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Domestic Health Hazard and Indoor Air-Pollution: An Approach to Find Alternative Energy Source for Rural Bangladesh to Minimize the Threat

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Abstract:

Indoor air pollution and health hazards for women and child especially in the developing countries have been overlooked for decades. It happened because there was no specific indoor pollution standard and alternative energy solution to minimize the indoor gaseous emissions at the domestic end-use level of energy. Traditional biomass fuel is one of the major sources of energy in the developing countries. About 2.4 billion people rely on traditional biomass, mainly for cooking and heating as they have limited access to better alternative energy sources like Natural Gas or Electricity. In Bangladesh per capita energy consumption is only 8.83 GJ by the year 2000 and 4% of this energy was served by electricity, 30% by natural gas and rest is from biomass. The biomass fuels are mostly used in the rural areas where the supplies of commercial fuels are very low. Biomass fuels are usually collected from the forests, agricultural residues and the solid form of cow dung. Rapid increase of biomass fuels consumption in the rural areas through indigenous technology causes deforestation and vast amounts of human effort being diverted to fuel collection, besides worsening indoor environment by emitting hazardous pollutants. About 90% people in the rural Bangladesh, use traditional mud made stoves for cooking and other heating purpose. Those mud stoves act as a point source for continuous hydrocarbon pollution. Burning biomass in the traditional cook stoves produce number of other air pollutants including suspended particulate matters, carbon monoxide, and carcinogenic organic compounds in an order of higher magnitude because incomplete combustion and less efficient combustion chamber use. The most hazardous pollutant that emits from biomass fuel is Hydro Carbon (HC). Other secondary pollutants are NO_x and CO₂.

HC, NO_x and CO₂ have direct health impact as in indoor gaseous pollutants especially on the women and children who use to inhale from the point source. In the rural areas the women usually spend 5 hours per day to collect and arrange the biomass fuel for cooking. At the same time every year more than 10,000 women and children in the rural areas suffer respiratory diseases that increase child mortality. The child mortality rates are increasing about 1.34% in rural areas by the indoor air pollution and now it is the second highest rate after water borne diseases. There is no standard has yet been fixed in Bangladesh for indoor pollution and health hazards as well there is no better alternative to minimize this health risk and pollution. This research aims to identify the average consumption of biomass fuel and the emission and concentration in the domestic level and health hazard especially in rural areas in Bangladesh.

Introduction:

Energy is a development issue because development, whether in terms of economic growth or in improvement in the quality of life is linearly interlinked with the availability of energy wealth. Therefore the role of economic development, technological innovation and the whole science of human welfare are determined by the energy factor.

On a global scale, various source of commercial energy play different roles. Oil is the single largest source of commercial energy around the world. In the 1973 the world oil consumption was 2141 Mtoe (Metric ton oil equivalent) and in 2004 it was 3231 Mtoe (IEA 2006). Peat and oil share accounts for 29% of the world consumption, and is closely followed by natural gas 20% of the world energy consumption (IEA 2006). The remaining commercial energy consumption is supplied by hydroelectric power, nuclear power, geothermal power, wind power, solar power and others. Furthermore the energy demand especially in the developing countries both in commercial and domestic sector are met by the biomass energy, like firewood and other traditional biomass fuels.

About 2.4 billion people rely on traditional biomass, mainly for cooking and heating (IEA, 2002). Essentially all of those users of traditional fuels reside in developing countries, and most of them live in rural areas; low incomes and the lack of access to alternative, modern fuels explain their choice of traditional energy supply. By the late 1990s, IEA (1998) estimated that biomass accounted for approximately 14 percent of final energy consumption.

Per capita energy consumption, which is an indicator of the physical quality of life, is quite low in Bangladesh (Akhter, 2002). In 1997, it was only 8.83 GJ per person per year [Islam, 2000]. Natural gas and electricity networks are accessible to only about 4% and 30% of households respectively. More than 90% of households depend on

unsustainable supply of biomass fuels for cooking (Akhter, 2002). The energy demand and consumption pattern in Bangladesh is rather complex because unavailability of sustainable energy resources, high population density and heavy consumption of biomass fuels. Over dependency on the traditional biomass cause ecological imbalance and the biomass resources are being rapidly exhausted.

Increasing consumption of biomass fuels with traditional technology will entail rapid deforestation and vast amounts of human effort being diverted to fuel collection, besides worsening domestic environment. About 90% people in Bangladesh use traditional cook stoves for cooking and other heating purpose. A traditional stove is usually a mud build cylinder with three raised points on which cooking utensil rest that cause unnecessary loss of heat. Besides biomass burning traditional cook stoves produce a number of air pollutants including suspended particulate matters, carbon monoxide, and carcinogenic organic compounds in an order of higher magnitude because incomplete combustion and less efficient combustion chamber use. The main pollutant that emits from biomass fuel is unburned Hydro Carbon (HC). Other secondary pollutants are NO_x and CO₂. HC, NO_x and CO₂ have direct health impact as in house pollutants especially on the women and children who use to inhale from the point source.

The biomass fuel are mainly used as domestic energy source especially in the rural areas in Bangladesh and mainly used for cooking purposes. The traditional home made cooking stoves cannot burn the fuels completely and emit a large amount of toxic air pollutants. The woman and children who spend an inordinate amount of time near the cooking activities are exposed to dangerous level of air pollution that cause serious health hazards even increase the child mortality rate especially for the pregnant women who inhale such polluted air.

The aim of this study is to find the domestic fuel consumption pattern in the rural areas and assesses associated health risk in compare national and international standard and to find an alternative energy source to minimize such health hazard, which has ignored over the periods.

Analytical methods:

The study focuses on for main sections to meet the study goal that is assessing the health hazard associated with the indoor air pollutants and to find the alternative sustainable fuel to meet the domestic energy demand. The sections covered by this study are:

1. Assessment of existing domestic fuel consumption pattern.
2. Asses the emission from the fuel sources.

3. Health risk assessment according WHO and DoE (Department of Environment) standard.
4. Asses the least cost alternatives for domestic fuel.

