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An Assessment on the Impact of Natural Gas Fertilizer Factory, Fenchuganj, on the Local Environment

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Abstract: A study on the impacts of Natural Gas Fertilizer Factory (NGFF), Fenchuganj, Bangladesh has been carried out by extensive field investigation and a questionnaire survey among the residents in the area and the workers of the industry. Plants, fishers and other natural habitants were considered as bio indicator. To find out the impact of the industry on surrounding river water and soil, chemical and physical analysis were done. It was found that the chemical and physical parameters occasionally exceed the respective permissible values while the value of some specific parameter remains higher all through the year. Due to improper treatment of the effluent and inefficient drainage system local crop production and fisheries of the wetlands and Kusiyara River are declining. Effect on the health of the workers and local people was also observed. Negative impact on self employed people like anglers and farmers have been found, resulting an effect to the local economy. On the other hand, the industry induced great positive impact on socio-economic sector, i.e. income and employment generation, education, infrastructure and on other economic sector like small-scale business, communication, etc.

Key words: Environment, fertilizer factory, bio-indicators, chemical pollutants, natural habitats

INTRODUCTION

Use of chemical fertilizer is essential in modern days Agriculture. Particularly, in case of Bangladesh, chemical fertilizers are of prime importance for its agriculture based economic system. Among the types, the urea and ammonium sulfate are widely used to increase agricultural production. Hence, Bangladesh is promoting rapid industrial development in this sector in past few decades. The Natural-Gas Fertilizer Factory Ltd. (NGFFL), situated in a hilly surrounding of Fenchuganj in 1961, under the district of Sylhet is the first chemical fertilizer industry in Bangladesh. It is located about 28 km. South-east of the Sylhet city and 4 km. east of the river Kusiyara (Fig. 1). Production capacity of the industry is 340 MT day^{-1} of urea and 40 MT day^{-1} of ammonium sulfate.

Fertilizer manufacturing process involves modern complex technology and deals with many chemicals, a part of which are disposed as an industrial effluent and are responsible for environmental pollution. Thus, an environmental study of the industry was needed to evaluate the overall environmental conditions surrounding the industry site to suggest suitable control measures for the abatement and mitigation of the adverse

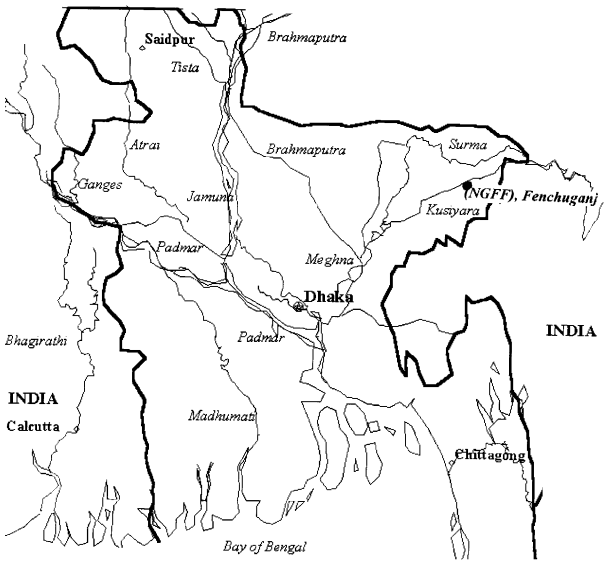

Fig. 1: Location of Natural Gas Fertilizer Factory (NGFF), Fenchuganj, Bangladesh

impacts on the environment. Recently, several studies have been carried out in the vicinity of fertilizer industries in order to establish the significance of the hazardous

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impact of their operations on the environment as well as on the human population[1-5].

It is necessary to ensure some degree of transparency and objectivity in the qualitative assessment and evaluation of the impacts on projects (in particular development projects where data may be scarce and implementation may take a number of years)[6]. EIA evaluations need to be re-assessed with the passage of time and the data contained therein should be open to scrutiny and revision as new data becomes available. This article describes a system of scoring within a matrix that has been designed to allow subjective judgements to be quantitatively recorded, thus providing both an impact evaluation and a record that can be re-assessed in the future. The system is ideally suited to EIA where a multi-disciplinary team approach is used[7,8], as it allows for data from different components to be analyzed against common important criteria within a common matrix, thus providing a rapid, clear assessment of the major impacts.

