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Mini Review

Brick Kilns: Massive Environment Destructors

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ABSTRACT

Several factors are contributing to environmental degradation these days. One of such elements is brick kilns. Although they act as a source of employment for the less educated lot, but that is not worth in comparison to the environmental damage they cause. The illegal setting up of multiple brick kilns, that too not at a required distance in the residential areas is very common these days. In this paper, light has been thrown on the possible harmful impacts associated with brick kilns so that a lay man can get an idea of the hazards of having them in the vicinity. Research should be promoted in this particular field in order to find more efficient precautionary measures that can help in reducing pollutants released from these 'smoky giants'.

Keywords: Brick Kilns, Brick Kiln Impacts, Environment polluters, Air pollution, Anthropogenic Environment Degraders.

INTRODUCTION

Environmental pollution is the primary consequence of population explosion, industrialization and urbanization. Demands of such an alarming demography for the sake of development are fulfilled at the cost of environment (Bisht and Neupane 2016). One of the basic human needs is shelter which in today's world means a massive beautiful bungalow. Bricks are small rectangular mud baked blocks, used to forge this dreams. As a result more brick kilns are being established. These are small scale industries in saying but are large in terms of pollution emission. India is the second largest producer of bricks after China having about 10,000 operational units across different parts of the country (Singh and Ashgar 2005). In their course of producing bricks, these act as source of employment for more than 12 million people (Budhwar et al. 2003). The amount of pollution caused depends on the type of kilns (Fig. 1) as vertical shaft kilns are the lowest emitters of pollutants. They are the largest consumer of coal and consume more than 25 million tonnes on annual basis. Incomplete combustion of these fuels leads to the emission of various pollutants like fly ash, SPM, $PM_{2.5}$, PM_{10}, green house gases like HF, SO_2, NO_2, CO_2, H_2S, black carbon and heavy metals like Pb, Hg, Zn, Cu, Ni, Se, Fe and Cd (Ahmed and Hossain 2008).

Fly ash is the most common pollutant which contains Na, K, Zn, Mg and Fe as well as a wide range of heavy metals and non- ferrous metals (Luo et al. 2009). Every activity involved in brick making (Fig. 2) beginning with excavation of soil to the loading of final made bricks is associated with dust increase in the nearby areas. The various types of fuel used in the brick kilns is mainly coal, wood, recycled motor oil, diesel, tires and plastic and the different pollutants released from them are given in (Table 1). Mostly Assam coal or black coal, lignite is used as fuel in brick kilns containing massive ash content of 25-30% and large amount of sulphur (Bhanarkar et al. 2002). It has been observed that average emission factor of CO, SO_2 and PM per 1000 bricks are 6.35-12.3 kg, 0.52-5.9 kg and 0.64-1.4 kg respectively. Use of low quality of fuel in the brick kilns and absence of air pollution control equipments results in emission of more pollutants (Lee and Oanh 2009).

Brick kilns operational activities associated with emissions that pose serious damage to its surrounding environment including soil, air, water, plants, animals, amenity, heritage and humans (FAO 1993, De-Sarker and Kundu 1996, Brumsack 1977,

