in volume, it is becoming increasingly difficult to manage wastewater effectively. The collection of sewer pipes transport the collected wastewater away from their origin to a centralized wastewater treatment plant that lies at the lowest elevation. Often the lack of dual distribution systems hampers the reuse of wastewater at the point of their origin. The treatment plant more often located at a remote location away from the busy city. Thus, reuse channels are absent due to the high costs of construction. Sometimes, smaller satellite treatment systems are used that are located close to the origin of wastewater; hence reuse is possible post-treatment. Bio-solids segregation and utilization are helpful for land applications. There are technological and socio-economic challenges for wastewater management.

Infrastructure & Finance

Collection of wastewater from source and transport to the treatment plant requires huge financial commitments. The huge amount of infrastructural development and continuous maintenance is the biggest challenge faced by urban planners due to inadequate manpower and machine support with adequate capacity building of ground staff. The treatment plants require modern technology and heavy infrastructural investment to manage with qualified manpower to disinfect, filter and reclaim useful elements. A large amount of energy is required to transform wastewater into a form that can be disposed to the primary water sources without polluting them.

Pollution of Water Sources

Wastewater pollutes the water body where it is discharged. Water pollution causes degradation of water quality and damages the flora and fauna of the water body. The aquatic ecosystem gets disturbed. The food consumed by humans also contain traces of wastewater solids, faecal deposits and chemicals associated with human discharge. Various chemicals including contraceptives, medication drugs and other harmful complex chemicals find their way to the human food chain. It is extremely important to maintain discharge quality standards. Contaminants emerging from pharmaceuticals and antibiotic-resistant bacteria can cause serious health hazards with disease spread by water (such as cholera and cryptosporidiosis). Moreover, the establishment of testing standards to identify pollutants will contribute towards effective treatment of wastewater. This is necessary before releasing the wastewater to the water system.

Implementation of Appropriate Technology

Advanced technologies have contributed new pathways for better treatment of wastewater. However, they might be costly and difficult to maintain. The choice of treatment technology is of the utmost importance. Choice of technology is also related to the nature of pollutants predominantly present in the wastewater. Latest technology may reduce energy footprint, further helping the environment.

Sludge production

Wastewater treatment produces sewage sludge. The sludge can be reused as manure for farmlands as bio-fertilizer. However, there is a risk of contamination by heavy metals, toxic chemical wastes and pathogenic microorganisms. There is every possibility that they might enter the human food chain through farm produce or aquatic foods. So appropriate routine analysis on regular basis has to be ensured for prevention from such risks.

Reuse

The most challenging task in wastewater treatment is to reuse the wastewater so that the potential benefits can be reaped. The important constituents of wastewater can be useful in irrigation, horticulture and aquaculture applications. The biggest challenge is to eliminate the harmful chemicals, microorganisms that might be present in wastewater and can cause a serious threat to human lives. Reuse of wastewater is possibly the best way to decimate wastewater from the system and so zero discharge systems are encouraged.

Conclusion

Wastewater disposal is historically known and recoded. The concept of removal of the wastewater away from the settlements was evident from the excavated ruins of Mohenjo-Daro (Indus valley civilization) done approximately 5000 years ago. Early urbanization in the Roman Empire and later in the recent history across Europe wastewater disposal and treatment is well noted. The industrial revolution introduced large-scale urbanization. The volume of sewage and industrial wastewater started to become a cause for concern. The immediate disposal of wastewater was necessary to keep the urban areas free from pollution and disease. This required planning, designing and implementation of large-scale sewage treatment plants in and around cities and industrial areas. The use of latest technology to optimise the process of wastewater treatment was adopted for a better energy-efficient solution. The reuse of wastewater is the latest trend in the process of wastewater treatment. This provides a greener solution to wastewater treatment as well as transforms the wastewater as a useful resource.

All of us has to remember that wastewater cannot be considered singularly, it is very much one of the most important components of the watershed management cycle. If we still ignore the alarm, we will run out of freshwater resource in near future irreversibly.

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state of environment report-II

WEST BENGAL

Chapter 20

Environment and Public Health

Chapter 20

Environment and Public Health

Health and environment are interlinked to each other. A healthy environment is the prime need for the protection and promotion of living organisms from all sources including humans, as they interact with each other and with the surrounding environment as well. Environment plays a very crucial role in maintaining physical, mental, and social wellbeing of people. The environmental risk factors on health are extremely varied and complex both, with respect to severity and the clinical significance. Human civilization spread agriculture, industrialisation, urbanisation and modernization to achieve economic development, which also led to tremendous improvements in peoples well beings but often at the expense of the environment. Human activities and over-exploitation of natural resources have deeply influenced the world's ecosystem thereby causing biodiversity loss. As a result, degradation of environment crops up through depletion of natural resources (air, water and soil), destruction of the ecosystem, alteration or habitat loss, extinction of wild-life, climate change and environmental pollution worldwide.

Besides environmental factors, other factors influence human health, namely, diet, sanitation, socio-economic status, literacy, and lifestyle. The practice of preventing disease and promoting good health within a community may be in a small group of people or as big as the entire country, by a joint venture of health professionals from different fields are within the purview of the public health system. The main goal of public health is to provide prolong healthy life to the population to which it represents. Environmental health is a branch of public health which focuses on establishing and maintaining a healthy environment for all the species including humans. It also aims to promote an environment that improves wellbeing and high quality of mental health so that the environment must be sustained for future growth and development. Built-environment, the human-made surroundings (buildings, parks, green space, streets, and other infrastructural facilities) significantly affect public health by influencing the individual physical activities. The non-existence of essential scopes and facilities develop sedentary habits among the populace and lead to lifestyle diseases like obesity, diabetes, hypertension, cardiovascular disease (CVD), stroke, asthma, chronic obstructive pulmonary diseases (COPD) and even cancers. Air pollution is a major environmental risk to health and is estimated to cause 2 million premature deaths worldwide per year. Infectious diseases are the primary public health threat to industrialisation vis-a-vis urbanization. Unhygienic and congested dwelling conditions in urban areas facilitate the spread of infection. As per WHO estimates on mortality and burden of disease, 23% of all deaths are linked to the environment (WHO, 2012). To achieve broader environmental goals in future linking environment and public health, it is very essential to reduce the environmental burden of population growth and pollution due to industrial development all over the world. Public health has immense responsibility towards tracking disease outbreaks and creating health awareness among the general population, especially on vaccinating children, adults to prevent the spread of disease, educating people about the risk of alcohol, tobacco, and initiating health and nutrition programmes for children.

Global Warming and Climate Change

The emissions produced from various industrial activities and fossil fuel (e.g. oil, coal, natural gas) burning (anthropogenic sources) along with extensive deforestation activities around the globe evolved the problem of global warming and climate change. The greenhouse gases (GHGs) like carbon dioxide (CO_2), water vapour (H_2O), methane (CH_4), ozone (O_3), nitrous oxide (N_2O), halocarbons e.g. chlorofluorocarbon (CFC), sulphur hexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) etc.) emitted to atmospheric air by such activities, trap heat that would otherwise escape to the earth. Greenhouse gases especially, water vapour and CO_2 play a very crucial role in the global rise of the earth's average surface temperature by absorption and re-radiation of infra-red radiation to cause the greenhouse effect. The rising earth's temperature decreases global ice cover and thereby decreases the earth's reflectivity (albedo), increasing more incoming of solar radiation to warm the earth's surface. The temperature rise becomes effective in melting glaciers and sea ice, shifting precipitation patterns and forcing animals to shift habitats, endangers the species that are adapted to cold, rising sea levels, extreme weather events and many more. The effects of climate change disrupt the symbiosis of coral reefs, responsible for maintaining the vast storehouse of genetic and biological diversity, with algae. Ocean and terrestrial biosphere, the two major carbon reservoirs of the global climate system absorb large amounts of anthropogenic CO_2 emitted to the atmosphere. Environmental degradation due to intensive and indiscriminate industrial activities from the last few decades have reduced the capacity of these reservoirs to sequester atmospheric CO_2 and thus increasing the CO_2 buildup in the atmosphere. The atmospheric vapour pressure increases with an increase in ocean's temperature by 7 % per degree Kelvin (° K) and the warmer atmosphere accommodates more water vapour and amplifies the warming effect as a greenhouse gas. The increase of atmospheric water vapour content affects the cloud formation which affects energy balance between incoming solar radiation and outgoing IR-radiation resulting in a positive or negative effect in planetary warming. Aerosols also scatter and absorb incoming solar radiation, thus contributing to Earth's albedo. Anthropogenic sources add significantly to aerosol sulphate, black carbon (soot) and SO_2 that ultimately form hygroscopic sulphuric acid and salts to act as nucleation sites for tiny water droplets. The sulphate aerosols formed in the atmosphere scatter a fraction of solar radiation to increase albedo and produce negative radiating forcing by limiting the amount of solar radiation reaching the surface. The global warming effects have become significant since 1906 and has increased the global average surface temperature by 0.87°C (likely range from 0.75°C to 0.99°C).

Impacts of Climate Change on Public Health

Global warming and climate change affect many of the social and environmental determinants of health e.g. clean air, safe drinking water, sufficient food and secure shelter. Extreme heat worsens human health conditions, especially in tropical regions. It contributes to deaths from cardiovascular and respiratory diseases, especially among elderly people. Heatwaves throughout the region may cause serious health implications (hyperthermia or heat stroke) on the vulnerable population, especially the elderly and sick. International Panel on climate change (IPCC) predicted on global warming as hot days followed by nights of higher temperatures. Ozone prevents the incoming of harmful ultra-violet (UV) rays to the earth. Stratospheric ozone layer becomes gradually thinner and thinner by ozone-depleting substances (e.g., halocarbons, pesticides and aerosols) released to the environment allowing more and more UV radiation to reach the Earth and exerts its harmful effects on humans (causing skin cancer) as well as affect the crops.

In the sunlight, volatile organic compounds (VOCs) react with nitrogen oxides (NO, NO_2) in ambient air to form ground-level ozone. Ground-level ozone and other photochemical oxidants and smog episodes are harmful to the ecosystem. Ozone has been increasingly linked to respiratory diseases and children are the most susceptible group for this. There are some aeroallergens (e.g. pollen, spores, and mites) which trigger asthma, and are also higher in extreme heat conditions. Weather-related natural disasters increased by three-fold and it destroyed countless homes and surrounding communities and also essential services. Increasingly variable rainfall pattern contaminate the freshwater supply system and increase the risk of water-borne diseases (e.g. diarrhoea, cholera, dysentery, typhoid) due to breakage in water pipelines, leakage in septic tanks, stormwater sewers and drainage systems. The climate change is also likely to increase frequency and intensity of drought as well as flood and landslide at regional, national and global scale. Flood also increases vector-borne diseases (e.g. malaria, dengue) by increasing breeding places of mosquito vectors and spreading epidemics. Drought affects food production and increases the prevalence of malnutrition. Developing countries are affected maximally as these countries are mostly lacking modern technological know-how, resources and well-equipped public health systems to control such types of an outbreak. As per the WHO report, climate change is responsible for at least 150000 deaths per year and the number is expected to be doubled by 2030. Besides, climate change increases the frequency and intensity of forest fires, tornadoes, hurricanes, that cause immense loss of life, property, and various other resources of the country.

Impact of Environmental Degradation on Health of Population

Environmental degradation is a great challenge to human beings as it increases the vulnerability of societies and contributes to the scarcity of resources. Environmental determinants of human health are related more to the exposure to toxicants in different environmental compartments (air, water, and soil), particularly in urban and industrial areas. Besides, there are other factors like diet, sanitation, socio-economic status, literacy and lifestyle that influence the health of the population. The potential sources of human exposure to such chemicals in the environment are many and are mainly the emissions from industries, transportation activities, pesticides used in agriculture, anti-fouling paints from marine vessels, waste incineration and leakage from waste disposal sites. Exposure to ambient air pollution is responsible for 7.9 % of the disease burden [in DALYs (Disability Adjusted Life Years)] in 2012. Exposure to ambient air pollutants ($PM_{2.5}$, PM_{10}, NOx, traffic density) is believed to significantly increase pre-term birth, low birth weight and infant mortality. As per the UN report, more than 2 million deaths and billions of illnesses are attributable to water pollution and hence safe water scarcity becomes acute due to contamination of water sources. Many diseases are spread by uncollected garbage and blocked drains. Health risks of hazardous wastes mainly from hospitals and health care units may occur within the surrounding community by polluting the groundwater resources.

Another important source of exposure is uptake from food consumption having contaminant residues. Intensive agricultural production uses pesticides, fertilisers; feed additives and medication for live-stocks which can get entry into the body by consumption. Besides, health risk due to accidentally contaminated or adulterated animal feed (poultry feed or cattle feed) which can move up to the food chain to humans. Feeds containing discarded animal remnants can cause the so-called "Mad cow disease" or Bovine Spongiform Encephalopathy (BSE) in live-stock, prevalent mostly in the UK and other western countries. Many bioaccumulative chemicals such as heavy metals (e.g. Pb, Cd, As, Hg), polynuclear aromatic hydrocarbons (PAHs) [e.g.benzo(a) pyrene], endocrine-disruptive chemicals (EDS) [e.g. DDT, polychlorinated biphenyls] which may be available in fish, meat and dairy products, may also get access into the body. Heavy metals reach the human food chain (e. g. fish, seafood) through different biogeochemical processes such as bio-concentration, bioaccumulation, biomagnification in different nutritive steps to cause a serious threat to human health.

Environmental Pollution and Effect on Human Health

Pollution is a concomitant evil of population growth and urbanisation. Environmental air, water and soil are getting more and more polluted with all-round developmental activities and economic growth. Industrial processes, fossil fuel combustion, transportation activities emit several pollutants in air namely, particulate matters (PM), PM_{10} and $PM_{2.5}$, hydrocarbons, CO, CO_2, NO, NO_2, SO_2, etc. which remain in the atmosphere for long and pollute the air. Air pollution, besides its climate change impact, is a global public health issue of the present time increasing the morbidity and mortality among exposed populations. Many natural sources are contributing to air pollution like natural disasters such as forest fire, volcanic eruptions, dust or sandstorms, and agricultural crop burning. The major industrial polluting sources are the emissions from thermal power stations, refineries and petrochemicals, chemical and fertilizer industries, metallurgical (e.g. smelters, foundries, mining) and other industrial plants, and, finally, municipal incineration. Besides, there are mobile sources like automobiles, cars, railways, airways, and other types of vehicles. Fine particulates, $PM_{2.5}$ and PM_{10}, are strongly associated with various respiratory diseases as these particulates get access into the lower respiratory tract and penetrate deep into the lung, These particles, having complex physicochemical properties, exert their toxic effects on the lung accordingly. The composition of toxic components in these particulates varies with the polluting sources and it may be comprised of organics (PAHs, dioxins, benzene, 1-3 butadiene) or inorganics (carbon, Cl^-, NO_3^-, SO_4^-, metals etc). Long-term exposure to fine particulate matter, <

$PM_{2.5}$, sulphur dioxide, oxides of nitrogen, ozone cause respiratory diseases (e.g. chronic obstructive pulmonary disease (COPD), asthma, bronchitis) and cardiovascular diseases. Besides, there are air pollutants namely, volatile organic compounds (VOCs), dioxins, and polycyclic aromatic hydrocarbons (PAHs) and heavy metals (e.g. Pb, Cr, Mn, Hg, As, Cd, Cu, Al) having toxic potentiality on the central nervous system, reproductive system, respiratory system and mutagenic as well as carcinogenic effects.

Noise is an important polluting parameter of public health importance. A large population is occupationally exposed to workplace noise. Environmental noise is increasingly becoming a potential hazard to health, physically and psychologically, and affects the well-being of the general population. Besides commercial activities, noise due to heavy traffic and transportation activities contributes to higher noise in cities and industrial towns. Excessive noise interferes with people's daily activities at home, school and offices. Noise is reported to cause various non-auditory manifestations like, sleep disturbance, annoyance, irritation, headache, raised blood pressure, and pulse rate, reduce work efficiency, cause cardiovascular and psychophysiological effects etc. on exposed population. Among auditory effects of long-term exposure, hearing impairments (i.e. increase in the hearing threshold) of temporary and permanent nature have been reported. Noise may be monitored by i) area monitoring and ii) personal noise dosimetry. Identification of noisy conditions may be assessed by conducting an initial assessment, also called a check-list survey. Once the noise hazard is identified, a quantitative assessment may be undertaken by systematic noise monitoring programmes (e.g. on-spot measurement, full-day monitoring, area monitoring, frequency spectrum analysis and plotting noise contour profile of the area.) Noise-induced hearing impairment mainly occurs in the frequency range of 3-6 kHz, and with increased exposure, at lower frequencies. Significant hearing impairment occurs on exposure to prolonged exposure to noise levels of 70-85 dB(A). Noise-induced hearing loss has been recognized as an adverse health effect of noise. The ambient noise levels in silence zones (areas like hospitals, educational institutions) were found to go even upto 90 dB(A), both in daytime and night-time. In a study undertaken by the Central Pollution Control Board (CPCB, 2014), higher noise level, 73.53 dB[A] in silence zones (hospitals, educational institutions, court, and religious places) during the day-time and lowest in residential areas, 63.5 dB[A] was reported.

Indoor Air Pollution

The sources of indoor air pollution include combustion from cooking (by using dung, wood, coal, kerosene, and LPG), building material, and bio-aerosols, tobacco smoking inside the home, use of disinfectants, use of detergents and other cleaning agents, mosquito repellant etc. Consumer products like air conditioning systems, photocopiers, electrical heating gadgets (e.g. micro-oven, room heater) have been recognized as potential sources of indoor pollutants in homes. While radon, asbestos, pesticides, heavy metals, volatile organic matter, and environmental tobacco smoke are considered major indoor pollutants in developed countries, the combustion products of biomass fuels contribute most to indoor air pollution in developing nations. In India, people using fuels for cooking are as follows: 49% use firewood; 8.9% cow dung cake; 1.5% coal, lignite, t or charcoal; 2.9% kerosene; 28.6% liquefied petroleum gas (LPG); 0.1% electricity; 0.4% biogas; and 0.5% any other means. Pollutants such as aldehydes, volatile and semi-volatile organic compounds are produced from resins, polishing materials, cosmetics, and binders. Biological pollutants like dust mites, moulds, pollen, and infectious agents produced in stagnant water, mattresses, carpets. The respiratory illness (bronchitis, asthma, Chronic Obstructive Pulmonary Disease (COPD), respiratory allergy, lung cancer etc) is the major health effect of indoor air pollution. COPD and lung cancer are mostly observed in women, while the acute lower respiratory disease is seen in young children under 5 years of age. Sick-building Syndrome (SBS) and Building-related Illness (BRI) are also persistent symptoms observed due to poor indoor air quality among the residents. As per the available statistical report in developing countries, the health impacts of indoor air pollution is more than outdoor air pollution. Indoor air pollution from solid fuels accounted for 3.5 million deaths in 2010. Though there is a decrease in household air pollution from solid fuels in Southeast Asia, still it ranked third among risk factors in the report of the Global Burden of Disease. Poor indoor quality is the second-highest killer with 1.3 million deaths every year.

A study on quantifying exposures to respirable particulate matter found particulate matter concentrations ranging from 500 to 2,000 mg/m^3 during cooking in biomass-using households. Average 24-h exposures ranged from 82 ± 39 mg/m^3 for those using cooking gas, to 231 ± 109 mg/m3 for those who used biomass fuel for cooking. In a large case-control study, after adjustment for demographic factors and living conditions, solid-fuel use significantly increased child deaths at ages 1-4 years. Biomass combustion associated with cooking practices is a major source of household air pollution in India. The spatial heterogeneity, there are areas in India having different climatic conditions, education levels, lifestyles which generate different indoor air qualities. North Indian states reported to produce higher $PM_{2.5}$ (557–601 µg/m^3) in indoor air compared to the Southern States (183–214 µg/m^3). The cold climate of North India may be the main reason for higher $PM_{2.5}$ levels as compared to the tropical climate of Southern India.

Emerging Infectious Diseases of Public Health Importance

Emerging infectious diseases (EIDs) pose a significant burden and threat to the global economy and public health. The emergence of the diseases is thought to be driven largely by socio-economic, environmental and ecological factors. Nearly 75% of all emerging infectious diseases (EIDs) that threaten human health are of zoonotic origin. The majority have spilt from wildlife reservoirs, either directly to humans or via domestic animals. The emergence of the diseases is caused by the pathogens carried by international travellers, immigrants, and refugees with them and spreads the risk and can also be attributed to predisposing factors like agricultural expansion, deforestation/habitat fragmentation, and urbanization. Ebola, SARS (Severe Acute Respiratory Syndrome related Corona virus that infects human), Nipah virus, Zika virus, and bird flu all spread from animal to human, often due to human encroachment on nature. The outbreaks of the complex infectious diseases required public health surveillance to detect rapidly by systematic collection, analysis, interpretation, and dissemination of health data to minimize the illness, deaths and economic loss. EIDs required to be prevented by using proven tools and developing new ones. Vaccines are excellent proven cost-effective prevention tools for diseases and deaths. Other proven prevention tools include screening and treatment of blood and blood products. Infectious diseases are currently the leading cause of death worldwide.

