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SOURCES, PROBLEMS, HEALTH HAZARDS AND MANAGEMENT OF DUST CONTAMINATIONS AT DHAKA METROPOLITAN CITY

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1. ABSTRACT

A research on evaluation of dust/clay colloids (diameter size 0.002/0.0002mm) i.e. $PM_{2.5}$ (less tha 2.5 µ size diameter) contaminations to air were investigated where major sources of dusts/clays from soils of various categories were reported. Such dust/clay colloids contaminations occurred by CO_2, CO, SO_2, SO_x, N_2O, NO_x, heavy metals like Pb, As, Cd, Cr, Ni, Hg, Co, etc move in air although soil has 16-24 heavy metals contaminants with various concentrations. Again, Coal-fired power plants carry lots of heavy metals like Zn, Se, Cd, Ni, Pb, Hg, Cr, V, Br, As, Ur, Ti, CO_2, CH_4, NO_x although most N_2O, N, NO_x etc. come from N-fertilizers. Such minor to major polluted/contaminated dust/dust colloids in air move/enter the human body as toxic/contaminated air and acts as slow poison and producing minor to major diseases including cancer. Here dusts related diseases (more than 20) are listed. Again, dust sources, contaminations and health hazards were also compared between developed countries and Bangladesh. Air is not fresh one at Dhaka i.e. air at Dhaka city means dust/dust colloid contaminated air. The satellite observation of $PM_{2.5}$ or more may or may not be severely contaminated until lab. analysis and detections covering of various heavy metals, widely used pesticide residues/contaminants and other pollutants in air although black dust/fume dusts carry huge contaminants. Finally, wide suggestions and recommendation are applied against dust contaminations in air. The entire study, observations, measurement guidelines are well analysed through five tables (Tables 1-5) and five figures (Figs. 1-5) and they are summarized and presented as schematic model in Fig. 1.

Key words: Dusts, dust colloids, clay colloids, contaminations, problems, health hazards, sources of dust contaminations, comparisons, heavy metals, suggestion/guidelines.

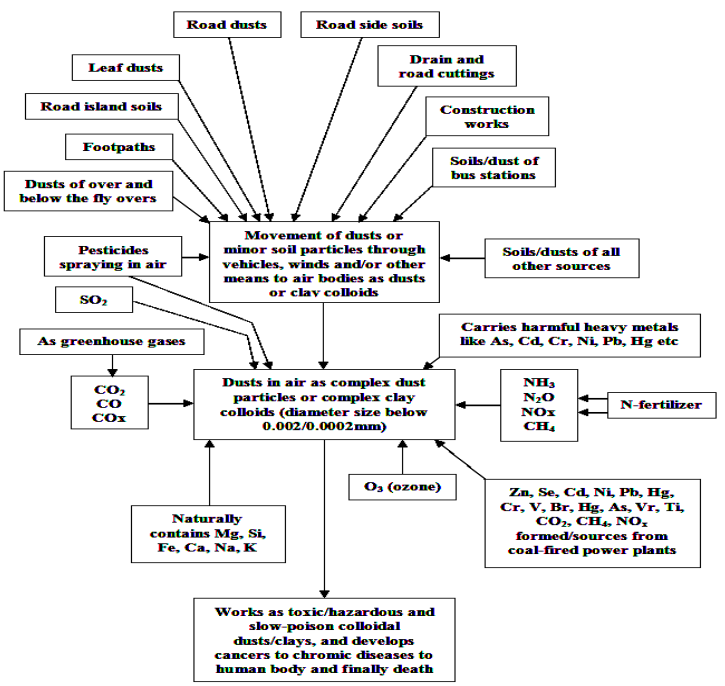

Fig. 1. Hazardous complex slow-poison atmosphic dusts or dust/clay colloids-a source of lot of chronic diseases to human body (Sattar, 2022; Ref. this article)

2. Introduction

Clay constitutes those minor soil particles-they are smaller than 0.002 mm in diameter. They are mostly the secondary minerals, mostly formed through the decomposition of original minerals or build up through sedimentation. Clays are the end products of weathering, and has been formed by hydorthermal action or deposition as sediment. Clay particles of 0.002 and 0.001 mm diameter contains primary minerals like mica, talc, hematite and quartz. Four main constituents silica, alumina, iron and water make up 90-98% of colloidal clays. Clay is a mixture of hydrated alumino-ferro silicates of varying composition mixed in some cases with an excess of sequioxides or silica. Each clay particle is made up of a large number of plate-like structural units. Besides the plate-like structure of clay also constributes towards greater surface area on which moisture and cations are held. The finer the fraction of soil or clay, the greater the percentage of hygroscopic moisture. Clay term implies natural, earthy fine grained material which develops plasticity when mixed with a limited amount of water. Clay contains a higher amounts of Mg, Si, Fe and smaller amounts of Ca, Na and K. Most of the soil clays are colloidal in size. There is no sharp line for demarcation or identification between clays and colloidal clays but particles less than 0.0002 mm in diameter are considered as colloidal clay. If clay colloids are examined under high power microscope, electron microscope or an X-ray their crystalline structure can be observed. Each crystalline clay is like a partial deck of magnetic cards, i.e. the clay is thinner in one dimension than/that of other two dimensions. Each card represents a layer each of which is nearly an exact replication of each other layer of that clay. Such many cards adhere together to make up a clay particle called a micelle. There are 2 oxygen sheets/layer in some clays 3 or 4 in others and 6 in still others.

Generally, all clay crystals are composed of one of 2-types, known as 2-layer or 3-layer crystals.

(i) 2-layer type consists of 1-layer silicon and oxygen atoms and other layer of aluminium of oxygen atoms.
(ii) 3-layer type clay crystals have 2-outside layers made of silicon and oxygen, and middle layer of aluminium and oxygen.

The common group of crystalline clay minerals with silicon is (i) kaolinite; (ii) montmorillonite; (iii) illite; (iv) smectite; (v) vermiculite and (vi) chlorite; are known as silicate clays. Some of the amorphous non-crystalline clays but have silica are included as silicate clays. Sesquoxides are a group of Fe-and Al-oxides and hydrous oxides. Manganese oxides and titanium oxides are often included under this gorup. Clay never exists as single mineral i.e. it is a mixture of several minerals where one type is prominent. Such mineral composition of clays vary in different layers/horizons of a profile and again they differ in different climatic zones/regions. Again, the composition varies due to differences in parent materials.

