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Brick Kilns in Kathmandu Valley: Current status, environmental impacts and future options

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'Kathmandu Valley' is vulnerable to air pollution problem due to its topography, which restricts the wind movement and allows pollutants to remain within the valley. Brick kilns, operating in the Valley, are known to be a prime cause of air pollution. There are currently more than 125 brick kilns operating in Kathmandu valley deteriorating its air quality and degrading the health of the people living near the kilns. Recent studies have found that the concentration of particulate matter in the air in an area with brick kilns is three times higher when the kilns are operating than during the off-season. Similarly, the health of students studying at a school situated near a brick kiln was found to be significantly worse than that of students studying in a similar school but located in an area without brick kilns. Other environmental costs of the brick kilns are the reduction in the soil fertility, reduced visibility, drying ground water sources. The use of an old and inefficient technology called Bull's Trench kilns and low quality fuel are the main causes of the problem. Recently the government has decided to ban Bulls Trench brick kilns in Kathmandu in a year and a half. As a result, entrepreneurs are searching for environment friendly and cost effective alternative technologies. There are some technologies currently in practice in India like Vertical Shaft Brick Kiln, Fixed Chimney Kilns which are environment friendly and economically sound. Introduction to these technologies in Nepal can save both ecology and economy.

Introduction

Kathmandu Valley is the main economic as well as cultural centre of the country. Situated at an altitude of about 1300 masl, the valley occupies an area of about 351 km^2. The cross section of valley is about 20 km North to South and 30 km East to West. Kathmandu valley, which includes three districts namely Kathmandu, Bhaktapur, and Lalitpur, has five municipalities and almost a hundred village development committees. Approximately 1.5 million people currently live in Kathmandu valley. Among these, about a million live in the urban areas in the Valley. Overall, Kathmandu valley's population is growing at a rate of 4.83% per year, which is high compared to the country's population growth rate of 2.27% per annum (CBS 2001). This is the result of centralization of development activities and migration of the rural people to the capital for different opportunities. This rapid and haphazard growth of Kathmandu is putting tremendous pressure on the valley's natural resources, including air, water and soil.

The Valley is especially vulnerable to air pollution due to an exploding population inflow, rapid urbanization, valley centric industrialization and significant increase of vehicular transport in narrow streets. Furthermore, the bowl like topography of the valley restricts wind movement and retains the pollutants in the atmosphere. This is especially bad during the winter season when thermal inversion – cold air flowing down from the mountains being trapped under a layer of warmer air – creates a lid, which keeps the pollutants sealing within the valley.

Kathmandu's brick kilns, most of which are situated at the southern part of the Valley, are largely responsible for the degrading air quality of the valley. The growth of Kathmandu's brick industry has brought with it significant environmental and health problems because the industry is using poor quality fuel and very inefficient technology. According to an emission inventory conducted under the URBAIR program by The World Bank, the main contributing sources for total suspend particles (TSP) in the valley are cement factory (36%), brick kilns (31%), domestic fuel combustion (14%), road resuspension (9%) and vehicle exhaust (3.5%). However, for the particulate matters less than 10 microns in size (PM_{10}) concentration, which is more of a concern because these are particles that can enter the respiratory system, contribution of brick kilns was found to be more than any other sources. The share of brick kilns was 28%, domestic fuel combustion 25%, cement factory 17%, vehicle exhaust 12% and road resuspension 9%. The study further estimated that dust particles in Kathmandu valley cause almost 18,863 cases of asthma and about 4,847 cases of bronchitis in children every year (URBAIR 1997).

There are around 125 brick kilns in Kathmandu valley (ENPHO 2001). Of these, over 90% are Bull's Trench kilns, which supply 87% of the total brick demand of the valley. As the Bull's Trench kiln runs seasonally and many of the kilns are operating illegally, the actual number of kilns under operation at a given time is variable. There are other brick making technologies in practice as well like 'Clamp Kiln' and

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'Hoffmann Kiln'. Hoffmann kiln uses cleaner technology and produces good quality bricks.