The study has been conducted at the field level and the data has compared with the international (WHO) and national (DoE) therefore both primary and secondary data are used to analyse the situation. The following diagram shows the analytical method of the study.

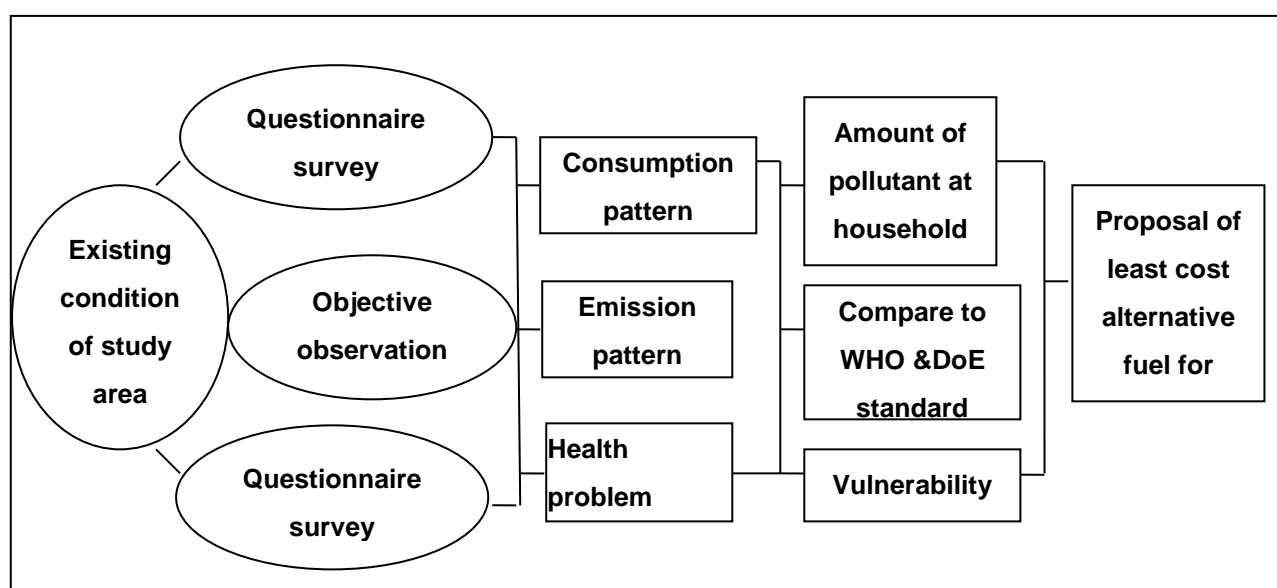


Figure 01: Analytical methods of the study.

Based on the type and quantity of the domestic demand in the rural areas has been calculated through questionnaire survey as primary data sources. A random sampling method has been used to get a representative number of the villagers and to get representative data. Furthermore the emotion levels of different pollutants are estimated by multiplying the mass of the fuel consumed by the household for cooking and lighting with the emission per unit of fuel consumption (Emission factor). The CO₂ emission factor has calculated based on IPCC 1996,

$$\text{Emissions} = \sum (\text{EF}_{ab} \times \text{Activity}_{ab}) \dots \dots \dots (1)$$

Where,

EF=Emission factor (gm/kg)

Activity = Energy input (kg)

a=Fuel type

b=Sector activity

Equation 1: Emission calculation

Emission factor depends on some parameter such as fuel type, condition of fuel (raw or processed) stove design etc. According to Sitara (2003), the emission factor of different pollutant due to burning of different fuel is shown in the following table 1.

Table: 1 Emission factor of different type of fuels based on the pollutants. (gm/kg of dry fuel).

Fuel type		Wood and leaves	Agri residue	cow dung
Emission factor (gm/kg)	CO ₂	1705	1266	1060
	CO	80	75	83
	CH ₄	9	4.9	4
	PM	9	7.4	20
	SOX	0.34	.29	6
	NOX	2.34	1.74	7
	N ₂ O	0.07	0.066	0.4133
	Benzene	0.4	0.4	0.4
	Xylene	0.2	0.2	0.2
	Styrene	0.06	0.06	0.06
	1,3-Butadiene	0.08	0.08	0.08

According to the above mentioned emission factor standard for different pollutants three different methods has been applied to calculate three different aspects of this study. The three different aspects that are considered in this study are:

- I. Concentration of the different pollutants while burning the biomass fuels to meet the domestic energy need.
- II. Estimation the exposure time of the residents in polluted air.
- III. Predicting health impact of the residents due to inhale the polluted air.

- I.** In the rural areas the pollutants emitted from the biomass fuel are mainly concentrated within the kitchen and the surrounding areas, where the women and children spend most of their day time for domestic purposes. Therefore the pollutants concentration has been measured in those zones through single compartment air quality balance mass model by Raina (2005). The model is as follows:

$$C(t) = \frac{F \cdot E_f}{V \cdot S}$$

Where,

C = Pollutant concentration, gm/m³
 F = Fuel burn rate, kg/hr
 E_f = Emission factor for fuel types, gm/kg
 T = Time, hr
 V = Volume of the kitchen, 40m³
 S = air exchange rate, 15/hr

Equation 2: Pollutant concentration.

- II.** Pollutant concentration and duration of staying in the breathing zone is highly correlated with the health impact. According to Bala, 1997 inhalation exposure is a function of the air pollutant concentration at the breathing zone and the duration that a person experiences it.

Mathematically potential exposure is defined (Bala, 1997) as below which is used in this study to calculate the exposure of individuals.

$$E = \int_{t_1}^{t_2} C(t) dt \dots\dots\dots(i)$$

Where,

E = Potential daily exposure of an individual, mg-h/m³. This is a time weighted average.

