AIR AND WATER POLLUTION ASPECTS OF BANGLADESH

Presented by:

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DEFINITION OF AIR POLLUTION

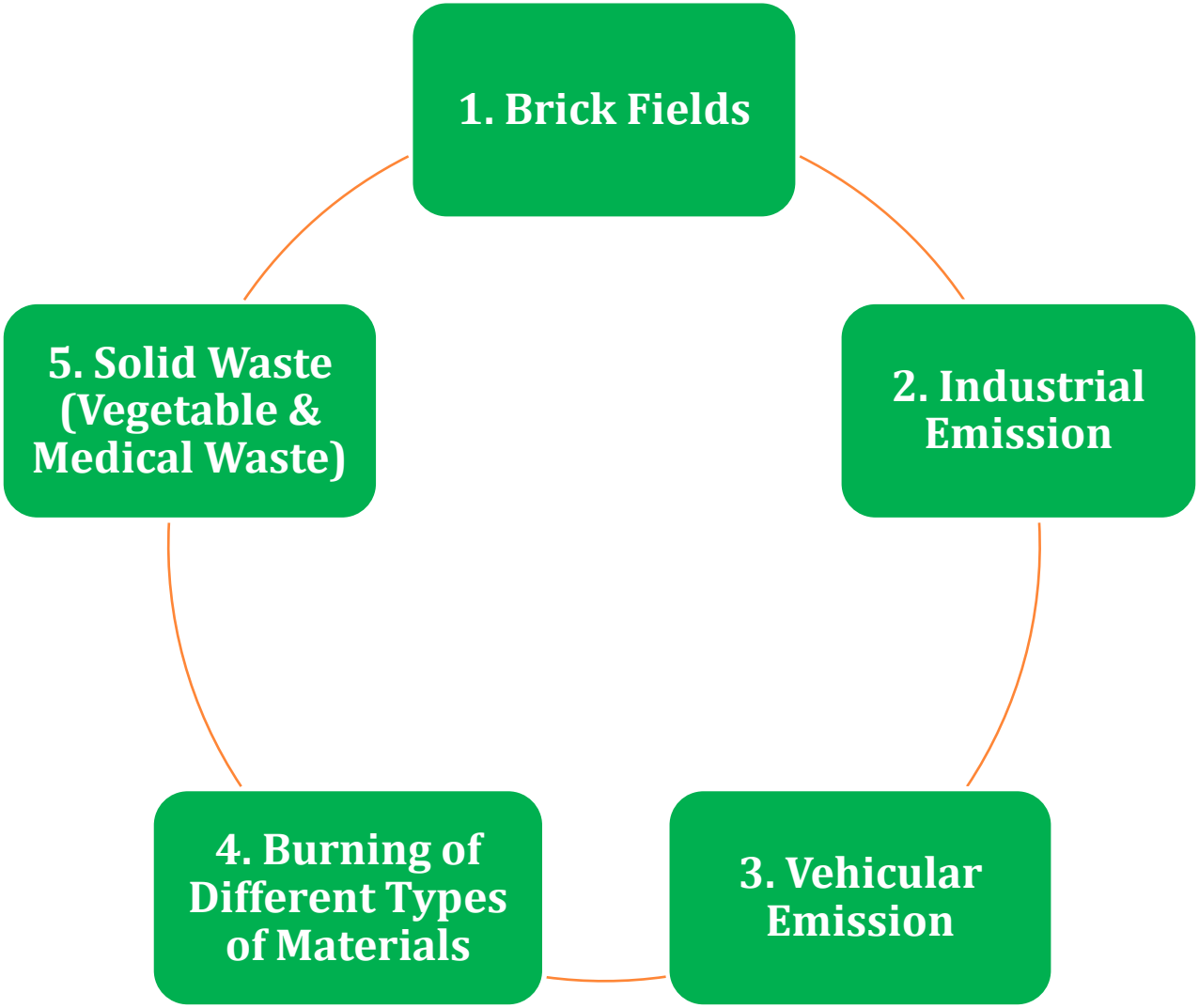
Air pollution can be defined as any atmospheric condition in which substances (natural or man-made chemical compounds capable of being airborne) are present at concentrations high enough above their normal ambient level to produce a measurable effect on man, animals, vegetation, or materials. Air pollutants are hazardous to human health and at high enough concentrations can even be fatal. The most important pollutants are Carbon monoxide (CO), Sulfur dioxide (SO_2), Nitrogen oxides (NO_x), Ozone (O_3), Hydrocarbons (HC) and Suspended Particulate Matter (SPM). In the late 1970s, Environmental Protection Agency (EPA) of USA added lead (Pb) to this list. Particulate matter with an aerodynamic diameter of less than or equal to 10μm (PM_{10}) was added to the list in 1987.

CLASSIFICATION OF AIR POLLUTION

- Outdoor Air Pollution

- Indoor Air Pollution

MAIN SOURCES OF OUTDOOR AIR POLLUTION



OUTDOOR AIR POLLUTION: BRICK FIELDS

POLLUTANT LEVELS AROUND BRICK FIELDS IN DHAKA CITY

Place	Pollutant's Concentration			
	CO ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	HC (%)	SPM ($\mu g/m^3$)
Edge of the cluster	2863	131	0.01	780.7
Center of the brickfield cluster 1	2978	157	0.02	1390
Center of the brickfield cluster 2	3207	157	0.01	728.5
Standards for Air (Industrial & Mixed) [ECR'97]	**5000**	**120**	**–**	**500**

Source: Begum, Dil Afroza and Ahmmed, K. M. Tanvir, Impact of Regional Co-operation on Reduction of Air and Water Pollution Level of Dhaka City

MITIGATION OF BRICK FIELD-INDUCED AIR POLLUTION

- Main problem of the brick fields is the suspended particulate matter (SPM) being introduced into the atmosphere.
- **Green Technology for Brick Making:**
  1. Incorporation of fuel injected brick making along with highly energy efficient kilns
  2. Combination of Hollow brick making and environment friendly technologies
  3. Hybrid Hoffman Kiln (HHK)