3. Classification of clay dusts on the basis of sand, silt and clay

On the basis of percentage of sand, silt and clay present in soils, Marshall's Traingular co-ordinates classified into 12 types of soils where clays are listed on 6-groups like (1) clay, (2) sandy clay, (3) sandy clay loam, (4) clay loam, (5) silty clay loam and (6) silty clay. USDA system showed 7 textural clays on the basis of diameter where clay occupied 2 groups like (1) sily clay (dimeter 0.05-0.002mm) and (2) clay (diameter below 0.002 mm). International system showed 4-types of textural groups on the basis of diameter ranges where clay covers the diameter range of below 0.002 mm in size. Again, Mohr's 10-fraction classified textural types into 10 classes where clay covers 2-groups (on the basis of diameter) like clay (diameter size 0.002-0.005mm) and colloidal clay (below 0.0005mm in diameter) (Sattar, 2022). There is no universal guideline for dust clays measurement. Usually, clays below 0.0002mm in diameter can be treated as dust clay too and similarly clay colloids cover the diameter size below 0.0002mm in diameter and can also be treated dust colloidal clays. On the basis of fineness of dusts-clay/dusts can be called as types or classes of dust clays similar to types of clays.

4. Properties of clay/dust colloids

The clay colloidal clay or dust colloidal clays carry the negative charges (anions) and attracts positively charged ions (cations). They have the following properties:

1. Structure
2. Substitution
3. Non-exchangeable cations
4. Cation base exchange capacity (me/100mg)
5. Anion exchange capacity
6. Cohesion and plasticity
7. Porosity and permeability
8. Size
9. Structural formula
10. Water entry into sheets/water absorptions
11. Relative swelling when wetted-remain in suspension settling velocity low
12. Relative stickiness
13. Clay dominant zone
14. Drained conditions
15. Soil condition
16. Behavior in nature
17. Shape-plates/flakes/rod shape under electron microscope
18. Na-clay/dust colloids produces defocculation and Ca-clay encourages aggregation
19. Same dust colloids from different soil differ in their properties
20. The finer the size of clay/dust colloids, the greater the intensity of colloidal properties.
21. The common clay/dust clay colloids are kaolinite, montmorillonite, illite, vermiculite, smectite and chlorite

5. Common group of clay minerals/colloidal clay/dust clay with their relative identity (Sattar, 2022)

The prominent element present in clay minerals are O, Al, Si, Mg, K, Fe etc., and they are variable on the basis of clay group including relative swelling and sickness, and again variable under natural environment conditions. The detailed descriptions of commons groups, prominent element present, relative swelling under wet, relative stickiness and visible ares of 8 categories of clays are outlined here-

Sl. No.	Name of common groups of clays	Prominant element presence	Relative swelling under wet	Relative stickiness	Prominent zone/areas
1.	Kaolinite	O, Al, Si	Nearly none	Low/slight	Warm to hot, moist subhumid to humid
2.	Smectite	O, Si, Al	High	High	Arid to humid low leaching
3.	Montmorillonite	O, Si, Al, Mg	High	High	Arid to humid low leaching
4.	Illite (hydrous mica)	O, Si, Al, K	Low	Low	Subhumid to cool zone
5.	Vermiculite	O, Si, Al, Mg	High	Moderate/medium	Subhumid to humid rich in micas
6.	Chlorite	O, Si, Al, K, Mg, Fe	None/no	None/no	Marine sediments
7.	Sesquioxides (metal oxides)	O, Fe, Al	None/no	None/no	Wet hot old soils of tropics weathered
8.	Amorphous	O, Al, Si	None/no	Poor/slight	Young volcanic ash, under weathering

6. Visible dust/dust colloids-sites (locations) at Dhaka metropolitan city

The major sources of visible clay/dust or clay/dust colloids at Dhaka metropolitan city are listed below and also listed in Fig. 1-2 where 12-15 sources of dust contaminations are reported by Sattar, in 2003:

1. All highway roads and road sides
2. Bus stations
3. Road cutting and repairing sites
4. Airports
5. Gas stations
6. Over the flyover zones-over and below the area/zones
7. Around railways stations
8. Poor carpeting roads and footpaths
9. All vehicle parking zones
10. Walking and parking areas
11. Poor drainage or erosion/breakdown of drain walls and
12. Slum zone/area
13. Tornado and/sudden windy weather
14. Kacha-sub road or soil minor road
15. High/severe crowdy areas
16. Regular walking on main road
17. Kalbaishaki winds
18. All contractions sites
19. Soils carrying by trucks or other vehicles
20. Minor ditches on roads-carry water and clay particles
21. At the rootzone areas of plants and trees
22. Soil islands (between two roads) erosion by winds and rainwater
23. Kacha market zones/areas
24. Ditch or lake development areas by adding of huge soils
25. Old or new construction/repairing zones
26. Railway line sides/areas
27. Dust on leaves of trees at road sides and urban zones
28. Hospital areas and their parking zones
29. Parks/parking zones of the residential area uses for exercises-walking, running, children playing, gaming etc.
30. Poor foot-paths/kacha walking paths.
31. Minor areas of car repairing garages
32. Poor grass carpeting or without grasses of playing ground or educational centres
33. Occupying roads and road-sides by hawkers
34. Unprotected soils of the roof-gardening
35. Longtime road repairing works
36. Preserving tops on road-sides and over flooding of water for ornamental/flowering plants
37. Digging of canal and/or river bodies around the city
38. Tyres of thousands of vehicles move around the city
39. Man walking like shoes e.g. IUBAT campus collect 1-2 kg dusts through floor cleaning at everyday
40. Fumes and movement of huge number of vehicles
41. Floor cleaning of shops, and throwing of dust main road or road sides.