C(t) = Concentration of pollutant at the kitchen area at time t, mg/m³
 t₁, t₂ = Time range of exposure, hr

Where,

$$\sum_{i=1}^m t_i = 24h \dots\dots\dots(i)$$

Equation 3: Exposure time of different pollutants.

Mainly the rural women are highly exposed to the air pollutants as they spend a big share of their day time in kitchen to prepare three meals per day using traditional biomass fuels.

III. Potentiality of health risk means chances to affect by different disease per person or the increasing chances to affect by a certain type of disease. The equation to predict the health risk for particulate matter (PM), on an annual basis is as below:

<p>Change in lower Respiratory illness (per child) = $0.0169 \times \text{change in PM}$ Change in Asthma attacks (per person) = $0.0326 \times \text{change in PM}$ Change in respiratory Symptoms (per person) = $0.183 \times \text{change in PM}$ Change in Chronic Bronchitis (per person) = $6.12 \times 10^{-5} \text{change in PM}$ The change in PM is calculated by the following equation: Change in PM = $C_{\text{avg}} - C_{\text{WHO}}$ Where C_{avg} = Annual average of PM (24-hour), mg/m³ = $E/24$ (E= Exposure) C_{WHO} = WHO standard, 0.04mg/m³</p>
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Equation 4: Health impact prediction.

Study area and the data compilation:

More than 60% of the total population in Bangladesh still lives in the rural areas where they have a very limited option of having better and safe energy and they meet their domestic energy demand by the traditional solid or biomass fuel. The main use of traditional fuel in the rural Bangladesh is for cooking purpose in a traditional method. That traditional cooking method failed to burn the solid and biomass fuel completely and emit different gaseous pollutants that cause severe health impact especially to the women and children as mentioned before. Therefore the study focus on the rural areas in Bangladesh and a typical village named Lohaidanga under Dumuria upazila of Khulna division has been selected as the study area.

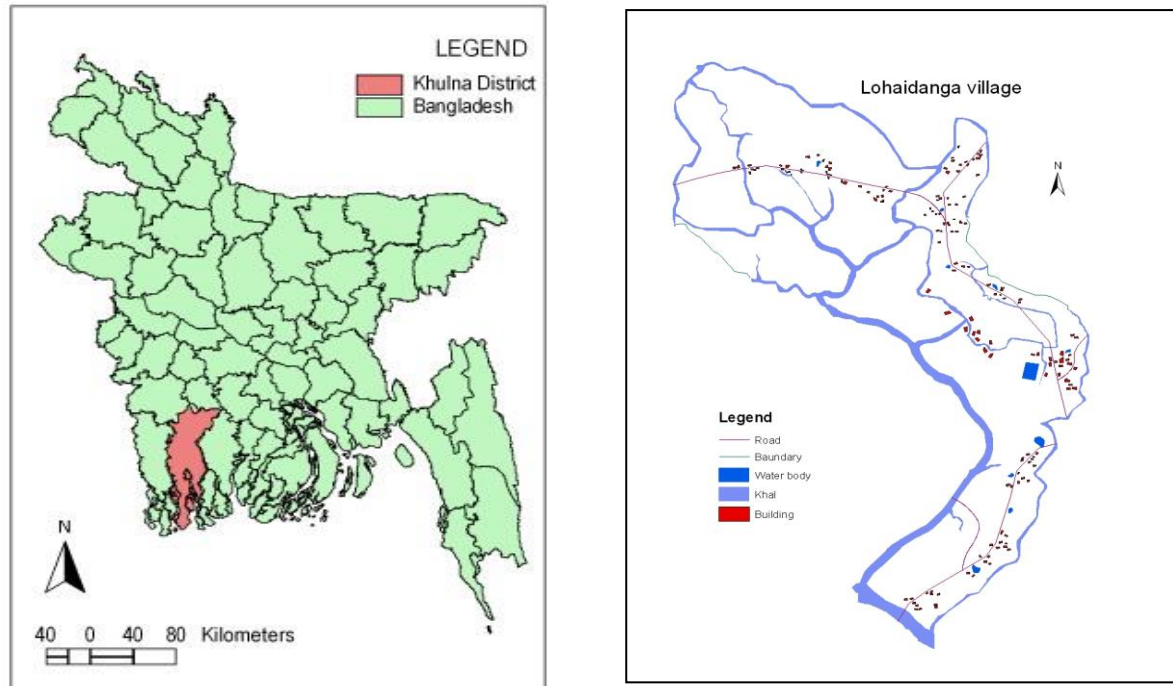


Figure 02: Location of the Study area. (Authors 2006)

The village is about 14 km away from the city and with about 10,000 residents in the village. The village is located with in a very short distance from the city even it does not have enough the commercial fuel supply network like electricity and gas to meet the energy demand and the villagers have to depend on the traditional fuel sources. In the rural area of Bangladesh the main source of traditional fuels (biomass fuels) are-

- ➡ Wood
- ➡ Cow dung
- ➡ Agricultural residues

Besides those fuels fallen leaves, rice husk, saw dust, straw, jute sticks are more or less used for household cooking. But wood, cow dung and agricultural residues are used as the main fuel for domestic cooking purpose. Electricity and kerosene are consumed as a commercial energy. Electricity and kerosene are used only for lighting purpose but the availability is too limited especially in the village areas.

The factors that influenced the local community to depend on biomass fuels to meet the energy demand are the land holding size, availability of fuel, income level of the population, family size etc. Land holding size is an important factor because the person who have huge amount of agricultural land, he might not buy any cooking fuel due to large supply of agricultural residues and cow dung.

Different types of biomass fuels: Under the random sampling method total 50 households (average household size is 5.1) are selected to get the data about different types of biomass fuel used in that particular village. The fuel types are classified in to two categories one is the primary fuels and the secondary fuels. The types are classified to understand the emission patter and the associated health risk with that and the amount the household use most.