The novel coronavirus that causes coronavirus 2019 (COVID-19) respiratory illness originated from SARS-CoV-2 virus into the human population and spread like a pandemic in March 2020.

COVID-19 was first identified in Wuhan, China and is currently a global pandemic. As of 19 October 2020, more than 1.07 million deaths all over the world had been attributed to COVID-19. As per the World Health Organization (WHO), COVID-19 has so far infected 40,278,207 people and has claimed 1,118,321 lives globally. 216 countries and/or territories have been affected so far by the deadly virus. The countries most affected by COVID-19 are namely, China, Italy, USA, Spain, German, France, the UK and many others including India. As per Ministry of Health and Family Welfare, Government of India, as on 19th October 2020, the status of active cases, 7,548,238 (12.1%), discharged, 6,659,895 (86.36%), deaths, 114,642 (1.53% approx.) and in West Bengal, total active cases, 30,236, discharged, 25,8948 and deaths, 5622. It has been reported that more than 70% of cases are due to co-morbidities. The worldwide disruption caused by the pandemic has resulted in different impacts on environmental conditions. Most parts of the world have been put under complete lockdown to curb and contain the spread of the highly contagious disease. The satellite imagery has revealed a noticeable reduction in aerosol levels, particularly, decreases in nitrogen dioxide and $PM_{2.5}$ air pollution. This "natural experiment" in a reduction in air pollution exposure offers important opportunities for the researchers on changes in health outcomes around the world. As per the statement issued by John Balbus, M.D., National Institute of Environmental Health Science (NIEHS), Senior Advisor for Public Health, *"The COVID-19 pandemic has brought out synergies between infectious disease epidemiology and environmental health in a more robust way than perhaps since the great pandemics of the past two centuries,"* A drastic reduction in modern human activities due to prevailing lockdown conditions all over the world resulted in a huge drop in air pollution. The pandemic has created an additional burden to the public health management towards awareness generation among the public belonging to different socio-economic strata, creating and strengthening the medical emergency support system, supply of essential commodities, effective measures for control of panics along with creating adequate facilities for hospitalisation of affected people, especially for the grass route level. Management of hospital wastes generated from different COVID-19 centres (used PPEs, injection syringe, needles etc.) adopting proper disposal norms is very crucial. Potential threats from antimicrobial resistance and new infectious agents to public health will continue and hence a long-term commitment towards the buildup of infrastructural facilities to address such EID problems in future must be developed.

Geogenic Contamination and Public Health Issues

Groundwater is an essential component in our day to day life. The rapid growth of population and urbanization led the groundwater resources under stress. The quality of groundwater is deteriorating due to geogenic and anthropogenic activities. The natural groundwater composition varies with soil type, depth, and subsurface geological formations. The quality of groundwater is also influenced by the anthropogenic factors like solid and hazardous waste disposal systems, leakage of drainage waters and septic tanks and excessive usage of agrochemicals. Landfills pose to be groundwater contamination a threat. Hazardous waste should always be disposed of properly, (i.e. by a licensed hazardous waste handler or through municipal hazardous waste collectors). Many chemicals should not be disposed of in household septic systems, namely, oils (e.g., cooking, motor), pesticides, paints and thinners, disinfectants, medicines, photographic chemicals, and swimming pool chemicals. Similarly, industrial wastes should not be disposed of in drains because they may contaminate a drinking water source. Proper disposal of these wastes is important for the protection of groundwater. Closed landfills should be capped with impermeable material to prevent the leaching of contaminants.

Although microbial content in drinking water is a prime concern, the health of millions of people is also affected by drinking geogenic or naturally contaminated groundwater derived from aquifer rocks. It has been estimated that 300 million people worldwide or roughly 10% of the population who are using groundwater sources for drinking purposes are known to be exposed to elevated levels of arsenic and fluoride. Arsenic and fluoride pose to be serious health threats to the people consuming groundwater. In many regional pockets, groundwater arsenic and fluoride are naturally in higher concentrations that are harmful to human health. The World health organization (WHO) has recommended permissible levels of 10 µg/L and 1.5 mg/L respectively for arsenic and fluoride. The chronic poisoning with fluoride and arsenic is an emergent endemic disease in many developing and developed countries like China, Mexico, Argentina, India and Bangladesh. There are several places throughout the world where arsenic and fluoride both are present in groundwater at high concentrations.

Ground Water Fluoride

In groundwaters, fluoride can occur, depending on the nature of the rocks and the occurrence of fluoride-bearing minerals (e.g. fluoride-rich minerals, such as apatite, fluorite, hornblende and biotite). Possible sources of fluoride (F^-) in groundwater are weathering and leaching of F^- bearing minerals under the alkaline environment. The beneficial and detrimental effects of fluoride in natural water were well established. Fluoride ion normally accumulates only in calcified tissues such as bone and teeth. High levels of fluoride up to 10 mg /L were associated with dental fluorosis (yellowish or brownish patches or mottling of the enamel) while low levels of fluoride, < 0.1 mg /L, were associated with dental decay. Poor nutritional status is also an important contributory factor. Symptoms of long-term fluoride toxicity include emaciation, stiffness of joints and abnormal teeth and bones. Excessive fluoride intake causes erosion of tooth enamel. Endemic skeletal fluorosis, well documented and crippling skeletal fluorosis, is associated with the higher exposure (e.g. osteosclerosis, ligamentous and tendinous calcification and extreme bone deformity). Besides, excessive consumption of fluoride may lead to muscle fibre degeneration, low haemoglobin levels, excessive thirst, headache, skin rashes, nervousness, depression, etc. Endemic fluorosis, a challenging and extensively studied national health problem in India. The most seriously affected areas are Andhra Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Tamil Nadu, and Uttar Pradesh, Odisha, Maharashtra, Madhya Pradesh. In India, about 62 million people in 17 states, including Andhra Pradesh, are affected with dental, skeletal and/ or non-skeletal fluorosis. Most of Andhra Pradesh falls within the highly endemic fluorosis zones. In West Bengal, excess fluoride in groundwater has been found in seven districts, namely, Puruliya, Birbhum, Barddhaman, Bankura, Maldah, Dakshin Dinajpur and Uttar Dinajpur.

Groundwater Arsenic

In contaminated groundwater inorganic arsenic is available in two oxidation states, As^{+3} and As^{+5}. The trivalent inorganic arsenic (As^{+3}) is 60 times more toxic than the pentavalent (As^{+5}), whereas organic As is non-toxic. Geogenic groundwater contaminated by arsenic in high concentrations has emerged as a major public health problem.

A large population, over 296 million people, from more than 107 countries worldwide is potentially at risk. The problem related to arsenic is more grave in West Bengal and Bangladesh. In India, the Ganga-Meghna-Brahmaputra (GMB) plain (covering 79% of GMB) affected by arsenic covering different states such as Uttar Pradesh, Bihar Jharkhand, West Bengal, Assam and other North-Eastern hill states and in Bangladesh, Padma- Meghna-Brahmaputra (old). Besides, some parts of other states like, Chhattisgarh, Punjab, Haryana and Himachal Pradesh are also reported to be affected by arsenic in drinking water. West Bengal is worse affected by arsenic than other states in India. A large population in West Bengal consuming arsenic-contaminated water residing in districts, Maldah, Murshidabad, Nadia, North 24 Parganas, South 24 Parganas, Haora, Hugli, Barddhaman and Kolkata are severely affected. Affected rural population is more than the affected urban population in West Bengal. Total risk population in West Bengal is about 36%. It is reported that 98% of public tube wells in the state have a maximum arsenic concentration of 0.50 mg/L and average arsenic concentration of 0.135 mg/L. Several epidemiological studies have established the arsenic-induced health effects. Arsenicosis is the reported health effect of chronic exposure to arsenic-contaminated drinking water. Specific skin lesions of chronic arsenic toxicity are pigmentation and keratosis. It was found to produce various other multi-organ diseases and health complications, such as chronic lung disease (e.g. chronic bronchitis, chronic obstructive and/or restrictive pulmonary disease, liver diseases, weakness, black foot disease, peripheral vascular disease, arsenic-induced gastrointestinal effects, anaemia, burning sensation of eye, swelling of legs, liver fibrosis, cardiovascular disease, gangrene of toes, neuropathy, cancers of the skin, urinary bladder and lung. Cutaneous manifestations are the most prominent characteristic used in identifying arsenicosis patients.

Efficient water management and community participation are very important in ensuring the sustainable use of water resources. Continuous groundwater abstraction from the deeper aquifer to meet the irrigation demands, current rigorous effort to provide deep tube wells for arsenic-safe drinking water may be difficult to achieve. The existing safe tube wells required to be monitored at regular intervals to track the possibility of arsenic contamination. Installation of new tube wells should be strictly regulated. Traditional water management like arsenic-filtration system (three Kalsi filtration unit), arsenic treatment units (with cost-effective technology for arsenic mitigation) and piped water (arsenic-free) supply systems and rainwater harvesting with control over bacterial and other possible chemical contamination are possible sustainable solutions in most of the Ganga river basin regions. It is also very important to create awareness among common people about the arsenic calamity, its associated health risks. Above all, the scientific community and public health organizations should come together to focus on the graveness of cancer, vascular disease, and other serious health complications of arsenic exposure. The Gangetic river basin (GRB) is highly vulnerable to groundwater arsenic contamination. Elevated levels of arsenic in drinking water, vegetables and other food grains grown in these regions are reported. A large number of people are reported to be suffering from dermal, neurological, reproductive, cognitive, and cancerous effects and many arsenic-induced deaths reported among younger age groups. Arsenic victims also face critical social and economic challenges and loss of jobs. All these problems may be aggravated and go out of proportion if proper arsenic mitigation measures are not taken.

Heavy Metal Toxicity and Human Health

There are a large number of metals and metalloids which are potentially toxic to humans [e.g. lead (Pb), arsenic (As), mercury (Hg), cadmium (Cd), chromium (Cr), copper (Cu), nickel (Ni), and zinc (Zn)]. Their distribution in atmospheric air depends on the properties of the individual metal and on different environmental factors. Heavy metals get access into the environment through the anthropogenic activities (e.g. mining, industrial effluents and emissions, urban runoff, sewage discharge, pesticides etc.) and natural processes (e.g. soil erosion, natural weathering of the earth's crust, volcanic eruption. Human beings get exposed to heavy metals mostly through the environment and diet. Some essential heavy metal nutrients (e.g. Co, Cu, Cr, Fe, Mg, Mn, Zn, Se) are very much required in the body to maintain good health but in large concentrations it becomes toxic. Toxicity of heavy metals lowers the energy levels and affects the normal functioning of the brain, lungs, kidney, liver, blood composition and other important organs. Chronic exposure to these metals on a long-term basis initiates degenerative processes in the physical, muscular, and neurological systems that gradually lead to diseases like Parkinson's disease, Alzheimer's disease and muscular dystrophy and even cancer. The toxicity levels of a few heavy metals are very low, just above the environmental background concentrations. It is, therefore, essential to Monitor the exposure levels in the environment (air, water, soil), biological monitoring in body fluids or tissues (e.g. blood, urine, saliva etc) to confirm exposure and probable interventions for early prevention. Production of reactive oxygen species (ROS) and oxidative stress play a key role in the toxicity and carcinogenicity of the heavy metals like, As, Cd, Cr, Pb and Hg. These metals, because of their high degree of toxicity are capable of inducing multiple organ damage, even at lower exposure levels, are ranked as priority metals and are of great public health importance. Based on several epidemiological and animal experiments, the United States Environmental Protection Agency (USEPA) and International Agency for Research on Cancer (IARC) classified these metals as either "known" or "probable" human carcinogens. The contamination chain of heavy metals usually follows this cyclic order: from industry to the atmosphere, soil, water and foods then human. Humans may directly get in contact with heavy metals by consuming contaminated food, seafood, and contaminated drinking of water, through inhalation of polluted air as dust and fumes, or through occupational exposure at the workplace. These heavy metals can be taken up through several routes. Some heavy metals such as Pb, Cd, Mn, As can enter the body through the gastrointestinal route, i.e., through oral route when eating food, fruits, vegetables or drinking water or other beverages. Others can enter the body by inhalation while others (e.g. Pb) can be absorbed through the skin. Consumption of contaminated aquatic animal is the major route of human exposure to methyl mercury. Tanneries discharge numerous polluting heavy metals and compounds into the water streams. Cadmium and its compounds are highly water-soluble compared to other metals. Their bioavailability is extremely high and hence it tends to bioaccumulation. Long-term exposure to cadmium can result in morpho-pathological changes in the kidneys. Smokers are more susceptible to cadmium intoxication than non-smokers. Tobacco is the main source of cadmium uptake in smokers as tobacco plants, like other plants, can accumulate cadmium from the soil.

Conclusion

It is very much evident that the present-day developmental activities have reached to a level that very much affected the ecosystem and biodiversity, deteriorating the natural infrastructure to cause climate change and pollution, nature's ability to provide oxygen, food crops, clean water and climate regulation plummets. All these directly impact human health in global as well as regional levels. It is high time to strengthen environmental protection. The economic investments should focus on the pro-nature growth for climate regulation by protecting wetlands, forests, mangroves, stopping deforestation and degraded lands to protect wildlife, boost food production and store carbon. To reduce climate impacts and bring back biodiversity, it is important to integrate natural infrastructure with built infrastructure.

The scenario of public health status in the state is not very prospective. Besides pollution by industries, there are significant contributions from intensive construction activities, heavy vehicular traffic system, damaged and/or inadequate roads, improper drainage system and blockage of drains, poor sanitation and huge solid waste generation which contribute to the public health issues of the cities, towns and even in the rural regions. The available health care facilities all over the state are also not adequate and need immediate public health attention. Though hospitals, dispensaries, public health centres and other medical facilities are present, these are not sufficient to cater to the growing needs of the substantial population. Management of toxic and infectious biomedical wastes generated by hospitals, health care centres, research organisations also need special attention.

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WEST BENGAL

Chapter 21

Environmental Regulation

Chapter 21

Environmental Regulation

India has had a philosophy of environment management dating back to the ancient Hindu period. Hindu culture had a great tradition of environmental conservation which taught to respect nature and to take cognizance of the fact that all forms of life, human, animal and plants are closely interlinked and that disturbance in one give rises to an imbalance in the other's. Moral injunctions acted as guidelines towards environmental preservation during the ancient period. Such injunctions were initially propagated by the religious scriptures, seers and later enforced by the rulers. Under the Mauriyan regime and Ashoka's rule, forest conservation and wildlife protection received the utmost attention. It was during this period that detailed and perceptive law provisions as contained in Kautalay's Arthashastra were followed and enforced.

Environmental protection concern received a setback in the medieval India as there had been a great deal of ecological loss due to frequent invasions and political instability. During the Mughal period, after returning of political stability, the environmental policy did not take a precise shape and the natural resource management remained by and large a neglected field.

During the British rule, the environmental concern took a new shape with the enactment of forest legislations and other legislations pertaining to pollution control and the first forest policy of 1894 whereby the State controlled forest administration initiated in India. The British period by far had not been a good period in the environmental history of India as it was during this period the natural resources were ruthlessly appropriated and exploited with a primary objective of earning revenue. The polity ignored the environment conservation.

Background of pollution control laws

Law is born out of social, economic and political causes. The first law for protecting nature was implemented in India during the British Rule. The year was 1905 and the whole of Bengal was caught up in the tide of the revolutionary movement following the partition of Bengal.

Amidst the storm, inconspicuous for the moment, was born in Calcutta, the Bengal Smoke Nuisance Act, with the purpose being mainly to preserve the dazzling whiteness of Victoria Memorial.

The British had come to our country to rule, not to serve. Hence in matters regarding the preservation of balance of nature in India, they had borne neither concern nor responsibility. Their thoughts remained limited within the borders of their own profits. Following the end of the British Rule, India plunged into a series of troubles – communal riots, the partition, external wars causing conflicts and disintegration, problems which glaringly and prominently stares us into the face even today. Hence India has not been able to pay proper attention to matters relating to environment. The Five Year Plans were implemented with a view to the economic development of the country. The Second Five Year Plan designed for industrial development paid no attention to the harmful consequences that nature would have to face with the growth of industry. Hence the plans remained unconcerned about protecting nature. This implies a lack of a sense of responsibility about protecting the environment and there was no awareness of the necessity of preserving it until the beginning of the seventies when a law for the protection of the environment was passed.

The United Nations Conference on the Human Environment, held at Stockholm, Sweden, in June 1972, was the first comprehensive international attempt to articulate the interrelationship between the quality of environment, a growing world population, and the world economic growth needed to sustain it. The conference recognized the need for specific national and international actions to ensure that economic growth is planned in full appreciation of the long term value of environmental protection and natural resources conservation. Since, 1974, number of Acts were enacted for the protection of environment and also there are other Acts which can be enforced for the protection of environment by the different enforcing authorities i.e. Police Authority, Local Authority, District Administration, Chief Inspector of Factories, Fisheries Department etc. The Department of Environment and the West Bengal Pollution Control Board are now the main enforcing authorities to protect the environment exercising its power under the provisions of Water (Prevention and Control of Pollution) Act, 1974, Air (Prevention and Control of Pollution) Act, 1981 and Environment (Protection) Act, 1986 and Rules made there under.

Constitutional aspect of environmental law

Environment protection has found a special mention in the Indian Constitution. In fact, the environment protection has been given a constitutional status in the Indian policy. The Constitution, being the fundamental law of the land, has a binding force on citizens, non-citizens as well as the State. The Fundamental Rights and the Directive Principles of State Policy underline our national commitment to protect and improve the environment. The Courts in India have also given a new interpretation to the constitutional provisions touching the environmental perspectives. In fact, the interpretation given to Article 21 of the Constitution, which is contained in the chapter on Fundamental Rights, has added new dimensions to the quality of life and the effect of environment relating thereto.

The Constitution of India, as originally enacted, did not contain any specific provision to deal with environmental pollution, though Article 47 made an indirect reference to improvement of public health as one of the primary duties of the states. This, in fact, envisages a pollution free environment for all the people. Some of the constitutional imperatives for control of environmental pollution are detailed below.

Distribution of Legislative powers

The Constitution provides for division of powers between the Union and the States. Part XIII of the Constitution contains provisions governing the legislative and administrative relations between the Union and the States. Within the framework laid down in the Constitution, the Parliament has been given the power to make laws for the entire nation whereas the State Legislatures have been given the powers to legislate for their respective states. Article 246 determines the distribution of powers between the Union and the States. The Parliament and the Legislature of any state have exclusive power to make laws with respect to any of the matters contained in List I (Union List) and List II (State List) in the VIIth Schedule of the Constitution respectively.

In addition to this, the Union and the States also enjoy concurrent powers to make laws on any subject enumerated in List III (Concurrent List) of the schedule. Besides, the Constitution also empowers the Parliament to enact laws in respect of matters contained in List II. Similarly, the Parliament has been vested with the residuary power to enact laws on matters not covered by the three lists. These provisions of the Constitution definitely enlarge not only the legislative ambit of the Parliament but also give a power to take administrative measures which are considered necessary for protecting human environment.

The Directive Principles of State Policy

Part-IV of the Indian Constitution lays down certain fundamental principles of state policy which the future government of the country will have to take into account while framing the laws for the governance of the country. Though the directives incorporated in Part IV of the Constitution are not enforceable in a court of law but the Indian Judiciary has made use of these directives in a number of cases and these have been read as complementary to the Fundamental Rights.

Article 253 and environmental legislation

Article 253 of the Constitution gives power to the Parliament to make laws implementing international obligation of the country as well as any decision taken at an international conference, association or other body. The provision reads, *"Notwithstanding anything in the foregoing provision of this Chapter, Parliament has power to make any law for the whole or any part of the territory of India for implementing any treaty, agreement or convention with any other country or countries or any decision made at any international conference, association or other body."* In view of the broad spectrum which could be addressed at the international convention, conference, treaties and agreements, Article 253 gives teeth to the Parliament to legislate on any of the matters enumerated in the State List.

Fundamental Rights vis-à-vis environment

Part III of the Constitution of India incorporates Fundamental Rights which have been made judicially enforceable. The Supreme Court of India has contributed significantly, especially during the 80's, in broadening the contents and contours of some of these basic rights. Here an attempt is being made to examine this perspective in the context of environmental protection.

The interpretation given by the Supreme Court in Maneka Gandhi's case has added new dimensions to the concept of personal liberty of an individual. It laid down that a law affecting life and liberty of a person has to stand the scrutiny of Articles 14 and 19 of the Constitution. In other words, if a law is enacted by a legislature which touches upon the life and liberty of a person and curtails it, then it is a mandatory requirement that the procedure established by it for curtailing the liberty of a person must be reasonable, fair and just. It is this interpretation of Article 21, which the Court has extended further so as to include the right to a wholesome environment. In other words, environmental pollution which spoils the atmosphere and thereby affects the life and health of the person has been regarded as amounting to violation of Article 21 of the Constitution.