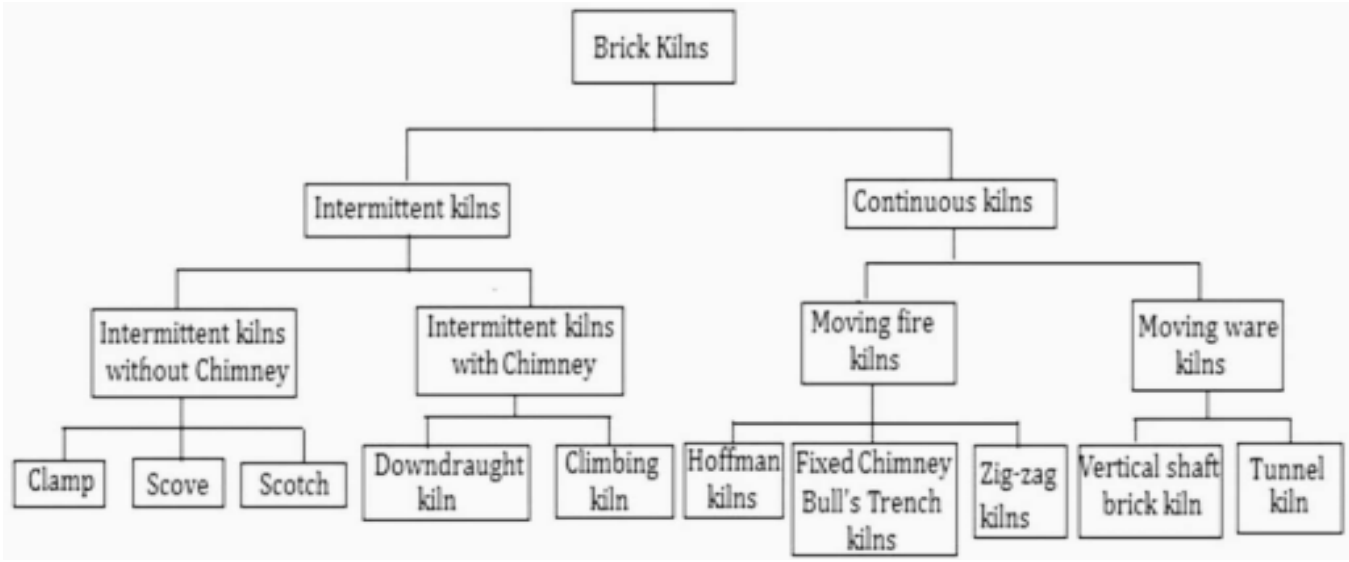

Figure 1. Types of brick kilns

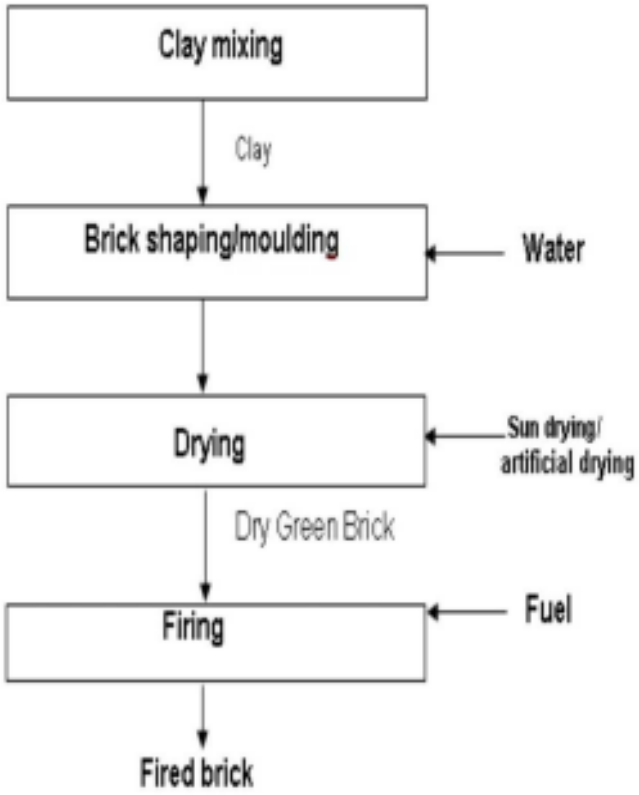

Figure 2. Sequential steps of brick making

Bhanarkar et al. 2002, RERIC 2003, Brick Industry Association 2006) should be brought into the notice of local people residing in the vicinity, so that they can oppose their establishment in the residential areas.

The main aim of writing this article is to collaborate all those studies which have taken place on brick kilns impacts with respect to plants, animals, soil and water so that one can know the general impacts in a single glance.

METHODS

The relevant literature was searched online through web of science, Google scholar, Wiley online library and PubMed. Some of the papers were searched online directly using keywords like brick kilns, brick kilns impacts, environmental impacts of brick kilns, sources of air pollution and anthropogenic greenhouse gas sources etc.