The following table 2 shows the primary fuel types in the village.

Table 2: Consumption of cooking fuel by the household on priority basis.

Fuel consumption based on priority level by households.		Which one is consumed secondly (No of households)					
		Wood	Cow dung	Agricultural residue	Fallen/dry leaves	Rice husk	Total
Which fuel is consumed as primary	Wood	4	14	25	2	1	46
	Cow dung	1	0	1	1	1	4
Total	50	5	14	26	3	2	50

(Source: field survey, July-2006)

Table 2, presents the number of households who use different types of fuel as a primary energy source to meet their domestic need.

At the same time, the households who use wood as their primary fuel they also use wood as secondary fuel too. Furthermore who use cow dung as primary fuel they also use wood, leaves and other fuels as secondary. Therefore the use of biomass fuel is a combination of both the primary and secondary fuel. The following diagram presents the composition of domestic fuel consumed by the villagers both in primary and secondary level.

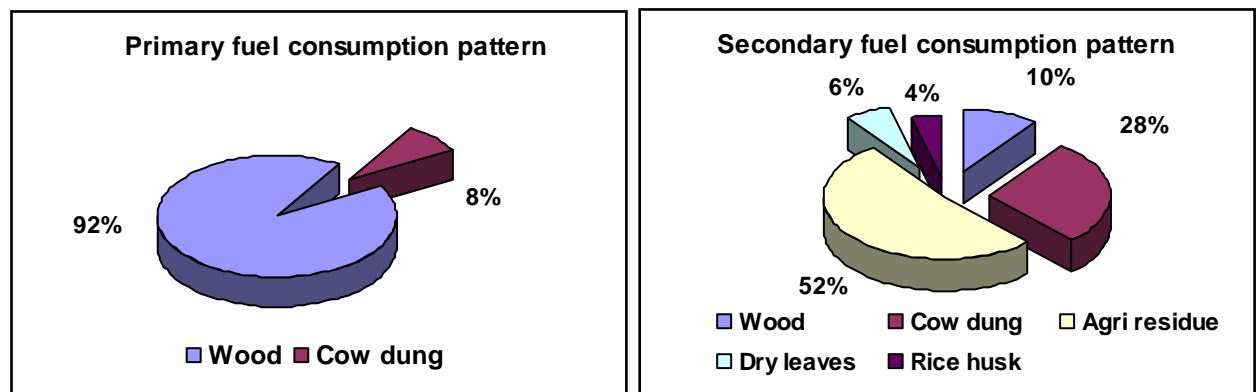


Figure 3: Relative consumption of biomass fuels in the study area. Source: field survey, July-2006.

According to the above figure most of the villagers use wood as their main fuel source to meet the domestic energy need, cow dung and agricultural residues are in second choice to meet their demand. Therefore these figures conclude that the use of biomass fuel types is related with the land holding size of the households.

Fuel collection: Unfortunately all those biomass fuels in this village are not free and available for everyone who has very limited landownership and low income. Therefore the low income households have to purchase the biomass fuel even it is cow dung (in a processed way). According to the field survey 2006, 3735kg biomass fuels are collected as free source and about 8110 kg biomass fuel are purchased per month.

Agricultural residue and cow dung are the cheapest and mostly available domestic fuel energy in the rural areas, as well wood is also available but not as cheap as other fuels. The villagers have the opportunity to collect certain percent of the fuel just as free sources but still that is not enough to meet their demand because most of the lands in the village are used for fish farming rather agriculture and forestry. Therefore they have limited access to the fuel like wood and agriculture residues and they use to purchase those fuels. The following diagram shows the relative percentage of different fuels the villagers purchase and collect as free resource.

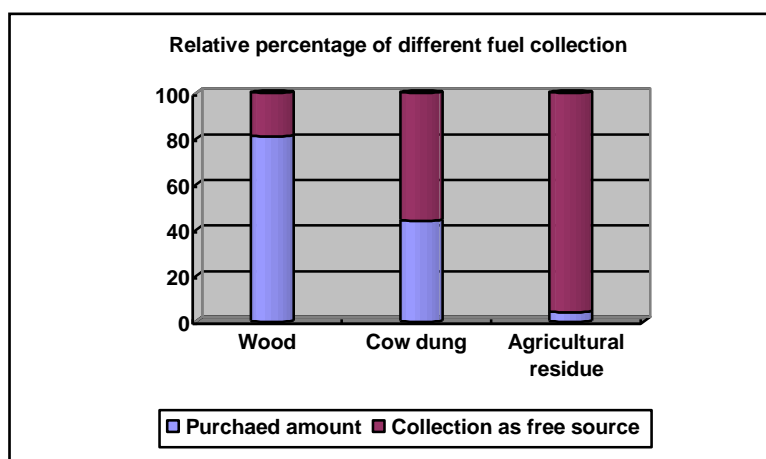


Figure 4: Relative percentage of different fuel collection (purchase and free) methods. Source: Field survey, July-2006.

Source of the fuels: The local village markets are the major sources for biomass fuel (wood and processed cow dung), which are not collected as a free source and they have to buy. The free fuel sources are mainly the agricultural land, small forestry and homesteads. Some local households also supply the cooking fuels to others as a part of their household income.

There are two main village markets (highlighted by red circle in figure-5), where the biomass energy for cook fuels is available. In this market wood and cow dung are much more available than agricultural residues. Agricultural residues are found in a certain period of a year in harvesting time. The rest of the sources are the households serving their neighbored households.