In this connection it will be worthwhile to refer to the decision of the Apex Court in Dehradun Query's Case. In this case, the Supreme Court entertained complaints from the Rural Litigation and Entitlement Kendra, Dehradun alleging that the operations of lime stone quarries in the Mussoorie-Dehradun region resulted in degradation of the environment affecting the fragile ecosystems in the area. In this case, the Supreme Court moving under Article 32, ordered the closure of some of these queries on the ground that these were upsetting the ecological balance. Though the judgement did not make a reference to Article 21, but involving jurisdiction by the Court under Article 32 presupposed the violation of right to life guaranteed under Article 21.

In the case of Moulana Mufti Sayed Mohd. Noorur Rehman Barkati vs. State of West Bengal, while dismissing the writ petition, the Supreme Court held that nobody can exercise his right to practice, profess or propagate religion at the cost and in total deprivation of others right. It was held that 'Azan' is certainly an integral and essential part of the Muslim religion but use of micro-phone is certainly not an integral part of 'Azan' and it violates the fundamental right of the citizens under Article 19(1)(a) of the Constitution. The argument of the Environmental (Protection) Act, 1986, the Rules made thereunder and the Schedules thereof are ultra vires under Article 14 and 25, is wholly misconceived as the provisions had not resulted in any discrimination and citizens have a right to be protected against excessive sound under Article 19(1)(a) of the Constitution.

Constitutional remedies

A regulatory mechanism for the prevention of environmental degradation, through writ process is provided for in the Constitution. Under Articles 32 and 226 of the Constitution, the Supreme Court and the High Courts respectively, possess wide latitude to grant relief and prevent environmental damage by issuing directions, orders or writs.

Under Article 32, which itself is a fundamental right, any person whose fundamental right as conferred by Part III of the Constitution has been violated, can invoke the Supreme Court's jurisdiction to enforce his right. Whereas, the writ jurisdiction of the High Court under Article 226 may be invoked not only for the enforcement of a fundamental right but for any other purpose as well. For that matter, the Supreme Court's jurisdiction under Article 32 is more limited than the jurisdiction of the High Courts under Article As now, the Supreme Court has accorded judicial recognition to the right to a wholesome environment as being implicit on Article 21, a litigant may accordingly assert his or her right to a wholesome environment against state, by a writ petition to either the Supreme Court or a High Court.

The Green Tribunal

The concept of environmental courts was initially and positively addressed in two minor judgements of the Supreme Court of India. In M. C. Mehta vs. Union of India, the Supreme Court observed that as environmental cases frequently involve assessment of scientific data, it was desirable to set up environmental courts on regional basis with a legally qualified judge and two experts, to undertake relevant adjudication. Similarly, in Indian Council for Enviro-Legal Action vs. Union of India, the Supreme Court again floated the idea of establishment of environmental courts having both civil and criminal jurisdiction in order to deal with environmental issues in a speedy manner. Again, in the judgement of A. P. Pollution Control Board vs. Professor M. V. Nayudu, the Court referred to the need for established environmental courts. Such courts would have the benefit of expert advice from technically qualified environmental scientists, as part of the judicial process. It was suggested that the Law Commission of India should examine this matter in detail.

These judgements were a result of concern within the Supreme Court about complexity and uncertainty underpinned due to the scientific evidence presented to the Court. Such evidence generated tensions between fears expressed by claimants and the assurances given by the defendants. Scientists may refine, modify or discard variables or models as more information becomes available. However, agencies and Courts must make choices based on existing scientific knowledge. In addition, evidence generally presented in a scientific form may prove difficult to test or refute. Therefore, inadequacies in the record arising out of uncertainty or insufficient knowledge may not be properly acknowledged or considered.

Following the observations made by the Supreme Court of India and the principles laid down in the international conferences held at Stockholm and Rio de Janeiro, the Law Commission of India undertook an extensive study on the establishment of separate and specialized ‘environmental courts’. The Commission is an active and influential participant in legal reform in India and it gave a detailed report on the subject of ‘environmental courts’. The Law Commission recommended separate ‘environmental courts’ staffed exclusively by persons with judicial experience and supported by persons having scientific qualifications and experience in the environmental field. The proposed environmental courts were aimed at accessible, open and speedy justice.

The Commission came to the conclusion that in seeking a balanced decision in such cases, ‘environmental courts’ with scientific as well as legal inputs might be better placed to reach a proper and judicious determination. Such courts could have wider powers to make on the spot inspections and hear oral evidence from resident panels of environmental scientists.

The Law Commission in its 186th Report, has inter-alia recommended establishment of a separate ‘Environment Courts’ in each state, consisting of judicial and scientific experts in the field of environment for dealing with environmental disputes besides having appellate jurisdiction in respect of appeals under the various Pollution Control Laws. The Commission has also recommended for repeal of the National Environment Tribunal Act, 1995 and the National Environmental Appellate Authority Act, 1997.

The National Green Tribunal Bill was introduced in Lok Sabha by the then Minister of Environment and Forests, Mr. Jairam Ramesh, on 31st July, 2009. The Chairman, Rajya Sabha in consultation with the Speaker, Lok Sabha in pursuance of Rule 270(b) of the Rules relating to the Department-related Parliamentary Standing Committees, the National Green Tribunal Bill, 2009 was referred to the Parliamentary Standing Committee on Science and Technology, Environment and Forests for its examination and report.

Based on the critique by members of the Parliament and recommendations of the Parliamentary Standing Committee, the Central Government made seven amendments to the National Green Tribunal Bill, 2009. The amendments broadened the definition of 'persons aggrieved' to allow individuals to approach the Green Tribunal.

It also outlined the 'foundational principles' like Precautionary Principles, Polluter Pays Principle and Inter-generational Equity that would govern the Tribunal. In keeping with the recommendation of the Parliamentary Standing Committee, the Act shall come into force in its entirety upon notification though the original Bill had given the Central Government the discretionary right for notifying different dates on which different provisions would come into effect.

The then Environment Minister, Mr. Jairam Ramesh informed that the Tribunal will have four benches across the country. It will follow a circuit approach to enable easy access for people. He also informed that *"Courts will go to the people. People won't have to come to the courts"*. The Parliamentary Standing Committee gave its report being the 203rd Report on the National Green Tribunal Bill, 2009 on 16th November, 2009 which was placed before both the Houses of the Parliament on 24th November, 2009. The Bill was passed by the Lok Sabha on 23rd April, 2010. The National Green Tribunal Act, 2010 received the assent of President of India on 2nd June, 2010, it formally came into existence as the National Green Tribunal Act, 2010.

The National Green Tribunal Act, 2010 came into force on 18th October, 2010 on issuance of a notification by the Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India and the enactment of National Green Tribunal Act, 2010 led to repealing of the National Environment Tribunal Act, 1995 and the National Environment Appellate Authority Act, 1997. The MoEF&CC vide notification dated October 18, 2010 has also notified the establishment of National Green Tribunal. The Tribunal's dedicated jurisdiction is only in environmental matters and shall provide speedy environmental justice and help reduce the burden of litigation in the higher courts. Initially, the Tribunal was proposed to be set up at five places of sittings and will follow circuit procedure for making itself more accessible. The Principal Bench is functioning at New Delhi and the four zonal benches are at Bhopal, Pune, Kolkata and Chennai.

Judicial approach for protection of environment

Environmental litigation is of recent origin in India. During short span of time, the Indian judiciary not only has successfully undertaken a complex task of balancing the environmental and development concerns but in the process for its adjudication of cases, evolved new principles of the environmental jurisprudence. A few new trends have been set up by the judiciary which hitherto had not been seen in the legal system. Here an attempt is made to evaluate the role of the Courts with reference to certain specific situations in the context of environment protection.

Rural Litigation and Environment Kendra, Deradun Vs State of UP & Others, AIR 1985 SC 652

Supreme Court of India ordered closure of limestone queries. The question involve in this case was that the working of lime stone queries was polluting environment and disturbing ecological balance for which the people residing in the Moussouri Hills were suffering. This case was first of its kind in India on the issues relating to environment and ecological balance and the question raised for consideration are of grave importance and significance not only for the people residing in that area and also to the welfare of the generality of the people of the country. Supreme Court reiterated that the task of environmental protection is not only that of the Government but is also every citizen's fundamental duty under Article 51A(g) of the Constitution.

M. C. Mehta Vs Union of India, AIR 1987 SC 965

The writ petition was filed praying for the closure and relocation of certain units of Sriram Foods on the grounds that such hazardous industries cannot be allowed to function in highly polluted areas. While this petition was pending, there were two instances of Oleum gas leakage. Supreme Court for first time laid down the rule of absolute liability in case of environment torts and the power of the Court to grant compensation in the case of Public Interest Litigation (PIL) under Article 32. Supreme Court held that *"Where an enterprise is engaged in a hazardous or inherently dangerous activity and harm results to anyone on account of any incident in the operation of such hazardous or inherently dangerous activity resulting in for example escape of toxic gas, the enterprise is strictly and absolutely liable to compensate all those who are affected by the accident and such liability is not subject to any exceptions which operate vis-à-vis the tortuous principle of strict liability under the rule in Rylands."*

M. C. Mehta Vs Union of India, AIR 1988 SC 1037

The writ petition was directed at the Kanpur Municipality's failure to prevent waste water from polluting the Ganga. The discharge of trade effluents passed through a primary treatment plant has been causing considerable damage to the life of the people who uses Ganga water and also to the aquatic life in the river.

The Supreme Court issued directions to the tanneries to set up effluent treatment plants within a period of six months. Each tannery is to make arrangement for the primary treatment of their effluent (before its discharge into the municipal sewer) and then discharge it into common treatment plant. The Court also directed the Central Government, Pollution Control Board and the District Magistrate to oversee the work. The Court further observed that the closure of tanneries may bring unemployment, loss of revenue, but life, health and ecology have greater importance to the people. Just like an industry which cannot pay minimum wages to its workers cannot be allowed to exist, a tannery which cannot set up a primary treatment plant cannot be permitted to continue to be in existence.

Indian Council for Enviro-Legal Action Vs Union of India (1996) 3 SCC 212

The writ petition was filed against the Union of India, the Government of Rajasthan and the State Pollution Control Board to compel them to perform their statutory duties. The main issue under consideration was the pollution caused by chemical industries and the impending threat to people living in the vicinity. The Court held that –

(a) The authorities had not performed their duties under the law and therefore the Court had the authority intervene and give appropriate directions.

(b) The principle of 'absolute liability' is a binding principle and the Court can direct the industries to bear the costs of remedial measures under Article 32.

The 'Polluter Pays Principle' as interpreted by this Court means that the absolute liability for harm to the environment extends not only to compensate the victims of pollution but also the cost of restoring the environmental degradation. the damaged environment is part of the process of 'sustainable development' and as such polluter is liable to pay the cost to the individual sufferers as well as the cost of reversing the damaged ecology.

Vellore Citizens' Welfare Forum Vs Union of India (1996), 5 SCC 647

The instant case is a Public Interest Litigation filed under Article 32 of the Constitution and was directed against the pollution caused by the discharge of untreated effluents by tanneries into agricultural lands, waterways etc. in the state of Tamil Nadu. The Court held that - Keeping in mind the duty imposed on the State under Articles 21, 47, 48B, 51A(g) the State must adopt the principle of "Sustainable Development" as a balancing concept between industrialization and protecting the environment. *"Sustainable Development as defined in the Brundtland Report means Development that meets the needs of the present without compromising the ability of the future generations to meet their own needs."*

The "Precautionary Principle" and the "Polluter Pays Principle" which are essential features of "sustainable development" are part of the environment law of the country. The principles are a part of customary international law and those rules of international law which are not contrary to municipal law shall be deemed to have been incorporated in the domestic law and shall be followed by the Courts as has been held by this Court in a plethora of cases.

The 'Precautionary Principle' – in the context of the municipal law - means environmental measures by the State Government and the statutory authorities must anticipate, prevent and attack the causes of environmental degradation. Where there are threats of serious and irreversible damages, lack of scientific certainty should not be used as reason for postponing measures to prevent environmental degradation. The 'onus of proof' is on the actor or the developer/industrialist to show that his action is environmentally benign.

Municipal Council, Ratlam Vs Verdhichand, AIR 1980, SC 1622

The Supreme Court for the first time treated an environmental problem differently from an ordinary tort or public nuisance. The Court rejected the plea of financial difficulties of the Municipality in constructing public latrine and covering drains for redressing environmental pollution. It held budgetary constraints did not absolve a Municipality from performing its statutory obligation to provide sanitation facilities. Further, the Supreme Court interpreted Section 133 of the Criminal Procedure Code to impose a mandatory duty on a Magistrate to remove public nuisance whenever exists.

M. C. Mehta Vs Kamalnath (1997), 1 SCC 388

Facts of the case is that large area of the bank of river Beas, which is a part of protected forest, has been given on a lease purely for commercial purposes to the motel by the State Government. The area, being ecologically fragile and scenic beauty, should not have been permitted to be converted into private ownership and for commercial gains. In this case, Supreme Court ordered that

- The public trust doctrine is a part of the laws of the land.
- The prior approval granted by the Government of India, Ministry of Environment and Forests by letter dated 24.11.1993 and the lease deed dated 11.09.1999 in favour of the motel are quashed. The Himachal Pradesh Government shall take over the area and restore it to its original natural conditions.
- Public Trust Doctrine primarily rests on the

principle that certain resources like air, water, sea and the forests have such a great importance to the people as a whole that it would be wholly unjustified to make them a subject of private ownership. The doctrine enjoins upon the Government to protect the resources for the enjoyment of the general public rather than to permit their use of private ownership or commercial purpose.

M. C. Mehta (Taj Trapezium Matter) Vs Union of India (1997) 2 SCC 353

In this matter a Public Interest Litigation was filed under Article 32 to prevent the environmental pollution, which was causing the degradation of the Taj. The Court held that it is proved that the industries in the Taj Trapezium Zone using coke/coal are the main polluting industries and therefore these industries have to convert to natural gas or must stop functioning and relocate themselves as per the direction of the Court.

People United for Better Living in Calcutta Public Vs State of W.B. AIR 1993 Cal 215

The writ petition was filed for directions regarding the maintenance of the wetlands on the eastern fringe of Kolkata. The Court reiterated the principle of ‘sustainable’ development and held that

- While it is true that in a developing country there shall have to be developments, but the development shall have to be in closest possible harmony with the environment as otherwise there would be development but no environment. There should be a proper balance between the protection of environment and the development process and administrative actions ought to proceed in accordance therewith and not de hors the same.
- Wetlands being a bounty of nature do have a significant role to play in proper development of society whether economic or environmental. The State must prevent any encroachment on the wetlands and make all efforts to maintain their nature and character. The State was directed to restrain any reclamation of the wetlands and to maintain the nature and character of the wetlands in their present form.

Om Birangana Religious Society Vs State Cal LT 1996 (2) HC 474

This writ petition was filed for directions that the instant case the petitioner filed a writ application under Article 226 for directions that the right of the religious society to use microphones to play religious songs and propagate religion guaranteed under Article 25 cannot be restricted by the police and to direct the District Magistrate to accord necessary permission in this regard in terms of section 34 of the Police Act., 1963 (WB Amendment) which provides for the power of the police to regulate, prohibit, restrict the use of microphones etc. The Court held that

- Within the scope and ambit of the Art. 19(1)(a) of the Constitution is subject to the restriction imposed in Art. 19(2). The freedom of speech and expression guaranteed by Art. 19(1)(a) by necessary implication includes the right not to listen and/or to remain silent. It includes the right to leisure, sleep, right to read and speak with others and even the right to worship in his own way. Therefore the right to propagate one’s religion cannot be allowed at the cost of deprivation of the rights of the others in the community guaranteed under Art. 19(1)(a).
- It cannot be said that the right to use loudspeakers is an integral part of the right guaranteed under

Art. 25 to practice profess and propagate ones religion.

- Sound is a known source of pollution and by means of sound through loudspeakers other citizen cannot be made 'captive listeners' and made to hear something, which their body cannot bear.

- Police authorities / Administration have no absolute authority to grant permission for using microphones. They must keep in mind the restriction that must be imposed in order to preserve fundamental rights guaranteed under Art. 9(1)(a).

The Court also gave directions that loudspeakers cannot be allowed to operate between 9 p.m. and 7 a.m. except when used by police, ambulances or fire brigades to carry out their duty. Loudspeakers used for religious communication must keep within the prescribed limits set down by the West Bengal Pollution Control Board.

Burrabazar Fireworks Dealers Association Vs The Commissioner of Police, Calcutta, AIR 1998 Cal 121

The writ petition was filed by the Burrabazar Fireworks Dealers Association against the police notification (02-11-1996) pursuant to the order of the Pollution Control Board which prohibits the manufacture and sale or use of fireworks and crackers above 65dB in the ambient atmosphere under section 2(b) of the Environment (Protection) Act, 1986 and Rule 3 of Environment Protection Rules, 1986. The notification was challenged on the grounds that it is violative of Article 19(1)(g) which guarantee the right to freedom of trade and profession. The Court held that

- Art. 19(1)(g) does not guarantee the fundamental right to carry on any trade or business which creates pollution or which takes away the community's safety, health and peace. There is no inherent or fundamental right to manufacture, sell and deal with fireworks which will create sound beyond the permissible limits and which will generate pollution, which would endanger public health and order guaranteed under Art. 19(1)(g) and cannot be made 'captive listeners".

- The restriction on decibel level in the various areas of the city must be determined and notified by the PCB after giving due consideration to all relevant aspects and expert opinion.

W.P. No. 16280 of 1998 – Cutting of Trees

The Court drew attention of the State Government to the U. P. Protection of Trees in Rural and Hilly Areas Act, 1976 and expressed the desirability of having such type of legislation in West Bengal and asked the Government to take early steps accordingly. Ultimately Government of West Bengal got the West Bengal Trees (Protection and Conservation in Non-Forest Areas) Act, 2006 enacted with effect from 12.04.2006.

Badal Ch. Mondal Vs State of West Bengal & Others – W.P. 7255 (W) of 2000

In this matter, Hon'ble Court considered the expert repots. Direction was given that brick kilns which were situated at a distance of a least 1.6 km away in the east and west and 0.8 km away in the north and south of any orchard (because of wind direction) having chimneys at a height of more than 100 ft might be allowed to operate, but, if that were otherwise, they should be directed to establish their brick kilns outside the above mentioned distance or they must be asked to suspend their operation from February to May. Future consent also shall or shall not be given accordingly.

Before the National Green Tribunal, Principal Bench, New Delhi
Civil W.P. No. 3727 of 1985 along with other original applications

In connection with the Ganga pollution matters Hon'ble Tribunal is of the considered view that effective directions need to be passed in this case to prevent and control pollution of river Ganga, resulting from indiscriminate discharge of industrial effluent into the river. Accordingly, Hon'ble Tribunal constituted three committees - Principal Committee, Implementation Committee and the State Level Committee to ensure proper implementation of the orders of the Tribunal. The Implementation Committee and the State Level Committee shall be responsible for implementation of the orders of this Tribunal. They shall report jointly or severely to the Principal Committee in regard to the various facts of compliance to the orders of this Tribunal and its progress from time to time. The Principal Committee shall be entitled to suggest policy decision and action plans that are required to be taken in the interest of environment. It shall have overall control over the State Level and the Implementation Committees. It shall be responsible for submitting monthly reports to the Tribunal with complete data that is prepared and collected, during the intervening periods, during which orders are passed by the Tribunal from time to time. The Committees would ensure that proper criteria for identifying seriously water polluting industries is put on the website of the MoEF&CC, GoI, the respective states, CPCB and the concerned State Pollution Control Boards. Determination of this aspect need not be quantity -based but be quality based. This is for the reason that a smaller unit of the above industries/ units operating without consent and without having any ETP, may cause even much greater pollution than a bigger industry, which is operating with ETP and consent or a unit which is a 'no discharge unit' or 'zero discharge unit'.

The Tribunal also directed the Regulatory Authorities to issue guidelines in relation to the 'zero discharge unit'. A 'zero discharge unit' must essentially be a unit which does not discharge any amount of liquid effluents, not even treated effluents. It may be as a result of complete recycling of its effluents or evaporation or because of adoption of any other mechanical process, like incinerator etc.

Conclusion

The proper implementation of law depends on a disciplined administration, active judicial system and social consciousness. Mere enactment of laws does not suffice to serve their purpose. What is needed simultaneously is a mass consciousness regarding the necessity and use of law. Legally the ‘Sati’ system was abolished long ago. Yet even today widows are burnt alive on cremation pyres in the name of ‘Sati. Administration stands a silent witness. Rejoicing in the re-survival of Sati, its supporter distributes sweets amongst themselves. Similarly, laws passed for the protection of the environment will never be properly implemented until the masses become conscious of the necessity of protecting nature. However the responsibility of creating such a consciousness by national efforts and legal compulsion remains absolutely essential. In the present times quite a few important decisions have been taken by the Indian Judicial system. The highest seat of Judgement in India, the Supreme Court in deciding a case has stated that every man has the basic claim to a healthy, pollution-free environment in which he can live. In our country, correct implementation of laws for the prevention of pollution coupled with a social movement alone can give the next generation a pollution free society. The only other path points to an unknown, uncertain darkness which equals death in has monstrosity.