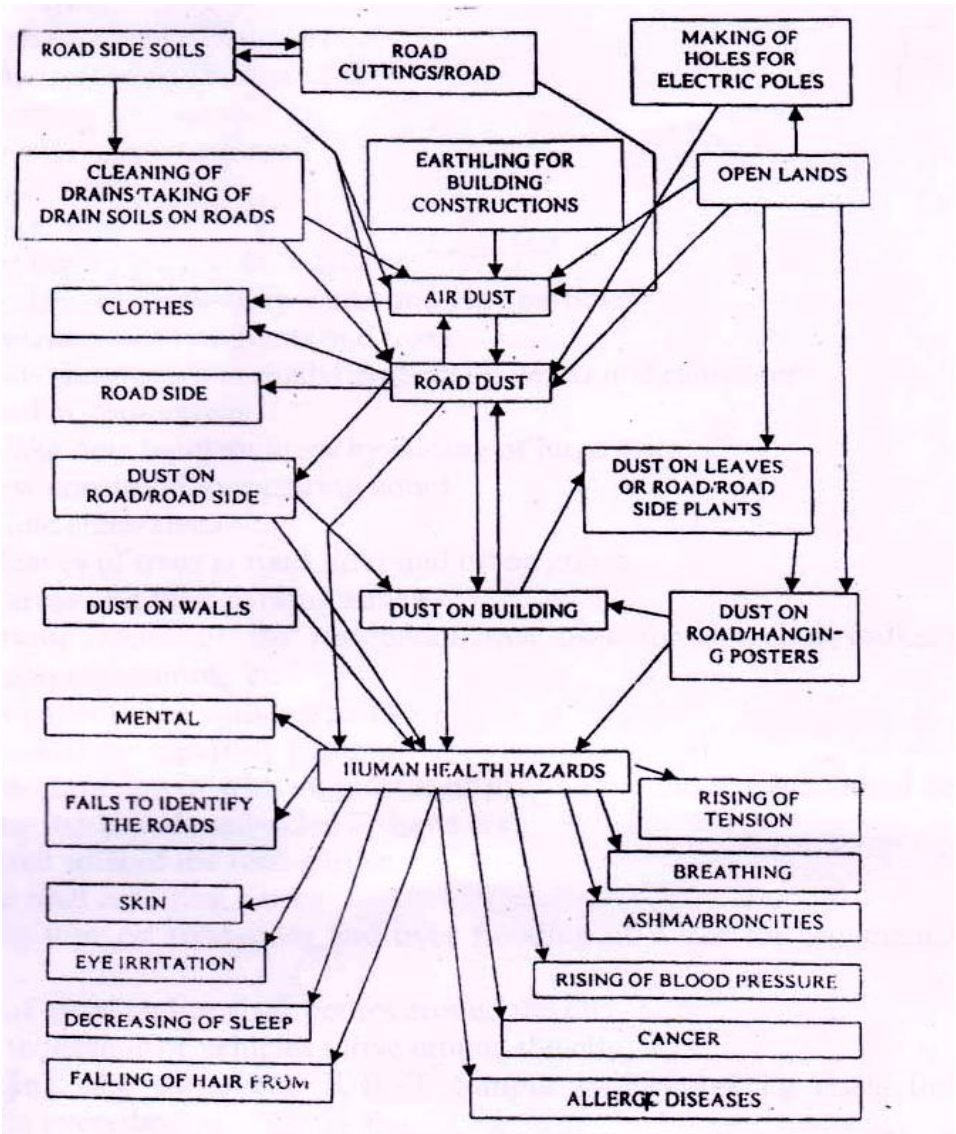

Fig. 2. Sources of dust deposition and dynamics of dust hazards to human health at metropolitan cities of Bangladesh (Sattar, 2003)

7. Observation of air contaminations by road dusts and dust colloids from House building to Banani highway road during May to October 2022

1. Everyday rush of vehicles at Housebuilding to airport, Hotel Radisson Flyover connecting zone, Navy-HQ zone, Kakoli traffic signal and Banani Rd. 11 signal
2. Dust plays in air from ground to 2-4 metre up from 8 am to 12 pm 50-100 times more than normal
3. House building to airport zone looks like a dust zone and sometimes front road zone not visible even after 5-8 meters front
4. Black air or black dust zone can be visible here and there
5. Ground dusts move behind all cars and vehicles
6. Some days air dusts become so rich that front buildings were not visible

7. Both sides of road face the similar types of dust movement and air contaminations
8. White dusts cover on ground and all over the roads same/similar white dust pictures are visible
9. Severe air dust contaminated sites are Azampur to new airport i.e. 3-5km zone
10. Air colloidal dusts entre the inside of vehicles and quickly covers the seats of the vehicles
11. Everybody's hair enjoys lot of dusts and difficult to touch by hands
12. Dust plays with vehicles and part of them may settle near the walls/road-boundaries
13. Sometimes somewhere huge dust layers moves on roads covering 1-6/7 metre height/high zone, and then even drivers could not see front clearly
14. Many times lots of people could not properly breath due to such high contaminated air/dusts colloidal forms
15. Plant leaves face minor to major white dusts on the surface
16. Sometimes some days even airport and/or its name-plate was not visible to eyes although normally quite clear and visible to all.
17. Normally 3-5 lines/rows of vehicles move side by side although 6-8 rows are visible near to airport, railway station where it looks only vehicles and air dusts.
18. Thousands of motor bikes near the road sides add huge dusts to the main road or around
19. Sometimes heavy dusts come in air from trucks carrying sands or soils from one place to another
20. The area covers very minor to poor foot-path zones where people cannot move/walk due to severe dusts

8. Comparison of source-related dust problems between developed countries and Bangladesh. (Sattar, 2022; Ref. this article)

Developed countries	Bangladesh-Dhaka city
1. No visible dusts at urban zone/region.	1. Wide/severe visible dusts at urban zone/region.
2. Very clean, observable and enjoyable weather.	2. Not clean/clear but dusty air is visible.
3. Mostly comes fresh air for inhalation.	3. Usually dusty air comes during inhalation.
4. Visible all round the year fresh air.	4. Very often not visible around the year because of fine dust in air.
5. 24-hours period is uniform of the outside air.	5. Dusty air situations gradually increases with day time and still stays upto 10/12 pm at night
6. Winter foggy weather in the day time.	6. Dust foggy weather stays most of the year although severe in winter time.
7. Views appears almost uniform all the day time/long.	7. Views variable minor to severe dusty nature/air conditions.
8. No visible dust moves during running of cars/vehicles.	8. Dust always play/move with cars/vehicles.
9. There is no survival-life of dusts in air at urban zone including on roads and highways.	9. There is always terrible fighting/existing life of dusts in air particularly on roads and highways.
10. Almost uniform dust free to all roads and all around the city.	10. Dusts life are severely visible and identical one road to another, or one place/location to another/other.
11. As there is no dust problem so no question of management.	11. There are dusts and dusts, so it is important for management.
12. They have no dust chapter in urban life.	12. There is always a strong dust chapter in the urban life.
13. They may have dust management regulation during developing of road/road systems or construction.	13. No dust management regulation during construction works or may have weak regulation.
14. Nature and life styles helps/works to protect dusts.	14. Nature and life styles strongly encourage for facing such dust problems.
15. Road dust works out of imagination of the people.	15. 100% urban people know/familiar with road/urban dust problems.