OUTDOOR AIR POLLUTION: INDUSTRIAL EMISSION

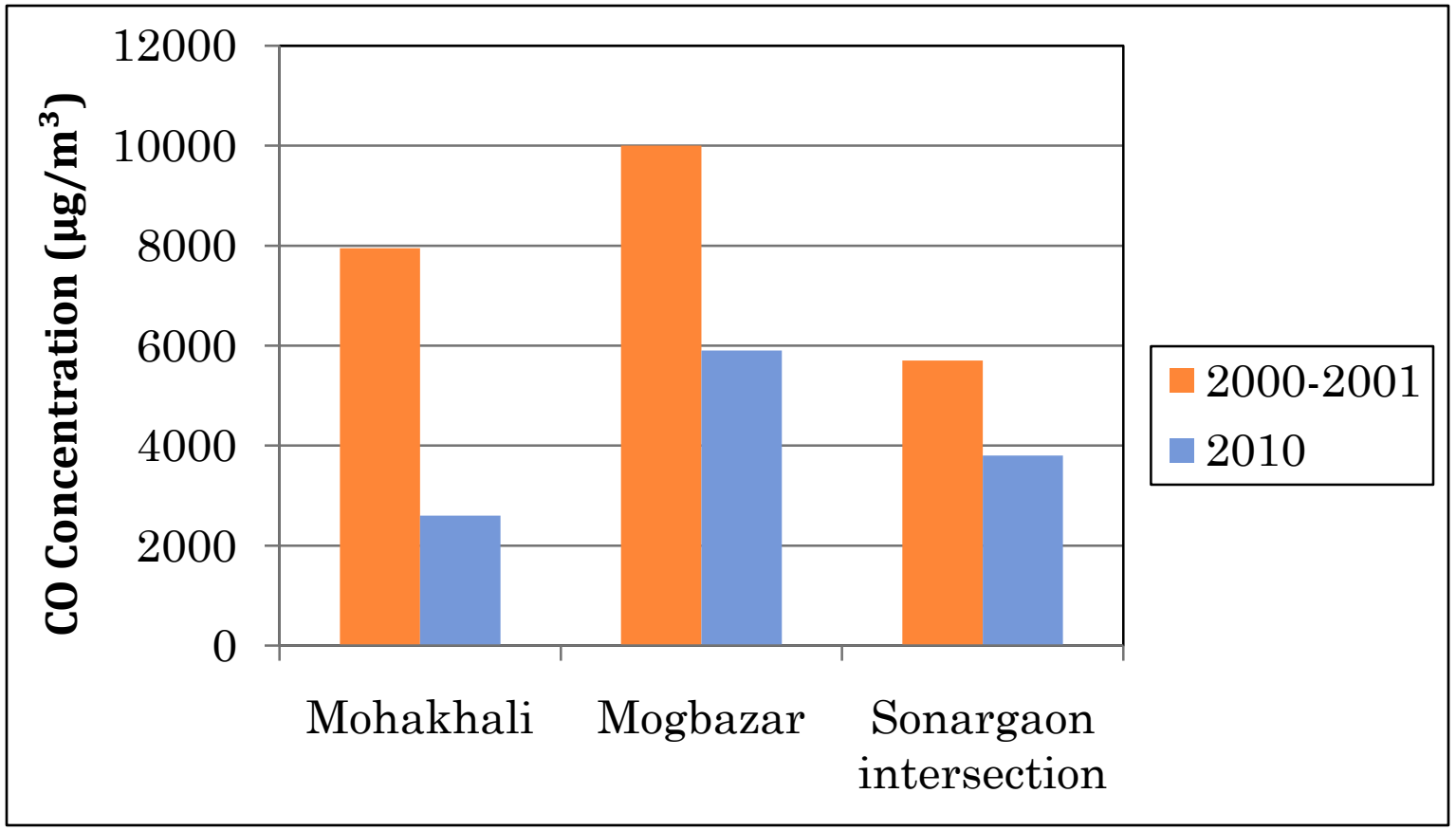
MITIGATION OF INDUSTRIAL EMISSION

- Increase of Burning Efficiencies of all relevant Industrial Units
- Treatment of Chimney Exhaust
- Proper and Regular Maintenance for Eliminating Leakage
- Burning of Clean Fuel
- Technological Change

OUTDOOR AIR POLLUTION: VEHICULAR EMISSION

MITIGATION OF VEHICULAR EMISSION

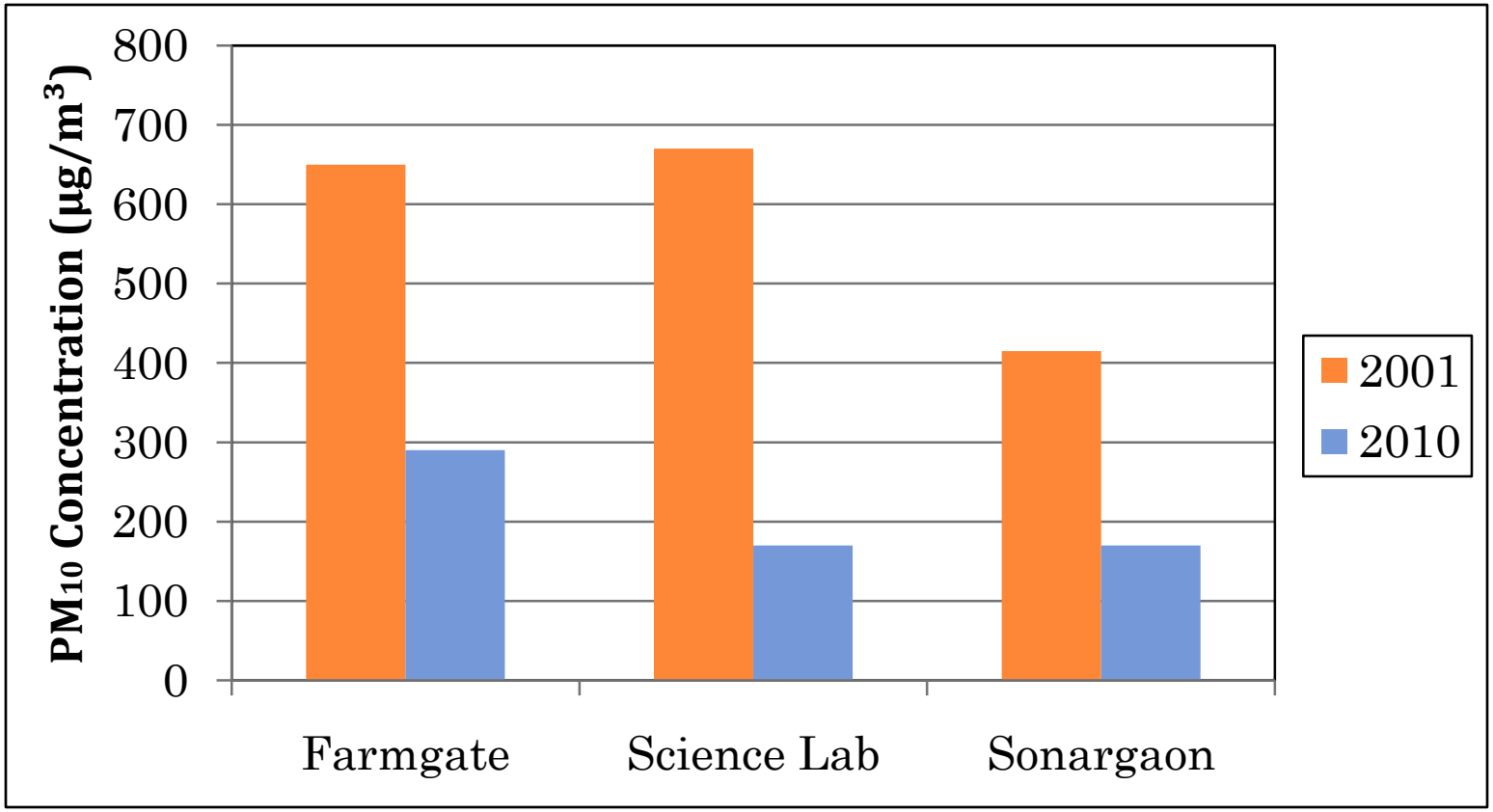
- Change of Fuel



Source: Begum, Dil Afroza and Ahmmed, K. M. Tanvir, Impact of Regional Co-operation on Reduction of Air and Water Pollution Level of Dhaka City