In summing up, brings us back to square one. The responsibility is ours, the power and means are in our hands, the world is ours and its all upto us either to face perils or to boldly assert survival for the human race.

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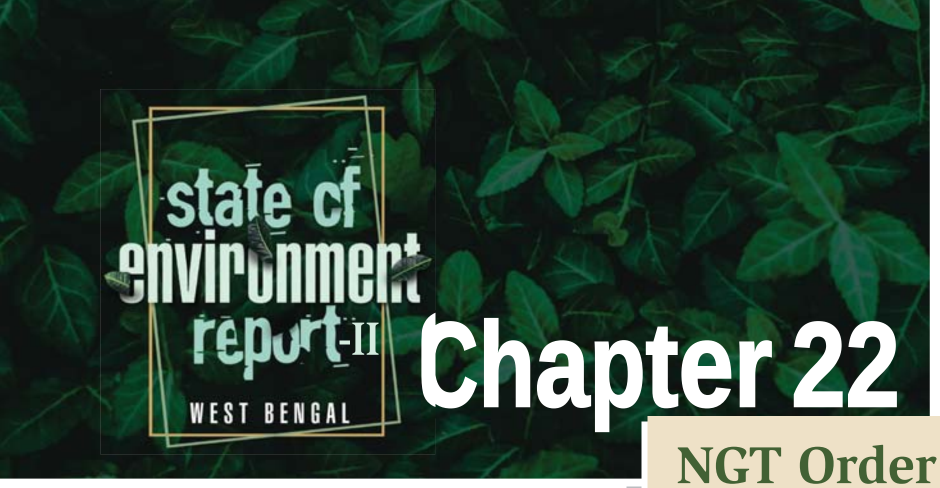
state of environment report-II

WEST BENGAL

Chapter 22

NGT Order and its Compliance



Chapter 22

NGT Order and its Compliance

National Green Tribunal or NGT was established in 2010 to adjudicate environmental cases throughout the country. All the ongoing Supreme Court and High Court cases relating to the environment were then transferred to the NGT. NGT's Eastern Regional Bench is situated at New Town, Kolkata. At present, in the prevailing COVID pandemic situation, National Green Tribunal has been functioning from its principal office in New Delhi through V.C. mode.

Let us have a look at the important cases of NGT which have a pan-India impact. In 2016 Govt. of India came out with six Rules under the Environmental Protection Act,1986. These Rules prescribed the procedure for handling, storage and disposal of municipal solid waste, bio-medical waste, hazardous waste, plastic waste, construction and demolition waste and *e*-waste. In these Rules, timelines were given by which scientific waste management was to be introduced in respect of each of the Rules.

When we say solid waste, we mainly mean municipal solid waste. How many of us know that if at the household level we segregate our domestic waste in basic three categories before handing it over to the municipal waste collector next morning, it will go a long way to implement the Solid Waste Management Rules effectively. Every domestic household usually creates three kinds of solid waste. First category waste is comprised of kitchen waste, peels of vegetables and fruits, fish scales, fish, meat and chicken bones, discarded food etc. Another category is dry waste in which we can put paper, plastic, bottles, glasses, metals etc. The third category is hazardous waste including biomedical waste in which we can put used sanitary napkins, discarded medicines, injection syringes etc. If we segregate the waste generated at our household levels into these three basic categories before handing it over to the municipal wastes collector then only it will be possible to reduce, reuse and recycle the generated waste. We become anxious if the municipal waste collector does not turn up even for a day (how many of us have noticed that these workers have not taken a single day off during entire lockdown period when we were securing ourselves in the comfort of our rooms). We want to keep our home clean and we are oblivious as to what is happening to the accumulated waste which is getting piled up in our backyard, meaning in the city backyard, i.e the dump-yards. A visit to Dhapa or Mollar Bherry or Pramod Nagar dumpsites will only make us understand the severity of the disposal problem. No more land stretch is left in or around Kolkata or say in all the 125 Municipalities in West Bengal which can be converted into additional dump sites. For years together we went on dumping our garbage in the dump-yards thinking that our responsibility ends there. We have never wondered what will happen if those dumping grounds get filled up.

Ancient Indian culture had an inbuilt mechanism to reduce and recycle the waste generated at domestic levels. Peels of vegetables and fruits were the feed of the cattle. Discarded food was given to domestic dogs and cats. Even fish scales and other discards were used to feed the ducks, kitchen waste and garden waste were used as natural compost. At the end of the day, whatever waste we generated were all reused and recycled and there was no plastic, the devil of the present day.

Now we must know how to reduce the generated waste to a manageable size that is why the Solid Waste Management Rules of 2016 was notified. The Rule says that domestic waste is first to be segregated into dry waste and wet waste. Wet waste is to be used for converting into compost fertilizer and the dry waste is to be recycled. If households do not hand over domestic waste after segregating it into dry and wet waste, it becomes impossible for the municipalities to do the segregation later at secondary collection/storage point or the dumpsite. Solid Waste Management Rules has made it mandatory to collect domestic waste in a segregated manner. National Green Tribunal is now closely monitoring the entire Solid Waste Management issue right from the point of household collection to its disposal as per law. In every quarterly report, every State Government is now required to specify where segregated waste collection is being done and where still mixed waste collection is going on. In short, we can say that the entire waste management issue of the country revolves upon the collective will of the domestic households to segregate its waste before handing it over to the waste collector. National Green Tribunal is now monitoring the stepwise activity of every urban local body/municipality from waste collection to waste disposal.

Another important concern is what to do with the huge pile-up of garbage in the city dump yards which are technically called legacy dumpsites. The problem of the legacy dumpsite is that accumulated waste gradually generate leachate which in turn can contaminate nearby water sources or the underground water table. We can all imagine as to how much environmental damage can be caused if these garbage hills lie as it is with untreated garbage for years. The law says that these legacy dumpsites are to be cleared by bio-mining. Components are to be segregated item wise. Some portion is to be used for compost manufacturing. Construction debris is to be reused to manufacture paver blocks and plastic waste is either to be recycled or to be consumed in cement or thermal power plants as fuel.

New Rule says that 70 to 80% of municipal waste should be reused or recycled and inert leftovers are to be stacked in a sanitary landfill (SLF) site in such a way so that there can be no contamination of the groundwater by leachate or pollution to the surrounding environment. NGT is now strongly monitoring the action taken by urban local bodies throughout the country in clearing up these legacy dumpsites. Barring a few, almost all urban local bodies have missed the statutory timelines. NGT has now given a strong direction that either clear legacy dumpsites or pay up the environmental damages. So, the action before the State is now two folds. Firstly, to take care of fresh waste in such a manner so that it does not increase legacy waste and secondly, to clear up the existing legacy waste dumpsites. NGT has been urging the Municipal Bodies to frame by law and take stern action against all including the individual households if they do not dispose of the domestic waste in terms of the Rule.

In O.A. No.606 of 2018, National Green Tribunal has asked all the Chief Secretaries of the Country to personally monitor the solid waste management issues. NGT has made it clear that solid waste management issue is not a stand-alone problem. Since principally waste is generated from domestic households where all sorts of waste like kitchen waste, plastic waste, hazardous waste, e-waste and biomedical waste are generated, so the waste management strategy must be an integrated strategy taking care of all these issues. It has been noticed that among the riverine cities age-old practice has been to dump the city garbage into the river water itself. So in O.A. 606 of 2018, NGT has taken up liquid waste management also in the same vigour. Sewage generated at household level must be taken care of in a scientific way. Either every individual household of a town or a city must be connected to sewerage network of an STP or if the households are having septic tanks or soak pits then the sewage therefrom must be collected and brought to a cesspool for its further treatment in a faecal sludge treatment unit. It is now very much clear that unless and until dumping of solid waste in water bodies or rivers are stopped and generated sewage is properly treated, environmental degradation cannot be stopped. In O.A. 606 while talking about solid waste management, NGT has been reminding us to take urgent action to control biomedical wastes, hazardous wastes, e-waste and liquid waste along with solid waste management issues. While giving orders in the case relating to 351 highly polluted river stretches of the country (OA 673 of 2018), NGT has been constrained to remind us, again and again, to take immediate action for solid waste management and liquid waste management because unless all sorts of wastes are managed comprehensively our target for giving cleaner environment to the posterity can never be achieved.

Environment studies is now a subject taught mandatorily to all students to make them environment conscious. Without massive public awareness, it is impossible for any Govt. to bring about a qualitative change in our environment. Showing reverence to river Ganga we throw our puja remains on the river water. We are not conscious that in the process we are only further polluting Mother Ganga. Now, West Bengal Govt. has placed large waste bins in all the Ganga Ghats to collect flowers, petals, leaves etc. of puja offerings in these receptacles. Our age-old rituals are also now a contributing factor in polluting the water sources. The Pujas, Bisarjans, observance of Chhat etc. are causes of concern to the environmentalists because they not only contaminate the water bodies including the rivers but also cause immense harm to the diverse biological organisms present in the water.

If we study the NGT orders carefully we shall find that the protection of environment depends on the creation of awareness, participatory planning, its implementation and a resolve to change our lifestyle to make it more environment friendly. When there is a law which prohibits the use of the loudspeakers in residential areas during nighttime beyond 45 decibels from 10 PM to 6 AM its incumbent upon all the citizens to abide by the law. If everybody makes it a point to disobey the law and play hide and seek with the law enforcing agencies then who are the worst sufferers, only we, the people. In successive NGT orders, State is being asked again and again to strictly enforce the environmental laws and take timely action for implementation, but success ultimately depends on peoples' participation. Unless it devolves upon us that honking a horn in a silence zone especially in front of a Hospital is an unpardonable offence, implementation of law regarding noise pollution cannot be effectively implemented.

Another unique feature of NGT's intervention is that whenever any serious issue comes to its notice even by any newspaper reporting, NGT starts a *Suo Moto* case and calls upon the State Govt. and the Central Govt. to respond appropriately. Based on a news item published in "The Hindu" authored by Mr Jacob Koshi titled " More river stretches are now critically polluted: CPCB" NGT has started the celebrated case on water pollution (O.A. No.673 of 2019). Similarly, when Sri Viswa Mohan wrote an article titled "Encapped with multiple timelines to clean air in 102 cities to be released around August 15" in The Times of India, NGT initiated a *suo moto* case on air pollution called O.A.No.681 of 2018. Similarly, the case of legacy waste being O.A. No.519 of 2019 was triggered by a news item in Times of India authored by Jasjeev Gandhiok and Paras Singh. Besides, when noted environmentalists like M.C. Mehta, Almitra Patel, Lieutenant Colonel Sarvadaman Singh Oberoi or our own Sri Subhas Dutta raise important environmental issues and file cases before Hon'ble NGT, NGT takes necessary cognizance and issues suitable directions. The speciality of NGT cases is that rather than harping on law points the issues are assessed based on the opinion of experts, reports of fact-finding committee and reports of amicus curiae. Wherever necessary, NGT seeks the intervention of the Chief Secretary to strengthen inter-departmental synergy and to ensure time-bound compliance. In the case of polluted river stretches of O.A. No.673 of 2018, NGT directed Ministry of Jal Shakti to hold a monthly review with the State Governments and report the developments. So, in a way, NGT has created an atmosphere where environmentalists and administrative bodies are working together to bring about a qualitative change in the environment we breathe in. A list of important cases is given in Table 22.1 to understand how NGT has been monitoring the key environmental issues.

Table 22.1: Important Cases: How NGT has been Monitoring the Key Environmental Issues

Case No.	Details
OA 33/2014/EZ	The air quality of Kolkata and Haora worsen during the winter season because of an increase in the level of particulate matters beyond the permissible limit. Plying of very old diesel vehicles, heavy traffic congestion, stubble burning, hot mix plant of KMC and improper solid waste disposal including the burning of plastic etc. are to be controlled/restricted. After considering Government's Action Plan NGT has disposed of this case recently
OA 606/2018 On Solid Waste Management	NGT has directed to take a holistic approach towards solid waste management along with bio-medical and plastic waste management issues. River rejuvenation and air quality monitoring programme are also to be monitored. Urban Dev Department has been made Nodal Department. Chief Secretary is to monitor all related issues every month with DMs and DMs to monitor twice every month with all the stakeholders. District level Environment Plan is to be prepared.
OA 173/2018	In this case, Sudarshan Das, a resident of Orissa alleged that illegal sand miners from WB were stealing sand from the Orissa part of Subarnarekha river using sump pumps. NGT ordered proper demarcation of the boundary between the two states and stoppage of sand mining in the area till such time and also to take action against the illegal sand miners. State Government has taken necessary action accordingly.
OA 12/2015/EZ	NGT has asked State Government especially KMC and I&W Department to prepare and implement concrete Action Plan so that the ecological value of Adi Ganga (i.e. Tolly Nullah) water is restored. Upon considering the Action Plan prepared by the State Government the case has been disposed of.
OA 200/2014	No untreated sewage from any drain is to fall in the Ganga. All Ganga towns have been asked to cover all the outfall mouths of such drains with proper sieves. All industries are also to remain compliant in this respect. NMCG from New Delhi is funding the projects for construction of STPs in the urban areas. Central and State PCB to regularly monitor water quality.
OA 148/2016	The issue is the utilization of treated wastewater from STPs
OA 710/2017	The issue raised is non - compliance of the provisions of Bio-medical Waste Management Rules, 2016 (BMW Rules)
OA 673/2018 (Based on News Item published in the Hindu authority by Shri Jacob Koshy)	A matter relating to 351 highly polluted river stretches in the country where NGT has directed to bring the water to at least bathing quality. In West Bengal, we have 17 such stretches.
OA 32/2019/EZ	East Kolkata Wet Land issues
OA 681/2018 (Based on News Item published in the Times of India, authorized by Shri Vishwa Mohan)	A matter relating to National Clean Air Programme (NCAP).

Case No.	Details
Original Application No. 1038/2018 (Based on News item published in “The Asian Age” Authored by Shri Sanjay Kaw)	A matter relating to air pollution in the identified industrial clusters area.
Original Application No. 72/2020	Scientific Disposal of Bio-Medical Waste arising out of COVID-19 treatment-Compliance of BMW Rules, 2016
Original Application No. 30/2020/EZ	Scientific Disposal of Bio-Medical Waste arising out of COVID-19 treatment-Compliance of BMW Rules, 2016
Original Application No. 325/2015	A matter relating to a framework of restoration of all the water bodies.

Now let us be specific about West Bengal. How are we complying with the directions of National Green Tribunal? In compliance with Hon’ble National Green Tribunal’s directions passed in O.A. 606 of 2018, Government of West Bengal formed a high-level Monitoring Committee under the chairmanship of Hon’ble Justice (Retd.) Jayanta Kumar Biswas to monitor solid waste management and other related issues every month. Although originally National Green Tribunal wanted the Committee to function for a term of 6 months, the State Government on its own, extended the term of the Committee till July 2020. The Committee held regular monitoring meeting with all the related Departments like Urban Development & Municipal Affairs Department, Environment Department, West Bengal Pollution Control Board, Health & Family Welfare Department, KMDA, KMC, Irrigation & Waterways Department, Public Health Engineering Department, Panchayats & Rural Development Department, Commerce & Industries Department, Micro & Small Scale Industries Department, Transport Department etc. to draft a well-coordinated action plan to achieve the statutory target of solid waste, liquid waste, plastic waste, bio-medical waste management etc. Chief Secretary formed an environment monitoring cell to monitor the key environmental issues through inter-departmental coordination and with District Magistrates on a regular basis.

In our battle against pollution, air quality management got the topmost priority. In 2019 from October onwards WBPCB started implementing an innovative programme of using water sprinklers to mitigate road dust throughout the winter months. Important roads of Kolkata, Haora and Bidhannagar were regularly sprinkled with water to mitigate road dust till February. Simultaneously, NEERI, a Central Govt. organisation was given a project to make a source apportionment study of the major pollutants of Kolkata and Haora and recommend a solution. We realised that simultaneously some concrete action must be taken to bio mine Dhapa dumpsite. Fire tenders were pressed into service to douse the fire in order to contain Methane contamination. Simultaneously, KMC passed *a by-law* prohibiting open burning of waste and also for mandatory use of cover at the construction sites. Later the NEERI study also supported our theory that during winter, mitigation of dust particles that is PM_{10} and $PM_{2.5}$ particle matters are of major importance to keep the city air within the permissible limit. From NEERI study we now know that the most important contributor to winter air pollution is a secondary aerosol which invades West

Bengal from the Gangetic plains during winter. A study is also being conducted by Delhi I.I.T. to find out an escape from this pollution.

Now we know for sure that proper handling of solid waste is a must to keep the PM_{10} and $PM_{2.5}$ level within the permissible limit. Nowadays conservancy workers are alerting the individual households to hand over the garbage in a segregated way. Two types of bins have been distributed in major urban cities for this purpose and we expect to target 100% segregation of municipal waste at the household level at least in major urban areas by the year-end. Regular sweeping of roads and maintenance of cleanliness in the neighbourhood area are now quite apparent. For the initiative taken by the Govt. of West Bengal in this regard, India Today group awarded West Bengal the State of the State award for its performance in 2019 in the environment sector and the trophy was handed over to the State team by none other than the Union Environmental Minister in New Delhi.

In the COVID pandemic situation, one of the major areas of concern was proper disposal of biomedical waste including COVID waste generated from Hospitals as well as quarantine homes. When National Green Tribunal wanted reports from all the State Govts. in the celebrated COVID case of O.A. 72 of 2020, joined by Sri Subhas Dutta by another O.A. 30 of 2020, our performance did not lag behind other States in this regard. All the hospitals and major cities have been successfully networked with six organisations for treating biomedical waste. These organisations are called Common Biomedical Waste Treatment Facilities or CBWTF. Appreciating the role of WBPCB for establishing and running a successful model with the help of Health & Family Welfare Department and Urban Development Department, WBPCB has got a nomination for celebrated Skotch Award.

Positive action has been taken in terms of important National Green Tribunal directions to remedy the legacy dumpsites. If we look eastward on the Science City bound E.M. Bypass near Metropolitan bus stop we will be amazed to find a green coloured small hillock which is nothing but scientifically capped old dumpsite at Dhapa done with the World Bank aid. Huge exercise is being undertaken to clear the forty thousand lakh metric tonnes of accumulated garbage lying at 60 acres of Dhapa area which, when completed, will give the city a new lease of life.

West Bengal Pollution Control Board has distributed sound meters along with sound calibrators to measure sound level in each of the Police Stations of the State. Similarly, the initiative has been taken to install air quality monitoring stations in almost all the major cities of West Bengal. All the STPs are being monitored again and again to make them fully functional and to rejuvenate dilapidated STPs. Simultaneously, we are trying to set up as many faecal sludge treatment units as may be required to treat the liquid waste of sewage and effluents so that the river water and underground water do not get contaminated any further.

The State Pollution Control Board has also taken necessary action for setting up disposal facilities by authorized vendors regarding hazardous and *e*-waste in Haldia. All the 52 grossly polluting industries are regularly monitored online for proper effluent discharge as per standard. In Bantala Leather Complex four Common Effluent Treatment Plants (CETPs) are now being operated and four more are in the pipeline. STPs have been provided or under construction in all the industrial parks also. All other individual MSME units operate with independent septic tanks and soak pits and they do not require separate STPs. Industries are closely monitored by the State Pollution Control Boards and violators are made to pay environmental compensation (EC). From 1.1.2019 to 20.6.2020 about 150 such violators have been booked to pay EC to the tune of Rs.589.73 lakh.

The vigorous tenacity and the coordinated approach taken by the State Govt. in battling pollution problem has also been noticed by National Green Tribunal and over the last one year, some important Court Cases relating to the Sundarbans, air quality in Kolkata & Haora, noise pollution, Adi Ganga issue have been disposed of by National Green Tribunal based on action taken by the State Government.

The first step to bring about major environmental change is handing over our domestic waste in a segregated way to the conservancy worker the next morning. What National Green Tribunal trying is also the target of the State and we believe that this can be achieved with positive participation of the citizens. Our children have a right to demand a cleaner environment from us.

