American Journal of Engineering Research (AJER)
e-ISSN : 2320-0847 p-ISSN : 2320-0936
Volume-02, Issue-09, pp-251-257
www.ajer.org

Research Paper Open Access

Water and Soil Pollution in Punjab with Special Reference to Mandi Gobindgarh & Surrounding Areas

Dr. Shalini Gupta[1], Dr. D S Grewal[2], Ajay Gupta[3]
1. Pro Vice Chancellor, Desh Bhagat University, Mandi Gobindgarh, Punjab, India
2. Dean R & D, Desh Bhagat University, Mandi Gobindgarh, Punjab, India
3. Research Scholar, Desh Bhagat University, Punjab, India

I. INTRODUCION

Mandi Gobindgarh is an industrial town in Fatehgarh District of Punjab, India, located on NH-1 at an equi-distance of 55 kms from Ambala, Ludhiana and Chandigarh. It is the second biggest industrial town in Punjab and its industry includes 475 units generating hazardous waste making it as one among the list of 43 critically polluted industrial hubs of the country on which the ministry had imposed a moratorium. (Indian Express: 09 Dec 2012). The population showed a higher prevalence of symptoms of respiratory problems, angina, cardiovascular and skin diseases. The rural area around the city too stands polluted due to industrial smoke, dust and 'the burning of over 20 million tons of paddy husk by Punjab's farmers' triggered smog.' (Times of India 12 Dec 2012). The Commutative Environment Pollution Index for land (soil and ground water) has been calculated as 62 for Mandi Gobindgarh and it has been declared as critical as per the analysis results of the samples of ground water collected by the Punjab Pollution Board from different localities of the town.

II. NEED FOR THE STUDY

No detailed study on pollution of water and soil in Mandi Gobindgarh and its perforation into surrounding areas have been found studied. None of the related studies has covered the pollution in rural areas of the district or the adjoining rural areas of the industrial town. No study has yet been carried out on macro scale or nano-scale. The detailed impact of all types of pollution on health is also not studied so far, hence this study is conducted.

III. BACKGROUND

There are 89 induction furnaces, 38 cupola furnaces, 1 arc furnace, 247 steel rolling mills, 13 refractories and forging industry each and 3 lead extraction units. It stands the 17th most polluted industrial town in India. (The Tribune India: 9 Dec 2011) 475 units situated in Mandi Gobindgarh that area generating hazardous waste. The main hazardous waste is generated from arc /induction furnaces as dust from air pollution control device. About 3 TPD of hazardous waste is generated by these industries. In addition 9 hospitals operating in Mandi Gobindgarh generate about 20 Kg/day of biomedical waste pertaining to category No.1, 4, 5, 6, 7 and 8 is generated in the town. About 44 T/day of municipal solid waste is generated from the Mandi Gobindgarh town. The Municipal Council has not made any arrangements for proper treatment and disposal of the said waste. Presently, the solid waste is disposed of on 1.25 acre of open land located on Agni Casting Road (link road from G.T. Road on Sirhind Side). The solid wastes in the shape of solid sludge generated from the cooling water recirculation tanks of re-rolling mills are disposed of along the road sides. The e-waste is generally generated from dismantling activities of various electrical/electronic appliances/gadgets such as audiovisual components, televisions, VCRs, stereo equipment, mobile phones and computer components. But till date, no inventory of such waste has been prepared. However, for the proper disposal of such type of waste, the Ministry of Environment & Forest India, has included this waste in the Hazardous Wastes.

A report prepared by the Punjab Pollution Control Board identified various bodies responsible for different actions in different areas of pollution control. These bodies included Punjab Pollution Control Board, Municipality, Police, PWD, Department of Forests, industries, transport, and local bodies and prepared an action plan. It found the following areas need corrective action in order to improve the ground water quality:

(i) Stagnation of M.C. sewage / silage
(ii) Unscientific disposal of municipal solid waste
(iii) Improper disposal of industrial solid waste

IV. OBJECTIVE OF THE STUDY:

1. To study the water and soil pollution in Mandi Gobindgarh and surrounding rural areas.
2. To find out the causes of water and soil pollutants in the area.
3. To measure the impact of soil and water pollution on health of the population of the area.
4. To find out solutions to these pollutants and their effects
5. To evaluate the measures adopted to control/eliminate these pollutants
6. To suggest an Environment Management System.