MITIGATION OF VEHICULAR EMISSION (CONT'D)

- Change of Fuel (continued)



Source: Begum, Dil Afroza and Ahmmed, K. M. Tanvir, Impact of Regional Co-operation on Reduction of Air and Water Pollution Level of Dhaka City

MITIGATION OF VEHICULAR EMISSION (CONT'D)

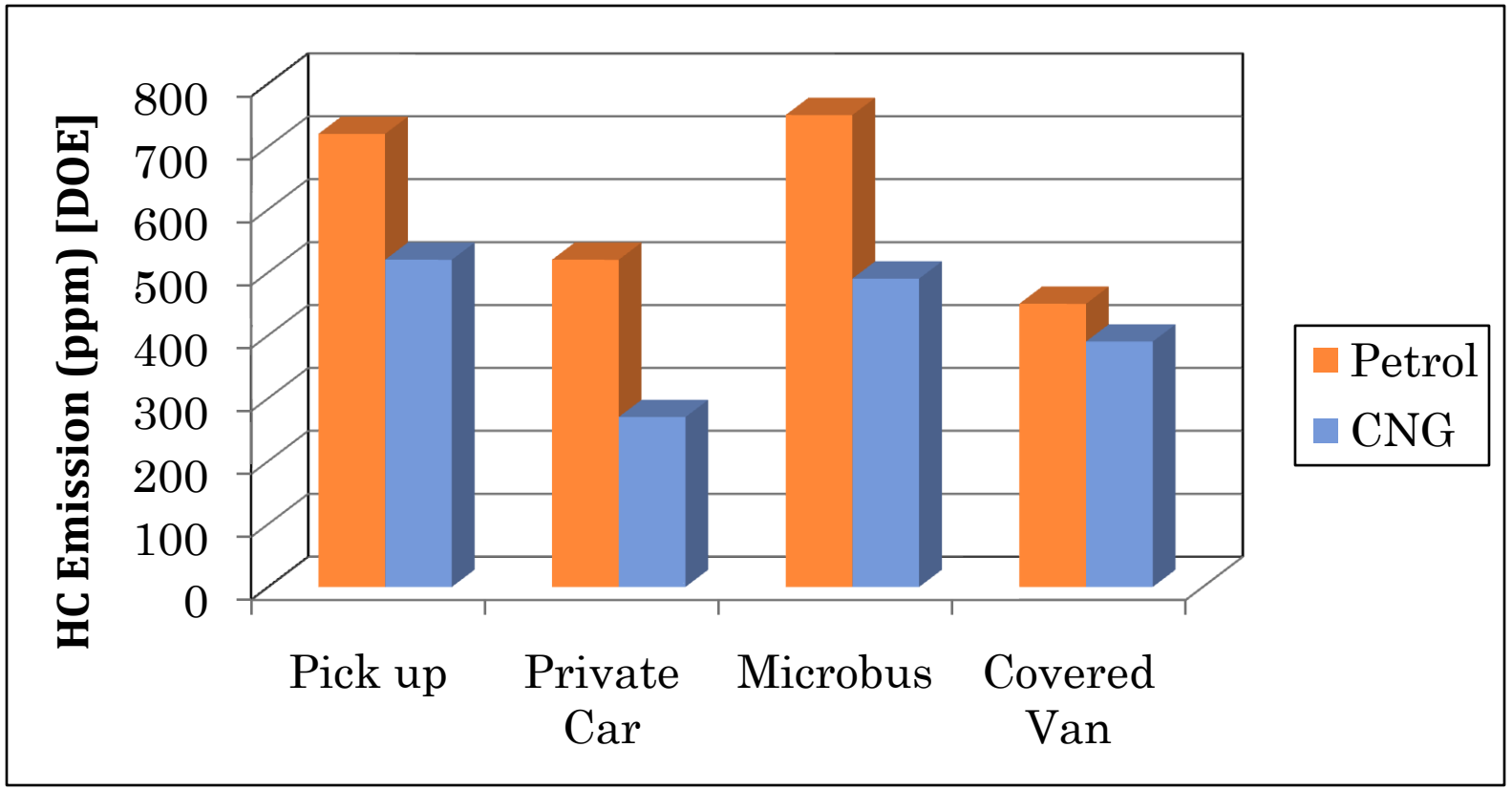
- Change of Fuel (continued)

Place	SO_2 Concentration ($\mu g/m^3$)	
	Year 2000	Year 2010
Mohakhali	152	Trace
Farmgate	121	
Mogbazar	146	
Sonargaon	393	
Science Lab	146	

Source: Begum, Dil Afroza and Ahmmed, K. M. Tanvir, Impact of Regional Co-operation on Reduction of Air and Water Pollution Level of Dhaka City

MITIGATION OF VEHICULAR EMISSION (CONT'D)

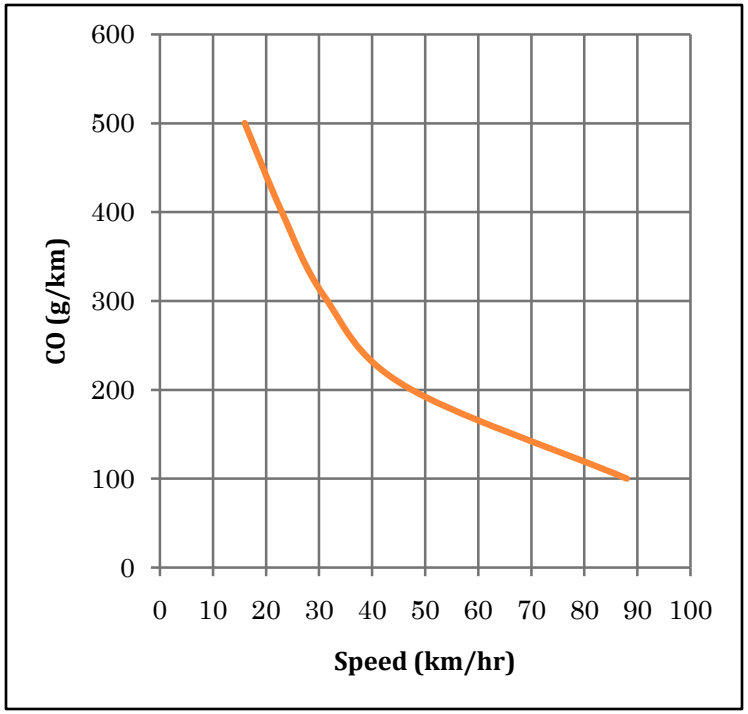
- Change of Fuel (continued)

