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CARBON DIOXIDE EMISSION FROM BRICKFIELDS AROUND BANGLADESH

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Abstract

The study was undertaken at six divisions of Bangladesh to investigate the CO_2 emission from brickfields**.** to explore the rate of carbon emission over the last 10 years, based on existing technology for brick production. The finding reveals that there were more than 45,000 Brick kilns in Bangladesh which together account for about 95% of operating kilns including Bull's Trench Kiln, Fixed Chimney Kiln, Zigzag Kiln and Hoffman Kiln. These kilns were the most carbon emitting source but it varies on fuel type, kiln type and also for location. It has been found that, maximum carbon emission area was Chittagong, which was 93.150 with percentage of last 10 years and 9.310 per cent per year. Whereas Sylhet was lower carbon emission area indicating percentage 17.172 of last 10 years and 4.218 percent per year. It has been found that total annual amount of CO_2 emission for 4 types brick kilns from Dhaka, Chittagong, Rajshahi, Khulana, Sylhet and Barisal were 8.862 Mt yr^{-1}, 10.048 Mt yr^{-1}, 12.783 Mt yr^{-1}, 15.250 Mt yr^{-1}, in the year of 2002, 2005, 2007 and 2010 respectively. In Mymensingh district, the maximum CO_2 emission and coal consumption was obtained in Chamak brick field, which was 1882 tons and 950 tons, respectively and minimum was obtained in Zhalak brick field, which was 1039.5 tons and 525.0 tons, respectively during the year of 2013. The percentage in last 10 years of CO_2 emission was 72.784 and per cent per year 7.970, which is very alarming for us. The estimates obtained from surveys and on-site investigations indicate that these kilns consume an average of 240 tons of coal to produce 1 million bricks. This type of coal has a measured calorific value of 6,400 KJ, heating value of coal is 20.93 GJ t^{-1} and it produces 94.61 TJ t^{-1} and 56.1 TJ t^{-1} CO_2 from coal and natural gas, respectively.

Keywords: CO_2 Emission, Carbon, Brick Kiln, Consumption

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Introduction

Brick making is a significant sector in Bangladesh, contributing about one percent to the country's gross domestic product (GDP) (BUET, 2007) and generating employment for about one million people. Due to the unavailability of stone aggregate, brick is the main building material for the country's construction industry, which grew an average of about 5.6 per cent per year (Arifur, 2006).

Despite the importance of brick making, the vast majority of kilns use outdated, energy-intensive technologies that are highly polluting the environment. In the North Dhaka cluster, brick kilns are the city's main source of fine particulate pollution, accounting for nearly 40 per cent of total emissions (Biswas *et al.*, 2009) during the 5-month operating period. It leads to harmful impacts on health, agricultural yields and global warming. The New technologies, such as the Vertical Shaft Brick Kiln (VSBK) and the Hybrid Hoffmann Kiln (HHK), are substantially cleaner than the Fixed Chimney Kiln (FCK) currently used. These improved technologies consume less energy and emit lower levels of pollutants and greenhouse gases (GHGs) (BUET, 2007; Heirli and Maithel, 2008). The existing brick kilns are the number one cause for fine particulate pollution in Bangladesh and its total greenhouse gas (GHG) emission is estimated to be 15.67 million tons of carbon dioxide (CO_2) equivalent (tCO_2e) per annum.

Global warming is an issue that calls for a global response. The rapid change in climate will be too great to allow many eco-systems to suitably adapt, since the change has direct impact on biodiversity, agriculture, forestry, dry land, water resources and human health. In addition, Bangladesh is one of the most climate change vulnerable countries. In Bangladesh, 92% of the 4,880 (Butler *et al.*, 2004) brickfields are highly polluting Fixed Chimney Kilns (FCKs) because of a combination of low capital cost requirement and high investment return. However, these kinds of kiln use more coal/wooded fuel, which emits more carbon. Brick making significantly contributes to local air pollution including emission of various harmful gases such as Sulphur Oxides (SO_x), Nitrogen Oxides (NO_x), Carbon dioxide (CO_2) and Suspended Particulate Matter (SPM) and PM10 (Iqbal, 2007). About half of Bangladesh's bricks are baked with the use of coal, which is now considered the source of some 20 per cent of global greenhouse-gas emissions (Enters, 2000).