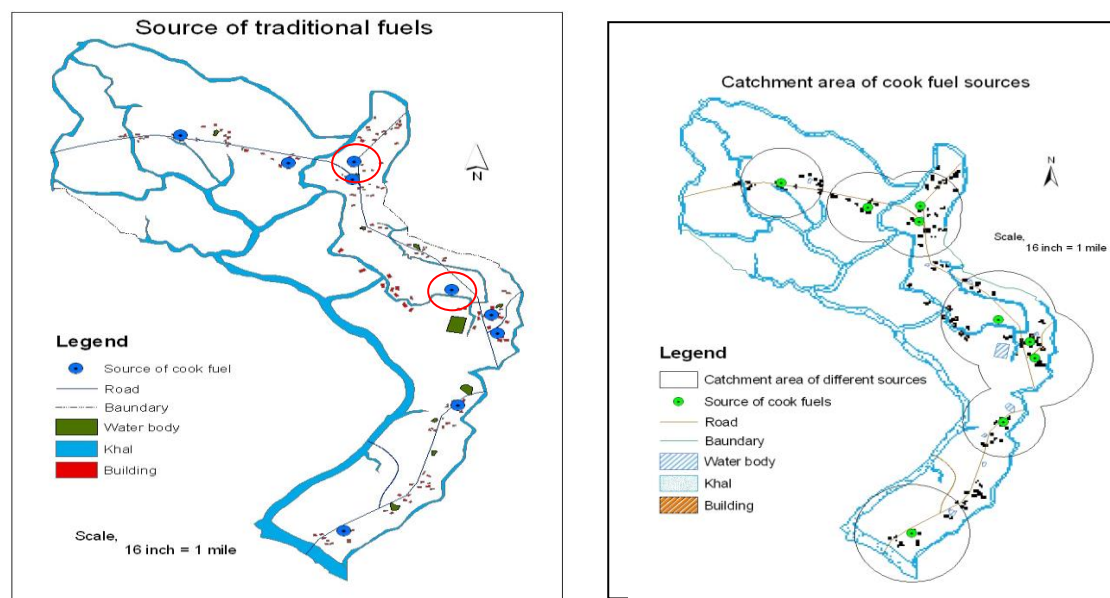


Figure 5 & 6: The fuel sources in the village

The other map shows, the catchments area of fuel sources. These are the sources from where the villagers can collect free cooking fuels as well as they can purchase the fuels. The figure presents that the villagers collect their fuels for cooking and to meet other energy demand from the village itself.

The primary cooking and domestic fuel source in the village is wood and that not that

Using type of biomass fuel	Actual amount of fuel used (kg/month)		Purchasing amount (kg/month)	
	Actual amount	Percentage	Actual amount	Percentage
Wood	8875	75.98	7130	91.64
Cow dung	1395	11.94	600	7.71
Agricultural residues	1410	12.07	50	0.64
Total	11680	100	7780	100

ample and free. The villagers have to purchase the big share of their primary fuel only a little amount is collected from the free sources. The following table shows the actual

amount of biomass fuel consumed by the villagers and the share they have to purchase.

Table 3: Total consumption of biomass fuel and the expenditure in this purpose.

Source: field survey, July 2006.

The biomass fuel consumption pattern in the study area is also related with the family size. Though wood is the primary biomass fuel in the study area, but with a big family size the household shift from wood to cow dung as their primary fuel especially for cooking, to save the family expenditure for energy. The following diagram shows the fuel consumption and family size of the study area.

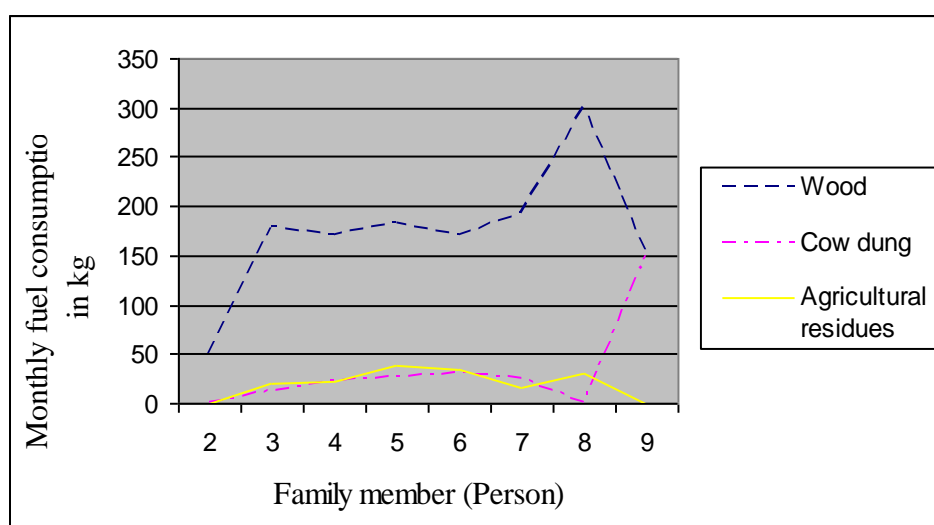


Figure 7: The fuel consumption pattern and household size.

Normally the household with small family members use wood as primary cooking fuel, as well as cow dung and agriculture residue as secondary fuel. But a family with 8 persons or more they usually use cow dung as primary fuel.

Emission from different pollutants:

The study has identified three main biomass fuel types that commonly used in the study area and they are wood, cow dung and agri residues. The amount of different biomass fuel consumption data by the villagers are collected through questionnaire survey. Based on those data the emission from different biomass fuel are calculated by using the emission factor (table 1) and the general method of emission measurement by IPCC 1996 (equation 1). The following table shows the average amount of different biomass fuel consumed by the villagers per month and the emission of different pollutants from those fuels.

Table 4: Total emission of different pollutants from different biomass fuel.

Biomass fuel type		Wood	Cow dung	Agri residues	Emission
Biomass fuel amount kg/month		8875	1395	1410	(kg/month)
Emission production kg/month	CO ₂	15131.875	1478.7	1785.06	18395.635
	CO	710	115.785	105.75	931.535
	CH ₄	79.875	5.58	6.909	92.364
	PM	79.875	27.9	10.434	118.209
	SO _x	3.0175	8.37	0.4089	11.7964
	NO _x	20.7675	9.765	2.4534	32.9859
	N ₂ O	0.62125	0.5765535	0.09306	1.2908635
	Benzene	3.55	0.558	0.564	4.672
	Xylene	1.775	0.279	0.282	2.336
	Styrene	0.5325	0.0837	0.0846	0.7008
	1,3-Butadiene	0.71	0.1116	0.1128	0.9344

Source: Field survey July 2007.