Environmental impacts

The Bulls Trench kiln is an old and inefficient technology, which has been banned in India, the place of its origin. The main problem associated with this technology is the excessive air pollution it causes which degrades the local environment. A study conducted by Clean Energy Nepal (CEN) before and during brick kiln operating season at Tikathali VDC of Lalitpur district shows that the air pollutants were three times higher during the brick kiln operating time than during the off-season (Tuladhar and Raut 2002). Total suspended particulate (TSP), PM_{10}, sulfur dioxide (SO_2) and nitrogen oxides (NOx) were the criteria pollutants measured at the area for eight hours. Average value of PM_{10} during the off-season was 217.95 $\mu g/m^3$ whereas it reached 602.16 $\mu g/m^3$ at the same location when the brick kilns were operating. Similarly, TSP value was 265.49 $\mu g/m^3$ during off-season and 633.78 $\mu g/m^3$ during operation time. In Jhaukhel VDC of Bhaktapur district, PM_{10} concentration in an area with brick kilns was found to be 568.78 $\mu g/m^3$ while it was only 158.33 $\mu g/m^3$ in Sipadol, an area which is south of Jhaukhel but does not have brick kilns (Tuladhar and Raut 2002).

Loss of soil fertility is another environmental cost of these kilns. According to ENPHO (2001), brick kilns in Kathmandu valley occupy about 509.1 ha of land. For the brick manufacturing process, a large plot of land ranging from 2 – 10 ha, or 40 – 200 *ropani* (~ 20 *ropani* = 1 ha) is taken on rent from farmers during the dry season (December to May). Farmers take one crop of paddy during the summer and then lease the land for brick making and soil excavation and get paid between NRs 1200 – 2400 per *ropani* of the land. On an average 4 ha land is used by each kiln and this area includes land on which the kiln is constructed.

Studies have shown that concentrations of essential nutrients like nitrogen (N), phosphorus (P) and potassium (K) are very low in the fields that have been used by the brick industry as the kilns use fertile topsoil (Tuladhar and Raut 2002). A soil fertility test conducted by CEN along with ENPHO and Environmental Camps for Conservation Awareness (ECCA) at the Tikathali VDC, Lalitpur district have found that the use of top soil by brick kilns is making a significant negative impact on soil fertility and agricultural production. The tests indicated that areas without brick kilns showed high concentration of all these nutrients, whereas in areas, which had been used by brick kilns, these essential nutrients were very low. Discussion with local farmers also indicated that the production of crops went down after an area was used by brick kilns. Many farmers add large amount of chemical fertilizer to improve soil quality, but this causes additional environmental problems (Tuladhar and Raut 2002).

Areas that have been used by brick kilns also suffer from other problems such as drying of water wells, lower yield of crops, small landslides and poor visibility. According to the local residents in Tikathali, previously they could easily get water from 4-5 feet below the ground surface. But these days, at the same place there is no sign of water even below 70 feet and most of the water wells are dry. Similarly, impact on agriculture can be seen from the declining crop yield which has decreased by 50 percent. Local residents also reported that after extracting the topsoil for brick making, there are possibilities of landslide along the road, which is now at a higher elevation compared to the surrounding fields (Tuladhar and Raut 2002). Due to the poor visibility, some pilots have complained about problems faced during landing of airplanes from the southern part of the valley (Rai 2002).

Health impacts

Air pollution caused by brick kilns has adverse impact on the health of local people. The PM_{10}, emitted from these brick kilns has direct relation to the human health, as these particulates are small enough to pass through the nose and enter the respiratory system causing problems such as asthma and bronchitis. A health check-up conducted by Clean Energy Nepal and Pro-Public showed that young children studying at High View School, located next to the kilns in Tikathali, suffer more from respiratory problems than students at Valley Public School in Lamatar, which does not have brick kilns in its immediate vicinity. When a doctor examined over 100 children under the age of five in these schools, only 3.85% of the examined children at Valley Public School showed signs of abnormality in lower respiratory tract, whereas in High View School, the figure was 50.85%. Similarly, absence rate at these two schools were very different. On an average, a student was absent 3.6 days per month at the school located near brick kilns whereas 1.9 days per month at the school located away from the kilns. As ill-health is normally the main cause of children being absent in school, this also indicates that the kilns are having an adverse impact on the health of local people, particularly young children (Tuladhar and Raut 2002).

The way ahead

Recently, HMG Nepal has taken few steps to address the problems caused by brick kilns. In March 2002, Industrial Promotion Board decided that after a year and half the government will ban brick kilns that use outdated Bulls Trench kiln technology in Kathmandu valley. The Board has also decided to start the legal and administrative work to change existing polluting industries towards the cleaner options. The Board further ordered the Department of Small and Cottage Industries (DSCI) to close down the brick kilns which are operating without registration (illegal kilns). In the fiscal year 2000/2001, DCSI conducted action against 33 illegally operating brick kilns in Kathmandu valley and fined them a total of NRs. 3.65 million (DCSI, 2002). At the same time, government had announced to stop registration for new Bull's Trench brick kilns in Kathmandu valley.