IMPACTS OF BRIK KILNS ON ENVIRONMENT

Impacts on plants

Plants play an important role in cycling nutrients and absorption of gases by providing large surface area, maintaining ecological balance and acclimatization of various pollutants (Diaz et al. 2007). Brick kilns have tremendous impacts on surrounding plants. Numerous studies have taken place on plants which are in support that brick kilns do impacts plants anatomy, physiology and biochemical parameters. The various toxic gases released like HF, SO_2 and H_2S in wet as well as dry form, blocks stomata (Gheorghe and Ion 2011), decreases photosynthetic rate (Jha et al. 2008), plant growth rate, enzymatic activity and productivity. In certain plants visible marked impacts are observed like in mango trees, mangos develop black spots due to sulphur and fluorine exposure (Wahid et al. 2014). Air pollution tolerance index (APTI) is the ability of plants to

Table 1. Types of fuel and associated pollutants

S.NO	TYPE OF FUEL	POLLUTANTS
1	Wood	NO_X, VOC, CO, PM_{10} and $PM_{2.5}$, SO_2
2	Oil impregnated wood/ wood shavings	NO_X, VOC, CO, PM_{10} and $PM_{2.5}$, SO_2, NH_3
3	Mesquite and Tecate	NO_X, VOC, CO, PM_{10} and $PM_{2.5}$, NH_3
4	Sawdust	NO_X, VOC, CO, PM_{10} and $PM_{2.5}$, NH_3
5	Saladillo or typical flora of the region, cob corn, coffee husks, coconut shell	NO_X, VOC, CO, PM_{10} and $PM_{2.5}$, NH_3
6	Used oil	CO_2, CO, NO_X, PM_{10}, SO_2, TOC, HCL, Cr, Ni, CH_4
7	LP Gas	CO_2, CO, NO_X, PM, SO_2, TOC, N_2O, CH_4
8	Tyres	CO_2, CO, Metals, NO_X, VOC, PM_{10} and $PM_{2.5}$, SO_2
9	Cow manure, chicken manure, or manure	COT, Dioxins and furans, CH_4, NH_3
10	Waste and plastics	CH_4, CO_2, N_2O, Dioxins and furans, TOC, VOC
11	Oil	CO_2, CO, NO_X, PM_{10} and $PM_{2.5}$, SO_2, CPM-Cot, CPM-IOR, CPM-ORG, CH_4, N_2O, Polycyclic Organic Matter (POM) and formaldehyde (HCOH), Chlorides, Fluorides, NI, V, CO, Cr, Pb
12	Hazardous waste, solid tow, waste from filtration	TOC, VOC
13	Sole and leather	CO_2, CO, NO_X, PM_{10} and $PM_{2.5}$, SO_2, VOC, Hexavalent chromium, Metals

Source: Erbe 2012

tolerate air pollution, can be calculated by analyzing different physiological parameters like total chlorophyll content, pH, relative water content and ascorbic acid (Esfahani et al. 2013). The APTI index helps in recognizing and classification of sensitive and tolerant plant species in a heavily polluted area (Okunlola et al. 2016, Kashyap et al. 2018). Researchers like Tripathi and Gautam (2007), Chauhan and Joshi (2010) and Adrees et al. (2016) and have worked on the impacts of gaseous pollutants present in air on the growth, physiological and biochemical attributes of plants whereas Leghari et al. (2011), Agbaire and Akporhonor (2014), Otuu et al. (2014), Sikder et al. (2016), Gholami et al. (2016), Achakzai et al. (2017), Molnar et al. (2018), Rathore et al. (2018), Manjunath and Reddy (2019) and Khanoranga and Khalid (2019) have worked on the APTI of different plants.

Impacts on air quality

Brick kilns release gaseous pollutants in the atmosphere and therefore, cause air pollution. Various workers have determined air quality around brick kilns and observed that brick kilns operation causes enormous increase in the concentration of pollutants like PM_{10}, SPM, $PM_{2.5}$, SO_2, NO_2 and CO_2. (Khan and Vyas 2008, Ahmed and Hosain, 2008, Lee and Oanh 2009, Jamatia and Chakraborti 2015 and Nepal et al. 2019)

Impacts on soil

People living in the vicinity of brick kilns sell their top soil for brick making practices, without having any knowledge of the associated harmful impacts. The harmful gases and heavy metals released cause nutrient loss in the soil and ultimately productivity. Higher heavy metals content in the soil alters cation exchange capacity, organic carbon and water holding capacity (Duker et al. 2005 and Bisht and Neupane 2016). Several other researchers like Ishaq et al. (2009), Ismail et al. (2012), Ravankhah (2016), Sikder et al. (2016) and Dey and Dey (2017) have also reported brick kilns impacts on soil quality.