Realizing the importance of estimating the level of green house gas emission to combat against climate change and related ill consequences the present research was taken to fulfill the following objectives:

- To estimate the amount of green house gas mainly CO_2 emission from brick kilns in Bangladesh;
- To compare CO_2 emission among four types of brick kilns running in Bangladesh;
- To evaluate the future prediction of environmental condition and/or problems associated with the present level of GHG emission to help the policy makers to take necessary steps in time.

Materials and Methods

To determine the Carbon emission from brick kiln, six divisions has been selected all over Bangladesh (24° 00' N and 90° 00' E) on the basis of BTK, FCK, Zigzag, Hoffman technology for brick production from January 2013 to June, 2013. Currently, there is no recommended estimation method to estimate CO_2, non-CO_2 GHGs and other gas pollutant emission from brick kilns. In this research study, CO_2, non-CO_2 GHGs and other gas pollutant emissions have been estimated based on natural gas and coal consumptions. CO_2, non-CO_2 GHGs and other gas pollutant emissions of brick kilns are divided into two categories, namely direct and indirect emissions. In this research study, direct gas emissions have been estimated independently. Direct an emission, which is due to natural gas and coal combustion from energy conservation units, were calculate based on Intergovernmental Panel on Climate Change (IPCC) guideline by using natural gas and other fossil fuel consumption. The CO_2, non-CO_2 GHGs and other gas pollutant emissions from brick kiln was calculated by the following equations: 44/12

Equation (1) $\text{direct } CO_2 = FC \times CEF \times f_o \times 44/12$

Equation (2) $\text{direct } e_i = FC \times CEF$

Where,

FC = Total annual natural gas and/or coal consumption in energy conservation unit of brick kiln during a year (TJ)

CEF = Carbon emission factor of natural gas and coal (tC/TJ)

f_o = Carbon fraction of natural gas and coal that has been oxidized during combustion process

44/12= Mass conversion factor of mass carbon to mass CO_2 generated during combustion processes

e_i = emissions level of non-CO_2 GHGs and other gas pollutant component (metric tons)

[BCAS, 2011]

Firstly, the quantities of natural gas and coal consumption are converted into energy units as tera joules, (TJ) using appropriate conversion factor, and then transformed into carbon emissions based on carbon emission factor (CEF). Though the IPCC has established CEF values, which can be used for general cases, data regarding fuel combustion in particular country has not been determined. As an approximation IPCC provides CEF value of natural gas, diesel, and coal that are 15.3 tC/TJ, 20.2 tC/TJ, and 26.4 tC/TJ (the average value of CEF for anthracite, coking coal, other bituminous coal, sub-bituminous coal and lignite). The fraction-oxidized value is used to account the carbon compound of natural gas and other fossil fuel that are not oxidized during combustion process. As an approximation, fraction-oxidized value of natural gas, diesel, and coal that are 0.995, 0.99, and 0.98, respectively (IPCC, 2000).

Results and Discussion

The experiments were conducted to study the rate of carbon emission from brick kilns around Bangladesh. Results of the experiments are presented and discussed as follows. The present situation of brick kilns in Bangladesh is as follows.