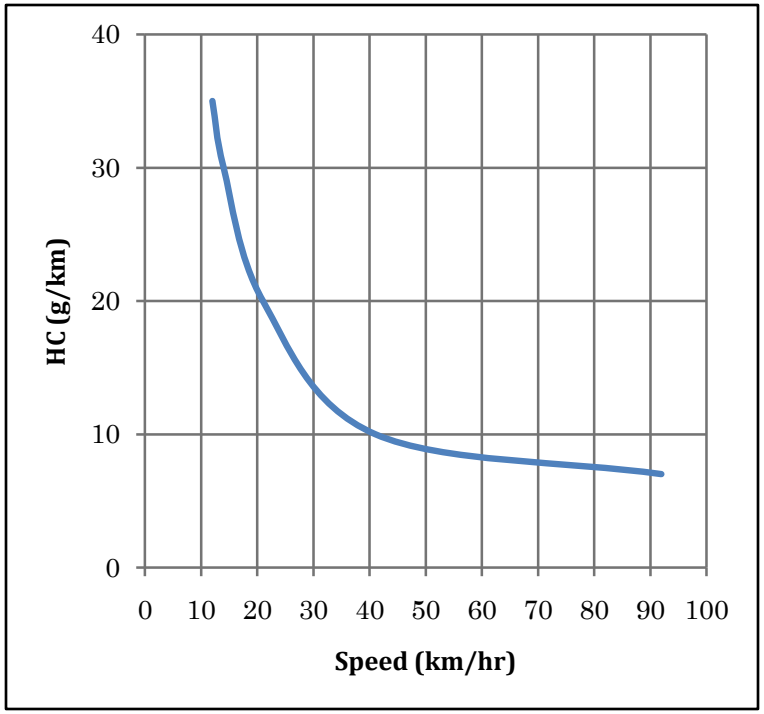


Source: Begum, Dil Afroza and Ahmmed, K. M. Tanvir, Impact of Regional Co-operation on Reduction of Air and Water Pollution Level of Dhaka City

MITIGATION OF VEHICULAR EMISSION (CONT'D)

- Improvement of Quality of Petroleum Products
- Reduction of Traffic Jam





Source: Begum, Dil Afroza and Ahmmed, K. M. Tanvir, Impact of Regional Co-operation on Reduction of Air and Water Pollution Level of Dhaka City

SUGGESTIONS FOR REDUCING TRAFFIC JAM

- Appropriate transportation planning for efficient mass transit
- Gradual phasing out of Rickshaws from the main roads
- Better traffic control and management (flyovers, one-way streets, multistoried parking, metered parking, etc.)
- Decentralization of economic activities
- Strict enforcement of law and regulations by BRTA
- Coordination between service organizations such as WASA, DESA, and T&T to reduce particulate matters

OUTDOOR AIR POLLUTION: SOLID (VEGETABLE AND MEDICAL) WASTE

SUGGESTIONS FOR SOLID WASTE MANAGEMENT

- Introduction of Efficient Solid Waste Management System
- Door-to-door household waste collection
- Proper collection of medical waste from hospitals and its Central Incineration in open atmosphere
- Central Processing of solid waste into valuable products
- Recycling of Non-organic materials
- Composting of organic matters
- New technologies and foreign investment for implementation of Solid Waste Treatment Project

INDOOR AIR POLLUTION

- AROUND 24 million general households in rural areas and 5.8 million general households in urban areas of Bangladesh use biomass fuels for household cooking purpose. Almost all these households use traditional cook-stoves for cooking and other heating purposes. This traditional stove usually lacks a chimney which releases the combustion products directly into the unventilated small kitchen as smoke. This indoor air pollution (IAP) poses a serious health impact on the women and young children.

GENERAL ISSUES: INDOOR AIR POLLUTION (IAP) FROM SOLID FUEL IS A MAJOR HEALTH THREAT

- A leading cause of illness and death, according to World Health Report 2002 (WHO):
  - 8th top health risk worldwide
  - 4th top health risk in developing countries with high child mortality
  - 3rd top health risk in India, after malnutrition and water-borne diseases
- Particularly affects young children and women:
  - Kills 1.6 million infants, young children and women worldwide each year
  - 420,000 or over 25% of these deaths happen in India, mainly in rural areas
- An important factor for achieving **MILLENNIUM DEVELOPMENT GOALS (MDG)** of halving child mortality and improving maternal health

RESEARCH ON INDOOR AIR POLLUTION

- Several research groups and organizations have carried out studies to assess the indoor air pollution levels prevailing in our kitchens used traditional cooking stoves and biomass as fuel. The main groups are:

- Md. Khaliquzzaman, Michihiro Kamijima, Kiyoshi Sakai, Bilqis Amin Hoque and Tamie Nakajima
- Susmita Dasgupta, Mainul Huq, M. Khaliquzzaman, and David Wheeler
- Grant Miller, Paul H. Wise, Lynn Hildemann, Ahmed Musfiq Mobarak, Imran Matin, and Nasiama Akter
- Esther Duflo, Michael Greenstone, Rema Hanna
- USAID, WINROCK International

- Zohir Chowdhury, Leach Thi Le, Abdullah Al Masud, Karen C. Chang, Mohammad Alauddin, Mahmood Hossain, ABM Zakaria, Philip K. Hopke, Doughlas F. Barnes, ESMAP
- Bangladesh Atomic Energy Commission
- World Bank
- BCSIR
- GIZ
- IDCOL
- Grameen Shakti
- Department of Chemical Engineering , BUET

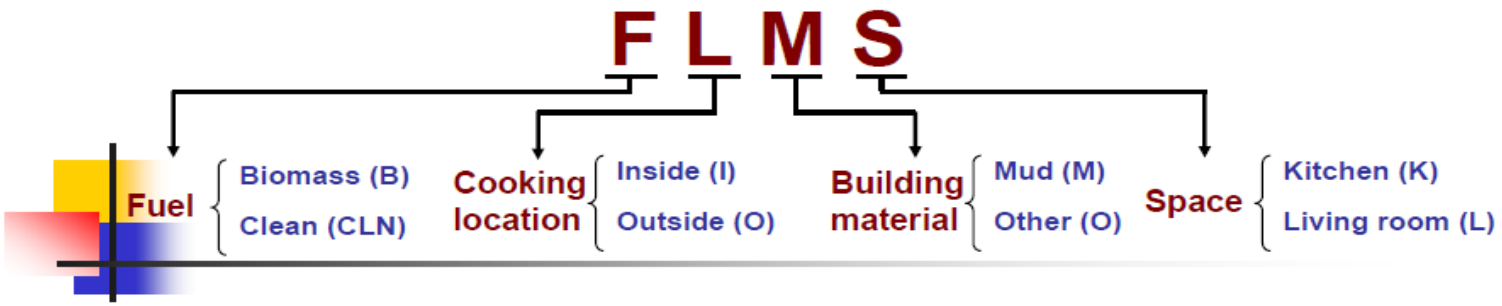
STUDIES ON INDOOR AIR POLLUTION IN BANGLADESH