Impacts on agricultural crops

As top soil carries the essential nutrients and minerals required to support a crop, so removal of it definitely lowers the soil fertility rate. The pollutants released

disturb the nutrient cycling and other processes like metal lowers cation, exchange capacity of soil, decreasing organic carbon content and reduces water holding capacity in soil (Bisht and Neupane 2016). Adrees et al. (2016) observed decrease in photosynthesis, growth and yield of wheat grown around brick kilns. Similarly Ismail et al. (2012) also observed high load of Cd and Cr in brick kilns surrounding plants and soil.

Impacts on human health

Heavy pollution load from the brick kilns not only influence surrounding environment but also effects human health. It is a high pollution prone workplace. Every gas released from brick kiln has harmful health impacts for instance sulphur dioxide exposure can leads to irritation in nose, throat, lungs and burning sensation in skin. Nitrogen dioxide exposure leads to cough and / or wheezing (most common), eye, nose or throat irritation, light-headedness or headache, dyspnoea (shortness of breath), chest tightness, choking, chest pain, diaphoresis (sweating). Similarly, exposure to PM matter can lead to various respiratory ailments like problem in breathing, heart attacks, asthma. Khan and Vyas (2008) during a survey observed various respiratory issues faced by workers. Trevelyan and Haslam (2001) observed musculoskeletal disorders in workers of a hand making brick industry due to the continuous force applied for moulding and shaping of bricks and sitting posture. Sanjel et al. (2016) have worked on the various health problems faced by brick workers, like heat stress, reproductive and mental disorders, gastrointestinal disorders, various physical injuries while working. Not only, workers working in brick industries, people living in vicinity also experience similar health issues. (Joshi and Dudani 2008 and Pariyar et al. 2013)

Impacts on water bodies

The Fluoride emitted from brick kilns in the form of particulates gets leached in the soil and increases soil fluoride content and ultimately boost ground water fluoride levels (Datta et al. 1996, Farooqi et al. 2009, Khalid et al. 2017). In addition to this, discharge from brick industry may also increase turbidity, total suspended and dissolved solids in water (Khan and Vyas 2008).

Other impacts

Animals: Animals like donkeys and horses are used to carry heavy loads of bricks and while working suffer from causalities associated with saddle, breeching, and neck collar and with excessive force/ beating, the shaft of the cart, and improper tethering. (Farhat et al. 2020).They may also experience problems like heat stress, dehydration (Pritchard et al. 2006).

Unhygienic surroundings: Most of the workers working in the brick kilns are illiterate, poor and unaware of the importance of keeping their environment clean. So they make their surroundings unclean by openly defecating and throwing garbage in the adjoining areas.

Regional climate change: Brick kilns operate for 24 hrs and add enormous amount of CO_2, SO_2, black carbon and other greenhouse gases which may alter and influence regional climate and other atmospheric process like wind patterns, rain patterns etc.

Mitigation measures

· Awareness is the soul key to stop the establishment of brick kilns in the residential vicinity. When people will be well aware of the harmful impacts, like land degradation and soil fertility loss, then they will not sell their land for this purpose.

i) Desulphurization of coal with use of calcium carbonate and calcium hydroxide as desulfurizing agents in coal briquettes.
ii) Use of protective devices for example use of gloves, boots, goggles and respirators, should be mandatory from both owners and workers.
iii) Periodic health check-ups of the workers as well as people living in surroundings should be carried.
iv) Brick kilns should not be allowed to operate for 24 hours. There should be a time limit beyond which they should stop working.
v) Pollution treatment devices like wet scrubbers and ash trappers should be installed so as to cut down the emission levels.
vi) There should be proper audit by SPCB in order to check whether they have installed pollution treatment equipment and if they have installed then they are in working condition or not.
vii) The kilns should be 0.8km away from habitation and fruit orchards, water bodies and other

sensitive ecosystems.

viii) There should be 1km distance between two brick kilns in order to avoid crowding in the area.

ix) Roads connecting brick kilns to the highways should be proper so as to avoid excessive dust load.

x) The bricks transportation vehicles should be properly covered.

xi) All Brick kilns should be with Zig-Zag or vertical method of brick making and if not so then they must convert it within period of 1 yr.

xii) Every country should have brick kilns rules and regulations and should have a strict legal body for properly follow up.

xiii) Tolerant plant species should be grown in large number in order to combat the harmful pollutants released.

CONCLUSIONS

Working in brick kilns is one of the lowest paid and high health risk job. Though brick kilns are a source of income for local and poor people, but that should not be at the cost environment and human health.

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