The highest amount of gaseous pollutants that emit from the traditional biomass fuel is CO₂. The main reason of that, all those fuels are burnt as raw fuel without proper processing and drying the fuel. The other pollutants have a very limited percentage in the total emission composition. The following diagram shows the composition of different pollutants in the total emission.

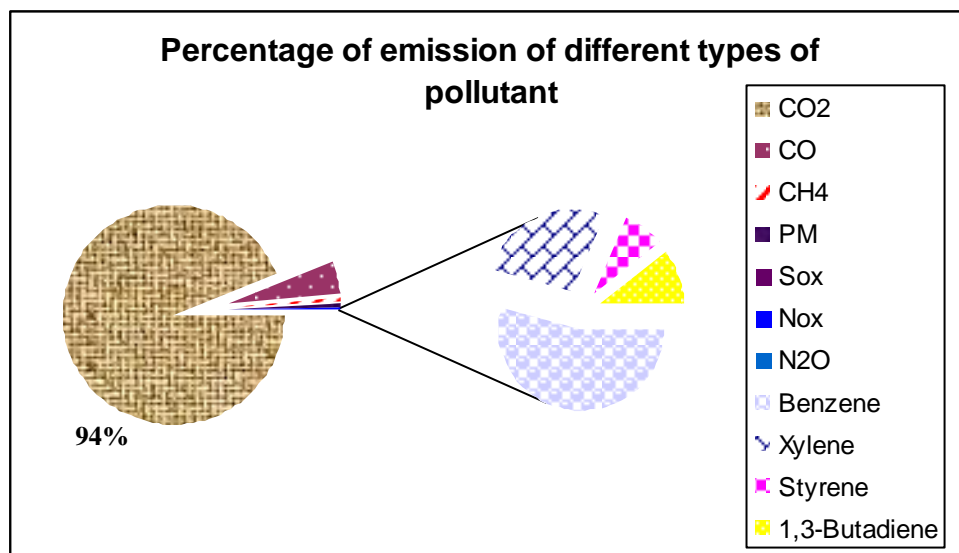


Figure 8: Composition of different pollutants.

In the total pollutants composition about 94% pollutants are CO₂ rest of the 6% pollutants cover all other pollutants. According to the field study the main health risk associated with CO₂ emission from the biomass fuel and that mainly affect the women and children in the village. The health risk also associated with the concentration of indoor pollution and the exposure time.

Indoor pollutants concentration:

The combustion of domestic cook fuel in traditional stove release smoke, which contain a complex and unstable mixture of huge pollutants with different chemicals. The indoor concentration of those gaseous pollutants is highly hazardous for human health. Therefore this study also measured the concentration of all those gaseous pollutants by using the pollutant concentration model (equation 2).

The domestic health hazard in the village area is highly related with the pollutant concentration level. The villagers use the biomass fuel three times per day to cook their meal and most of those fuels are not processed well and increase the level of pollutants concentration. The total concentration of different pollutants at the household level have been calculated and shown in the figure below by using different color for different concentration.

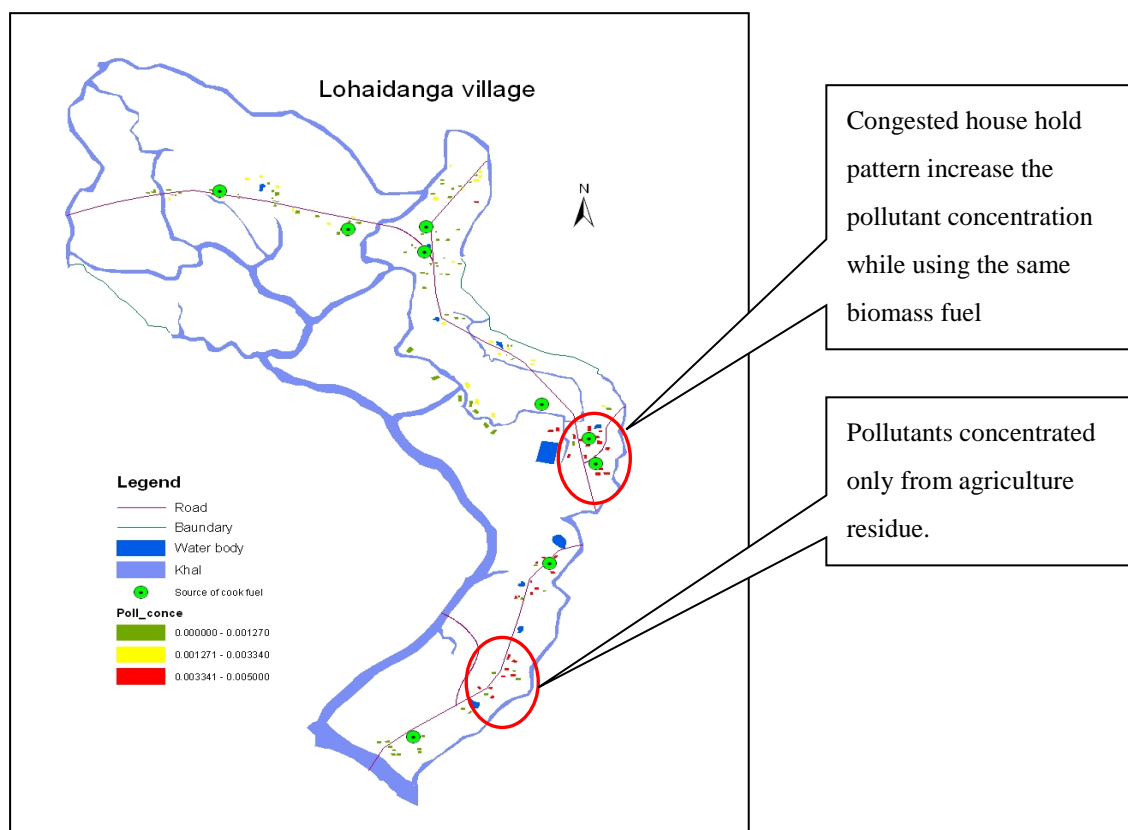


Figure 9: Pollution concentration of Lohaidanga village.