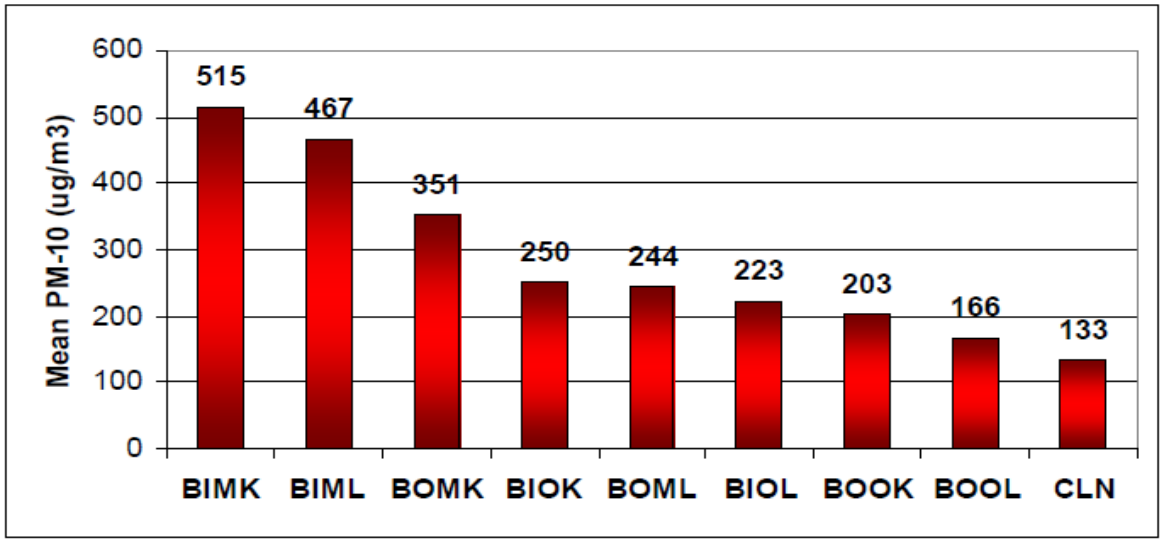
- Let us have a look into the main findings of indoor air pollution studies carried out in Bangladesh.

Indicators	During cooking[a] (n = 51)		During noncooking[a] (n = 57)	
	Biomass (n = 18)	Fossil (n = 33)	Biomass (n = 24)	Fossil (n = 33)
Winter				
Temperature (°C)	27.4 ± 2.4[†]	27.7 ± 2.5[†]	27.6 ± 2.8[†]	28.0 ± 2.9
Humidity (%)	52.0 ± 8.4[#,†]	57.9 ± 7.3[†]	50.5 ± 8.7[#,†]	58.3 ± 6.0
CO (ppm)	6.3 ± 9.8[#,†]	2.3 ± 3.6[*]	2.8 ± 4.0[#]	0.6 ± 0.9
CO_2 (ppm)	619 ± 196[†]	582 ± 158	652 ± 235	617 ± 186
Dust particles (mg/m^3)	0.821 ± 1.011[#]	0.141 ± 0.119[†]	0.454 ± 0.306[#,†]	0.097 ± 0.080
Summer				
Temperature (°C)	31.0 ± 1.6	31.6 ± 2.1	33.5 ± 7.6	33.1 ± 8.1
Humidity (%)	81.1 ± 7.2[*,#]	73.6 ± 7.4	75.1 ± 6.8	75.7 ± 4.9
CO (ppm)	19.6 ± 15.1[*,#]	2.0 ± 3.7	3.6 ± 7.6[#]	0.6 ± 1.9
CO_2 (ppm)	858 ± 278[#]	674 ± 259	797 ± 296[#]	597 ± 182
Dust particles (mg/m^3)	0.633 ± 0.727[#]	0.064 ± 0.099	0.208 ± 0.253[#]	0.041 ± 0.049

Source: Khalequzzaman et al., Indoor air pollution and the health of children in biomass and fossil-fuel users of Bangladesh: situation in two different seasons

COMPARISON AMONG DIFFERENT COMBINATIONS





Source: Douglas F. Barnes (2006), Clean household energy and indoor air pollution

POLLUTANT (CO) CONCENTRATION FROM DIFFERENT FUELS

Pollutant's Name	Pollutant's Concentration from Different Fuels (ppm)					
Carbon Monoxide	Wood	Cowdung	Bamboo	Jute Sticks	Coconut Leaf	Rice Straw
	53	70	46	19	62	30

- Standard allowable limit: 0.1 mg/m^3 for dust particle and 7.6 ppm for CO (UNDP/DESA/WEC)

Conclusions: Severe particulate matter and carbon monoxide poisoning exist in our kitchen having traditional biomass based cook-stoves.

MITIGATION OF INDOOR AIR POLLUTION

- Design change of existing traditional mud-type cook stoves
- Improvement of quality of fuel (agricultural residues) by briquetting using indigenous materials
- To provide training to the rural people about the efficient use of improved cook stoves
- Creation of awareness among the rural people about the health hazards of indoor air pollution

$PM_{2.5}$ CHEMICAL COMPOSITION

Species		Unimproved Mud Stove		BCSIR Improved Stove		Neighborhood Pollution	
		Mean	Abs Err	Mean	Abs Err	Mean	Abs Err
1	TC	**387**	27	**222**	23	ND	ND
2	EC	**176**	13	**152**	11	ND	ND
3	OC	**210**	15	**182**	12	ND	ND
4	Ag	0.029	0.033	0.021	0.036	0.000	0.000
5	Al	**0.141**	0.040	**0.123**	0.041	0.010	0.019
6	As	0.010	0.017	0.015	0.017	0.009	0.010
7	Ba	0.089	0.423	0.062	0.441	0.000	0.342
8	Bi	0.006	0.009	0.013	0.009	0.007	0.006
9	Br	**0.070**	0.014	**0.156**	0.011	**0.071**	0.010
10	Ca	**0.285**	0.018	**0.263**	0.023	**0.255**	0.019
11	Cd	0.009	0.047	0.014	0.034	0.000	0.019
12	Ce	0.061	0.341	0.146	0.418	0.478	0.578
13	Cl	**31.927**	0.086	35.005	0.11	**3.769**	0.006
14	Co	0.038	0.059	0.039	0.062	0.037	0.042
15	Cr	0.005	0.007	0.004	0.007	0.005	0.005
16	Cs	0.000	0.336	0.046	0.289	0.105	0.172
17	Cu	**1.106**	0.105	**1.213**	0.108	**1.015**	0.075
18	Fe	**2.901**	0.192	**2.908**	0.199	**2.844**	0.135
19	Ga	0.007	0.028	0.004	0.029	0.000	0.019
20	Ge	0.000	0.001	0.000	0.001	0.000	0.001
21	Hg	0.007	0.012	0.000	0.001	0.012	0.013

Note: Concentrations are expressed in $\mu g/m^3$ units. ND ≡ no data available

COMPARISON BETWEEN BUET MODELS AND GRAMEEN SHAKTI MODELS

- FUEL: Dried rice straw, cold start, WBT test (recent work-submitted for publication)

Parameter	BUET Models	Grameen Shakti Models
Thermal Efficiency (%)	18-25	10-13
Environmental Stove Index	ln[1.0] - ln[1.56]	ln[0.48] - ln[0.65]

It is expected that the efficiency will be enhanced to a great extent if wood is used as fuel in BUET models.

Now, the **Chemical Engineering Department of BUET** is working on optimizing the design parameters of existing models to get more **energy efficient low-cost mud-built** cook-stoves having chimney. Quality of fuel (Agricultural residues) can be improved by briquetting using locally available additives.