Reference:
https://greentribunal.gov.in/judgementOrder/zonalbenchwise

State of Environment Report-II

WEST BENGAL

Chapter 23

Awareness and People's Participation


স্বচ্ছ ভারত
পশ্চিমবঙ্গ দূষণ নিয়ন্ত্রণ পর্ষদ
পরিবেশ দপ্তর
আমাদের অঙ্গীকার সবুজ পৃথিবী
জাতীয় সবুজ বাহিনী


Save Water
Save Life


গাছ আমাদের
আক্সিজেন দেয়,
গাছ লাগাও
প্রাণ বাঁচাও,

Chapter 23

Awareness and People's Participation

Environmentalism is an ideology that evokes the necessity and responsibility of humans to respect, protect, and preserve the natural world from its anthropogenic (caused by humans) afflictions. Environmental awareness is an integral part of the movement's success. The West Bengal Pollution Control Board is continuously carrying out its responsibility and hence contributing all sincere efforts to spread environmental awareness among the people all over the State. The aims, objectives and the mode of the State Board's awareness campaign movement are:

1. To promote environmental awareness among all sections of the society;
2. To spread environment education about relevant laws and regulations and their rights, interests, duties and responsibilities, as well as about the social, environmental and economic consequences of non-compliance, especially in the non-formal system among different sections of the society;
3. To facilitate the development of education/training/campaign materials and aids in the formal education sector;
4. To promote environmental education through existing educational/scientific/research institutions;
5. Inclusion of awareness and environmental education programmes in schools and other educational establishments;
6. To ensure training and manpower development for environmental education, awareness and training;
7. To encourage non-governmental organizations, mass media and other concerned organizations for promoting awareness about environmental issues among the people at all levels;
8. To use different media including films, audio, visual and print, theatre, drama, advertisements, hoarding, banners, posters, seminars, workshops, competitions, meetings etc. for spreading messages concerning environment and awareness; and
9. To mobilize people's participation for preservation and conservation of the environment.

Figure 23.1: Awareness Rally by an Eco Club in hilly areas

Environmental Campaign has become an important tool to achieve effective compliance of various pollution norms. The following mechanisms can be fruitful to promote environmental awareness:

a. Generating public awareness and environmental education, particularly among targeted groups, about relevant laws and regulations and their rights, interests, duties and responsibilities, as well as about the social, environmental and economic consequences of non-compliance;
b. Promoting responsible action in the community through the media by involving e public players, decision-makers and opinion – builders in such campaign;
c. Organizing campaigns for fostering environmental awareness among communities, non-Governmental organisations, the private sector, industries and trade associations;
d. Inclusion of awareness and environmental education programme in schools and other educational establishments as part of education;
e. Organising campaigns for fostering environmental awareness and environmental education programme for women and youth ;
f. Organising campaigns for encouraging public involvement in the monitoring of compliance.

In a country like India, environmental awareness is very much required for every level of civic society of both urban and rural areas irrespective of their economic entity. This is necessary as well as helpful for any government to build up active public participation for any kind of environmental cause. This large-scale public involvement can strengthen the environmental movement for the sake of implementation of environment-friendly rules and regulations by government machinery in a much better way to have the most desired resulting terms of better environmental to live in.

In our state, West Bengal, considering the fact above the West Bengal Pollution Control Board with active cooperation of various departments of the State Government has initiated various types of environmental awareness programmes targeting the people of all walks of life. These positive initiatives also include the government of India's sponsored National Green Corps (NGC) programmes since 2001 throughout the country for the school children. Various activities/programmes emphasizing on nature, natural resource, environment & society are conducted under the National Green Corps Programmes. Apart from this, the State Board conducts various campaigns programmes throughout the year utilizing the services of various Government Departments, local bodies, education institutions, clubs etc.

Moreover, the State Board also participates in different fairs and melas, rallies and different State Government Programmes towards the generation of environmental awareness among general mass.

Figure 23.2: Students participated in Environmental Campaign on discarding banned plastic carry bags

The West Bengal Pollution Control Board used to take awareness programme across the State in two ways, through the National Green Corps Programme and its Awareness Cell.

Activities of the National Green Corps (NGC) Programme

Environment Education, Awareness, and Training (EEAT) is a central sector scheme of the Ministry of Environment, Forest & Climate Change (MoEFCC), Government of India launched during the financial year 1983-84. The basic aim of the scheme were (1) to promote environmental awareness among citizens, (2) to spread environmental educational and (3) to mobilize student's participation for environmental conservation. As a part of this scheme, the Ministry of Environment, Forest & Climate Change (MoEFCC), Government of India initiated a novel programme, popularly known as National Green Corps (NGC) in the year 2001 to make the school children more concerned for the environment by involving them in various environment-related activities and thereby building a cadre of young green citizens working towards environmental conservation from their early school years. By participating in various environmental activities under the NGC programme, the students acquire the basic knowledge, skills and values that promote environmental responsibility. Since the inception of this project, the West Bengal Pollution Control Board has taken the responsibility to implement the programme efficiently as a nodal agency in our State. The West Bengal Pollution Control Board took all the necessary steps and enlisted thousands of schools across the State under this programme since the year 2002-03 for active participation of Eco-Club in respective schools under the supervision and guidance of their teachers. The various environmental activities continue relentlessly with increasing enthusiasm in thousands of school children of West Bengal.

The prime objectives of this programme are stated below:-

- To communicate information to school children, through practical experience, about their immediate environment, interactions within it and the problems therein;
- To provide environmental education opportunities for school children;
- To develop essential skills of observation, testing, survey, recording, and study for conserving the environment through various activities;

- To utilize the unique position of school students for awareness of the society at large;
- To teach the proper attitude towards the environment and its conservation through community interactions;
- To enable children's involvement in decision making in areas related to environment and development in their locality;
- To inspire the children into direct communication with the environmental problems faced by the society they live in and make them think of its solutions;
- To involve children in action-based programmes related to the environment in their locality;
- To endorse logical and independent thinking capability amongst children to make the right choices towards scientific inquiry;
- To encourage young minds by involving them in action projects related to environmental conservation.

Besides these, the State Board has made a calendar to be followed mandatorily by the all Eco-Clubs to observe the World Wetland Day on 02nd February, Earth day on 22nd April, World Forestry Day on 21st March, World Water Day on 22nd March, World Environment Day on 05th June, International Day for the Preservation of the Ozone Layer on 16th September and National Pollution Prevention Day on 02nd December each year.

In this regard, a state-level committee chaired by Shri Subrata Ghosh, Chief Engineer, West Bengal Pollution Control Board, has been constituted and at districts level, the In-charges of all the Regional Offices of the State Board has been appointed as the District Nodal Officer to oversee the activities of the schools under NGC programme.

Moreover, as per the norms of the MoEF&CC, Government of India, a State Steering Committee was also constituted to coordinate the implementation of the programme. There is another committee in each district i.e. District Implementation and Monitoring Committee (DIMC) headed by the respective District Magistrate to oversee the proper implementation of the programme at the district level. The DIMC have been constituted in all the districts by the Department of Environment, Government of West Bengal.

The West Bengal Pollution Control Board has successfully been able to enlist 5,632 schools under the NGC programme. The State Board has decided to bring new schools under this programme and the process is continuing. A common guideline has been sent to the schools all the enlisted Eco-Clubs for organizing environmental awareness programmes and disseminating environmental messages among the common mass.

The MoEF&CC, Government of India, has granted financial assistance to the tune of Rs.5,000.00 (Rupees five thousand) per Eco-Club of the schools participating in the NGC programme to a maximum of 250 such Eco-Clubs in each district. The State Board has initiated online fund transfer to some of the schools from the financial year 2019-20 and has targeted the same to all the enlisted schools from the current financial year. Account payee cheques have been provided to rest of the schools. All the enlisted schools were also directed to submit their activity reports to the State Board including utilization certificate.

As a nodal agency of the National Green Corps Programme in West Bengal, the West Bengal Pollution Control Board used to provide 'Activity Calendar' to each school under this programme, so that the schools may undertake/organize different programmes month-wise and issue wise properly. The calendar also helps the Board to monitor all the enlisted schools which undertake/organize similar programmes across the State. Under this effective venture, some District Level Programmes and a series of diverse and novel activities were undertaken by the individual schools.

Figure 23.3: Students participated in celebration of World Ozone Day

Each school under the National Green Corps programme has an Eco-Club, which comprises of around 50 children who have joined voluntarily. Children are given instructions theoretically about Environment as well as involved in hands-on activities, which help to cultivate a sense of caring and appreciation for the environment. Each Eco-Club is being supervised by a Teacher-in-Charge, selected from amongst teachers of the school based on their inclination towards environmental issues. There are one/ two master trainers in each district to assist the Teacher-in-Charge for the smooth functioning of the Eco-Club activities. To implement the programme at the district level, the existing DIMC has been expanded to form an Expanded District level Implementation and Monitoring Committee for carrying out the various school-related activities of the campaign. The common programme undertaken by the Eco-Clubs of the NGS Schools is given below.

This is to be mentioned that the necessity of more man-power was felt to implement and monitor the different programmes under this National Green Corps throughout the year across the State. So, the inclusion of the *'Paribesh Shevak'* is a unique model to oversee all the activities of the schools under this programme. Since 2011, numbers of *Paribesh Sevaks* are working hard to implement various programmes as per the activity calendar each year.

Seminars/talks/debates: A no. of seminars/ talks/debates were organized under the NGC programme on the topics related to different global environmental issues, the present state of environmental pollution, different pollution mitigation and control measures etc. to generate knowledge as well as awareness and concern for the environment amongst school children.

Nature Camp/field visit: Through such nature camps/field visits the school children of different Eco-Clubs obtain an opportunity to directly interact with and study on nature, which is a unique combination of both the plants and animals, living and non-living components, biotic and abiotic factors of the environment. The children must understand the scientific process influencing the distribution of organisms, the interaction among organisms and the transformation of energy.

Figure 23.4: Students and teachers participated in plantation under the National Green Corps Programme

Plantation and afforestation programmes: Plantation programme is one of the most important initiatives undertaken by the maximum number of Eco-Clubs members of respective school under the NGC activity. The main aim is to increase the earth's total green cover through extensive afforestation and prevention of illegal tree cutting and encourage the whole society towards the same to save the environment.

Cleanliness drive: With a vision that "cleanliness begins in schools", the school children are involved in activities such as cleaning their school premises before starring the make efforts to make the world a cleaner place to live in.

Awareness by rallies: The student members of the Eco-Clubs organize and participate in rallies to make the people aware of various environmental issues, such as climate change, plastic pollution, noise pollution and observation of various environmentally important days etc.

Survey: Intensive nature survey works conducted by school students of different Eco-Clubs enable them to get knowledge about the environmental condition of a particular area / eco-system, bio-diversity, recognize the intricate problems and probable measures to eliminate them. For instance, the wetland survey carried out by Eco-Clubs members helps them to study about the eco-system, bio-diversity as well as the problems easily and pave the way towards solving the particular environmental problem.

Other activities: The other key activities undertaken by the Individual school and district committee are Eco-Clubs meetings, preparation of eco-diaries, sky watching setting up medicinal plant garden, observation of environmentally important days.

Apart from the above-mentioned programmes, the State Board took special initiative involving schools under the NGC programmes as mentioned below:

- **Sapling Distribution Programme:** The State Board took an extensive green initiative in the recent past by distributing a large number of various species of sapling to many schools and colleges. A total of 26,000 number of saplings like Kanchan, Rangan, Sewli, Jaba, Jarul, Bakul, Bel, Jam, Papaya, Lebu, Gandharaj, Akashmoni, Mehogoni, Arjun, Sisoo, Simul, Neem, Croton, Amloki, Hartoki, Supari, Segun, Chhatim, Alamanda, Jackfruit, Bel, Aata, Dalim, Tentul, Karanj, Guava, Radhachura, Krishnachura, Tagar etc. were distributed.

- **Environmental Awareness Programme during FIFA U-17 World Cup Tournament**
  The prestigious FIFA U-17 World Cup Tournament, 2017 was organized in India. The matches were scheduled to be held at the various metro and important cities including Kolkata. A number of matches were held at Swami Vivekananda Yuba Bharati Krirangan, Salt Lake since 8th October 2017. As directed by the Hon'ble Green Tribunal, Eastern Zonal Bench, the West Bengal Pollution Control Board decided to hold an environmental campaign drive involving students of different schools under the National Green Corps programme before the tournament from 7th September 2017 to 14th September 2017 to ensure a healthy environment as far as possible and to maintain or improve the Air Quality of the surrounding areas of Salt Lake and especially in and around of the stadium. For this purpose, the State Board selected 10 schools situated within 5-kilometre radius of the Swami Vivekananda Yuba Bharati Krirangan, Salt Lake. As requested by the State Board the students participated in an environmental oath–taking programme during their Morning Prayer time at school for the sake of environmental concern.

- **Oath-taking ceremony before Durga Puja:** The State Board conducts an environmental oath-taking ceremony involving the students of various schools in and around Kolkata each year. The Board Officials visited each school and gathered some students in a classroom to conduct such programmes. Headmaster / Headmistress / Principal, teachers and other officials of each school authority were present during the programme. Leaflets on various environmental guidelines are being distributed among the students and a banner is being given to the school authority to conduct such programme in future to create awareness about maintaining clean and green environment during festive days.

Figure 23.5: Oath-taking ceremony before Durga Puja at a School under the National Green Corps Programme

- **'Clean and Green drive'- an environmental campaign during Kolkata International Bookfair:** The Kolkata International Book Fair is being organized at Salt Lake Central Park for last few years. On this occasion the West Bengal Pollution Control Board used to erect a stall on behalf of the Department of Environment, Government of West Bengal showcasing a number of books and reports published by the Board, leaflets, pamphlets, posters, campaign boards etc. Apart from this, a massive campaign programme 'Clean & Green Drive' is being organized each year involving student and teachers of different schools under the NGC programme. The main objective of the campaign is to make the visitors, booklovers and others aware of restriction in using banned single-use plastic carry bags and its adverse effects on health and environment.

Figure 23.6: Chairman, Member Secretary and other senior officials are receiving the Commendation Trophy from the Hon'ble Chief Minister of West Bengal

Beside fundamentals of air, water, noise and auto- emission pollution control, special training on exhaust emission testing of in-use Petrol/LPG and diesel vehicles was also arranged during those programmes. A practical demonstration was arranged at the Board's Auto Emission Testing room. Machine manufacturers also shared their valuable suggestions on auto exhaust emission testing procedure.

- **Participating in Independence Day Parade**: The State Board participated in Independence Day Parade in the year 2019 at Red Road, Kolkata on behalf of the Environment Department, Govt. of West Bengal with a tableau where different aspects of the environment were depicted and live models were also seen. Moreover, students of a Kolkata school under the National Green programme were also trained specially to participate in this parade with campaign boards bearing environmental messages. The entire initiative of the Board was awarded commendation trophy by the State Government.

Activities of Awareness Cell

- Training Programmes organised by the State Board for In-Service Police Personnel
  The West Bengal Pollution Control Board organizes training-cum-awareness programme for the in-service Police Personnel of West Bengal Police Authority.

Figure 23.7: Training Programme Organised by State Board for In-Service Police

Course Outline of Training cum Awareness Programme for in-service police personnel:

- Fundamentals of air, water, and noise pollution
- Automobile Pollution with practical training for exhaust emission testing of in-use vehicles.
- Waste management
- Sources of pollution and their effects on human
- Instruments used for various pollution measurements

- Environmental laws and legal provisions on pollution control
- Audio-visual show on environmental pollution.

➢ **Air quality in Kolkata and its surrounding areas**

Several meetings were organized at the auditorium of Paribesh Bhawan, Kolkata to discuss the adverse condition of the environment as well as the air quality in Kolkata and its surrounding areas time to time in presence of Hon'ble Minister-in-Charge, Department of Environment, Government of West Bengal, Principal Secretary, Department of Environment, Government of West Bengal, Chairman and Member Secretary of the State Board and the Senior Officials of the Department of Environment. In these meetings discussion on the various causes and impacts of air quality in Kolkata and other districts of West Bengal particularly increase in the quantity of particulate matter (PM_{10} and $PM_{2.5}$) in the air has been made.

➢ **Interaction with various industry associations**

As desired by the Hon'ble Minister-in-charge, Department of Environment Government of West Bengal, several meetings with the representatives of about 49 nos. of Chamber of Commerce and Industry Associations have been organized from time to time at the auditorium, Paribesh Bhawan, Bidhannagar, Kolkata. Various issues related to the industrial operation and environment-friendly functioning were discussed in the meeting. The participants shared their problems and other relevant issues in the manner. Assurance of all possible cooperation and assistance on behalf of the West Bengal Pollution Control Board and the Department of Environment, Government of West Bengal was made. Hon'ble Minister-in-Charge, Department of Environment, Government of West Bengal, Principal Secretary, Department of Environment, Government of West Bengal, Chairman and Member Secretary of the State Board and the Senior Officials of the Department of Environment usually grace the meetings.

➢ **Combating noise pollution during Kali Puja/ Diwali**

The State Board organises a meeting each year before Kali Puja/Diwali at the auditorium, Paribesh Bhawan, Bidhannagar, Kolkata with the police authority and representatives of various housing complexes in and around Kolkata to discuss various issues regarding control of noise pollution as well as air pollution during Kali Puja/Diwali. Officials from Kolkata Police Authority and various Police Commissionerate (Barrackpore, Haora, Hugli-Chinsura etc.) remain present in the meeting. Dr. Kalyan Rudra, Chairman, WBPCB welcomed all the dignitaries, guests during the meeting. The Chairman and the Member Secretary of the State Board and the Senior Officials of the Board grace the meeting.

➢ **Meeting with the Civil Society**

The State Board organised a meeting with the members of civil society regarding the management of COVID-Waste in a pandemic situation. Considering the views of the members

Figure 23.8: Meeting with Civil Society on COVID Waste Management

of civil society, the State Board discussed the matter of management of COVID Waste in best possible ways.

- **District Environment Fair-2019**

Different types of fairs are being organized in our State every year from December to February. In 2019, the West Bengal Pollution Control Board under the Department of Environment, Government of West Bengal decided to organize district-wise Environment Fair throughout the State to leave a long term impact on people's mind about the knowledge of basic sciences and as well as environmental awareness. The State Board funded and organized such fairs in all 22 districts of West Bengal from 27 January to 4 February 2019 in association with the District administration. The detailed schedule of the district-wise fairs is stated in Table 23.1.

Table 23.1: Schedule of District-Wise Fairs held during 2019

	District Name	Date
	Paschim Barddhaman	3 – 4 Feb, 2019
	Puruliya	1 – 2 Feb 2019
	South 24 Parganas	1 – 2 Feb 2019
	Hugli	07 – 08 Feb 2019
	Uttar Dinajpur	2nd & 3rd Feb 2019
	Maldah	30 & 31 Jan 2019
	Murshidabad	29 & 30 Jan 2019
	Dakshin Dinajpur	31 Jan and 1Feb 2019
	Bankura	1 & 2 Feb 2019
	Birbhum	1 & 2 Feb 2019
	Purba Barddhaman	1 & 2 Feb 2019
	Kalimpong	1 & 2 Feb 2019
	Jalpaiguri	29 & 30 Jan 2019
	Alipurduar	1 & 2 Feb 2019
	Darjiling	27-28 Feb 2019
	Koch Bihar	27 & 28 Jan 2019
	North 24 Parganas	1 & 2 Feb 2019
	Nadia	30 & 31 Jan 2019
	Jhargram	4 & 5 Feb 2019
	Purba Medinipur	3 & 4 Feb 2019
	Paschim Medinipur	2 & 3 Feb 2019
	Haora	2 & 3 Feb 2019

The Board officials of the Regional offices of the State Board and officials of district administration in respective districts acted as the Nodal Officers for organizing the fairs. The students at different schools enlisted under the National Green Corps (NGC) Programme participated in the fairs and participated in the environmental campaigns to spread awareness among the visitors. Hon'ble Minister-in-charge, Department of Environment and Transport, Government of West Bengal inaugurated the Environment Fairs in Maldah, Murshidabad and Paschim Medinipur districts. Dr. Kalyan Rudra, Chairman, WBPCB, Shri Abhijit Bose, Sr. Personnel Manager, WBPCB & Jt. Secretary to the Govt. of West Bengal, Shri Subrata Ghosh, Chief Engineer, Dr. T. K. Gupta, Chief Engineer, Dr. U. K. Mukhopadhyay, Chief Scientist, other senior Board Officials, Government officials and other eminent persons visited environment fairs in different districts and graced the programme by their presence.

- **Participation in different Fairs/Melas**
  The State Board used to participate in various Fairs/Melas etc. in urban and rural areas by installing stalls to spread environmental awareness amongst the visitors every year. Apart from this, the State Board financially patronize different fairs/melas including campaign materials.

- **Participation in International Kolkata Book Fair 2020**
  The State Board participated in International Kolkata Book Fair 2020 organized by the Publishers & Book Sellers Guild, on behalf of the Department of Environment, Government of West Bengal. The State Board exhibited campaign boards on different issues of the environment; provided facilities for online checking of real-time air quality; made available different environmental messages electronically; displayed publications of the Board and other wings of the Department of the Environment; distributed posters, leaflets, booklets among the visitors.