9. Comparison of road dust study between developed countries and Bangladesh (Sattar, 2022; Ref. this articles)

Developed countries	Bangladesh-Dhaka city
1. Road sides are covered similar to roads.	1. Road sides are open i.e. no plastering like plain land.
2. No visible plain soil side in road side.	2. Road side soil is open, visible and transferable.
3. No scope of movement/removal of road side soils.	3. Road side soils can severely supply dusts on the main roads.
4. Road side treated as walking zone similar to main roads.	4. Very often vehicles move to the road side zones and produces dust for the main roads.
5. No scope to carry soils by tyres of the vehicles.	5. Tyres always can carry outside zone soils/dusts to the main roads.
6. Road cutting is rarely done or work done mostly at night.	6. Road cutting and keeping of soils on sides is a common practice and adds huge dusts on roads.
7. In the urban zone, carrying soils by trucks or vehicles is not visible.	7. It is a common practice where thousands of trucks carry soils/sands from one side/place to another, and add dusts on main roads.
8. All construction works are highly technical and mechanized, so soils around are not disturbed and not producing/adding dusts.	8. During construction works huge soils/dusts come out/move from the area and spread around the zone.
9. Canal sides are permanently covered/carpeted like roads and no scope for moving of soils/dusts.	9. All canal sides are normal soil body and during digging, add soils to both/one side soils to both/one side and gradually spreads dusts to main land/roads.
10. Urban dust contamination regularly checked as routine work.	10. Urban dust contamination situations or problems are rarely checked.
11. Take urban dust as a severe case study i.e. no dust question.	11. Take it as normal city life and never go on as severe case.
12. Roads are well protected and no scope for removing/eroding of surface soils/dusts.	12. Road islands (between 2-roads) are poorly developed and during raining erosion occurs and encourages dust movement to main roads.
13. Road and its inner side is free from dusts or soils.	13. 15-20 cm inner side of roads are covered with 5-10 cm or more height with soils or dust layers and add dust during movement of vehicles.
14. Rain water carries clean water on roads.	14. Rain water carries clay/dusts on roads and road sides and after dryness add again dusts and dusts.

10. Clay or dust colloid contaminations

Clays/dust sizes cover below 0.002mm in diameter and clay/dust colloid sizes come below 0.0002 mm 0.02μ in diameter. According to the global issue dusts come as particulate matters (PM) where they counted as PM_{10} to $PM_{2.5}$ i.e. sizes cover $PM_{10\text{-}2.5\mu}$ or 0.01 mm to 0.0025mm in diameter. Normally, when dusts pollution or contaminations in air are observed then it is measured or treated as particulate matters and mostly measured or recorded under satellite measurement covering PM_{10} to $PM_{2.5}$ (larger to smaller grades of clays/dusts against areas of m^{-3} size. The moving clays/dust particles or particulate matters never be counted or treated as pure clays, pure dust particles or very minute sizes of pure particulate matters. Such satellite workers never think the real contaminated matters of dusts of particulate matters.

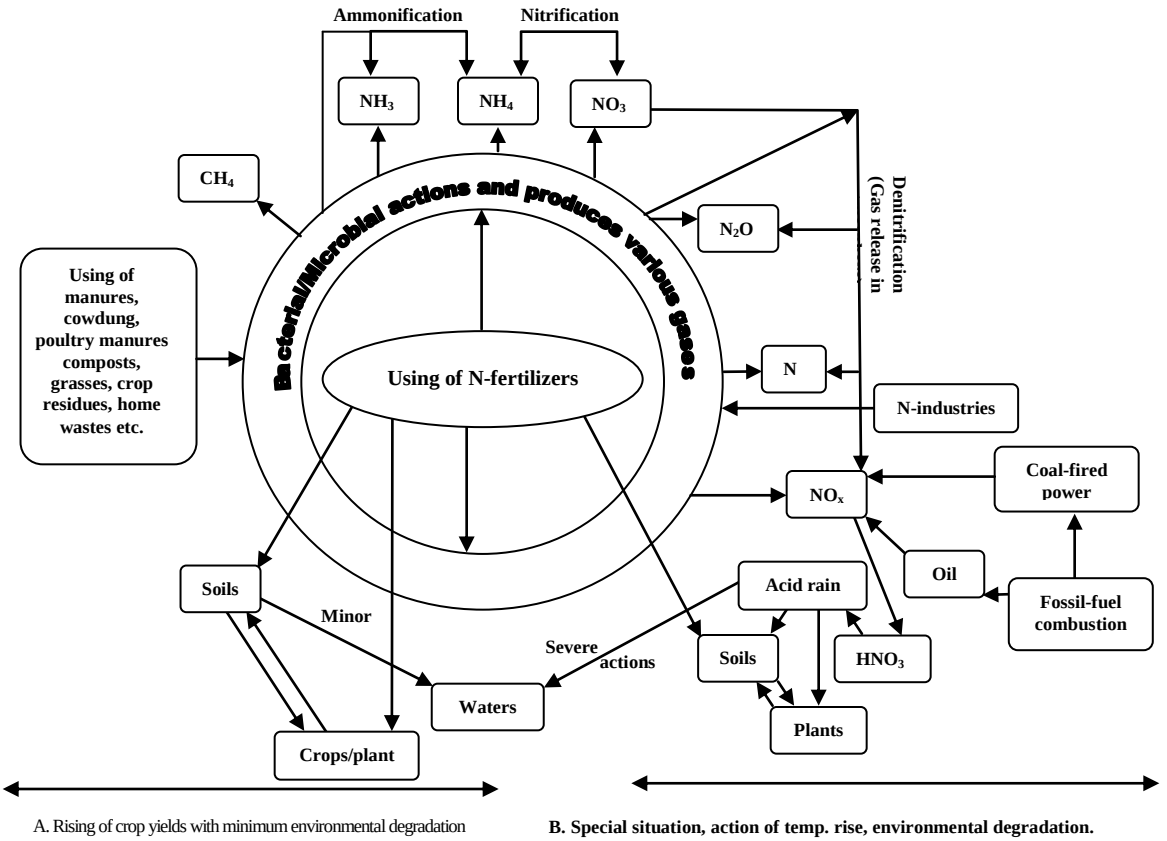

Fig. 3. Schematic model of N-cycle showing the NO_x contamination to the soils, crops and environment (Sattar, 2010)