V. HYPOTHESIS

1. Water and soil of Mandi Gobindgarh town and the surrounding rural areas are highly polluted
2. Pollution is the cause of chronic diseases like Cardiovascular and Gastro diseases in the area.
3. Pollution in urban area is also impacting the surrounding rural area.

VI. DELIMITATION

Area of the study is the town of Mandi Gobindgarh town and surrounding villages of Fatehgarh Sahib District with in 10 Kms of the town. In addition some samples are also obtained from other neighbouring villages to know the actual extent of impact. 397 samples were taken from industry and rural areas.

VII. METHODOLOGY

Research Methodology adopted is exploratory in nature since very limited research has been carried out on pollution in Mandi Gobindgarh and surrounding areas. The methodology involved observation and survey. Techniques used were questionnaire and camera in addition to personal observation. Observations of Mandi Gobindgarh and adjoining areas were conducted by the researcher in detail since she has been the permanent resident of the area for the last 30 years. She visited most part of the area of research to find out the exact details and established contacts with the samples for information. The important pollution sources were photographed with the help of institution's photographers. The survey was conducted through 10 questionnaires. Secondary data was provided by the Punjab Pollution Control Board and the medical Authorities. Both Primary and secondary data was made use of.

Data Collection through Questionnaire

The observations were further extended with 8 sets of questionnaires. In addition records from Medical authorities at Mandi Gobindgarh and Amloh were also obtained through 2 different questionnaires. The questionnaire to the general public and the rural areas was both in English and Punjabi since most of the population is Punjabi speaking. One questionnaire was given to Punjab Pollution Control Board, Patiala. The data and the information so collected through these 10 questionnaires were crosschecked for validity and reliability through cross checking because certain questions were meant for cross-check to check the reliability. Keeping in view the validity requirement, questionnaires were separately prepared for Industry management: industrial labour, farm management: farm labour, urban residents: rural residents respectively. To check the effect of the pollution and the remedial actions taken so far by various agencies; two questionnaires were given to medical authorities at Mandi Gobindgarh and Amloh and one to Punjab Pollution Control Board Patiala. Photography of prominent pollution sources was also obtained.

Samples

Samples were selected from among the residents of Mandi Gobindgarh (113) and over 20 villages (99) around to know their experience of pollution. Also samples were obtained from the persons involved with sources of pollution i.e., industry managements (45), industry labour (48), farmers (49) and farm labour (40). Observations of 397 observers through questions were thus obtained; about 98% of them having the experience of pollution in the area for more than 5 years. Out of these 207 samples were from Mandi Gobindgarh and 190 from adjoining villages. Samples were taken from male as well as female respondents. Samples were selected both from urban and rural areas.

Data Tabulation & Analysis

The obtained data was compiled in Tables and results in tables and graphs. Analysis of the data was done statistically with the help of Wiconxon Tests and Paired Sample Test.

VIII. RESULTS AND ANALYSIS

Observations:

The researcher visited the entire area of Mandi Gobindgarh and adjoining villages to find the actual state of pollution and found that the entire Mandi Gobindgarh area was heavily polluted. The environment degradation in Mandi Gobindgarh and surrounding area is observable and recordable.The rural areas are polluted most due to pesticides and stubble burning. Pesticides are chemicals used to control a whole range of pests and include insecticides, herbicides, fungicides and rodenticides. There are serious environmental problems and health concerns resulting from the use of pesticides. Pesticide residues have been found in breast milk, milk from cattle, and in fruits and vegetables. The mortality rate of milch cattle in this area has been increasing during the monsoon for the past few years. While veterinarians say the increasing mortality rate is a consequence of the excessive use of pesticides and insecticides by farmers in their fields, toxicologists claim that concentration of nitrate in the stalks of crops is the main reason. The affected farmers, however, feel that some poisonous wild growth has been the cause of their death. Locals are voicing forcefully for the government to outlaw pesticides and advocate organic agriculture. After decades of relying on fertilizers, some farmers now say that the benefits have come at too great a cost, slowly siphoning the health of both the soil – sapping nutrients and killing micro-organisms – and the surrounding communities. It has led to a spike in cancer, low sperm counts in men, the early onset of menstruation and an increase of still births in women, as well as other ailments. Presently medical teams are assessing the TB cases in the area under a Central Government project from Ministry of Health.