Figure 23.9: Participation in International Kolkata Book Fair 2020

Prof. Dr. Soumen Kumar Mahapatra, Hon'ble Minister-in-Charge, Department of Environment and Public Health Engineering, Government of West Bengal, Dr. Kalyan Rudra, Chairman of the Board, Senior officials of the Board along with the students of the NGC schools took part in an environment awareness rally on the Book Fair Ground regarding discarding banned plastic carry bags. The Hon'ble Minister and the Chairman interacted with the book lovers handing over them jute bags with a request to discard plastic carry bags. Jute bags were also distributed among the publishers and booksellers.

Celebration of Different Environmentally Important Days

- **Observation of World Ozone Day**

  The State Board celebrates the International Ozone Day in a befitting manner every year. The Chairman, the Member Secretary and the Senior Officials of the Board used to grace the occasion as a speaker. Also, Experts are invited to present their views on the present status of the ozone layer. Several students and teachers from different colleges and students are invited to participate in the programme. To commemorate this occasion, the State Board released a leaflet on ozone layer depletion.

Figure 23.10: Celebration of the World Environment Day, 2020

In many occasions, the State Board patronise similar programme organised by the different educational institutions and the senior officials of the Board take part to disseminate information on the ozone layer.

- **Celebration of the World Environment Day 2020**

  The World Environment Day (WED) commemorated each year on June 5th, is one of the principal vehicles through which the United Nations Environment Programme (UNEP) stimulates worldwide awareness of the environment. The World Environment Day is celebrated as an annual event on 5th June every year since 1973 to raise global awareness about the importance of the healthy and green environment in the human lives, to solve the environmental issues by implementing some positive environmental actions as well as to make aware common public worldwide that everyone is responsible for saving his environment and not only somebody, government or organisations working for it. The theme selected for 2020 was "Time for Nature. Celebrate Biodiversity".

  This year, the whole world has come to a standstill due to the pandemic COVID-19. Suddenly, the whole scenario of society across the globe has been changed. Most of the countries feel helpless for the villainous attitude of the coronavirus. Considering the pandemic situation, the State Board had decided to observe the World Environment Day Programme, 2020 in a changed way.

  During the lockdown period, the West Bengal Pollution Control Board organised an on-line competition amongst the students of West Bengal under the National Green Corps Programme. During lockdown period due to COVID 19, the Chairman of the Board appealed to all the students through schools to submit their experiences during lockdown period through a poem, essay, short video, photograph, and drawing. Hundreds of entries have been submitted online by the students from the different districts of our State. The names of the successful ten entries have been announced on the World Environment Day 2020 for conferring award and certificate.

Considering the pandemic situation, the State Board prepared three special posters in Bengali and English mentioning the dos and don'ts to encourage general mass as well as students to keep them safe from the killer virus.

Moreover, considering this year's theme, four types of posters, specially designed on biodiversity, have been printed to make students aware about biodiversity which is the foundation that supports life on earth and it how it affects every aspect of human health by providing clean air and water, nutritious food, scientific understanding of medicine sources, natural disease resistance, and climate change mitigation.

Apart from this, a competition was organised among the professionals to prepare posters on the subjects including solid waste management, plastic waste management, E-waste management, water pollution, air pollution to make general mass aware of different issues of the environment. Finally, 17 types of posters were printed and released on World Environment Day.

The State Board prepared a unique quiz book named "Test Your Knowledge – Environmental Quiz", comprising of approximately 500 questions for the students under National Green Corps. This quiz book has been also released on World Environment Day.

One pamphlet was also released on the World Environment Day, which narrates the success story behind the improvement of air quality of Kolkata. This pamphlet informs the mass that the State Board has kept its commitment in making the environment of Kolkata 'Clean & Green' through continuous efforts and effective steps to provide the citizens with a healthy environment to live in.

An 'Activity Report of National Green Corps Programme, 2018-19' was also released on the World Environment Day.

The celebration programme on June 5, 2020, started with a welcome address by Dr. Kalyan Rudra, Chairman, WBPCB who delivered his elaborated speech on the importance of conserving biodiversity and other different environmental issues. Shri Vivek Kumar, IAS, Principal Secretary, Dept. of Environment, Govt. of West Bengal addressed the gathering and discussed the issues of biodiversity and climate change in his speech.

Prof. Dr. Saumen Kumar Mahapatra, Hon'ble Minister-in-charge, Dept. of Environment and Public Health Engineering, Govt. of West Bengal graced the programme as chief guest. He envisioned the future action plan of the Environment Department. The programme ended with the vote of thanks by Dr. Rajesh Kumar, IPS, Member Secretary, WBPCB. He summarized all the issues discussed in the programme and conveyed his gratitude to all the dignitaries, senior officers of the department and all the officials of the State Board present in the programme.

The following Board's publications were released during the programme:

- ✓ Activity Report of National Green Corps Programme, 2018-19
- ✓ A Book - "Test your knowledge-Environment Quiz"
- ✓ A Booklet- "Success story Behind Improvement of Air Quality of Kolkata"
- ✓ Environmental and COVID-19 Posters

The names of the ten winners of the World Environment Day competition organized digitally among the school students under the National Green Corps were announced.

At the end of the programme, Hon'ble Minister and other guests planted trees at the office premises to mark the auspicious occasion.

Special Initiative in Distributing Lead-Free Non-Toxic Paints

➢ **Lead-free Paint distribution among the idol-makers**
Like earlier years, the State Board authority decided to distribute lead-free non-toxic paints among the idol makers across the State before the Durga Puja and Kali Puja to promote the use of such paints for painting idols for Durga Puja, Kali Puja and Jagaddhatri Puja. This endeavour had been taken for providing necessary support to the idol makers to comply with the order of the Hon'ble National Green Tribunal to prevent pollution in river Ganga, other major rivers and water bodies of the State.

Figure 23.11: Lead-free Paint distribution among the idol-makers

The inaugural programme is held at Paribesh Bhawan each year and subsequently similar programmes are organized at different parts of the State under the supervision of the concerned Regional Offices of the Board.

Publication of the Board

➢ **Making of Posters**
The State Board releases a number of posters each year on different burning issues of the environment like air pollution, water pollution, noise pollution, plastic pollution, solid waste management, biomedical waste management, biodiversity etc. In making the poster, the State Board organized a competition among professional agencies and individuals to disseminate the message strongly. Also, the selected designs have been awarded cash award. Maintaining this process, the State Board released 17 types of posters during 2020 only.

➢ **Making of Leaflets**
Leaflets are prepared on various occasions mainly before festive seasons to make general people including students aware about environmental norms to be followed on different issues like solid waste management, controlling of noise pollution, discarding banned firecrackers etc. during festive days. Similarly, the State Board published a colourful leaflet on 'Ozone Layer' to make the school students aware of the International Ozone day.

➢ **Making of Book/Booklets**
Different books/booklets are released on various subjects like 'Clean Air is Our Birth Right-Fight for Right', 'Control Plastic Pollution' (in Bengali and English), 'Face to Face with the Mess' (a pictorial report), 'For Healthy Environment - Many New Hope' (a Bengali status report of environmental components specially for school

children), 'Solid Waste Management Rules, 2016' (Bengali version of the rules), 'Plastic Waste Management Rules, 2016' (Bengali version of the rules), 'Test Your Knowledge- Environmental Quiz' (quiz book for school children).

- **Making of Reports**
  The State Board publishes reports on different environmental issues from time to time. Publishing Annual Report on the Board's performance is one of the key books published by the State Board each year. Apart from this, the State Board releases Activity Report of the National Green Corps Programme in West Bengal.

- **Making of Pamphlets**
  Pamphlets on different environmental issues are published by the State Board. For example, the State Board has published a pamphlet namely 'Success Story Behind Improvement of Air quality of Kolkata' which showcases the actions taken by the State Board to keep its commitment in making the environment of Kolkata Clean and Green through continuous efforts and effective steps by providing the citizens with a healthy environment to live in.

- **Awareness through Advertisement**
  Apart from statutory advertisement, the State Board releases awareness-advertisement in popular newspapers regularly and also advertises in electronic media on different issues of the environment. The State Board provides advertisement on environmental issues to 'little magazines' as financial assistance. Moreover, the State Board provides financial support to hundreds of puja committees during Durga Puja, Kali Puja and Jagaddhatri Puja by providing banners on environmental norms to be followed during festive days.

Other Important Programmes

- **Noise Pollution Campaign at different Bus Depots in Kolkata:** According to the Noise Pollution (Regulation and Control), 2000, under the Environment (Protection) Act, 1986, 'Silence Zone' is defined as areas upto 100 meters around premises like hospitals, nursing homes, educational institutes, courts, religious places or any other areas. It is also clearly stated in Rule 6(ii), that no horn can be blown in these Silence Zones.
  According to the Rule, noise level at Silence Zones should be maintained as stated below: -

Category of Area/Zone	Noise Limits in dB(A) Leq.	
	Day Time (6 am to 10 pm)	**Night Time (10 pm to 6 am)**
Silence Zone	50	40

Despite the existence of such Rules, the Hon'ble National Green Tribunal has observed that the noise level is much above the permissible limit.

For maintaining the statutory noise level, which is the main objective of declaring such areas as Silence Zones, the Hon'ble National Green Tribunal (NGT) issued an order (O.A. No. 158/2016/EZ) expressing its view about making the people aware of the fact that the said areas are called "Silence Zones", where honking is strictly prohibited.

As directed by the Hon'ble National Green Tribunal in the order, the West Bengal Pollution Control Board immediately took up necessary action through organizing several awareness programmes to sensitize the drivers plying commercial, private or government vehicles about the health hazards of noise pollution. These awareness campaigns were organized at various bus depots/stands in Kolkata, where the Board officials visited and talked with the drivers, conductors and others about the health hazards of noise pollution and requested them to stop honking near hospitals, nursing homes, educational institutes, courts, religious places or any other similar areas which are declared as Silence Zones.

Figure 23.12: Award ceremony of Green Puja Contest

- **Green Puja Contest:** The State Board organizes an exclusive competition among the Durga Puja organizers to encourage them to organize the festival in an environment-friendly way.

  The main objective of the competition is to encourage puja committees to adopt proper solid waste management practices, discard plastic materials used as decoration goods, use Noise Limiter machine with the sound system so that noise pollution is restricted, use lead-free colour in idol-making or colouring other decoration parts, set up lights in those places where the life cycle of biodiversity are not disturbed, implement maximum use of biodegradable materials etc. A number of Puja Organisers participate in this competition each year. The best Puja Committees are selected by the committee constituted by the State Board and given an award every year.

state of environment report-II

WEST BENGAL

Chapter 24

Success Story on Environmental Issues

Chapter 24

Success Story on Environmental Issues

Initiatives for Control of Air Pollution

On-Road Water Sprinkling

A recent study conducted by the West Bengal Pollution Control Board, Department of Environment, Govt. of West Bengal by engaging NEERI for non-attainment cities, revealed that road dust is the major contributor (10-15 %) to particulate matters present in ambient air in Kolkata and adjoining area, particularly during the winter season. To control resuspension of road dust, WBPCB had taken an extensive programme for water sprinkling on roads and other strategic locations in Kolkata, Haora, Salt Lake, Belghoria Expressway and adjoining areas in last winter season (November 2019 to February 2020) involving various stakeholders like ULBs such as Kolkata Municipal Corporation, Haora Municipal Corporation, Bidhannagar Municipal Corporation, South Dumdum Municipality, police authorities (Barrackpore & Siliguri Police Commissionerates) and Fire Departments etc.

Dedicated water tankers with sprinkling arrangements were deployed at different road stretches under the jurisdiction of each stakeholder. Water sprinkling has been carried out extensively under the supervision of concerned ULBs/Police/Fire Departments and monitored by the WBPCB.

Under KMC area, water sprinkling in two shifts was carried out in major roads including Diamond Harbour Road, Central Avenue, Mahatma Gandhi Road, Prince Anwar Shah Road, Alipore Road, Pratapaditya Road, Mominpur Road, Hyde Road, Joka, Jadavpur, Gariahat, Golpark, Ballygunje Phari, Park Circus, Rabindra Sarobar, Tollygunge, Behala Chowrasta, New Alipore, Taratala etc. Apart from that water sprinkling was done along stretches of Bishwa Bangla Sarani, VIP Road, New Town, South Dumdum Municipality & adjoining areas.

Under the jurisdiction of Bidhannagar Municipal Corporation area, on-road water sprinkling was carried out in Sector V, Sector-III, Karunamoyee, City Centre & adjoining areas.

Main roads & areas under Haora Municipal Corporation where extensive water sprinkling was done are G.T. Road (from Bally to B. Garden), Benaras Road, J. N. Mukherjee Road, Jheel Road, N.S. Road, Goshala Road, Dobson Road, Salkia School Road, Foreshore Road, Swarnamoyee Road, Panchanantala Road, Natabar Pal Road, Ghusuri area, Belur, Belgachia, Liluah, Haora Maidan area, Kazipara, Shibpur, Mandirtala, Sarat Chatterjee Road etc.

Under South Dumdum Municipal areas water sprinkling was carried out in Jessore Road, Shyamnagar Road, Dumdum Park, Bangur, Dunlop & Nagerbazar areas.

Figure 24.1: Water Sprinkling being Carried out at Various Locations

Fire department carried out extensive water sprinkling along VIP Road (Airport to Ultadanga), Chingrihata to Technopolis, Joka to Taratala Crossing (D H Road), James Long Sarani, Dunlop to Chiria More (B T Road) to Dumdum Station, Esplanade to Shyambazar (Central Avenue), Sealdah to Barabazar (M G Road), Gariahat to Exide Crossing (Via Rasbehari & Hazra) and the road stretches in Ghusuri Area, Padmapukur Area and Mandirtala Area.

Dousing of Fire at MSW Dumpsites by Water Sprinkling

In the eastern fringe of Kolkata, there is a huge MSW dumpsite located at Dhapa used by the KMC for dumping of MSW. One more MSW dumpsite is located at Pramodnagar near Dumdum to cater the requirement for the dumping of MSW. During the dry winter season, uncontrolled fire due to auto-ignition of methane gas generated naturally in these existing MSW dumpsites results into indiscriminate burning of waste and generation of smoke and obnoxious gases. Such burning deteriorates air quality of adjoining areas. Last winter, the WBPCB requested the Fire Department, GoWB to initiate continuous efforts to douse such fires at Dhapa and Pramodnagar MSW dumpsites with dedicated fire tenders and extensive water sprinkling was carried out on regular basis to keep the waste moist to ensure that incidents of such spontaneous ignition of waste are minimized.

Figure 24.2: Dousing of Fire at MSW Dumpsites

The above initiatives of water sprinkling have resulted in drastic improvement of ambient air quality in Kolkata and Haora area, compared to previous winter seasons. The initiative was recognized and praised in different newspapers at the national level.

Because of such experience, WBPCB has decided to take up extensive water sprinkling programme in different vulnerable areas for improvement of ambient air quality during the winter season by involving more local bodies and police authorities. Kolkata, Haora, Barrackpore, Durgapur, Asansol, Ranigunj and Haldia had been declared as 'non-attainment cities.' Extensive water sprinkling programme to be undertaken by the WBPCB will cause the improvement of ambient air quality in such areas, particularly in winter by minimizing resuspension of road dust due to vehicular movement.

Other Initiatives for Improvement of Air Quality

Apart from water sprinkling, the WBPCB has taken some other initiatives for improvement of overall ambient air quality in Kolkata and surrounding areas. Some of them include the followings:

Complete Banning of Open Burning of Leather Wastes

Leather industries are situated in integrated clusters in Bantala area namely Calcutta Leather Complex, in the outskirts of Kolkata, developed by Government of West Bengal following the order of the Hon'ble Supreme Court. About 350 tanneries are operating within the complex.

With more and more tanneries started functioning in the leather complex at Bantala, a nuisance is faced arising out of the indiscriminate open burning of leather shavings along both sides of Basanti Highway. This activity is mostly done illegally in a very crude process, leading to the emission of poisonous smoke, engulfing a large part of the city and exposing the people to detrimental health hazards. Hon'ble NGT has also expressed serious concern about the pollution problem caused due to such illegal activities.

Several raids were conducted by the Board along with police authority to stop these illegal activities. After long persuasion and with collaborative efforts of WBPCB, KMC and police authority, all the illegal leather shavings burning units along the Basanti Highway have been removed. As a result source of toxic flue gases which used to have a very bad effect on the air quality of the city have been largely eliminated to a great extent leading to significant improvement of ambient air quality.

Figure 24.3: Air pollution caused by unauthorized leather shavings processing units along Basanti Highway

Figure 24.4: View after dismantling of unauthorized leather shavings processing units along Basanti Highway

Strict Monitoring of Construction and Demolition Activities

A recent study has suggested that emission of dust from the construction sector contributes significantly towards the degradation of urban air quality. WBPCB has in recent times strictly monitored such projects and ensured that standard operating practice is strictly adhered to by all the projects. Construction activity and storage of construction material under covered condition, regular water sprinkling, maintaining good housekeeping and other such measures have remarkably reduced the emission of dust from such construction projects.

Figure 24.5: Construction projects before and after the intervention of WBPCB

Distribution of LPG and Gas Ovens to Coal Based Roadside Eateries

A recent study for identification of sources of air pollution and relative contribution of different sources towards such pollution revealed that roadside coal-based eateries contribute significantly towards the deterioration of air quality of urban areas in and around Kolkata. To address the issue, WBPCB proactively conducted a series of programmes involving Kolkata Police, Bidhannagar Police Commissionerate, Bidhannagar Municipal Corporation, Haora Municipal Corporation and Public Sector LPG companies like IOCL and HPCL.

Under such programme WBPCB distributed around 2500 LPG cylinders to roadside coal-based eatery owners. The cost incurred for the first cylinder and required gadgets and ovens has been borne by WBPCB. It is expected that such conversion of coal-based eateries to LPG will significantly contribute towards the improvement of the air quality of the concerned urban area.