MATERIALS AND METHODS

Environmental compatibility matrix was used for EIA. Based on field investigation, public opinion survey and laboratory test results, initial environmental impact assessment was made and presented throughout checklist form. According to a usual practice the degree of environmental impacts of a project varies within the range -5 to + 5, - 5 representing an extremely negative impact and + 5 representing an extremely positive impact and higher the number, higher the degree of the impact. Again, the impacts are classified as short-term (S) and long-term (L) impact. Short-term impact is associated with the immediate implementation of the project while long-term impact arises as a result of changes in environment long after the project. In order to achieve the objectives, some secondary data were collected from the laboratory of NGFFL. For comparing with the secondary data, water samples from Kushiara river and Awlachhara canal near the industry were collected and tested in the water supply and sewerage engineering laboratory of the department of "Civil and Environmental engineering" in Shahjalal University of science and technology, Sylhet. The samples were collected in a sterilized plastic container with stopper, from the middle of the river and canal in about 2 feet below the top surface of water. Temperature and pH were measured electrometrically at the time of sampling. Ammonia nitrogen, Alkalinity, Total solids, Dissolved solids, Arsenic, DO, BOD and COD were determined by standard method[9]. Soil samples from near and far of the industry were also collected and tested. Some nutrients of soil sample including nitrate, potassium, phosphorus and soil pH were measured *in situ* using "ELE – plain test" soil testing kit. Several field visits were made to observe the changes occurred in and around the industry and wastewater discharge points. To visualize and elucidate the impact of NGFFL on various environmental issues, some photographs were taken during field visits. In order to assess the public awareness and their reaction of the environmental consequences of the project, a questionnaire survey was conducted. In this study four sampling stations both for water and soil was taken (Fig. 2).

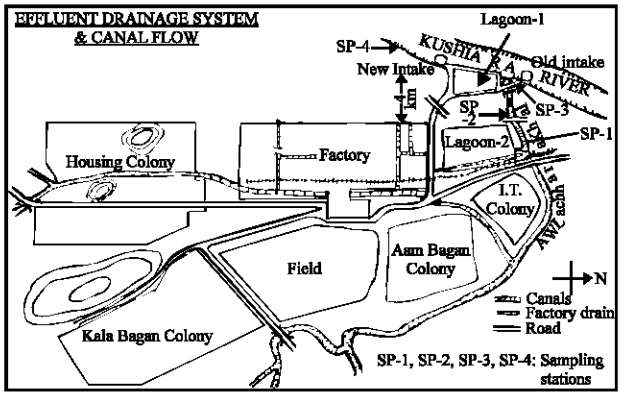

Fig. 2: Typical lay out of NGFFL and sampling locations

RESULTS AND DISCUSSION

In the study, assessment of impact was carried out on fourteen different environmental issues. The probable impacts of natural gas fertilizer factory on these environmental issues are discussed (Table 1).

Aquatic environment: The analysis of the Kushiara river water shows a DO level of 4.7 and pH of 5.63 (Table 2). At the point where Awlachhara canal carrying the wastewater discharge from the industry, meets with the other wetland, the DO and pH level have been found to be 4.2 and 5.75, respectively (Table 2). For the survival of Fisheries and other aquatic habitants the standard level of DO and pH are 5 and 6-9, respectively. Comparing with the standards it can clearly be stated that the water of the wetlands nearby the industry ('Chiluar Haor' and 'Chatol Haor') are not suitable for the fisheries to sustain their life. The Kushiara River is lacking in fisheries for the same reason. Moreover the mixing of ammonia with water makes it to contain high nutrient for algae and other aquatic weeds when ammonia is converted into nitrate by the bacteria. This causes the water bodies to initiate eutrophication, when fishes and other aquatic animals die due to the lack of oxygen. Based on the nature and