Carrying out Environmental Impact Assessment (EIA) remains a problem. The researcher found that the major obstacles are the difficulties in obtaining reliable baseline data, the lack of access to modern technological tools like Global Positioning Systems and Geographical Information Systems, a shortage of quality laboratories and little public participation.

The researcher herself visited the entire area of Mandi Gobindgarh and adjoining villages to find out the actual state of pollution and also the action taken on the points by Punjab Pollution Control Board in the Action Plan 2010. The researcher found that entire Mandi Gobindgarh is heavily polluted and did not find any improvement since 2010.

Analysis and Interpretations

All the primary sources i.e., observations, discussions, survey questionnaires, schedules and photography and the secondary sources; the report of Punjab Pollution Control Board, articles and news in local papers and the two field studies reveal that Mandi Gobindgarh and its surrounding areas are polluted. All the air, soil and water in the area are badly affected by the pollution. The presence of all these chemicals are considered an alarming as its prolonged exposure has led to various health ailments. Diseases like TB, heart ailment, skin, breathing problems, allergy, gases, anemia, asthma which did not exist ten years before have now come in a big way.

Population of Mandi Gobindgarh is 155416 in 2012 and of Amloh is 12686. It shows that every person in among ten in Mandi Gobindgarh is sick by one or other disease while the sickness ratio in Amloh just 14 kms from Mandi Gobindgarh is not even 0.5%. For example respiratory diseases, problems are 1000 times more heart problems are more than 400 times and skin 300 times more in 2012 in Mandi Gobindgarh than Amloh. This is all due to heavy amount of pollution in the area. The excessive particulate matter is a potential danger to the residents and it is very essential that it is controlled at war footing. Wilcoxon test for pollution due to water and soil in urban and rural areas was carried out to find out the relationship between pollution and various diseases.

Wilcoxon Test Urban Area for Water

Table 1:Wilcoxon Signed Rank Test Statistics of relationship between water pollution and various diseases in Urban Area Mandi Gobindgarh[b]

	TB - Water	Gastro - Water	Skin - Water
Z	-7.649[a]	-7.620[a]	-4.250[a]
Asymp. Sig. (2-tailed)	.000	.000	.000

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

Analysis 1: From table 1 relationship between water pollution and TB, Gastro and Skin diseases in Urban Areas of Mandi Gobindgarh were compared through Wilcoxon Signed Ranks Test. The test showed a

significant impact of water pollution on TB, Gastro and Skin diseases because of z value of 7.649 between water pollution and TB diseases; z value of 7.620 between water pollution and gastro diseases; z value of 4.250 between water pollution and skin diseases. All these values are well above z values 1.96, 2.58 and even 3. It showed that impact of water pollution on TB, Gastro and Skin diseases in urban area of Mandi Gobindgarh is very significant.

Wilcoxon Test Rural Area for Water

Table 2: Wilcoxon Signed Rank Test Statistics of relationship between water pollution and various diseases in Rural Areas surrounding Mandi Gobindgarh[b]

	TB - Water	Gastro - Water	Skin - Water
Z	-4.557[a]	-5.632[a]	-4.901[a]
Asymp. Sig. (2-tailed)	.000	.000	.000

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

Analysis 2: From table 2, relationship between water pollution and TB, Gastro and Skin diseases in Rural Areas surrounding Mandi Gobindgarh were compared through Wilcoxon Signed Ranks Test. The test showed a significant impact of water pollution on TB, Gastro and Skin diseases because of z value of 4.557 between water pollution and TB disease; z value of 5.632 between water pollution and gastro diseases; z value of 4.901 between water pollution and skin diseases. All these values are well above z values 1.96, 2.58 and even 3. It showed that impact of water pollution on TB, Gastro and Skin diseases in rural area surrounding Mandi Gobindgarh is very significant.