They thought it is the particulate matters or colloidal dusts alone responsible for producing of health hazards creating minor to major diseases and even finally death. This is not the true statement or decisions. The practical fact is entirely different where they first clearly must know the chemical compositions of the contaminants to air dusts or dust colloids/clay colloids or particulate matters. On the basis of concentrations of various contaminants and their severity then one can conclude the type and severity of health hazards including facing of minor, trace, medium or severe attack of diseases. The quality or contaminated composition of dusts, particulate matters varies from one place to another. Without laboratory analysis of the clays/clay colloids/dusts/dust colloids or particulate matters-only PM area measurement, and conclusions on health hazards and diseases attack concepts can poorly be advised as an issue concept. Practically, clays/clay colloids/dusts/dust colloids/particulate matters (sizes >0.0002mm in diamter) of various sizes and sources (Fig. 1-2) move as air dusts in air where they carry pollutants/contaminants like CO_2, CO, SO_2, SO_x, N_2O, NOx (Fig. 3, Table 2), various heavy metals where 19-heavy metals like Pb, Al, Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn, Cd, Sn, Sb, Ba, Hg, As, Mo, Sn and Zn were recorded from soils or dusts of various locations at Dhaka metropolitan city (Table 1) although 5-7 heavy metals normally move in air as PM and actively participate in health hazards even cancer to death (Table 5). Here As, Pb, Cr, Hg, Ni etc. actively move in air as dust colloids/particulate matters associated with lot of diseases of human body even cancer (Table 5, Fig. 5). Normally, various heavy metals enter the human body through foods, vegetables, air, dust, dust colloids as PM, water etc. and work as slow poison and gradually encourages diseases. Here

foods and vegetables, even rice etc. contain heavy metals below the standard, and no problems of health hazards except exceptional circumstances like severe uses of heavy metal bearing fertilizers or pesticides to crops, so routine analysis is important but for questions 3-lab. analyses are required (Sattar, 2005; Sattar and Islam, 2011). Even coal fired power plants contaminate air through dusts or particulate matters where they add CO_2, CO, SO_2, O_3, CH_4, NO_x and heavy metals like Ur, Tr, As, Mo, Zn, Se, Cd, Ni, Pb, Br, Cr, V and Hg (Fig. 4), and again most of them are closely related and causes minor to major health hazards. Usually, they work as slow poison to the human body and similarly, associated with minor to major diseases like ashma, allergic, vomitting, eye and skin diseases, loss of hair, mental diseases, cancer, paralysis, breathing troubles, blood pressure etc. (Fig. 5, Table 5). Dusts are scientifically treated as clay colloids, so here their sources, problems, health hazards and managements at Dhaka Metropolitan city are properly and scientifically analysed and reported.

Table 1. Heavy metal contaminations from soils and dusts at different sites of Dhaka metropolitan city (Sattar, et al. 2005)

Sl. No.	Name of heavy metals	Ranges ppm
1.	Pb	7 – 234
2.	Al	366 – 3983
3.	Ti	12 – 1766
4.	Cr	15 – 54
5.	Mn	160 – 498
6.	Fe	2500 – 29,433
7.	Co	4 – 15
8.	Ni	14 – 70
9.	Cu	15 – 101
10.	Zn	33 – 263
11.	Cd	1 – 4
12.	Sn	1 – 6
13.	Sb	1 – 6
14.	Ba	36 – 106
15.	Hg	3 – 10
16.	As	6 – 11
17.	Mo	1 – 7
18.	Sr	111 – 155
19.	Zn	113 – 205

According US Environmental Protection Agency (USEPA, 2012) the major sources of air pollutants like CO, SO_2, NO_2, O_3, Pb and PM are listed in Table. 2.

Table 2. Major sources of air pollutant (USEPA, 2012)

Serial No.	Pollutants	Sources
1.	CO	Motor vehicle exhausts, kerosene, power plants with internal combustion engines or wood/biomass burning stoves.
2.	SO_2	Coal-fired power plants, brick kilms, petroleum refineries, H_2SO_4-manufacture and smelting, S-containing ores.
3.	NO_2	Motor vehicles, power plants and other industrial, commercial and residential sources those burn fuels (like diesel generator) and nitrogenous fertilizers.
4.	O_3	Vehicle exhaust and certain other fumes (hydrocarbons); formed from other air pollutants in presence of sun light.
5.	Pb	Metal refineries, lead-smelters, battery manufactures, iron and steel producers.
6.	PM	Diesel engines, motor vehicles, power plants, brick kilns, industries, windblown and road dust, wood/biomass stoves, open burning.

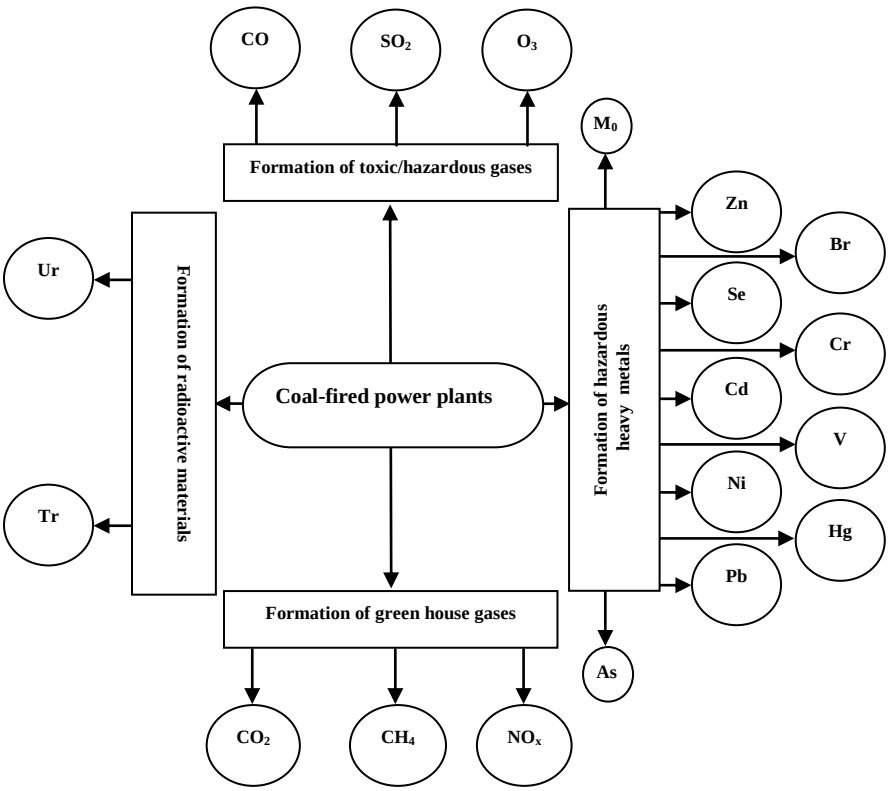

Fig. 4. Formation of various gases (hazardous and green house) and toxic/harmful heavy metals to air from coal-fired power plants (Sattar 2010)

Initially, human health face minor diseases and gradually attacked with cancer or other severe diseases and finally death.