Table 1: Checklist of impact on different environmental parameters

Environmental parameters	Degree of impact	Nature of impact	Comments
Aquatic Ecosystem	-3	L	Interruption due to eutrophication, high oxygen demand, oil and grease prevents the process of dissolving oxygen from atmosphere to the water.
Agriculture	-2	S	
	+5	L	Negative impact in the sense due to potential loss of agricultural land, occasional burning of crops etc. Positive impact in the sense due to the industry has earned a national benefit on agricultural sector.
Horticulture	-1	L	Reduced fruit yield, burning of trees.
Livestock	-1	L	Occasional highly polluted effluent at outlet may cause harmful effect.
Fisheries			
Capture fisheries			
Culture fisheries	-3	L	River water fisheries have declined due to polluted effluent.
	-1	L	Fish cultivation in adjacent water bodies is hampered.
Forestry	-2	S	Forests and bushes destroyed for the establishment of the industry.
Surface water	-3	L	Deteriorate some parameter.
Ground water	x	x	Further study is necessary.
Noise and vibration	-2	L	Effects on health of the workers and inhabitants of the area.
Air quality	-2	L	Deteriorate air quality of adjacent area through contamination with ammonia.
Terrestrial wild life	-2	L & S	Losses of terrestrial wild life.
Rare and endangered species	-1	L & S	Losses of endangered species.
Socio-economic			
Resettlement	-1	S	Landowners of the project area were not properly settled.
Income and employment	+5	L	The industry provided a large scale of Employment Opportunity.
Education	+3	L	Increased literacy rate.
Infrastructure	+5	L	Existence of the industry largely improved road communication facility.
Public health	-2		
	+3	L	Positive because people surrounding the industry aware about health, negative because health hazards due to industrial emission and waste discharge.
Aesthetic	-1	S	Strong popular problem and around the industrial area, problem with fog during winter season.

Table 2: Water quality data

	Sample location			
Parameters	1	2	3	4
CO_2 (mg l^{-1})	N.D	35.0	30.0	18.0
pH	7.4	5.8	5.7	5.6
Hardness (mg l^{-1})	6.0	6.0	6.5	8.0
NH_3-N (mg l^{-1})	21.0	15.6	10.0	6.0
COD (mg l^{-1})	7.9	6.8	5.0	4.5
DO (mg l^{-1})	5.2	4.2	4.0	4.7
BOD_5 (mg l^{-1})	5.2	4.2	4.0	3.8
TS (mg l^{-1})	405.0	455.0	495.0	450.0
DS (mg l^{-1})	345.0	391.0	427.0	380.0
SS (mg l^{-1})	60.0	64.0	68.0	70.0

Table 3: Soil nutrient data

Points	Nitrate (mg l^{-1})	pH	Phosphate (mg l^{-1})	Potassium (mg l^{-1})
1	15	4	<20	245
2	5	11	20	<65
3	<5	10	<20	120
4	<5	11	<20	<65

Table 4: Air quality data

	Parameters in ppm.				
Sample points	NH_3	CO	CO_2	SO_2	NO_x
Ammonia compressor house.	93	N.D	--	--	--
Co- Removal Section.	30	3.0	500	--	N.D
Urea Compressor House	110	--	800	--	--
Urea reactor feed and pump	23	--	1000	--	--
Near Waste Water Pit & Pond	45	--	--	--	--
Ammonium Sulfate Plant	1.5	N.D	--	95	1.1

(Source: NGFFL Laboratory)

Table 5: Noise levels in and around the factory

Locations	Distance from sound source (meter)	Noise level in Decibel (db)
Ammonia plant:		
Inside of compressor house		
Circulator (centre) area	03	78
	02	80
Main gas compressor area	03	75
Out side of compressor house		
Circulator gland leakage vent	15	95
Refrigeration compressor area	03	82
Air compressor-1 area	03	86
Air compressor-2 area	03	88 to 90
Instrument air compressor area	03	88 To 90
Water demineralization section		
(about 50m. away from compressor		
House and surrounded by		
many sound sources)	--	68
Urea plant:		
Inside of urea control room	--	62
Carbon dioxide plunger pump area	03	96
Ammonia plunger pump area	03	98
Power plant:		
Ground floor (with several		
sound sources).	--	95
First floor of power plant:		
Of this area	--	62
Control room	--	65
SPD House neared generator	03	90
Outside of boiler floor	--	78
Area and boiler furnace	02	92
Other locations:		
Factory main gate area	350	48
Residential area near a school	650	37
The guest house area	1250	30

intensity of impact, the impact on aquatic ecosystem has been assigned a value of –3 and indicates long-term (L) impact.