Wilcoxon Test Urban Area for Soil

Table 3:Wilcoxon Signed Rank Test Statistics of relationship between soil pollution and various diseases in Urban Area Mandi Gobindgarh[b] Urban Test Statistics[b]

	TB - Soil	Heart - Soil	Respiratory - Soil	Skin - Soil
Z	-6.862[a]	-2.907[a]	-6.379[a]	-3.402[a]
Asymp. Sig. (2-tailed)	.000	.004	.000	.001

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

Analysis 3: From table 3, relationship between soil pollution and TB, Heart, Respiratory and Skin diseases in Urban Areas of Mandi Gobindgarh were compared through Wilcoxon Signed Ranks Test. The test showed a significant impact of soil pollution on TB, Heart, Respiratory and Skin diseases because of z value of 6.862 between soil pollution and TB diseases; z value of 2.097 between soil pollution and Heart diseases; z value of 6.379 between soil pollution and respiratory diseases and z value of 3.402 between soil and skin diseases. All these values (except of Heart and Soil) are well above z values 1.96, 2.58 and even 3. It showed that impact of soil pollution on TB, Respiratory and Skin diseases in urban area of Mandi Gobindgarh is very significant and significant between Heart diseases and soil.

Wilcoxon Test Rural Area for Soil:

Table 4: Wilcoxon Signed Rank Test Statistics of relationship between water pollution and various diseases in Rural Areas surrounding Mandi Gobindgarh Rural Test Statistics

	TB - Soil	Respiratory - Soil	Skin - Soil	Gastro - Soil	Heart - Soil
Z	-2.429[a]	-6.581[a]	-2.429[a]	-3.429[a]	-2.263[a]
Asymp. Sig. (2-tailed)	.015	.000	.015	.001	.024

a. Based on positive ranks.

b. Wilcoxon Signed Ranks Test

Analysis 4: From table 4, relationship between soil pollution and TB, Heart, Respiratory and Skin diseases in Rural Areas surrounding Mandi Gobindgarh were compared through Wilcoxon Signed Ranks Test. The test

showed a significant impact of soil pollution on TB, Heart, Respiratory and Skin diseases; because of z value of 2.429 between soil and TB; z value of 6.581 between soil pollution and Respiratory diseases z value of 2.429 between soil pollution and skin diseases; z value of 3.429 between soil pollution and gastro diseases and z value of 2.263 between soil and Heart diseases. All these values are well above z values 1.96, and respiratory and gastro diseases have relationship well above the value of 2.58 and even 3. It showed that impact of soil pollution on respiratory and gastro diseasews in rural areas surrounding Mandi Gobindgarh are very significant but significant between TB, heart and Skin diseases.

Paired test: Water Pollution Urban Area

Table 3: Paired Samples correlations test Statistics of relationship between water pollution and various diseases in Urban Areas Mandi Gobindgarh

		N	Correlation	Sig.
Pair 1	Water & TB	113	.120	.204
Pair 2	Water & Gastro	113	.257	.006
Pair 3	Water & Skin	113	-.130	.169

Analysis 3: From table 3 relationship between water pollution and TB, Gastro and Skin diseases in Urban Areas of Mandi Gobindgarh were compared through Paired Test. The test showed a significant impact of water pollution on TB, Gastro and Skin diseases.

Paired test Water pollution Rural Area

Table 4: Paired Samples Correlations Test Statistics of relationship between water pollution and various diseases in Rural Areas surrounding Mandi Gobindgarh

		N	Correlation	Sig.
Pair 1	Water & TB	99	-.089	.378
Pair 2	Water & Gastro	99	.120	.237
Pair 3	Water & Skin	99	.098	.334

Analysis 4: From table 4 relationship between water pollution and TB, Gastro and Skin diseases in Rural Areas surrounding Mandi Gobindgarh were compared through Paired Sample test.. The test showed a significant impact of water pollution on TB, Gastro and Skin diseases.

Paired sample test for Soil Pollution in Urban Area

Table 5: Paired Samples Correlations Test Statistics of relationship between soil pollution and various diseases in urban Areas Mandi Gobindgarh

		N	Correlation	Sig.
Pair 1	Soil & Respiratory	113	.177	.061
Pair 2	Soil & Heart	113	-.449	.000
Pair 3	Soil & TB	113	.038	.688
Pair 4	Soil & Skin	113	-.106	.262

Analysis 5: From table 5 relationship between soil pollution and Respiratory, Heart, TB and Skin diseases in Urban Areas of Mandi Gobindgarh were compared through Paired sample Test. The test showed a significant impact of soil pollution on Respiratory, Heart, TB and Skin diseases.