11. Air quality standards

Air quality standards of Bangladesh including WHO and US standards covering of CO, NO_x, SO_2 (24 hrs and annual), O_3 (1 hr and 8 hrs), SPM, PM_{10}, $PM_{2.5}$ (24 hrs and annual) and Pb are presented in Table 3 (ADB, 2006). Again, Indian Air quality standards covering of SPM, SO_2 and NO_2 of industrial and residential areas, and recorded data from four Metropolitan cities of Kolkata, Delhi, Mumbai and Chenni of industrial, commercial and residential area of 2000 and 2001 are reported in Table 4 where on the basis of SPM Kolkata and Delhi industrial although residential area of Kolkata, Delhi and Mumbi are shown to be slightly contaminated. But on the basis of NO_2 and SO_2 no air pollution/contamination was marked as results showed below the standard. Now very often it is stated in the newspaper of Bangladesh about the air pollution/contamination at Dhaka Metropolitan city where area, comparison of standards covering CO, NO_x, SO_2, O_3, SPM, $PM_{1.0}$, $PM_{2.5}$ and Pb (Table 3) showed against the real field and lab-data. Standards are variable place to place and again on industrial, commercial and residential area (Table 3-4). Only applying of SPM or $PM_{2.5}/PM_{10}$ result without adding of other factors-CO, NO_x, SO_2, O_3 etc. as in Table. 3, one cannot say air (dust colloids in air) is really polluted or contaminated although still there might be a question of regarding the As, Pb, Cd, Hg, Ni, Cr etc. or other heavy metal situations on air dusts/air colloids/dust colloids in that particular areas.

Table 3. Ambient air quality standards in Bangladesh and their various/comparisons with WHO and US standard (ADB, 2006)

Serial No.	Pollutants	Averaging time	Bangladesh standards μg(m3)	WHO guideline μg(m3)	US standard μg(m3)
1.	CO	8 hrs.	10,000(9 ppm)	10,000	10,000
2.	NO_x	annual	100 (0.053 ppm)	-	-
3.	SO_2	24hrs.	365 (0.14 ppm)	20	365
4.	SO_2	annual	80 (0.03 ppm)	-	78
5.	O_3	1hr	235 (0.12 ppm)	-	235
6.	O_3	8hrs.	157 (0.08 ppm)	100	157
7.	Suspended particulate matter (SPM)	8hrs.	200	-	-
8.	Coarse particulate matter (PM_{10})	annual	50	20	-
9.	Fine particulate matter ($PM_{2.5}$)	24hrs.	65	25	35
10.	$PM_{2.5}$	annual	15	10	15
11.	Pb	annual	0.5	0.5	0.15

Table 4. Ambient Air Quality in 2000 and 2001 under NAQM for four Metro politan cities (Annual average, μg/m^2) of India

(NAQS = National Ambient Air Quality Standard) (De, 2005)

City	Pollutant	Industries area		Commercial area		Residential area	
		2000	2001	2000	2001	2000	2001
Kolkata	SPM	420	300	320	290	280	220
	(NAAOS)	(360)				(140)	
	SO_2	30	25	15	22	14	15
	(NAAOS)	(80)				(80)	
	NO_2	42	48	40	80	36	50
	(NAAOS)	(80)				(60)	
Delhi	SPM	680	650	480	590	470	400
	SO_2	20	18	14	18	12	12
	NO_2	62	70	62	65	50	52
Mumbai	SPM	300	250	280	250	210	250
	SO_2	13	12	10	12	8	11
	NO_2	37	30	37	28	22	28
Channai	SPM	100	90	100	95	80	85
	SO_2	6	10	4	4	4	4
	NO_2	36	30	38	12	22	10

12. Clay/dust or clay colloids/dust colloid hazards to human health

Dust or dust colloids (PM below 2.5μ) as poison on the basis of presence of contaminants enter the human body with air, and also move to human body with crops, foods, fishes, water, vegetables, fruits as heavy metals, pesticide residues and other contaminants and produces different diseases (Sattar, 2003; 2016; Sattar and Sattar, 2004, Fig. 5; Table 5) and they are listed herewith:

1. Eye irritation
2. Various skin diseases
3. Mental disorders
4. Falling of hairs
5. Decreasing of sleep
6. Rising of tensions
7. Breathing troubles
8. Various health, lung or kidney diseases
9. Ashma/broncities
10. Increasing of blood pressures
11. Different cancers or other chronic diseases
12. Allergic diseases
13. Vomiting tendency
14. Depressior or loss of interest
15. Brain/kidney damages
16. Diabetes
17. Arises of blindness
18. Loss of appetites
19. Hormonal disorders
20. Headache, drowniness, confussion, convalsion etc.
21. Diarrhea, burning of mouth and/or throat.