The red circles in the map emphasize the maximum pollution concentration zone in the village. The main reasons are the congested households with traditional consumption of biomass and the dependency on agricultural residues, which releases the high amount of toxic pollutant in compare to other fuels.

The pollutants concentrations are also measured mg per hour per m³ to compare the pollutants concentration with the room size to identify the exposure intensity by the households. The following table represents the concentration of different pollutants per hour per m³ according to the filed survey July 2006.

Table 5: Concentration of different pollutants in mg/h/m³

Different cook fuel	Concentration of different pollutants (mg/h/m ³)			
	CO	PM	NO _x	SO _x
Wood	114.81	12.91636	3.35825	0.48795

Cow dung	18.71	4.50909	1.57818	1.352727
Agri residues	17.09	1.68630	0.396509	0.0660848
Total	150.61	19.11175	5.332939	1.9067618

Comparison the pollutant concentration with national standard:

The Department of Environment (DoE) is the national environmental organization in Bangladesh has an air quality standard for the country. The field data of different pollutants concentration in the study area also compared with the national (DoE) standard to understand the present air quality and also to assess the impact on human health hazard by the pollutants. The following table shows the data comparison of the different pollutant with the national standard.

Table 6: Comparison of pollutant concentration data with national standard

Pollutants	Pollution concentration level of study area. (mg/h/m ³)	DoE pollutant concentration standard.	
		(mg/m ³)	Average time period
CO	150.61	40	1 hour
PM	152.894	0.2	8 hour
NO x	5.332939	0.1	Annual
SO x	45.76	0.365	24 hour

Every single pollutants' concentration in the study area is too high than the national standard. Only CO emission is 3.7 times higher than the national standard and PM concentration is about 760 times higher. The data comparison could illustrate the severity of health impact in the study area. This is a common picture in all over rural Bangladesh.

Pollutant exposure and health hazards in the study area:

Health hazards of the villagers is not only related with the pollutants concentration but also associated with the exposure time. The exposure time per m³ per hour in milligram of different pollutants has been calculated by using the equation 3 to understand the health impact of those pollutants in the study area.

Under this study only CO, PM, NO_x and SO_x exposure time has calculated as those gaseous pollutant have high level of health risk. The following table shows the pollutants' exposure time in the study area.

Table 7: Pollutants exposure time.

Fuel type	Pollutant exposure (h-mg/m ³)			
	CO	PM	NO _x	SO _x
Wood	1436.12	161.45	41.97	6.098
Cow dung	233.875	56.362	19.725	16.9
Agri residues	213.625	21.075	4.95	0.82575
Total	1882.625	238.88	66.65	23.823

Source: Field survey July, 2006.

The number patients suffering respiratory infection in the study are justify the evidence that exposure to biomass cook stove smoke (Traditional chula) may contribute to higher mortality rates than the known diseases in the rural areas in Bangladesh.

The study used the dose response function developed by Bala (1998) for predicting the potentiality of different type of health risk due to pollutant exposure. The potentiality of different type of health risk means the change in diseases attacks per person or the increasing chances for attack by the certain type of diseases.

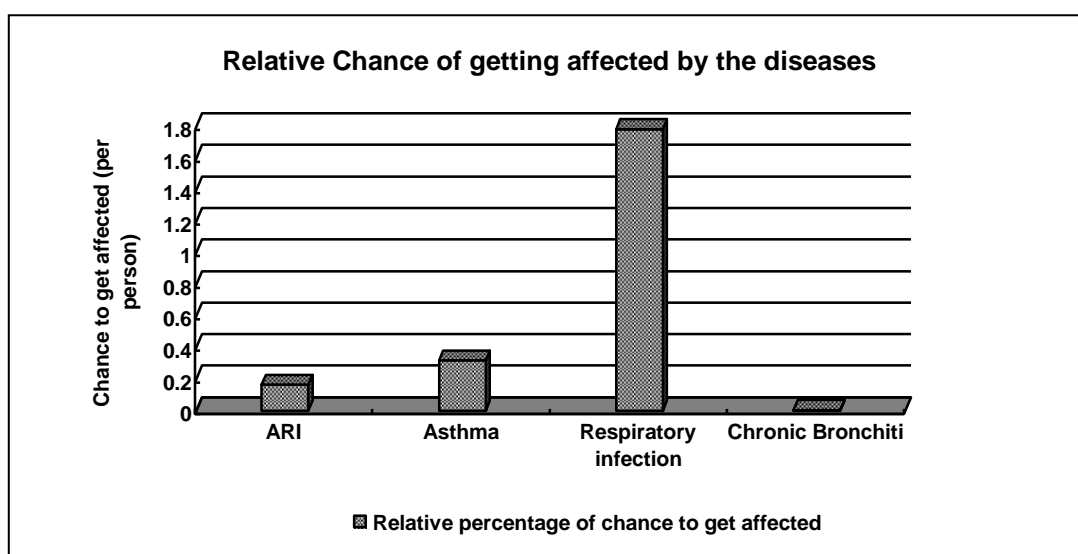


Figure 10: Relative chances of getting affected by different diseases.

According to the figure 10 the highest possibility of getting affected by the respiratory disease on the other hand the chance for ARI (Acute respiratory infections) and the se Asthma also very significant but it is also vary with the variation of fuel use for changing the concentration of particulate matter.