Paired sample test for Soil pollution in Rural Area

Table 6: Paired Samples Correlations Test Statistics of relationship between soil pollution and various diseases in Rural Areas surrounding Mandi Gobindgarh

		N	Correlation	Sig.
Pair 1	Soil & Respiratory	99	.094	.357
Pair 2	Soil & Skin	99	.034	.736

Pair 3	Soil & Heart	99	.011	.911
Pair 4	Soil & TB	99	.034	.736

Analysis 6: From table 6 relationship between soil pollution and Respiratory, Heart, TB and Skin diseases in rural Areas surrounding Mandi Gobindgarh were compared through Paired sample Test. The test showed a significant impact of soil pollution on Respiratory, Heart, TB and Skin diseases.

This corresponds to the earlier report by Punjab Pollution Control Board in 2011 who initiated measures to control the pollution in which almost all the departments of the Government were involved. Results of the same are yet to be seen. The public however is not yet involved in making them aware of this monster of pollution and to take effective measures to save themselves from the serious ailments which is essentially needed.The quality of input in industry should also be improved and the junk received from foreign war zones should be discontinued.

IX. FINDINGS

This study has been able to cover the research gap of macro study of various pollutants and their effects and has also covered the environment in the adjoining rural areas. The study found Mandi Gobindgarh heavily polluted. The impact of pollution caused by the industry of Mandi Gobindgarh was also felt strongly in surrounding rural areas. Water and soil was found heavily polluted. The detailed impact of all types of pollution on health has also been studied. Relationship to various chronic diseases to pollution through water and soil has also been established. The heart, respiratory, skin, TB Gastro are all effectd by water and soil pollution.

Water is found stagnated in number of vacant plots. Untreated water consists of harmful chemicals and vehicle fluids i.e., motor oil, antifreeze, gasoline, air-conditioning refrigerants, and transmission, brake, hydraulic and windshield-wiper fluids. Soil is found polluted from chemicals, molted and grinded metal, untreated water, factory and domestic refuse and bio-waste

The pollution control by various government agencies is not much effective since the impacted diseases are continuously increasing. All citizens must be made aware of the pollution and its causes and effects and help the pollution control agencies to control the pollution religiously. NGO's and religious institutions' must help to propagate the effects of pollution.The Government and the pollution Control agencies have to work harder than they are doing at present as the spread and increase of pollution is faster and even getting out of control. The citizens themselves have to be aware and stand against this demon to fight united before every one's life goes into danger Zone. Special care is needed to control the effect of pollution on heart and gastro diseases which are continuously increasing at an alarming rate.

The existence of pollution much more than the National level limits is a great cause of concern. This proves the hypothesis that pollution in Mandi Gobindgarh and surrounding areas are highly polluted. The study was able to find the type and amount of pollution in Mandi Gobindgarh in qualitative terms. However the quantitative measure of pollution requires a separate detailed study and special equipment at nano scale. This study will help the various authorities and the persons responsible to check pollution to go into more depth and to be more serious in controlling pollution since the diseases pertaining to heart, skin and lungs are of alarming proportion. All the objectives of the study are thus met by studying the pollution, its extent, causes and impact and evaluating the measure adopted to control the pollution. Solutions and suggestion have been provided to control the pollution and its effects in various fields and an awareness campaign has been started at Desh Bhagat University level through lectures and demonstrations. The major effect on environmental pollution and cause of diseases being nanoparticles; these nanoparticles however still remain to be studied in detail with the help of advance microscopes like SPM, SEM and TEM.

X. RECOMMENDATIONS

Since the environment pollution in Mandi Gobindgarh is much more the limits laid down by national and international standards, there is an urgent requirement to take strong measures to check and control the pollution. An Environmental Impact Assessment (EIA) must be carried out and a dedicated team be detailed by Punjab Pollution Control Board to carry out assessment of pollution at least at the 10 identified points in the industrial area. A reliable base line data is required through the use of Global Positioning System and Geographical Information Systems.A dedicated effort be put up to make the public aware of the effects of pollution and public participation must be encouraged in reducing pollution at their homes and surrounding areas.