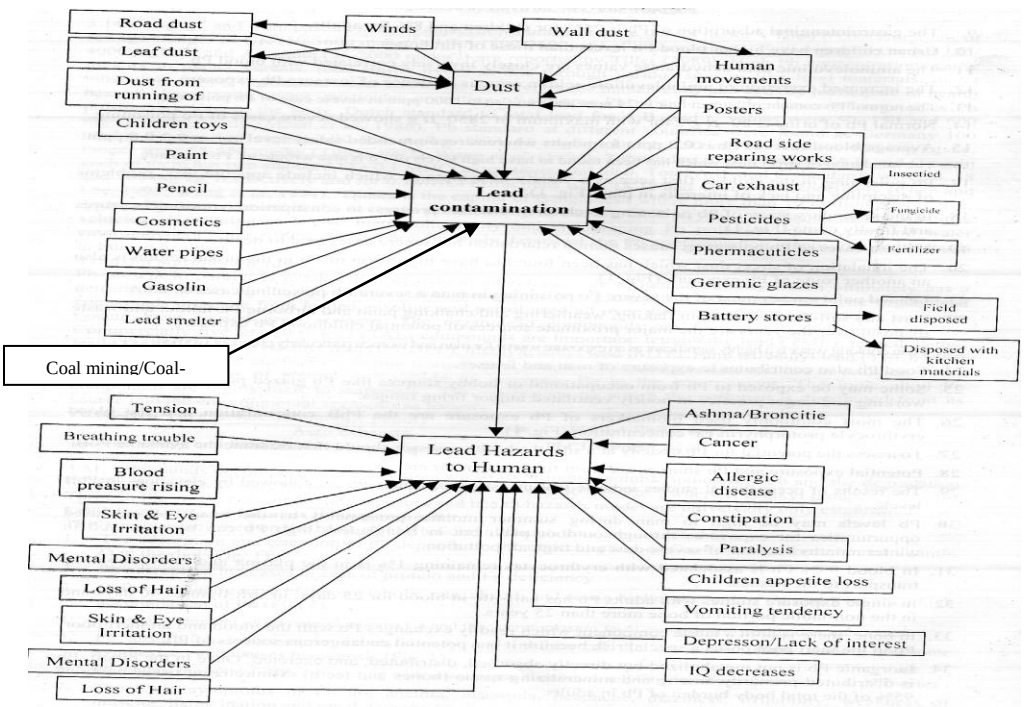

Fig. 5. A schematic outline of the lead contamination, exposures and health hazards (Sattar and Sattar, 2004)

The sources of Pb contaminations are listed in Fig. 5 where more than 20 sources including dust contaminations in air, soils and food materials encourages health hazards and causes a lot of diseases (10-15) to human body (Fig. 5, Table 5). Again, presence of heavy metals like Pb, Cd, Hg, As, Cr, Ni, Co, Zn, Mn etc. in dusts or dust colloids in air also associated with numerous health hazards and various minor to major diseases to human health and they are widely listed in Fig. 5 (Sattar and Sattar, 2004) and Table 5 (Sattar, 2016).

Table 5. Heavy metal related health hazards (Sattar, 2016)

Sl. No.	Heavy metals	Symbol	Causes of diseases/health hazards
1.	Cadmium	Cd	i Kidney, lung and liver diseases or damages ii Blood pressure iii Kidney stone/various infections iv Severe actions on bones, central nervous system v pancreas, salivary glands, etc. vi Increase excration of amino acids, glucose, P and Ca vii Cd-dust or fumes-growth of cough, infection and damages of kidney, lung viii Severe cases death
2.	Mercury	Hg	i Minor to major irritation, inflammation and possible death ii Damages of kidney and intestine iii Mental and emotional disorders iv Fear, headache, depression v With high concentrations arises mental problems/abnormalities vi Brain damages vii Causes tumors, vertigo, loss of vision, hearing etc. viii Changes organs of cardiovascular, urogenital and endocrine system or disfunctions
3.	Lead	Pb	i Appetite loss, abnormalities, not like to play or more for the case of children ii Constipation, vomiting, seizures, coma iii Mental retardation to death in some cases iv Changes blood tissues due to wide inhalation v Reduces plasma Ca finally brain damage vi Anemia, headache, dizzines, irritability, weakness of muscles, renal damages vii Discomfort and disliking of works/any matters viii Sometimes passes days and/or mights without sleep ix Feels tension and anxity

Sl. No.	Heavy metals	Symbol	Causes of diseases/health hazards
4.	Arsenic	As	i Loss of weight, loss of appetite, gastointestinal, disorders ii Lunge and skin cancer even to death iii Nausea, vomiting iv Diarrhea, burning of mouth and/or throat v Weakness, prostration vi Peripheral neuropathy, pigmentation of various types in fingers, nails, foot, legs etc. finally arises cancer then gradual death vii Headache, drowniness, confussion and convulsion viii Skin damages/abnormalities
5.	Nickel	Ni	i Abnormalities to plasma, cholesterol level, liver glycogen ii Hormonal disorders iii Affects RNA and DNA systems/structures iv Lung cancer v Causes respiratory tract neoplan/disfunctions vi Dermatites, enzymes
6.	Cobalt	Co	i Affect hemoglobin ii Produce polycythemia and huperlipena iii Goiter discase iv Loss of work speed
7.	Chromium	Cr	i Causes diseases on skin and respiratory tract ii Lung cancer even to death iii Causes nasal irritation and reflex activity iv Diseases like hyperglycemia, hypocholestone v Causes diabetes, weight loss
8.	Zinc	Zn	i Loss of appetite ii Growth of retardation iii Poor hair/nail growth or absence of hair iv Causes diarrhea, anemia v Skin diseases vi Arises blindness vii Alopecia viii Mental disorders ix Altered PO-metabolism x Diabetes xi Cerebellar diseases xii Forming panceratic cysts xiii Parakeradic disease
9.	Manganese	Mn	i Cause paralysis ii Diseases of lung and trachea iii Causes moodiness iv Comparative rural people are very much contaminated

13. Comparison of dust related health hazards between Bangladesh and developed countries (Sattar, 2022, Ref. this article)

Developed countries	Bangladesh-Dhaka city
1. Everyone knows dust is closely related to health hazards.	1. Everybody severely know-dust occurs health hazards.
2. Urban people never or rarely face dust problems.	2. Urban zone/region people always face dust problems.
3. People usually inhale fresh air.	3. People usually inhale dusts or contaminated air.
4. People know dust may work as slow poison in the body.	4. Very limited people know it but no scope to deny the fact.
5. People are very much aware of road about dust inhalation as creates a lot of lung diseases.	5. People have no alternative methods/technique to remove dust from lives.
6. Dust affected death case none or very rare.	6. 70-80% people enjoy dust as common practice but gradually face minor to major diseases, and finally to die.
7. As dust create heart disease so dust related health disease or death is minimum.	7. Dust related health hazards is severe/wide so disease widely increased in the country.
8. There is no question of poor or slum people, so related health hazard problem not arises.	8. Poor or slum people are largely affected or infected due to severe urban dusts at urbon zone.
9. Life leading is smooth and normal.	9. Leading with smooth and peace life in different due to dust contaminations to everyday life.
10. As there is no dust, so no question of dust contamination to children.	10. Mostly children and older people face severe/wide dust contaminations and health hazards.
11. As there is no dust, so no question of seasonal contamination of hazards.	11. Severe contamination occurs in winter although dust contamination and health hazards are visible throughout the year.
12. Dust never changes quality of head-hair, as there is no dust in air.	12. Dusts make sticky hair of head and needs regular washing.
13. Never affect normal life of people at any place.	13. Dhaka as the zone of global heaviest dust contaminated city, so people face dust related various diseases and cause death of large number of people.
14. As there is no dust in air people wash usually after 2/3 days.	14. Due to severe dust in air, so people are bound to wash atleast one-time in a day.