Agriculture: Before the establishment of the industry, most of the land was used for tea plantation. Considering all the area suitable for tea plantation, the total loss would be at least 7.5 million Tk. Per year. The two water lands namely "Chiluar Haor" and "Chatol Haor" remains as water bodies for part of the year and is being used for the production of rice. The ammonia containing effluent

adversely affects these two places in the vicinity of the industry and cause a great loss of grain crops (3500 M.T. of rice) per year. As there is potential loss of agricultural land due to the establishment of the industry, industrial effluents cause occasional burning of crops and polluting soil (Table 3). The value assigned for this kind of impact is –2 and is considered as short-term (S) impact. As the industry has earned a national benefit on agricultural sector positive impact is given a value of +5 and is considered as long-term (L) impact (Table 1).

Horticulture: There is no real orchard near the industrial area but there are fruit trees like mango, jack fruit, coconut etc. in almost all homesteads and tea gardens. Many of the trees are found to be affected by the burning of leafs due to the emission of ammonia near by the industry. The SO_2 gases that are emitted from the Ammonium Sulfate plant of the industry are causing to increase the acidity of the soil by being dissolved in the rainwater to form sulfuric acid. The annual yield of the fruit trees of the area is very low with respect to nearest surrounding areas. Considering the impact on fruit trees, the value assigned for impact on horticulture is –1and considered as long-term (L) impact (Table 1).

Livestock: Both draft and non-draft animals comprise the total livestock of the area. Due to the industry there would be considerable increase in the concentrations of air pollutants. There is an open channel through which the industrial effluent is disposed into the Kushiara River. The channel is called "Awlachhara" Canal. The cattle grazing into the near by fields have easy access to the channel and there are reports of sickness and even death of cattle by drinking this contaminated water. So there are impacts on the livestock due to the wastewater of the industry. The value assigned for impact on livestock by the industry is –1 and considered as long-term (L) impact (Table 1).

Fisheries: Due to low DO oxygen level as well as higher concentration of ammonia, the fisheries and other aquatic live in the near by river and wetlands have been suffering. Considering the effect of the industry on local fisheries, the value assigned –3 for local capture fisheries and –1 for culture fisheries and both of the impacts are considered long-term (L) impact (Table 1).

Forestry: Agro-forestry is the traditional practice in this area. Usually farmers grow cereals, root crops, fibers, vegetables, fruits etc. and also trees and other woody perennials with the objective of meeting their daily needs. But unfortunately, the project area has a less reserve of forest land due to destruction of forest for further construction and development purposes. Considering the destruction of forests related to the establishment of the industry the value assigned is –2 and considered as long-term (L) impact (Table 1).

Surface water: Some of the wastes generated at high concentrations of chemicals are discharged to the river at times during the rainy season to get the benefits of dilution. From their idea it seems that the administration of factory do not normally visualize that it could affect the downstream quality of the river water. Main harmful element involved in the surface water around NGFFL is ammonia. Kushiara river water contains a high concentration of 6 ppm ammonia as nitrogen (Table 2) that should never discharged into the river without more treatment. Considering the deterioration of surface water quality due to discharge of industrial effluent, the value assigned is –3 and considered as long-term (L) impact (Table 1).

Ground water: It was found that the ground water is free of arsenic and there is no claim of water born diseases from the water of the tube wells that people are using. The arsenic compounds that are used for the synthesis of urea are dumped as waste product which can cause severe impact on the local ground water if the lifetime of the containers in which they are dumped goes under exhaustion. During the dry season surface water containing high concentrations of ammonia can percolate deep into the ground to reach the water table and can contaminate the ground water.

Noise and vibration: A noise level of 100 dB permits a maximum exposure of 1 h day^{-1} for a person and there are many places in the industry where noise level exceeds this point (Table 5). It certainly causing harm to the workers at these places as a worker in one shift used to work in the plant side for about 8 h day^{-1}. Obviously, from the consideration of standard limit they are in danger of sound hazard. Considering the effect on workers and the local people the value assigned is –2 and evaluated as long-term (L) impact (Table 1).

Air quality: It was observed that all emission towers, stacks, vents are well designed and kept at a height of 25-30 meters to disperse the possible pollutants at high altitude to reduce the adverse effect of pollutants. The air quality of vast remote hilly area like Fenchuganj is still good. Presently ammonia emission level of the factory is high. The emission of methane gas is neither controlled nor identified. The amount of methane emission increases with the increase of production, which might hamper

surrounding ecological pattern. Further, any uncertain occurrence of the same due to faulty operation may also cause serious air pollution. The air quality of the plant at different locations is presented in the Table 4. Considering the impact on air quality, the value assigned is –2 and evaluated as long-term (L) impact (Table 1).