Proper effluent treatment plants must be setup and industrial, house hold and medical wastage must have proper dumping ground away from the residential area. Proper channeling of water must be done, sewerages system be approved and allowing the water in plots must be paid punishable. The Govt. administration must coordinate the activities of Punjab Pollution Control Board, Municipality, Police, PWD,

Department of Forest, Industries, Transport and local bodies and estab;ish a proper environment managements system (EMS) and update the action plan. A policy must be framed and proper action plan must be prepared and circulated not only among the departments but also in industry and public to make them more aware. In rural areas the proper sewerages system and water outlets will save water stagnation. The use of fertilizers is required to be controlled immediately. An overall awareness campaign must be started through pamphlets and paper advertisements highlighting the dangers of environmental pollution

XI. CONCLUSION & SUGGESTIONS

The study found Mandi Gobindgarh heavily pollutedwhich in turn has affected surrounding rural areas. Water and soil in addition to air were found heavily polluted causing chronic diseases relating to heart, respiratory, skin, TB Gastro to pollution. Water is found stagnated in number of vacant plots. Untreated water consists of harmful chemicals and vehicle fluids i.e., motor oil, antifreeze, gasoline, air-conditioning refrigerants, and transmission, brake, hydraulic and windshield-wiper fluids. Soil is found polluted from chemicals, molted and grinded metal, untreated water, factory and domestic refuse and bio-waste. The pollution control by various government agencies is not much effective since the impacted diseases are continuously increasing. Detailed study on pollution at micro and nano scale in the area is needed and there is an urgent necessity of having a proper Environment Management System. All citizens must be made aware of the pollution and its causes and effects and help the pollution control agencies to control the pollution religiously. NGO's and religious institutions' must help to propagate the effects of pollution. The Government and the pollution Control agencies have to work harder than they are doing at present as the spread and increase of pollution is faster and even getting out of control.

REFERENCES

[1] Britton RS, Tavill AS, Bacon BR.(1994).Mechanisms of iron toxicity. In: Iron metabolism in health and disease. Brock, J.H., Halliday, J.W., Pippard, M.J., Powell, L.W. (eds.). WB Saunders, London, pp. 311-351.

[2] Brunekreef B, etal (Veenstra 1981). Lead uptake by 1- to 3- year old children living in the vicinity of a secondary lead smelter in Arnhem, The Netherlands. *Environ Res* 25, 441-448, Bush RK, Portnoy JM, Saxon A, Terr AI, Wood RA. (2006). The medical effects of mold exposure.*J Allergy ClinImmunol*117, 326-333.

[3] Calderon J, Navarro ME, Jimenez-Capdeville ME, Santos-Diaz MA, Golden A, Rodriguez-Leyva I, Borja-Aburto V, Diaz-Barriga F. (2001).Exposure to arsenic and lead and neuropsychological development in Mexican children. *Environ Res* 85, 69-76.

[4] Campen MJ, Nolan JP, Schladweiler MC, Kodavanti UP, Evansky PA, Costa DL, Watkinson WP. (2001). Cardiovascular and thermoregulatory effects of inhaled PM-associated transition metals: a potential interaction between nickel and vanadium sulfate. *ToxicolSci*64, 243-252.

[5] Corhay JL, Weber G, Bury T, Mariz S, Roelandts I, Radermecker MF. (1992.), Iron content in human alveolar macrophages. *EurRespir J*, 5, 804-809,

[6] Damstra T. (2002).Potential effects of certain persistent organic pollutants and endocrine disrupting chemicals on the health of children. *J ToxicolClinToxiol*40, 457-465.

[7] Finland M. (1982), Pneumococcal infections. In: Evans AS, Feldman HA, eds. Bacterial infections in humans. Epidemiology and control. New York: Plenum.

[8] Lambert AL, Dong W, Selgrade MK, Gilmour MI.Enhanced allergic sensitization by residual oil fly ash particles is mediated by soluble metal constituents. *ToxicolApplPharmacol*165, 84-93, 2000.

[9] Lanphear BP, Dietrich K, Auinger P, Cox C. (2000), Cognitive deficits associated with blood lead concentrations <10 µg/dL in US children and adolescents. *Pub Health Rep* 115, 521-529.

[10] Prpic-Majic et al (2000), Lead absorption and psychological function in Zagreb (Croatia) school children. *NeurotoxicolTeratol*22, 347-356,

[11] Rahman A, Maqbool E, Zuberi (2002), HS.Lead-associated deficits in stature, mental ability and behaviour in Karachi.*Ann Tropical Med* 22, 301-311.

[12] Raizenne M,et al, (1996)Health effects of acid aerosols on North American children: pulmonary function. *Environ Health Perspect*104, 506-514..