14. Suggestions and Recommendations

1. First universal and then 100-years master plan of Dhaka Metropolitan city must be done through wide research and experts of national and international categories.
2. Road cutting and drain side cutting should be strongly avoided, if needed that must be done at night, and that/those should be completed during the night period.
3. There must be public walking street/road at the side of the main road where the area should be properly cemented and/or covered like main roads so that dusts never comes out to the main road or the surrounding regions.
4. Road peach or carpeting must be done to the main roads and side roads or sub-roads, so that soils/dusts never come out for action.
5. High mechanical and technical building constructions should be done skillfully with strong capacity avoiding of sound or displacement of soils or dusts.
6. Regular watering is required on the main roads during winter and other times on the basis of dust situations/movement in air or the surrounding area/region.
7. Soil or sands carrying from one place to another on the road and/or sub-roads should be strongly protected against ground falling on roads/area where it widely creates quick hazards of dusts in air.
8. Sand carrying for constructions works should be moved or transported through protected/closed trucks/vehicles so that wind movement from top layers can be checked properly.
9. All soil sand parks should be properly maintained with green grass carpeting. Clear grassless field/area spreads soils and/or dusts to the surrounding area/zones.
10. Road-islands cover with soils and dusts must be enough below the sidewalls so that soils cannot move with rain-water erosion, wind or human activities.
11. One point must be remembered that road-zone/area always be 100% free from dusts so that vehicles cannot carry/spread dusts in air.
12. Under the Dept. of Environment, there must be an Environmental Research Institute or separate environmental research cell where a separate Director can widely handle the soil, water and air pollution or contamination at Dhaka metropolitan city. Here routine research must be conducted throughout the year under various research projects. Here soil, air, water, foods, vegetables and fruits quality must be checked against as routine work heavy metals, pesticides and/or other hazardous materials.
13. Under Dept. of Environment, there must be a strong govt. expert committee covering 8-12 members including public university professors for building of proper guidance, suggestions and recommendations for observation, lab. study and management of dusts at Dhaka city.
14. There must be a strong project for 5 years for proper handling and management of dust air-dust contaminations at Dhaka and all other Divisional cities of Bangladesh.
15. Routine lab. analysis and checking (once within 6 months) of air quality like CO_2, CO, SO_2, SO_x, NO_x and N_2O is also very much important for proper identifying the pollutants/contaminants against the standard limits. Here $PM_{2.5}$ should also be taken/measured under satellite observations to everyday as routine work too.
16. Regular routine checking (once in a year) of city's soil/dusts from various areas- roads, highways, highway sides, bus stations, parks, residential areas, airports, playgrounds, garages, pump stations, road cutting sites/areas, drain-soils for proper observation of problems and management and here heavy metals like As, Pb, Cd, Ni, Cr, Hg etc. should be measured, although 18-24 heavy metals can be detected from soils.

17. Road side cleaning of dusts and wastes should be done in the early morning i.e. before 6 am. As the main road covers huge white dusts so sometimes main road dusts should be cleaned too by large road/dust cleaners through brushing.
18. Dust collections should be done from heavy dust zone/regions where toxic/harmful 10-12 or more heavy metals should be routinely checked, and in case high levels proper precautions and management must be done.
19. Roof-gardening's should be done so smoothly that they never drain out or erode soils/dusts from the tops/floors to the ground.
20. Gardening in the road sides must be done properly so that no wind, water or rainfall erosion creates dust hazards to main roads.
21. Soil sediments/dust deposition near to two sides of main roads should be cleaned everyday at early morning or late night time.
22. Drain sands, soils/wastes collected once or twice in a year usually kept on road sides for longer times encourages soils/dust erosion through winds or vehicles so those must be removed immediately after collection.
23. Sometimes somewhere road cutting is done for placement of electric or gas pipes but those are then mostly filled with soils or sands and kept years after years where soils, sands, dusts or dust colloids are moved by winds or vehicles to the surrounding areas buildings/producing a zone/regions of dust contaminated or hazardous areas. Such road cuttings and after fillings with soils or dusts, cemented should be done properly so that no dust contaminations/hazards may arise/come out on roads.
24. Everyday after cleaning of floor of the shops, the dusts are normally thrown/removed to the front-roads where again dust contaminations occur, and such floor wastes/floor dusts should be thrown to dustbins or proper containers for disposal.
25. Most of the offices, public and private houses, restaurants, shops, malls/departmental stores etc. use different categories of carpets or mats and everyday or veryoften those are mostly cleaned on roads, road sides, parks, garages etc. where those produce severe dusts in the areas; and such cleanings must be done through proper managing/controlling of dusts with saving of fresh air of nature.
26. During rainy seasons, occasional heavy rainfall creates flooding on roads and then water erosion develops sediments/sands or soil to one side or to low land area and after drying these dusts or sand particles encourage contaminations to air as air pollutants. So such rain water loggings must be checked and managed any deposition of sands or dust particles.
27. Vehicles produce black flumes add further contaminations like black dust contaminates air too and those must be protected developing/applying laws against such hazardous/problematic vehicles.
28. Now green Dhaka widely changed to dusted Dhaka where plantation must be done on road sides, islands zones, private, personal and govt. housing and residential area, river/lake sides/zones campus of educational institute, park zones etc. and regular nersuring should also be done.
29. Vehicles adding/spreading fumes in air should be strictly restricted to run for minimizing black dust fumes in air.
30. Finally, again it is stated that all roads and road/highways roads never carry any clay/dusts/dust colloids in its face as those move/play with vehicles making a dusty/contaminated air/nature.
31. During movement on roads, it is better to use mask against air dust hazards and safe sound and longer lives.
32. Brick fields around Dhaka city should be stopped or checked strongly against dust hazards.
33. All construction works should be done through applying of water everyday covering the sites/zones.

15. Acknowledgement

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