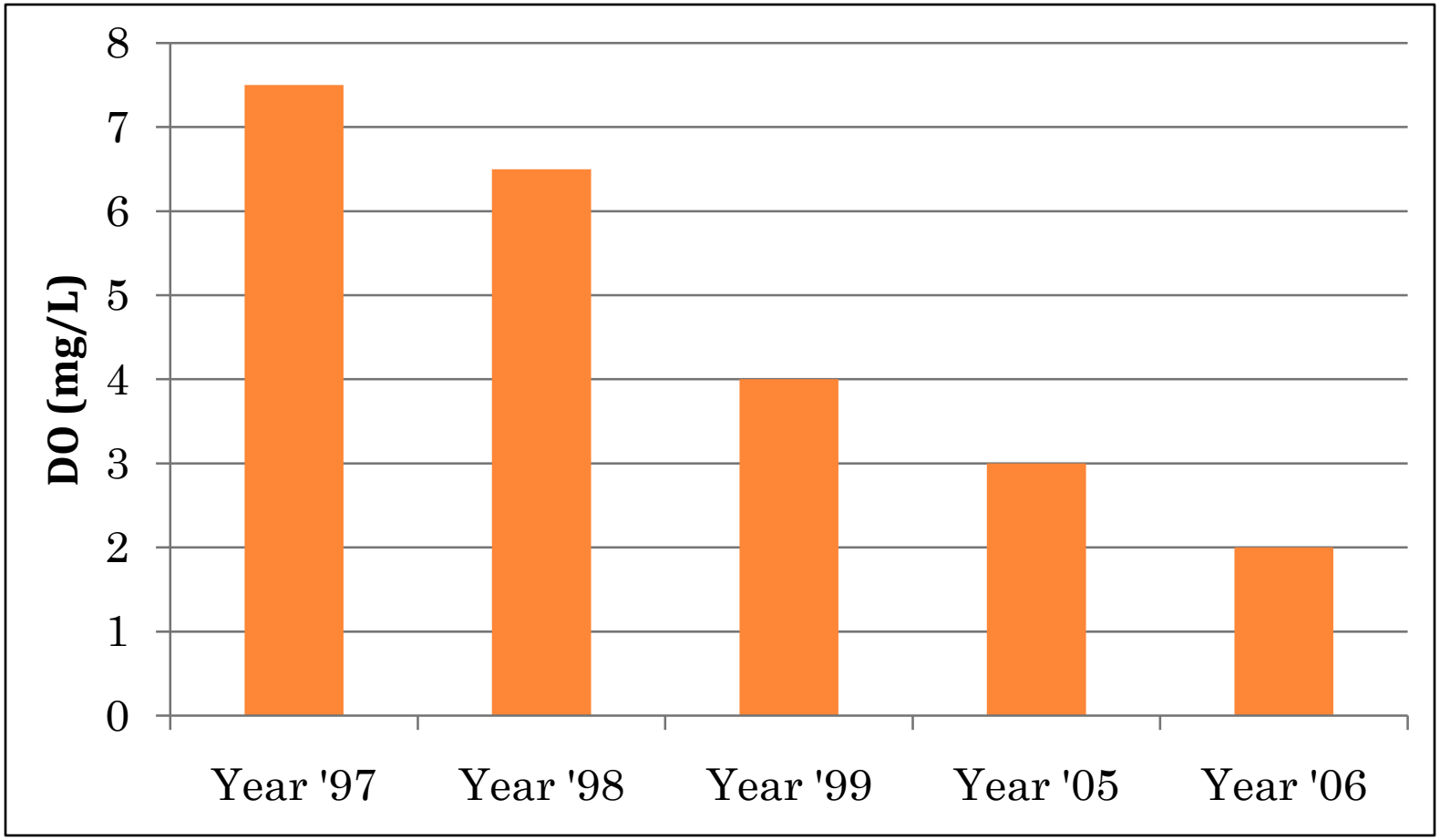
EXAMPLES OF CLEAN KITCHEN USING ICS OF BUET & GS MODELS

 WBT of BUET-single pot mud stove	 WBT of BUET-double pot ©stove	 WBT of BUET-single pot (E) stove
 WBT of BUET-triple pot mud stove	 WBT of GS-single pot concrete stove	 WBT of GS-double pot concrete stove

SOURCES OF WATER POLLUTION

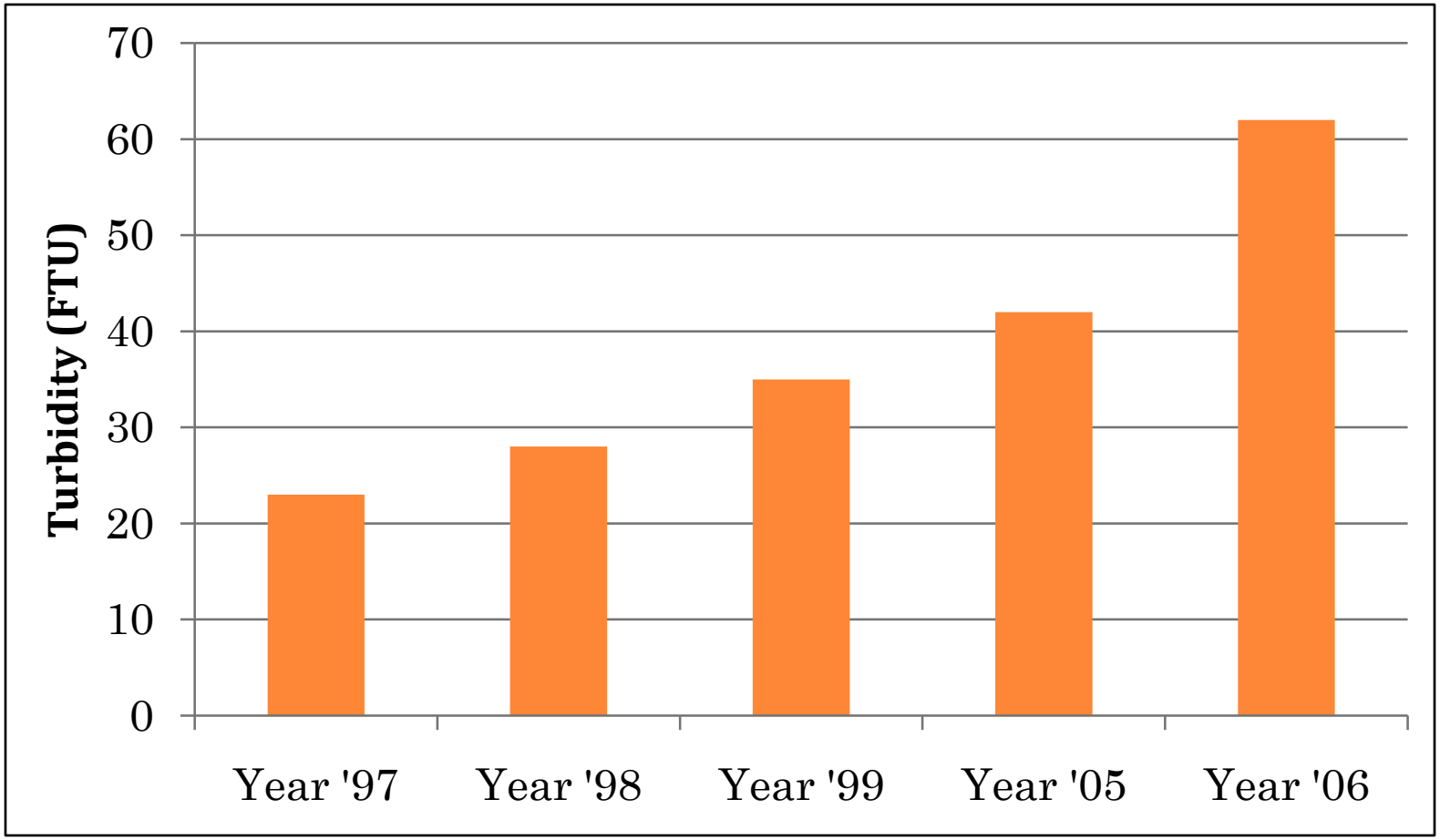
- Industrial effluents
- Livestock waste
- Oil spillages
- Detergent in sewage
- Residues of pesticides
- Arsenic contamination