Figure 24.6: Distribution of LPG and gas ovens

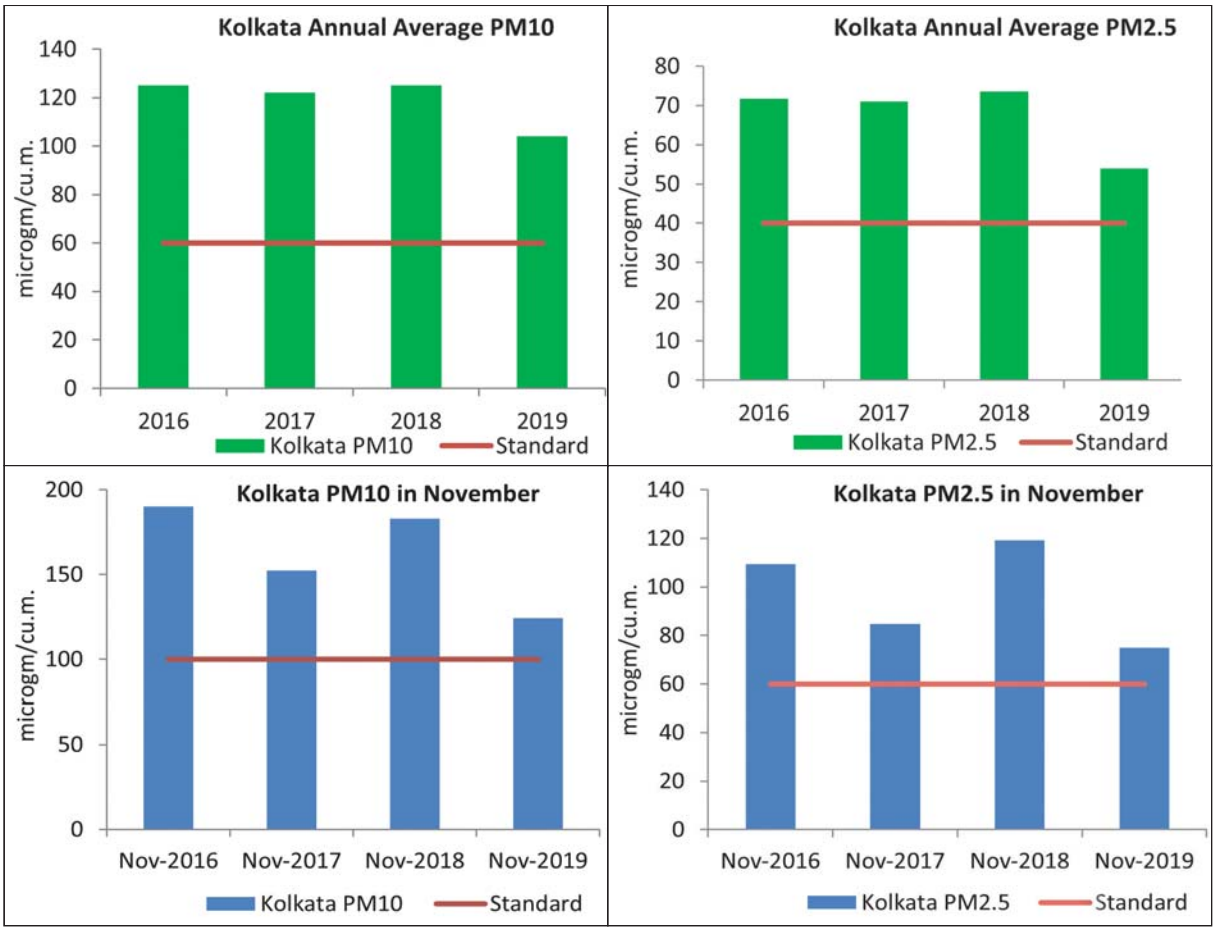


Figure 24.7: PM_{10} and $PM_{2.5}$ levels at various locations of Kolkata

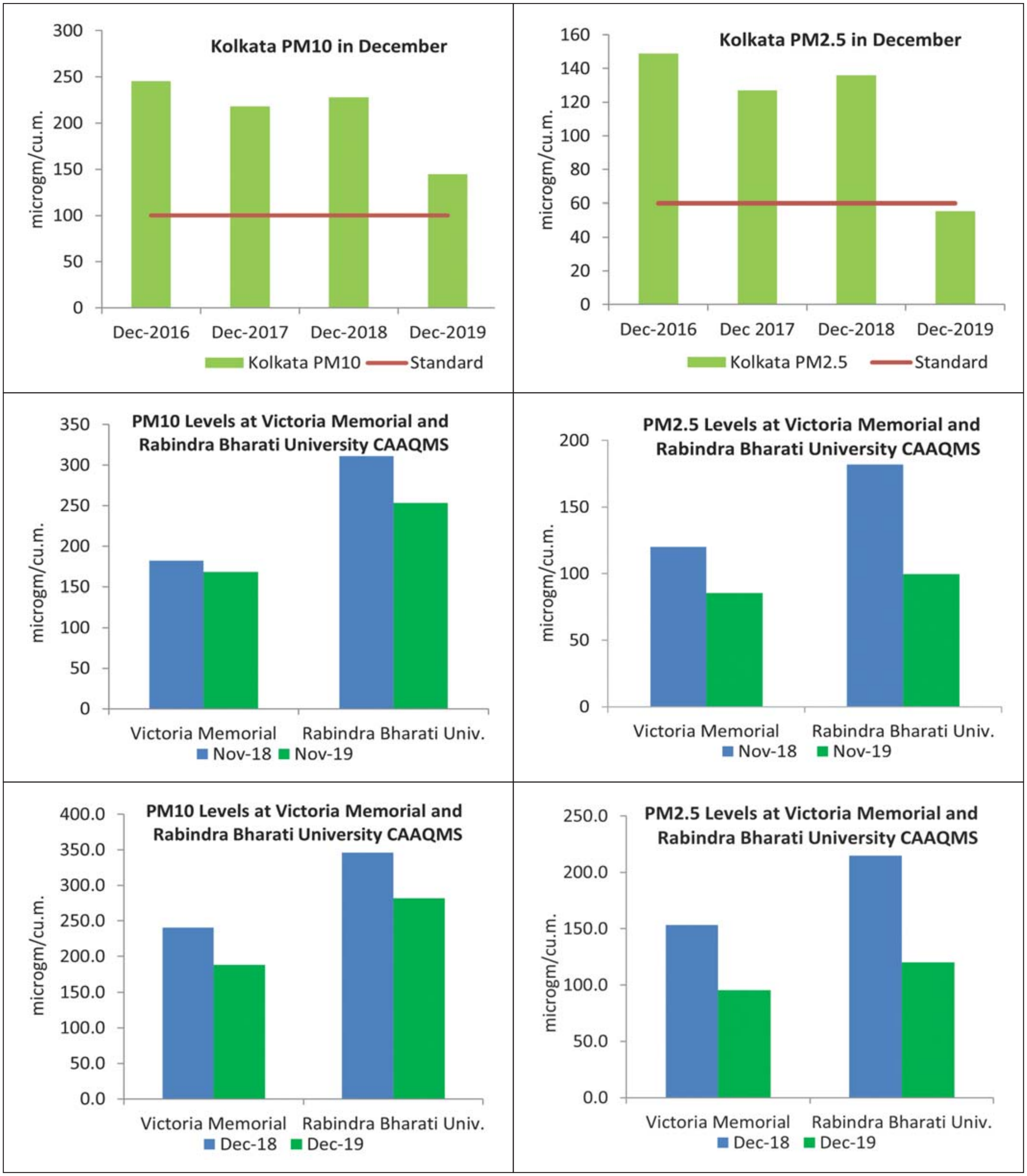


Figure 24.7: PM_{10} and $PM_{2.5}$ levels at various locations of Kolkata

Post-Amphan Re-Greening of Kolkata

Amphan, a devastating cyclone badly affected the State of West Bengal On 20th May 2020. Particularly in South Bengal including Kolkata, an innumerable number of trees was uprooted. The Hon'ble Chief Minister of West Bengal proactively took up the re-greening of the State as a dream project including Kolkata and Bidhannagar area. The State Board has initiated a project for re-greening of Kolkata – Bidhannagar and its adjoining areas in the post-Amphan scenario that has resulted in a rampant and large destruction of trees in the city. A project of the plantation of 10,000 seedlings at different places within 25 km radius of 'Paribesh Bhawan' under Bidhannagar Municipal Corporation area alongside VIP road (from HUDCO to Dum Dum Airport) of seedlings was taken up. Necessary prerequisite works like tendering and detailed planning was done on a war footing basis and the job was awarded to the successful bidder.

The project was formally inaugurated on 20th July 2020 by Prof. Saumen Kumar Mahapatra, Hon'ble Minister of Environment, GoWB in the august presence of Shri Vivek Kumar, IAS, Principal Secretary, Department of Environment, GoWB, Prof. Kalyan Rudra, Chairman, West Bengal Pollution Control Board, Dr. Rajesh Kumar, IPS, Member Secretary, West Bengal Pollution Control Board, Shri Ramesh Maharaj, Secretary, Ramkrishna Mission Ashram, Jhargram and other senior officers of Department of Environment, GoWB and West Bengal Pollution Control Board. Plantation of Neem trees was done in an enclave at the Canal Side Road (Opposite to Jadavpur University second campus) which was named as 'Neem Banani.'

The work of plantation of 10,000 seedlings at different places within 25 km radius of 'Paribesh Bhawan' under Bidhannagar Municipal Corporation area alongside VIP road (from HUDCO to Dum Dum Airport) has been completed. The total project involved planting 10,000 seedlings, besides fencing and maintenance of the planted trees for Rs 1.47 crore. Fencing and maintenance work will continue for the next two years.

Plantation of 4,000 seedlings of different trees has been undertaken at the Newtown-Rajarhat Satellite Township. Prof. Kalyan Rudra, Chairman, West Bengal Pollution Control Board and Shri Debashis Sen, Chairman, HIDCO inaugurated the programme on 7th August 2020 at DJ Block, Newtown by planting Guava trees to mark the day of '*22 She Shravana*.'

Other Initiatives towards Clean Environment

West Bengal Pollution Control Board, apart from its routine activities of implementation of different Environmental Acts and Rules throughout the state, takes initiative and works on different project/ scheme for best practices to improve the living environment, some of which are mentioned below

- Installation of grid-connected rooftop solar photovoltaic power plants at different locations of West Bengal
- Installation of Biogas Digester Plant
- Installation of Rainwater Harvesting Structures

Promotion of Solar Energy

Presently limited resources of fossil fuels are being used for different purposes like heating process, refrigeration and mainly for power/electricity generation. Combustion of fossil fuels, complete or incomplete, produces the greenhouse gases which potentially contribute to global warming. Simultaneously, depletion of natural resources occurs, hampering future sustainability of major industries. The utilization of renewable resources is the solution to preserve fossil fuels for the future for the sake of a clean & healthy environment.

Solar energy is a potential source of non-conventional energy where unused building roofs are utilized to generate electricity. The generated solar electricity feeds the power into the existing electrical system. The cost of solar energy is also less compared to conventional energy sources. Rooftop SPV power plants generate electricity close to the consumption centre and hence contribute to the reduction of transmission & distribution losses. The electricity generation also contributes to meet the demand and supply gap. The earth surface has the huge potential for deployment of grid-connected SPV power plants and WBPCB explores this potential by promoting solar energy in the state thereby sensitizing people to uptake solar energy.

Main Focus of the implementation of the Project:

- To promote use of green energy and hence reduce dependency on conventional energy sources.
- The system by its nature is pollution free involving minimum or no generation of emission, effluent or solid waste. Hence it will also largely contribute to the global effort to meet the challenges of climate change.
- Effectively used of un-used roof area for generation of solar power.

Approximately 400 units SPV power plants with a total module array field capacity of 2000 kWp have been installed at various locations in West Bengal & installation of 100 units each of 10kWp array field capacity is in progress.

Figure 24.8: Rooftop Photovoltaic Cells Installed by WBPCB

Waste to Energy Initiative

Bulk waste generators, such as large food and agro-based industries, hotels, food malls, markets face great problems in disposing of the organic wastes generated from their activities as the infrastructure for waste management is not developed in accordance with the waste generation. Unreliable waste collection along with internal storage gives rise to putrescible waste piles with malodour. Management of food and vegetable waste has become a major issue these days. Besides this, the disposal problems of organic waste are two folds. Firstly, organic materials cause severe environmental problems through methane emission in the landfill application. Secondly, disposed organic waste is the prime source of diseases and contamination of air and water.

West Bengal Pollution Control Board has financially contributed to few organizations such as Swami Vivekananda State Police Academy (SVSPA), West Bengal, Barrackpore, Ramakrishna Mission Ashrama, Eklavya Model Residential School, Satyaban Pally, Jhargram and Ramakrishna Mission Asharam, Narendrapur for installation of biogas digester plant. The generated biogas is utilized in cooking purpose. It is designed to meet aesthetic, safety, hygiene and odour standards of premier hospitality of the surroundings.

Main Focus of the implementation of the project:

- Biogas generated due to anaerobic digestion creates a closed-loop system, which converts waste into resources and improves profitability and efficiency while reducing overall waste disposal at the landfill site.
- Biogas is used as a renewable fuel for cooking purpose.
- The solid product that results from anaerobic digestion is a nutrient-rich fertilizer that is pathogen-free, doesn't smell, and can readily be absorbed by plants. It presents a lower risk of agricultural runoff than other fertilizers and is at least as effective as fossil-based fertilizers.

Figure 24.9: Organic Waste Digestors Leading to Biogas Generation

Rainwater Harvesting

Rainwater harvesting is a process in which the raindrops, as an uncontaminated water resource, are collected and stored for future use, rather than allowing it to run off. Rainwater can be collected from roofs and redirected to a deep pit (well, shaft, or borehole), aquifer, a reservoir with percolation, or collected for surface storage. The harvested rainwater can be used for gardening, irrigation, domestic use with proper treatment. Rainwater harvesting is one of the simplest and oldest methods of self-supply of water for households.

Under the implementation of the "Jol Dharo, Jol Bharo" initiative of the Govt. of West Bengal, financial assistance is provided to Panchayat & Rural Development Department, GoWB for construction of Rain Water Harvesting Structures in different drought-affected districts in the State by West Bengal Pollution Control Board, mainly in Bankura, Purulia, Birbhum, Jhargram and Paschim Medinipur districts.

Total 64 units of RWHS have been completed and the remaining 40 nos units are under construction.

Figure 24.10: Rainwater Harvesting Structures

Closure and Containment of closed Dumpsite at Dhapa

Kolkata, the capital of the state of West Bengal is one of the most densely populated cities in the country, with a population of 4.49 million as per the Census data 2011 (daytime population count rises to 8 million), generating about 4000 tonnes of municipal solid waste (MSW) daily This waste is almost entirely disposed of at the Dhapa Dumping Area which is owned and operated by the Kolkata Municipal Corporation (KMC)since the 1980s. The Dhapa Dumping Area is located within the East Kolkata Wetlands (EKW), a Ramsar Convention Wetland.

Background

The Ministry of Environment & Forests, Govt. of India has undertaken a World Bank-supported project titled “Capacity Building for Industrial Pollution Management” to develop a “National Programme for the Rehabilitation of Polluted sites”. As part of this initiative, some polluted sites were taken up for remediation in the country of which one site was a closed dumpsite, of area 12.14 hectares, in the Dhapa Dumping Area of Kolkata. The State level implementation agency for the project was the West Bengal Pollution Control Board. This project was conceived in the year 2010-11, before publication of Solid Waste Management Rules, 2016 The environmental and social assessment of the dumpsite and the surrounding areas were carried out for ensuring that all environmental and social objectives of the project were fulfilled while designing and implementing the remediation plan for the Dhapa closed dumpsite.

The Dhapa closed dumpsite located in the eastern part of Kolkata was in operation till 2009 and has been historically used for waste dumping for many decades. The dumpsite was unlined and uncovered and without any environmental protection arrangements. The dumpsite had a negative impact on the environment, in particular on surface waters and adjacent soil and to a less extent on the society.

Methodology of Assessment

The environmental investigation programme involving analysis of groundwater, surface water, sediment and soil samples were carried out by a laboratory recognised by the Ministry of Environment, Forests & Climate Change, Government of India, under the Environment (Protection) Act,2006. Also the assessment of Air Quality, Landfill gas generation carried out.

Human Risks and Hazards:

Leachate approximately 300KLD from Dhapa closed dumpsite enters into the wetland. There exists a risk of landslides and subsidence due to the unstable dumpsite slopes. Particularly the residents of Makaltala living very close to the northern side slope.

Social Assessment

The Social Assessment around the closed dumpsite was conducted to identify the existing social issues pertaining to the site and assess social impacts perceived for the proposed remediation of the dumpsite. The views of various stakeholders including the inhabitants of Makaltala village were taken into account for recommending possible remedial measures incorporated in the Environmental and Social Management Plan (ESMP) for the project.

Table 24.1: Positive impacts of the scientific closure and containment of the closed dumpsite

1	Surroundings and Environment	No odour and windblown dust Contaminated surface water runoff and leachate from the dumpsite no longer pollutes the neighbouring
2	Fewer accidents	Proper covering of the dumpsite eliminates risks of landslides, poisonous pests and insects
3	Better communication	The approach road is envisaged to be improved as part of the project thereby improving the accessibility of the area and indirectly paving the way to better access to alternative opportunities for income sources, education, training and exposure to improved ways of lives.
4	Social upliftment	The overall increase in aesthetics means an upliftment in the social status of the neighbouring Makaltala village who lived next to an unsightly dumpsite. Creation of recreational space where nearby communities can gather and can relax in an environment free from contamination
5	Improved health	Health status is expected to improve due to a decrease in the spread of vector-borne diseases/nuisance caused by mosquitos/flies/vermin and dust
6	Temporary Income opportunities	Scope for temporary income-generating opportunities for the local population through setting up of small enterprises like tea shops, eateries, etc. during remediation works.

No negative social impacts of the proposed closure and containment project have emerged through the primary survey and consultations. However, some short term negative impacts of the activities during the execution stage are anticipated. To mitigate the short term impacts appropriate preventive measures including appropriate engineering practices were meticulously followed

Containment & Closure plan

At the Technical Evaluation Panel (TEP) of MoEF & CC meeting held at WBPCB office in Kolkata 25th June 2013. Impermeable Cover, leachate collection and Passive Gas Control was selected during the operational phase and initial post-closure period.

Subsequently in a meeting of TEP held at Delhi on 20th November 2013 it was decided to install a Leachate Treatment Facility for treatment of leachate generated after completion of remediation project. KMC has allocated land of 1500 sq.m for the construction of leachate treatment facility beside the MSW site.
The Impermeable Cover and Passive Gas Control option is in-principle an encapsulation of the closed dumpsite. The idea of this option is to avoid any leachate generation and in few years achieve a situation where no more pollution by leachate generation from the closed dumpsite takes place.

Gas will still be generated but due to lack of infiltration of rainwater, the gas generation will decrease faster and can be handled by venting (via bio-filters) to the atmosphere without further treatment.

Surface water will be collected in lined wells around the closed dumpsite and discharged to the adjacent existing surface water drains as uncontaminated surface water & finally leading to Dry weather canal.

The main activities for the selected option:

- Profiling of waste surface
- Installation of a gas drainage layer, geotextile, 1.5 mm HDPE liner, drainage layer, soil layer and a vegetative layer including grass and other vegetation
- Construction of surface water collection drains

around the closed dumpsite and these channels are connected to existing open surface water drains/canal.

- Leachate collection facilities and treatment of leachates in the LTP
- Landfill gas collection and outlet system
- Internal service and access roads leading to the top of remediated dumpsite which will be used as a viewpoint in future
- Boundary fencing

The principle is that infiltration of rainwater is avoided and no more leachate is generated. It is assumed the waste body contains approximately 300,000 m³ of leachate. This leachate "reservoir" will in time seep out of the site either horizontally via the upper unconfined soil/fill layers (major part) and vertically through the low permeable silty clay layer (minor part) towards the primary aquifer until a new balance is created. When the new balance is achieved the leachate level below the dumpsite will be in the same level as the surrounding upper groundwater level or even a little bit lower as no "leachate" generation takes place in the dumpsite area. It is estimated that a new water balance in the dumpsite will be established 4-6 years after the top liner is installed.

A leachate collection system will be installed at the dumpsite for collection and treatment of leachate until the water level inside the dumpsite has reached the same level as outside the closed dumpsite.

A similar situation takes place for landfill gas. Decomposition of organic matter and generation of methane under anaerobic condition requires the presence of moisture and as water infiltration is avoided the decomposition processes will decrease with time and landfill gas generation will decrease more rapidly than in a situation where access to moisture was unlimited. In the gas drainage layer, a system of gas collection drains will be installed and approximately 10 outlets (ventilation) points will be established. Emission of landfill gas will be through a bio-filter.

Surface water will be collected in intercepting lined ditches and in a lined interception encircling the closed dumpsite. Surface water is discharged to the existing open surface water drains/canals.

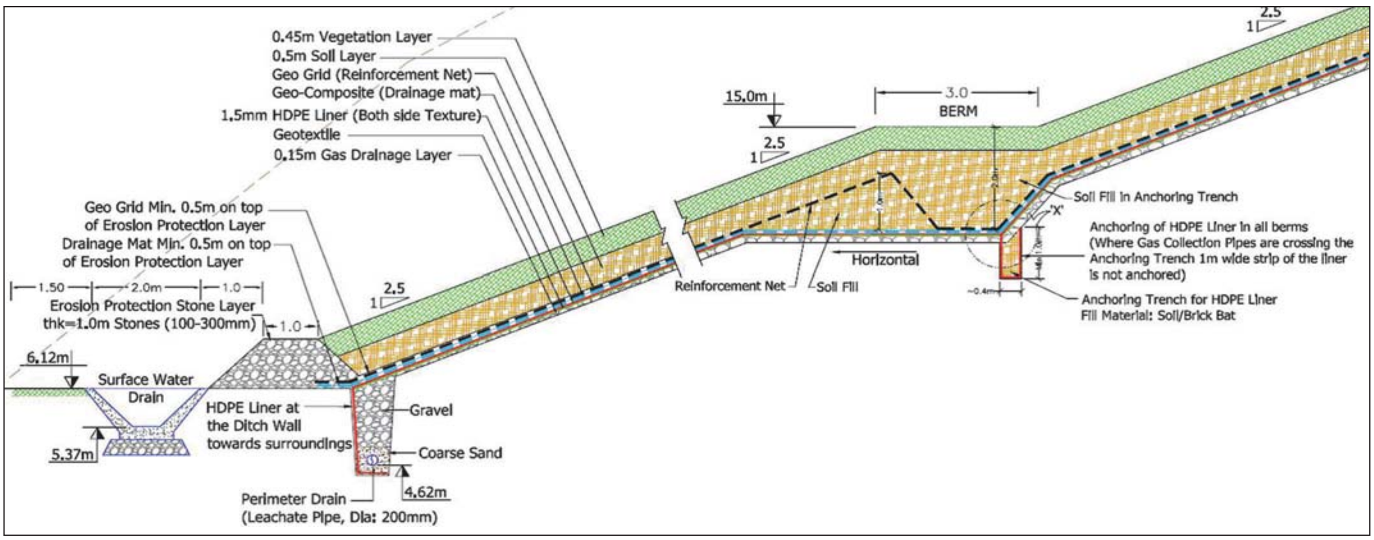


Figure 24.11: Typical cross-section of cover layers at the slope

Cover Layers from top to bottom:-

  - o 0.45 m vegetative layer with grass and other vegetation
  - o 0.50 m soil (protection) layer of soil
  - o Geo-composite (Drainage mat)
  - o 1.5 mm HDPE liner
  - o Geotextile
  - o Gas drainage layer

- On the dumpsite, a service/access road is constructed for access to the top of the site for the public and maintenance of the area. The road will be a gravel paved road.
- The area will be used as a recreational area having a viewpoint for overlooking the wetlands and the skyline of Kolkata. The shape of the remediated dumpsite will have a top flat paved surface at + 35 m MSL with benches and tables
- Subsequently, the operation and maintenance of the area will be done by KMC.
  - o Monitoring wells in an upper and primary water reservoir (sampling and water table)
  - o Monitoring wells in dumpsite (water table)
  - o Surface water (Sampling of surface water from dumpsite)
  - o Leachate collection wells/chambers (sample and amount/flow)
  - o Landfill gas (composition)
  - o Dumpsite surfaces and access/service roads (settlements and surface erosion)
  - o Grass and vegetation (growth/re-seeding)

Environmental and Social Management Plan

The Environmental and Social Management Plan (ESMP) provides a distinct and sustainable management response to the identified environmental and social impacts foreseen as a result of the project. This ESMP has been formulated specifically for the final selected closure and containment option, the impermeable cover and passive gas control, leachate collection and treatment option. The environmental and social impacts expected during project execution and post-execution have been identified and assessed.