Table 1. A comparative study of the four kilns being used in Bangladesh

Parameter	Unit	Bull's Trench Kiln	Fixed Chimney Kiln	Zigzag Kiln	Hoffman Kiln
1.Initial Investment	Taka (Tk.) US$=Tk. 77	2,500,000	4.000,000	4,000.000	32.000.000
2. Working Capital	Tk.	1.000,000	900,000	900.000	7.500,000
3. Land	acres	2.5	2.5	2.5	Min 10 year round
	Clay ft³	100,000	95,000	95,000	425,000
4. Raw Material	Labor	200 (5% skilled, 10% semiskilled, rest unskilled)	200 (15% skilled, 15% semi-skilled, rest unskilled)	200 (15% skilled. 15% semi-skilled, rest unskilled)	400 (25% skilled, 45% semi-skilled, rest unskilled)
	Electricity	Not essential	Not essential	Necessary in small scale	Necessary
	Fuel	Coal	Coal	Coal	Natural Gas
5. Fuel Consumption	Tones Per 100.000 Bricks	22-26	20-24	20-24	15000-17000 m3
6. Pollution		Severe pollution	Pollution	Pollution	Very little pollution
7. Production Period		Nov to mid-Apr	Nov to mid-April	Nov to mid-April	Round the year
8. Estimated Annual Production	Million bricks	2.0 to 2.5	2.0 to 2.5	2.0 to 2.5	7.5 to 9.0
9. Wastage	%	10 - 12	5 - 8	5 - 8	15 - 18
10. Quality of Bricks		Medium	Good	Good	Very good
11. Bricks Sale Price	Tk./1000 Bricks	3000-3500	3000-3500	3200-3800	3500-4000

Source: (DOE, 2010)

From the table 1 it is showed that, Initial Investment is varies on the basis of land type, location, kiln type, production period, etc. Eleven parameter has been identified on the table to understand the Study of the four kilns being used in Bangladesh.

Data table of CO_2 emission from four types of brick kilns

The major concerning greenhouse gas (CO_2) emission from four types of brick kilns, around Bangladesh, is presented in Table 2. The amount of CO_2 emission is calculated based on 100,000 bricks production.

Table 2. Amount of CO_2 emission from four types of brick kilns

Parameter	BTK	FCK	Zigzag	Hoffman
Fuel	coal	coal	coal	natural gas
Total fuel (tons)	28 t	20 t	18 t	16320 m³
Total energy consumption	586 GJ	4180 GJ	376 GJ	571 GJ
CO_2 emission(tons)	55.58 t	39.8 t	35.7 t	31.86 t

Basis : 100,000 bricks produced
Conversion factors: Heating value of coal = 20.93 GJ/t (Giga Joules/tons)
Calorific value of coal= 6,400 KJ
Heat value of natural gas = 35 MJ/m³ (Mega Joules/m³)
CO_2 emission of coal = 94.61 CO_2/TJ (Tera Joules/tons)
CO_2 emission of natural gas = 56.1tCO_2/TJ (Tera Joules/tons)

(Source: BCAS, 2005)

Fuel consumption and carbon emission rate of different types of kilns

Coal was used in the BTK, FCK and zigzag kilns. Natural gas was used only in Hoffman kilns. The most coal demanding kiln is BTK (Bull trench kiln) which consumes 28 tons coal per 100000 bricks production where as FCK and Zigzag kilns consume 20 tones and 18 tons respectively for same number of brick production (BCAS, 2011). The production period for BTK, FCK and Zigzag was November to mid-April. But Hoffman kiln can run all over the year. It concludes that to reduce CO_2 emission, at first Hoffman kiln should be chosen for brick manufacturing then gradually Zigzag kiln, FCK and then after BTK. (BCAS, 2005).