DETERMINATION OF WATER QUALITY OF THE RIVER BURIGANGA IN COURSE OF TIME



Source: Begum, Dil Afroza and Ahmmed, K. M. Tanvir, Water Quality Aspects In and Around Dhaka City

DETERMINATION OF WATER QUALITY OF THE RIVER BURIGANGA IN COURSE OF TIME (CONT'D)



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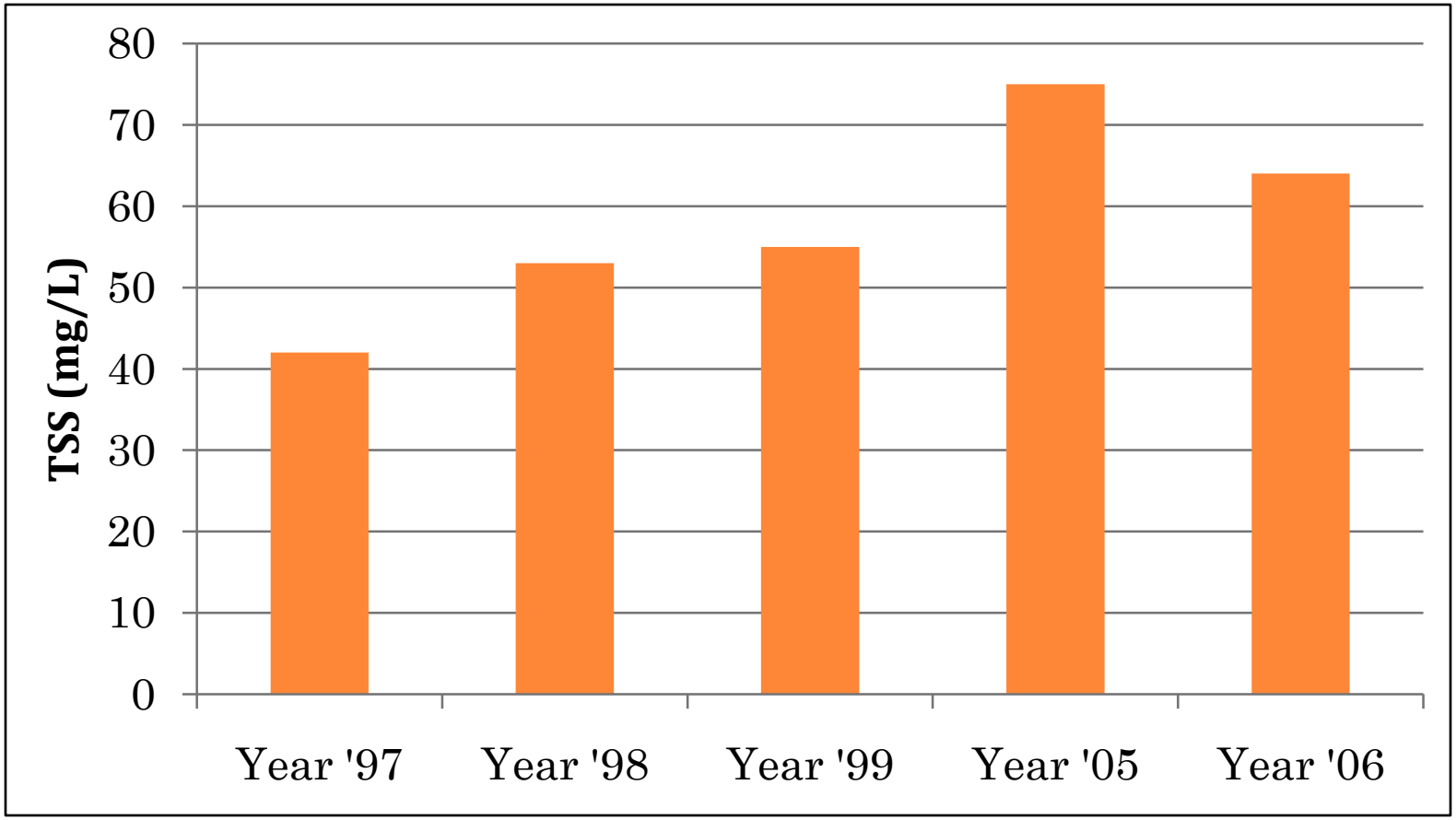