Environmental Monitoring

The key focus of the aftercare, inspection and replacement plan is the long-term sustainability of the remediation end-result. It includes inspection, sampling and replacement programme. After the construction phase, environmental impacts and measures identified that require regular inspection include:

- Groundwater monitoring system
- Piezometer presence and condition
- Surface water monitoring system
- Leachate collection chamber and its condition

Maintenance and aftercare of the following are required:

- All slopes and other unpaved surfaces (erosion control)
- The top cover (damage due to settling of waste)
- The passive landfill gas ventilation system
- The drainage channels and piping, pumps and collection channels
- The paved surfaces and vegetation

Community Development Plan

The community has mentioned the need for the development of some critical infrastructural facilities which are the main impediments to their accessing basic needs. The project has therefore considered some of the infrastructural needs which have a close bearing on the successful impact of the project. These are –

i. Repairing of KMC road connecting EM Bypass with Dhapa,
ii. Upgradation of existing access road from the weighbridge to the Makaltala village on the eastern side of the dumpsite outside the compound wall, and

iii. Replacement of the old dilapidated wooden bridge with RCC bridge across the canal at Makaltala village.

The remediation of Dhapa dumpsite does not have any negative social impact on the nearest community of Makaltala. The social management plan, therefore, concentrates on mitigation of perceived impacts during the remediation process.

The plan emphasises on awareness generation on health, hygiene, environmental sanitation, HIV/ AIDS mitigation issues amongst the community and possible challenges during the remediation process. The responsibility of the Service Provider (an NGO) appointed by WBPCB is to ensure community participation, mitigate adverse impacts and help in resolving any disputes and grievances that may arise. It would also engage in awareness programmes with the community. Overall, the project would improve the quality of life of the Makaltala community in the vicinity and also the surroundings.

Remediation/closure & containment of the dumpsite

The following agencies have been engaged by WBPCB for the implementation and execution of the project on Remediation/Closure & Containment of Dhapa Municipality dumpsite.

1.M/s COWI A/S, Denmark, as the design consultant.

2.M/s Saurashtra Enviro Projects Pvt. Ltd, Gujarat, Contractor for the execution of remediation work.

3.M/s Development Consultants Pvt. Ltd, Kolkata as supervision consultant.

4.M/s Development Action Society for consultancy services for communication & awareness campaigns in project areas.

5.M/s Trans Organics (I) Pvt. Ltd, Kolkata, Contractor for the execution of Leachate Treatment Plant.

Main components of the work

➢ Construction of Peripheral Leachate Collection System
Providing peripheral Leachate Collection System consisting of laying of leachate collection perforated/slotted pipes of 200 mm size (HDPE PE 100 grade, PN 6 rating) wrapped with Geotextile (135 GSM) in trenches all along the periphery of the dumpsite.

Figure 24.12: Construction of Peripheral Leachate Collection System

➢ Profiling & Reshaping of Dumpsite
Levelling and Reformation of Slopes along the area of landfill site by excavation and relocating the MSW, dumping and filling of the low areas by shifting MSW, achieving levels as per the future layout of the landfill, the formation of berms and side slopes, thus achieving the total height of the dumpsite to around +35 m above the existing ground level.

Figure 24.13: Profiling & Reshaping of Dumpsite

- Gas Drainage Layer
  Supplying, Providing and Laying over the profiled, levelled and finished surface of waste (duly compacted) cover layers of Gas Drainage Layer (as a base part of top cover layers) in a thickness of 150 mm, using free-draining graded crushed stone & bricks (grain size of 50 - 65 mm) for easy trapping and escape of gases via gas wells and gas collection pipes.

Figure 24.14: Gas Drainage Layer

- Installation of Non-woven Geo Textile
  Supplying, Laying, Jointing and Installation of Non-woven Geo Textile of minimum 4 mm thickness, at an overburden pressure of 20 KN/sq.m, over the gas drainage layer.

Figure 24.15: Installation of Non-woven Geo Textile

- Installation of 1.5 mm thick HDPE Liner
  Supplying, Laying, Jointing and Installation of 1.5 mm thick HDPE Liner (both side textured) acting as the main barrier layer (in the top cover), laid over the Non-Woven Geo Textile.

Figure 24.16: Installation of 1.5 mm thick HDPE Liner

- Installation of Geo Composite (Drainage Mat)
  Supplying, Laying, Jointing and Installation of Geo Composite (Drainage Mat), of 6 mm thickness, having sandwich construction of two geotextiles and an artificial drainage element (Geo Net / Geo Mat) in between with a high water flow capacity.

Figure 24.17: Installation of Geo Composite (Drainage Mat)

- Laying of 500 mm thick non-contaminated soil layer
  Supplying and Laying 500 mm thick non-contaminated soil layer consisting of natural soil of murram, silty clays with sand.

Figure 24.18: Laying of 500 mm thick non- contaminated soil layer

- Installation of Geo Reinforcement Grid
  Supplying, Laying, Jointing and Installation of Geo Reinforcement Grid for Stabilization on slopes steeper than 1:3 in the 0.5 m soil cover.

Figure 24.19: Installation of Geo Reinforcement Grid

- Installation of Geo Reinforcement Mats
  Supplying, Laying, Jointing and Installation of Geo Reinforcement Mats for Overall Dump Site Stabilization, to be laid in layers of 1 m in vertical and horizontal, between +25 m to +35 m levels.

Figure 24.20: Installation of Geo Reinforcement Mats

- Laying of clean vegetative soil
  Supplying and Laying clean vegetative soil (supporting the growth of grass, shrubs and lawn) as a final cover layer of a thickness of 450 mm, over the 0.5 m soil layer, consisting of natural soil, silty clays with sand as prevalent in Kolkata Region.

Figure 24.21: Laying of Clean Vegetative Soil

- Construction of Erosion Protection Stone Layer / Prism
  Supplying, Laying and Construction of Erosion protection Stone Layer / Prism at the ground surface, besides the stormwater drainage trench, using large size crushed stones/boulders.

- Construction of Leachate Collection Sumps

- Construction of Passive Gas Collection Wells

- Laying and Jointing of HDPE Pipes of different diameters for gas collection and transport
  Supplying, Laying and Jointing of HDPE pipes of different diameters for gas collection and transport, as well as making of slots for gas collection system. The pipes were laid within the gas drainage layer as well as in the topsoil layer to collect gas from waste and to transport the same to the Passive Gas Outlets via the Compost Boxes.

Figure 24.22: Laying and Jointing of HDPE Pipes of Different Diameters for Gas Collection and Transport

- Construction of Compost Filter Boxes: 10 nos.
  Construction of RCC pre-cast compost filter boxes (10 nos), of size 7.4 m x 4.0 m x 1.0 m, with cement slabs and filling up the same with matured compost fertiliser.

Figure 24.23: Construction of Compost Filter Boxes: 10 nos.

➢ Construction of Storm Water (Surface Water) Drainage System
Construction of Trapezoidal Storm Water (Surface Water) Drainage System (in RCC M 30 grade cast in situ) at the periphery of the dumpsite at ground level and along the access/ service roads on top of the berms of the closure layers of the dumpsite

Figure 24.24: Construction of Storm Water (Surface Water) Drainage System

➢ Construction of Service Road over the closed dumpsite
Construction of Service Road (3.75 m wide) over the closed dumpsite on top of the capped layers, with laying of coloured paver block & fixing of kerbstone along the edge of the road

Figure 24.25: Construction of Service Road Over the Closed Dump Site

➢ Construction of Access Road on North side of the closed dumpsite
Construction of Access Road (5 m wide) on North side of the closed dumpsite upto the leachate collection well at ground level, having layers of excavation and box cutting, compacted soil filling and stabilised soil layer with 10% lime mix, granular sub-base of crushed stone, wet mix macadam overlaying with bituminous pre-mix carpet and seal coat.

➢ Laying of Carpet Grass Lawn
Supplying and laying (including bed preparation) for carpet grass lawn, including dressing the surface as per the desired shape as per horticultural layout.

Figure 24.26: Laying of Carpet Grass Lawn

- Laying and planting of Hedge/Shrub
  Supplying and laying (including bed preparation) for the planting of Hedge/Shrub as per horticultural layout.

Figure 24.27: Laying and Planting of Hedge/Shrub

- Installation of Irrigation System
  Supplying and installation of Irrigation System for proper and efficient maintenance of landscaping on the entire closed dumpsite (all side slopes and top flat area, green belt along the roadside and steel fencing), consisting of Sprinklers and Hydrant system.

Figure 24.28: Installation of Irrigation System

Figure 24.29: Bird's Eye View After Closure & Containment

Leachate Treatment Plant.

For the treatment of the leachate generated from the Dhapa dumpsite, a Leachate Treatment Plant has been set up near the dumpsite for the discharge of the treated effluent at the stormwater drainage system.

The design basis for Leachate Treatment Plant (LTP):
Design Flow –300 KL per day (KLD).
Design Inlet and Outlet Characteristics of the LTP:

Table 24.2: Design Inlet and Outlet Characteristics for LTP

Sr. No.	Parameters	Unit	Inlet Quality (Design)	Outlet Quality *
1	Flow	cu.m/day	300	300
2	pH		6 - 8	5.5 - 9
3	COD	mg/l	4000	250
4	BOD	mg/l	1600	30
5	TSS	mg/l	2500	100
6	Oil and Grease	mg/l	10	10
7	Ammonia (as NH_3)	mg/l	120	50
8	Lead	mg/l	0.5	0.1
9	Total Chromium	mg/l	1.2	2
10	Mercury	mg/l	0.02	0.01
11	Fluoride	mg/l	5	2

** to be achieved matching with General Standards for Discharge of Environmental Pollutants (Effluents) - CPCB Guidelines for Inland Surface Water Treatment Processes*

Leachate Treatment Plant (LTP) consists of Primary Treatment, Secondary Biological Treatment and Tertiary Treatment System. Leachate Treatment Plant (LTP) includes the following units:

- Equalization Tank(s)
- Lime Reaction Tank
- Alum Reaction Tank
- Flocculation Tank
- Flash Mixer & Flocculation for mixing
- Hypochlorite Dosing Tank
- Primary Settling Tank
- Aeration Tank – I (Activated Sludge Process)
- Secondary Settling –I
- Aeration Tank – II (Activated Sludge Process)
- Secondary Settling Tank –II
- Intermediate Collection Tank
- Blowers and diffusers for aeration
- Tanks & Coarse Bubble for Equalization
- Pressure Sand Filter (PSF)
- Activated carbon filter
- Final Collection Tank
- Sludge Collection Sump
- Filter Press
- Leachate/ Effluent Transfer Pumps
- Return sludge pumps
- Filter Feed Pumps.
- Treated Leachate Transfer Pumps.

Figure 24.30: Leachate Treatment Plant

An environmental disaster that killed a river and the story of it's restoration

The Bakreswar and the Chandrabhaga are two important tributaries within Mayurakshi basin. Chandrabhaga is a left-bank tributary of Bakreswar and these two rivers join each other at Parbatipur about 11 km. downstream of Bakreswar Thermal Power Plant ash-pond. The combined river flows further east to join with Kopai and takes the name Kunye which ultimately discharges into the Bhagirathi through *Hizol bill* near Kandi. The two outlets draining from the *Hizol bill* are Uttarasan and Babla. Bakreswar Thermal Power Plant (BKTPP) was installed during late 1980s and underwent huge expansion in respect of its' capacity since then. Although situated in comparatively water-short region of the state, the huge water requirement was decided to be met from surface water accumulated in the reservoir constructed baffling the river Bakreswar. Both the Bakreswar and Chandrabhaga are exclusively rain-fed and remained perennial by the base flow from ground-water pool during lean months. Since a reservoir was commissioned across Bakreswar river in June 2000, a considerable length of river downstream of the dam has gone dry causing not only desiccation of the river but also cease of ecological services. The reservoir covers an area of 9.42 km^2, with water-storage capacity of 27 million m3 and a catchment area of 109.42 km^2 with land use patterns of forestry and villages. The BKTPP requires 90,000 m^3 of water/day and this is supplied from Tilpara barrage through a pipe line. The reservoir plays a supplementary role and supplies water to the plant during 2-3 lean months when supply from the Tilpara is interrupted due to maintenance or any other reason.

The catastrophe in nutshell

Power generation capacity of the BKTPP initially in year 2000 was 630 MW followed by an expansion to 1,050 MW in year 2008. This was done without any expansion of ash pond. This forced the BKTPP authority to dump the ash in to the only ash pond. The BKTPP authority got coal with more than 40 per cent ash content. Huge ash-pond overflow contaminated the Chandrabhaga river. The Total Suspended Solid (TSS) of the river went over 25 times that of the discharge standard for the ash pond overflow.

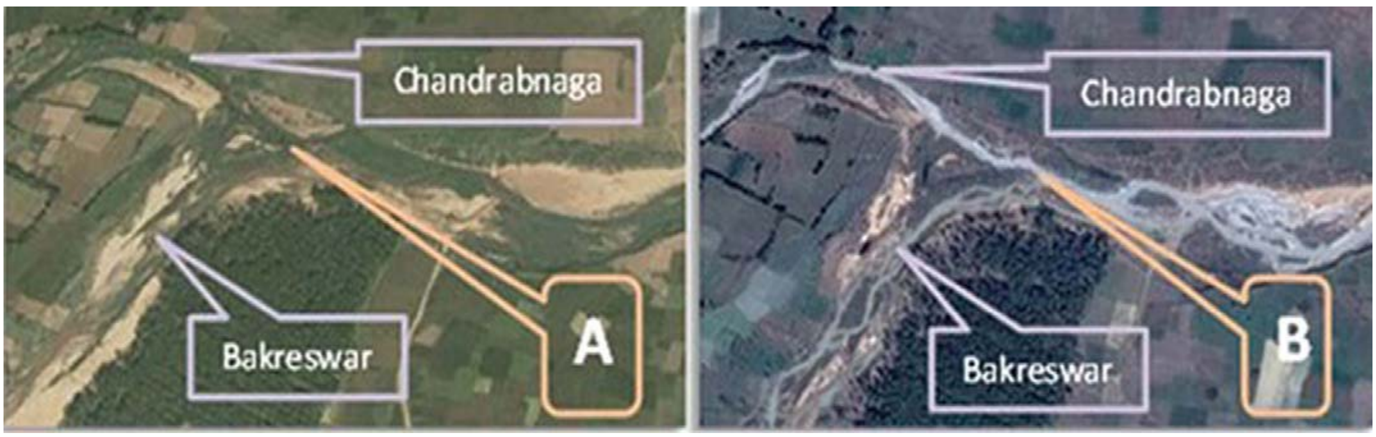


Figure 24.31 :Confluence of rivers Chandrabnaga and Bakreswar before (A) and after (B) the incident of ash pond overflow.

Source: WBPCB

- Ash pond was fully filled up from June to November of 2014.
- Ash accumulation rate was 2500 m^3 per day
- Total ash accumulation during 10/07/2014 to 20/11/2014 (110 days) – 275,000 m^3.
- Ash evacuated during 10/07/2014 to 20/11/2014 (110 days) – 27,992 m^3.
- Ash pond overflowed during 10/07/2014 to 20/11/2014 (110 days) –247,000 m^3 to Chandrabhaga river.

To a conservative estimate, to the tune of 200,000 m3 of ash was dumped by the incident of ash pond overflow and was to be removed from the river bed to set the river to come back to normalcy again.

Intervention of the Hon'ble National Green Tribunal

The event of ash-pond over flow happened during September-November 2014 and the two rivers, Chandrabhaga primarily and Bakreswar after it's confluence with Chandrabhaga received huge amounts of ash dumping on their beds. The Hon'ble National Green Tribunal stepped in and following their order(s) the massive and historical river clean up activity started.

- No further discharge from the ash pond should reach the river Chandrabhaga and Zero Liquid Discharge (ZLD) should be implemented with immediate effect.
- The BKTPP should construct and commission the new ash-pond immediately.
- De-silting of the stretch of the river Chandrabhaga, be done on war footing, manually and not deploying any mechanical dredger and should be completed before the monsoon of 2015.
- Disposal of removable materials may be done to abandoned mine(s) or supplied to brick fields, highway authority and organizations legally permitted to use such ash.
- Livelihood support must be provided tothe local people. One tube well for drinking water was to be established and one pond of area around 10 cottah was to be dug up in each village surrounding the affected river stretch.

Figure 24.32 : Confluence of two rivers at Parbatipur

Source: WBPCB

Removal of ash deposition from the river bed

Deposition of huge quantity of ash on the riverbed changed the hydro-geomorphic character of the river. It was found during inspection from the point of ash discharge to the point of confluence of river Chandrabhaga and river Bakreswar, the depths of the deposited ash layer to vary from a depth of 1,200 cm to 46 cm on an average. In their attempt in cleaning up the mess, the BKTPP authority deployed heavy earth moving instruments to remove the ash from the river bed. This created a deeper channel down the mid-stream for the water flow, dumping the ash-sand mixture on both sides of this channel on the riverbed itself. Dumping of this ash-sand mixture on the sides of the water channel changed the ecology of the entire stretch of the river is true not only for the region through

Table 24.3: Total Suspended Solids (TSS) in ash pond discharge/bypass

Date	TSS (mg/l)	TSS Standard (mg/l)
During the incident		
Jun-2014	1722	100
Jul-2014	14	100
Aug-2014	176	100
Sep-2014	2978	100
Oct-2014	2538	100
Nov-2014	2816	100
Present day situation		
Sep -2016	20	100
Oct-2016	14	100
Nov-2016	16	100
Dec-2016	16	100
Jan-2017	32	100
Feb-2017	32	100

which the water flows, but for the regions on the bank as well, which is why no sign of aquatic life could be identified for the stretch travelled during the inspection. Subsequently, the ash deposit were removed manually and that helped rejuvenate the river.

Deterioration of water quality

Water quality of the river Chandrabhaga has drastically improved and the locals are freely using the water for all sorts of purposes excepting direct drinking. It

appears that after one more monsoonseason the quality of water in Chandrabhaga will turn out to be as before. The Table 12.9, regarding the discharge of the ash pond during the incident and recent times is a clear indicator that the river water quality is free from the phenomenal threat.

Restoration of loss of biodiversity

Biodiversity, the index "last to reappear after restoration" for the health of the water body, has been found to be in place. Mother the Nature has been seen to take up the issue of restoration of the river biodiversity which could be visibly confirmed through appearance of algae and other aquatic plants including various fish species moving merrily in the river water. All these are clear evidence of the restoring biodiversity of the river system.

Figure 24.33: Re-appearing blue-green algae found in Chandrabhaga during February 2016

Source: WBPCB

Figure 24.34: Re-appearing small fishes found in Chandrabhaga during February 2016

Source: WBPCB

Livelihood support

With interventions by the BKTPP and the District authority to support the livelihood issues of the river side villagers, the condition improved much. Of the principal uses of the water resource, direct drinking of the river water may take some more time to be established. To substantiate, sufficient arrangements has been made in form of tube wells dug in close proximities of the habitations on both sides of the river Chandrabhaga. All other livelihood issues like bathing, cloth washing etc. including drinking by the domesticated animals have been restored.

Concluding remarks

The incident narrated here is a clear example of the "Developmental Spree" of now-a-days endeavour of re-shaping the world with little or no consideration to what may come if checks and balances are not weighed in the balance of appropriate consideration. It is to be reckoned that the pathway for development is complex and one-size-fits-all type of solution does not, to be precise, 'cannot' confront the severe complexity. Out of the myriad of global environmental narratives some general principal has to arise. What is required for the 'sustainability', has to be done. That the "Cost to be paid by the nature" is suicidal, need not any proof and is to be discarded outright. To do any less would be a dereliction of our social responsibility. That technology rules, and shall continue to do so is accepted by everybody, but, it is opinion of all wise men that where there are and when there are alternatives and choices, democratic political processes should be at the centre of decision making – not the technology.

Figure 24.35: People using Chandrabhaga river after restoration

Source: WBPCB

Figure 24.36: Cattles drinking water from Chandrabhaga river after restoration

Source: WBPCB

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