After the government's decision to shift towards cleaner technologies, brick kiln entrepreneurs are searching for environment friendly and cost effective technologies. Some international organisations like Swiss Agency for Development Co-operation (SDC) and Environment Sector Programme Support (ESPS) supported by DANIDA are providing assistance in demonstrating clean brick manufacturing technologies. Some of the cleaner technologies being considered are as follows:

Vertical Shaft Brick Kiln (VSBK)

VSBK technology was developed in China. In these kilns, the bricks are stacked in a shaft measuring 1 x 1 m and have a height of 6 m. Green bricks are loaded from the top in batches. At the bottom of the shaft, bricks are taken out at the same rate with a special unloading device. Combustion takes place in the middle of the vertical shaft. The combustion air enters at the bottom of the shaft and moves up through the already burnt bricks. So when the air reaches the combustion zone it is preheated to about 7500^0C. After combustion the hot flue gas moves up through the unfired bricks. The transfer of heat to the bricks so very efficient that the temperature of the exhaust gas is low enough to hold a hand over it.

Previously, GTZ/Ceramics Promotion Project set up a VSBK in Nepal in 1992 and after some time the project did not grow up with the expectation and it finally failed. However, the then erectors claimed that the kiln had a fuel saving efficiency of at least 50% and a corresponding reduction of flue gas emission. The combustion in VSBK was much more thorough compared to Bull's Trench kilns and during firing, no black smoke was seen from the chimneys. Lack of initiative for promoting this technology coupled with low production capacity of the demonstration kiln (4000 bricks in 24 hours) and higher rejection rate due to brick breakage are the major reasons for brick entrepreneurs' non-adoption of VSBK in the valley (ENPHO 2001).

The advantages of VSBK technology are energy efficiency and the possibility of operating throughout the year. Unlike other traditional kilns, VSBK has a roof, which affords protection from rain. In India, the emission from VSBK kilns is found to be within the country's standards (VSBK India website).

Forced Draft Zig Zag Brick Kiln

ESPS is to build at least three Forced Draft Zig Zag Firing type brick kilns in Kathmandu, Jhapa and Bhairahawa for demonstration. This type of kiln will have a blower instead of a high chimney to create a horizontal draft through the kiln and the bricks will be arranged in a zig-zag pattern so that the fire and warm air does not go through a straight line. This results in a very compact and efficient kiln design. According to experts, this type of kiln will be cheaper to construct and operate than the Bulls Trench kilns and will result in significantly lower pollution loads.

Fixed Chimney Brick Kiln

Fixed Chimney type of brick kilns are used in India because they are more environment friendly than Bull's Trench kilns. This technology uses a properly designed chimney of about 130 feet height along with an internal gravitational setting chamber (Priya Bricks website). To supplement the chimney, flue ducts are designed so as to provide the least amount of resistance to the flue gases. However, tall fixed chimney may not be appropriate for Kathmandu because the brick industry is located in the southern belt which has soil with low bearing capacity and high seismic risk. This means that setting up a tall chimney could be structurally challenging and expensive. Therefore, kilns with forced horizontal draft or a vertical shaft kiln would be more appropriate.

Conclusion and recommendations

For last few years, Kathmandu valley has been facing serious air pollution problem. Ambient level of TSP and PM_{10} is 4 or 5 times higher than World Health Organisation (WHO) guideline values. Due to this increasing air pollution, many people are facing respiratory diseases and it is increasing annually.

One of the main sources of pollution in the valley is the brick industry, which uses outdated Bulls Trench kilns that are inefficient and polluting. Health check up of children under the age of five in areas with and without kilns revealed that the children in an area with brick kilns are more vulnerable to the respiratory infections. Besides causing pollution and health problems, these kilns also cause problems such as loss of soil fertility, drying of wells and visibility reduction.

Despite its environmental problems, there is need of bricks as construction material in Kathmandu. Therefore, although it may not be possible to close down all kilns the problems of poor quality fuel and inefficient technology must be addressed immediately. A study conducted by Tata Energy Research Institute (TERI) in India indicated that improvements in this Bull's Trench Kilns could save energy consumption by 20% and reduce dust particle by 10 times (TERI website). Similarly, technologies such as Vertical Shaft Kilns and Fixed Chimney Kilns are also available which are more efficient and environment friendly. Introduction of these technologies in Nepal can also save both economy and ecology.

Although, there is no emission standard for brick kilns in Nepal, a recent move of the government to ban Bull's Trench technology is a positive move towards the improvement in brick kilns technology. The need now is to implement this policy and demonstrate the use of environment friendly technology. ■

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