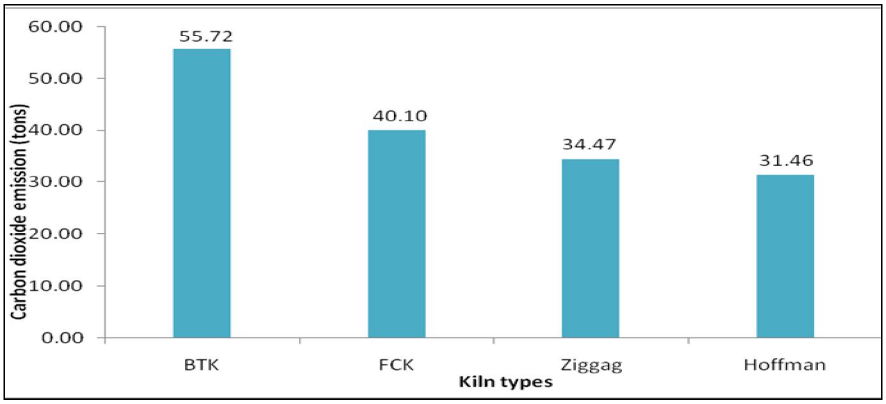

Fig.1. Coal consumption and CO_2 emission for individual brick kiln

CO_2 emission from different brick field of Mymensingh district

The statistical data of CO_2 emission from different brick field of Mymensingh and its surroundings are presented in Fig. 2. In those brick field they normally used different types of kilns such as Zigzag, Hoffman brick kiln etc. It has been found that highest amount of CO_2 is being emitted from Chamak brick field was 1882 t during the year of 2013 and the lowest amount of CO_2 is being emitted from Zhalak brick field was 1039.5t during the year of 2013.

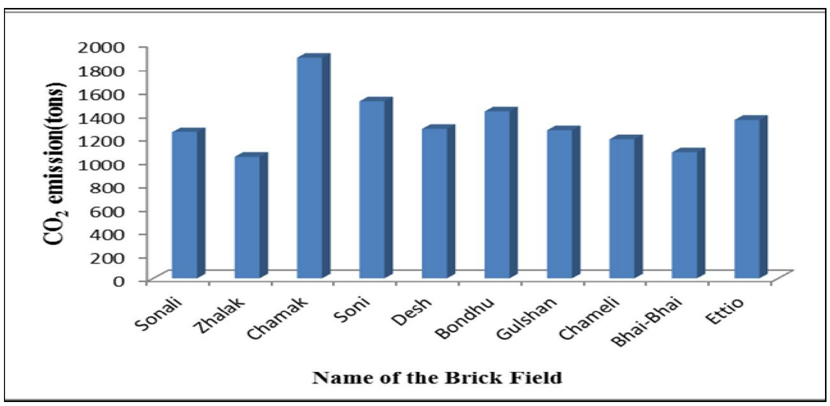

Fig. 2. CO_2 emission from different brick field of Mymensingh

Coal *consumption from different brick field of Mymensingh district*

The statistical data of coal consumption from different brick field of Mymensingh and its surroundings are presented in Fig. 3. The data shows that the maximum coal was consumed in Chamak brick field, which was 950 t and the minimum was in Zhalak brick field, which was 525 t during the year of 2013.