Terrestrial wild life: Before the establishment of the industry, wild animals like leopard, wild chicken, monkey etc. were living in the place. But with the establishment of the industry the bushes and jungles where cut down to a great extent and gradually all the wild creatures disappeared. Considering the losses of terrestrial wild life the value assigned for impact is –2 and considered as having both long term and short-term (L and S) impact (Table 1).

Rare and endangered species: Establishment of the industry increased the infrastructure development of the area and with time, all the bushes and the jungles are cut down for this purpose. Rare and endangered species like cheeta, pithon, monkeys, wild hens, etc. have disappeared gradually. Killing of fish also occurs due to high ammonia load in the surface water. While interviewing with the local people, it was informed that some of the small fish species are not found at present in the area. Due to potential threat to rare and endangered species caused by the industry, the value assigned is –1, which has both long term and short-term (L and S) impact (Table 1).

Socio-economic status

Resettlement: Among all the effects induced by any industry to the local area, resettlement is probably the most important and vital one. After the establishment of the industry many people are provided by various types of facilities such as housing, services, etc.

Income and employment: During construction of the factory some of the tea garden labors where employed by the factory as casual workers and some other or inhabitants of the place where absorbed as regular employees after the construction. The income and employment of the local people enhanced due to the factory.

Education: The literacy rate has been increased considerably after completion of the factory along with educational establishments.

Infrastructure: Accessibility of the factory area was riverain. For transportation of fertilizer some other railroads and approach roads were constructed. So several infrastructures where spontaneously developed to meet the needs of the people of the locality. Due to the massive improvement of the road communication, the area has become suitable for further industrialization. This situation can be well emphasized by the establishment of a large-scale electric power plant using natural gas as the raw material. In addition, the availability of natural gas supply in the area makes it suitable for further industrial growth.

Public health: There might be a possibility of health hazard due to industrial waste like chromium, ammonia, nitrogen etc. but due to the industrialization of the area the health care facilities have also increased in the mean time with establishment of a hospital and medical center in the vicinity of the factory.

Considering the impact on socio-economic conditions of the area, the following values and nature of impact are employed (Table 1):

- For resettlement the value assigned is –1 as the industry forced some of the local people to move to a newer place and the impact is short-term (S).
- The industry caused a massive growth in income and employment in the local area as well as for the country. The value assigned is +5 considering as long-term (L) impact.
- The industry caused an increased literacy in the local area. The value assigned is +3 considering as long-term (L) impact.
- The industry caused a massive infrastructure change and urbanization in the local area. The value assigned is +5 considering as long-term (L) impact.
- The industry hampers public health increasing pollution concentration in the local environment. So, a value of –2 is assigned considering long-term (L) nature of impact. The industry also facilitates the local people from public health point of view through the establishment of well-equipped hospital and medical center. The value assigned is +5 considering short-term (S) impact.

Aesthetics: The aesthetic environment of the place has changed to a great extent after the establishment of the industry. The place once covered with green vegetation is filled with chemical plants and buildings at present. The industrial emissions causing bad odor of ammonia in all over the places near the industry. Ammonia for being highly hygroscopic in nature causes heavy fog spread over a vast area during the winter season, which does not tend to disappear even at noon during daytime. This causes the interruption of vehicular movement in and

around the industrial area. Considering the impact on the aesthetic environment due to the industry, the value assigned is –1 considering as short-term (S) impact (Table 1).

Decision makers need reliable methods and data to make informed decisions about risk management. This article has suggested the utility of the matrix method of EIA and has illustrated its application. These tools can be used to compare and rank hazards, so that decision-makers can make informed choices about budgeting resources for risk management. The present study shows that the activities of natural gas fertilizer factory Ltd. Fenchuganj, has some adverse effects on the surrounding environment such as water bodies, air and soil. However no industrial development can be expected without any adverse impact on environment. The beneficial impacts on the nation as well as human beings would only be possible if the adverse effects were minimized through strict maintenance and control measures as proposed and recommended for this project. The industry was found to have positive impacts on agricultural and socio-economic sectors. It has a contribution on increased crop production of adjacent several districts and on increased reproduction in the greater Sylhet region. The industry brings a major positive change in income and employment, road communication, education and public health.

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