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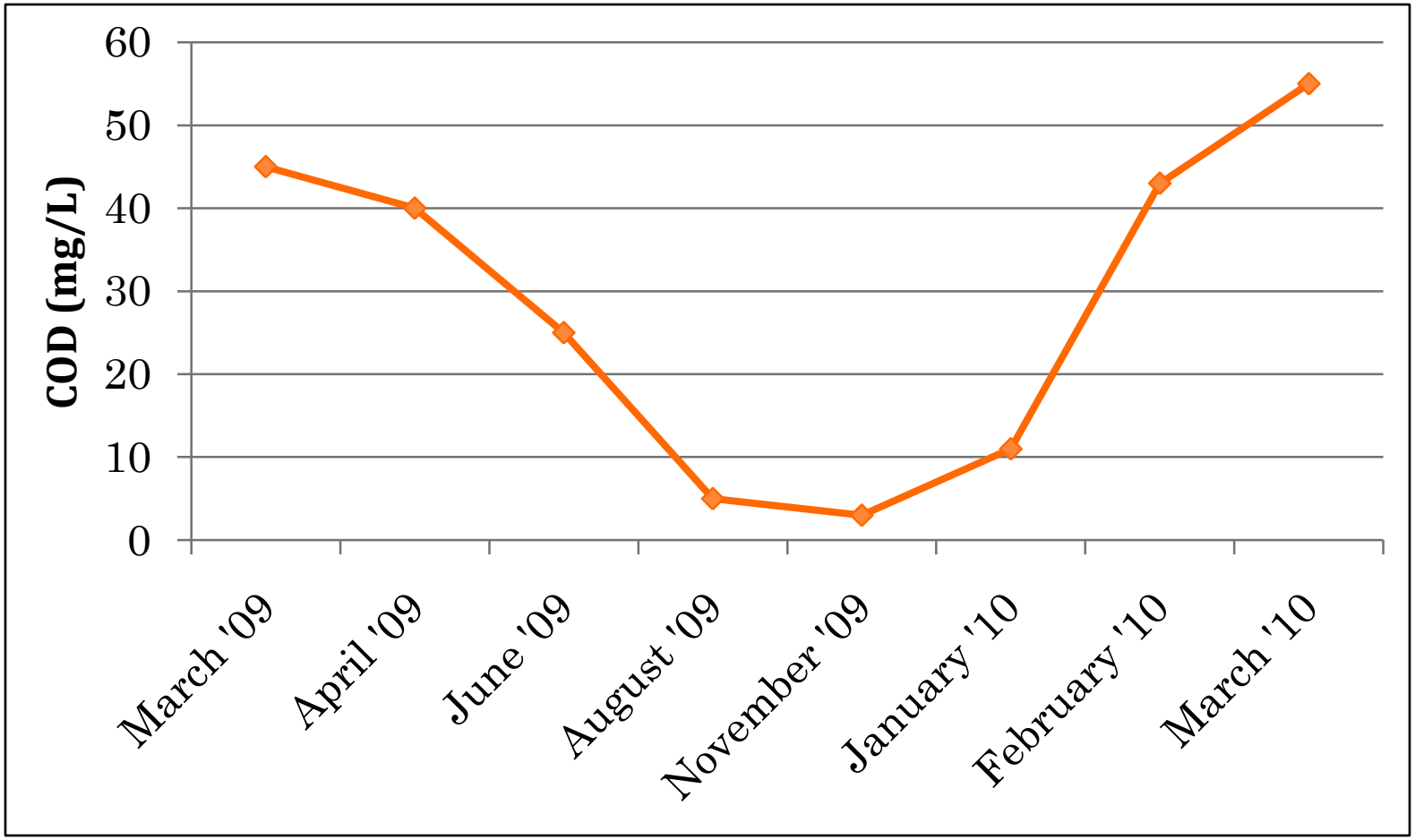
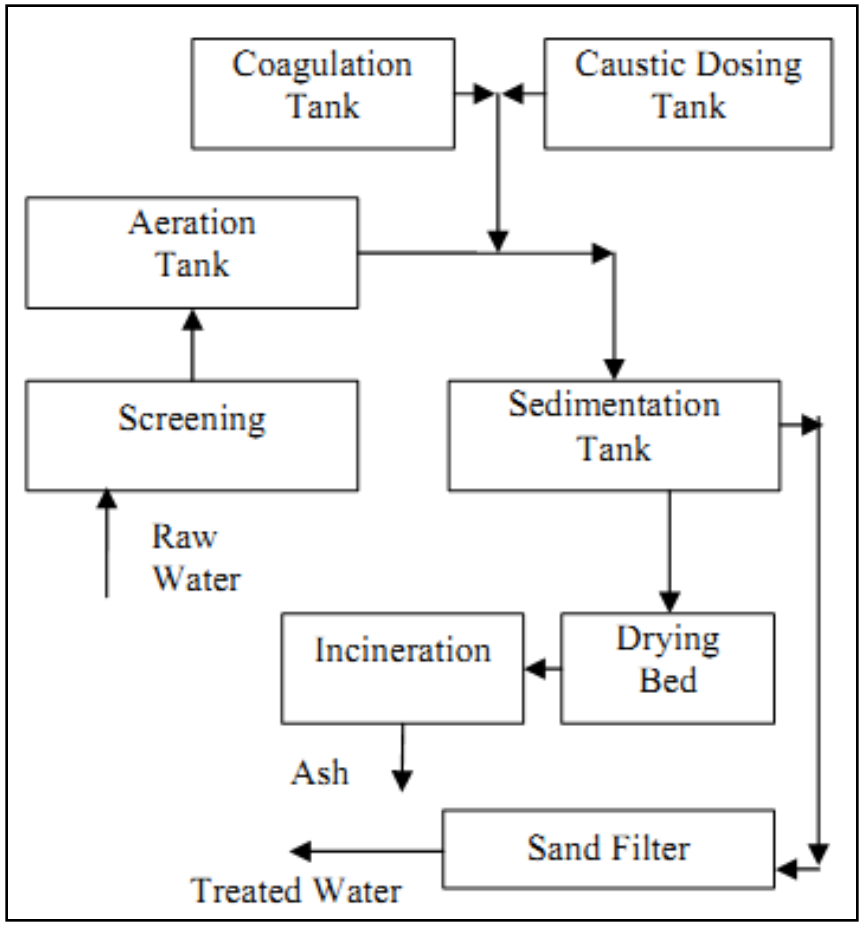
CHANGE OF COD OF THE RIVER SHITALAKHYA DURING A YEAR

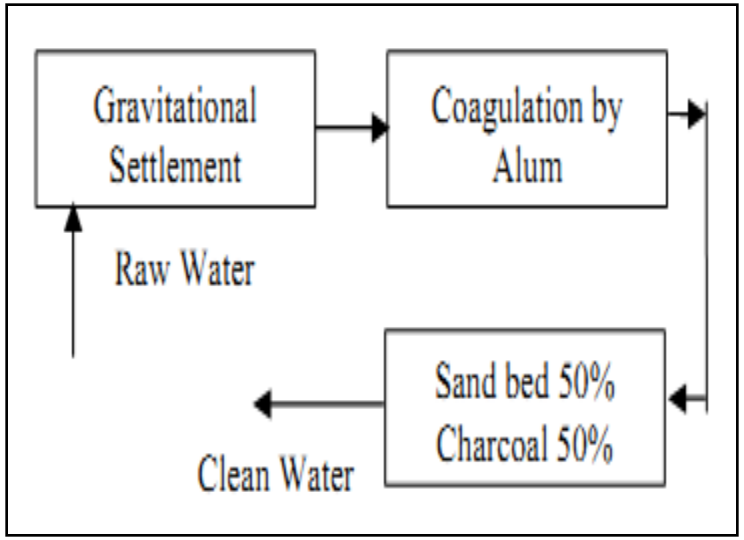


Source: Begum, Dil Afroza and Ahmmed, K. M. Tanvir, Water Quality Aspects In and Around Dhaka City

BLOCK DIAGRAMS OF LOW COST TANNERY WASTEWATER & SURFACE WATER TREATMENT PROCESSES



Tannery Wastewater Treatment Process



Surface Water Treatment Process

WAYS FOR REDUCTION OF WATER POLLUTION

- Development of indigenous low cost water treatment process and thereby its mandatory implementation
- Introduction of low cost effluent treatment process and efficient solid waste management system
- Strict law and regulatory enforcement by DOE
- Ensuring quality and quantity of water by modernization of existing water supply network system
- Decentralization of economic activities
- Creation of social awareness about the consequences of environmental degradation
- Central ETP

INDUSTRIAL PLANNING & DECENTRALIZATION

- Industrial planning should be done to ensure the establishment of different classes of industries in Bangladesh in an efficient way.
- A central marketing company is to be set up under the joint umbrella of FBCCI, Ministry of Industry, Ministry of Commerce, and Ministry of Environment.

THANK YOU ALL!!!