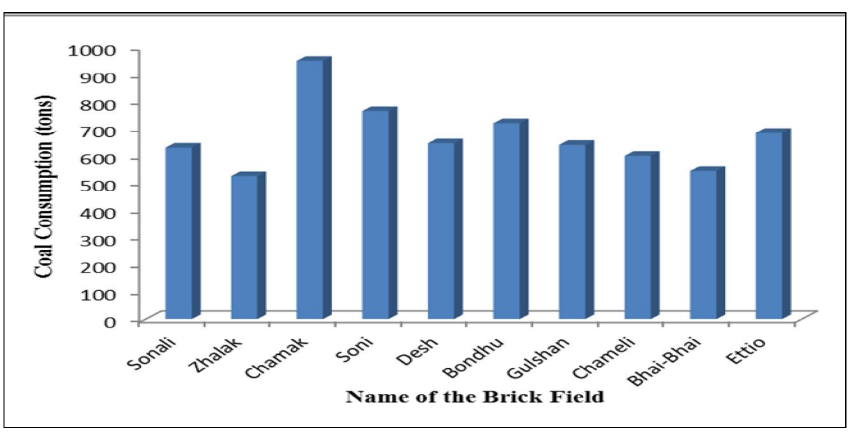

Fig. 3. Coal consumption from different brick field of Mymensingh

Total CO_2 emission from brick kilns

Total annual amount of CO_2 emission for six divisions are presented in Table 12. It has been found that total annual amount of CO_2 emission for 4 types brick kilns from Dhaka, Chittagong, Rajshahi, Khulana, Sylhet and Barisal are 8.862 Mt yr^{-1}, 10.048 Mt yr^{-1}, 12.783 Mt yr^{-1}, 15.250 Mt yr^{-1}, in the year of 2002, 2005, 2007 and 2010, respectively. The percentage in last 10 years of CO_2 emission geographically increasing which is very alarming for us.

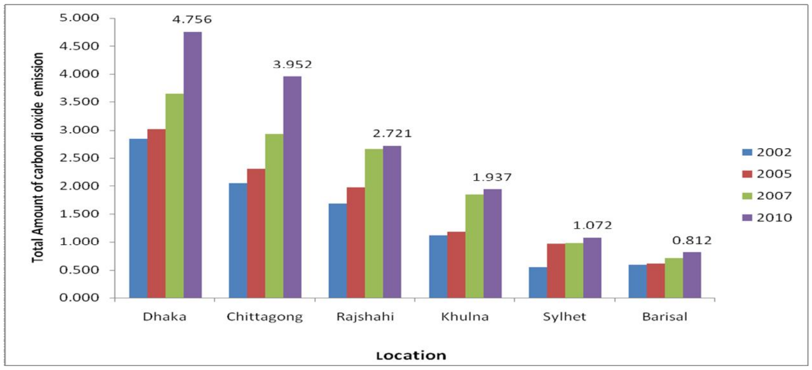

Fig. 4. Total CO_2 emission from brick kiln for six divisions for different years

All of the statistical graphs of total CO_2 emission in 2002, 2005, 2007 and 2010 of six divisions are presented in Fig. 4 shows the increasing rate of CO_2 emission in all of those years simultaneously around Bangladesh. The above result concludes that CO_2 emission rate are increasing day by day.

Conclusion

In the country such as Bangladesh with high level of poverty, malnutrition, and low human development index, it is unlikely that climate change will be a central focus for policies and measures. However, there are many interesting; conventional as well as innovative options, polices and measures those can benefit GHG (Green House Gas) reduction, better adaptation and increase sustainable livelihood potential. In spite of the issue of climate change, environment and resource management becomes important for sustainable development, which practically required integrated approach for accomplishment. Almost all the coal being used is imported from the Indian State of Meghalaya. This is because the brick industry has been growing at about 5.28% over the last decade with this trend leveling after 2014.

This baseline analysis indicates that GHG emissions from the brick industry are already at a high level and are expected to increase by at least 5.28% every year for the foreseeable future. This means that direct carbon emissions from kilns alone will rise to 8.7 million tons annually by 2014 or earlier depending on the growth rate of the industry. In addition, the brick industry is contributing in various ways to growing carbon emissions from other sources. Most notable, is the impact of brick making on land degradation and deforestation. In a country where the pressure of population growth on a relatively small land mass is significant, farmland depletion can have alarming prospects for food security. Total farmland in Bangladesh is about 14 million hectares and this is depleting by about 80,000 hectares every year, a 0.05% depletion rate. Moreover, wood fuel is used as a secondary fuel for brick making accelerating the depletion of scarce carbon sinks in Bangladesh.

The results consist of different types of information regarding number of brick kiln, annual amount of fuel consumption (natural gas and coal) and CO_2 emission from brick kilns around Bangladesh and presented in the following sections. According to Kyoto protocol, being a developing country it is not obligatory for Bangladesh to reduce green house gas emission but clean development mechanism (CDM) should be promoted here. Finally, Government needs to push people by creating awareness against traditional kilns and make the technology simply available to the brick manufacturers. Electronic and print media should come forward to encourage people for using such kinds of bricks. More marketing is required to familiarize people with green bricks and to reduce carbon emission for better future and sustainable development.

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