It has been experienced that burning of different fuel must have different form of pollutants exposure. So burning of different fuel must have different chance of affecting for respiratory problems.

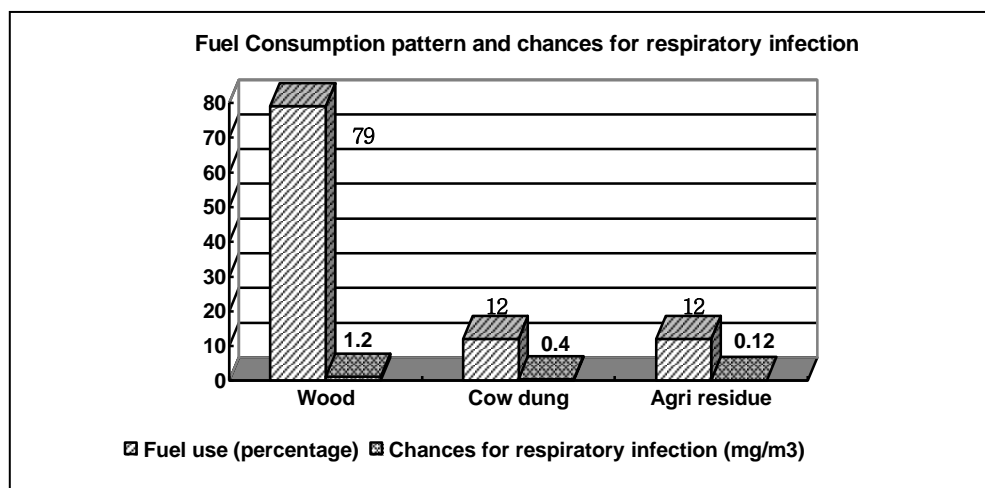


Figure 11: Fuel consumption pattern and the chances of getting affected by respiratory diseases.

The figure 11 expressed that the chances of getting affected by different types of respiratory diseases varies with use of different biomass fuels as energy sources. But one thing stated that the pollutants emitted from the traditional indigenous biomass fuels are highly associated with health hazard especially for those who are espousing those for a long time.

Alternative fuel:

The over all study state that the indoor air pollution and gaseous pollutant concentration is highly related with the biomass fuel consumption by the villagers. Those traditional or indigenous biomass fuel emit gaseous pollutant that has a sever health impact. The ambient air quality is very low and the pollutant concentration is 10 to 15 times higher than the national standard.

Under such circumstances an alternative fuel or energy sources are need to consider for the rural areas especially where they use biomass fuel. Presently different NGO's are trying to provide solar panel as an alternative energy source in the rural areas. But

the solar energy is not an affordable solution as well is not supportive for cooking purpose which is one of the prime needs of energy consumption in the rural areas.

Another alternative approach was community based biogas plant to meet the cooking fuel demand. This is one of the positive approaches still the villagers are working on. Like three or four households could share one biogas plant to meet their cooking energy demand. For such biogas plant they could use the same fuels like cow dung, agri residue, fallen leaves and eve woods. The advantage of biogas plant is the villager do not need alternative fuel rather they could use the same biomass fuel but in a different way. But the limitations for biogas plant are

- Limited access of technology, only a few people in the village are interested and use the facility.
- The common people are not aware of the biogas plant and are not ready to pay any thing for the fuel when they can collect that free.
- Most the villagers are involved with fish farming, there are limited amount of land for agriculture and forestry as well as animal husbandry. Therefore the amounts of raw fuels are not always available to keep the biogas plant running.

Under those issues the biogas plant is not a successful story in the study area as a source of alternative fuel rather working.

The high-tech approach like central gas network or electric grid supply is not at all possible as the whole nation does not have complete gas network or electric grid supply. The main objective is to provide safe and affordable energy supply for the villagers to meet the energy demand, especially for the domestic energy demand.

Based on that objective the better alternative solution is community based biogas plant to meet the domestic energy need in the rural areas. But to introduce the approach the most important things is to

01. aware the community about the pollution and health hazard.
02. government or local government authority need to take initiatives to develop low cost plant so the fuel could be in an affordable level.
03. training and educate the local people about the community based biogas plant approach and better management and use of the low cost clean fuel.
04. ensure access to all income level people to the community based clean fuel process.

Conclusion:

The national energy supply like electricity and gas are very limited in Bangladesh villagers especially for the students it is too limited. Therefore the villagers have to depend on the locally available energy sources like biomass fuels; for example wood, cow dung and agricultural residues. In the study are the villagers completely dependent on biomass fuel to meet their domestic needs like cooking and they collect those fuels around the locality and some time they have to purchase it. Most of those fuels are not at all processed to burn in a proper way therefore they emit severe gaseous pollutant like CO, CO₂, SO_x, NO_x and even PM. Those pollutants are highly hazardous for human health especially for women and children who expose that air for a long time.

There are almost no researches have focused on these particular issues before, to find out what are the pollutants emitted from the traditional biomass fuel used by the villagers and their concentration and health impact. Under this research we try to find type of biomass fuels are used in the rural areas in Bangladesh, the pollutants they emit, the pollution concentration and the associated health hazard.

Based on this research the pollutants concentration in the study area is about 10 times higher even some time more than the national ambient air quality standard. That concentration has a high risk for human health. Unfortunately in the rural areas mostly women and child spend most of their time in such polluted air and get affected. The child death rate in the village area and the chances to get affected by other disease associated with air pollution is quite high in the village area in Bangladesh because of using unprocessed biomass fuel to meet domestic energy need. As well there are no awareness about that.

This research tries to focus on that particular issue and try to find current situation and to get an alternative solution to get a safe energy for the villagers. Still the government and local level authority need to perform more actively to get an alternative to protect women and child health from gaseous air pollutants emitted from traditional biomass fuels.

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