Trans. Inst. Indian
Geographers

Status and Impact of Brick Fields on the River Haora, West Tripura

Shreya Bandyopadhyay, Kapil Ghosh, Sushmita Saha, Sumanto Chakravorti and Sunil Kumar De. Agartala, Tiripur

Abstract

The Sadar Subdivision as well as the Haora river Basin is the most economically developed region of West Tripura. Various small scale industries (84 numbers) have grown up in the basin among which brick industry has highest share. Most of the brickfields are of recent origin. The SOI Topographical sheet of 1932 (1:63360) and US Army Sheet of 1956 (1:250,000) do not show the existence of any brickfield. From Google Map of 2005, several field visits (since January 2010) and secondary literatures it is found that 62 brick fields are located within the Sadar division of these 57 are located in Haora Basin between Chandrasadhubari at Champaknagar to Jirania towards Agartala. Although brick fields constitute a major part of the industrial activity in Haora Basin area, it adversely affects the portion of river channel as well as its tributaries. Most of the brick fields in the study area were constructed after 1990. Since then the river has been affected by increasing pollution and sedimentation. Dumping of ashes, extraction of sand from the river bed and bank, cutting of tilla lands (approx 15-20 trucks /year/ field) hinder the natural flow of the river. Therefore, the present study has been undertaken to assess the impact of these brick fields in terms of pollution, sedimentation and changing course of the river Haora as well as its tributaries.

Key words: *Tilla cutting, waste pollutants, sedimentation, changes in river course.*

ydroHhhh

Introduction

Haora River is one of the major rivers of West Tripura and is considered as the life line of Agartala. Originating from the Baramura range, the river flows westward through Sadar Subdivision of West Tripura and finally meets with river Titas in Bangladesh.

Sadar is the most economically developed subdivision of West Tripura. Several small scale industries and manufacturing units based on available natural and cultural resources of this region have grown up in the district. Out of 1921 industrial units of West Tripura 1239 industries (TSPCB, 2004) are located within this subdivision. Excepting the residential areas in Agartala Town and other urban areas, there are 84 types of industries within Sadar Subdivision, among which brick field is considered as the major one (TSPCB, 2004). Ubiquitous raw materials, access to NH44, proximity to Haora River and Agartala Market are major factors responsible for the growth of 62 brick fields within the Sadar subdivision, 57 out of 62, almost 91% of these are located within the Haora basin.

Although brick fields constitute the major part of economic activity of the Haora Basin, it has some adverse effects on the trunk river and its tributaries. Indiscriminate cutting of *tilla* land and lifting of sand from the river bed lead to several hydromorphological changes in the river channel. It is also found that the river is gradually becoming sick due to the emission of pollutants from the brick fields as well as the dumping of garbage along the river bank. An attempt has been made to study the present status of the brick fields within the river basin and also to assess the impact of these brick fields on Haora River as well as on its tributaries.

Materials and Methods

Location of brick fields has initially been identified from the Google image and thereafter verified with the help of GPS during field survey. Survey of India Toposheets (1932) of 1:63360 scale, Google image and SRTM DEM have been used to determine the location of *tilla* lands and flood plains from where the brick fields collect their raw material. Data base has been generated on 50 brick fields, located near the river course, through intensive field investigation. Several cross sections have been taken along the river adjacent to the brick fields in different time periods in order to find out the spatio-temporal changes that may have occurred within the river basin. Water samples from different points have also been collected in order to check the quality variation of the river water and tested in the laboratory of Tripura State Pollution Control Board.

Location of the brick fields

There are 57 brick fields within the Haora River Basin. 50 of these are located along both sides of the River Haora, River Donaigang and NH44 (Fig.-1) between Chandrasadhubari in Champaknagar and Jirania. Of these 50 brick fields, only 4 are located along the left bank and the remaining

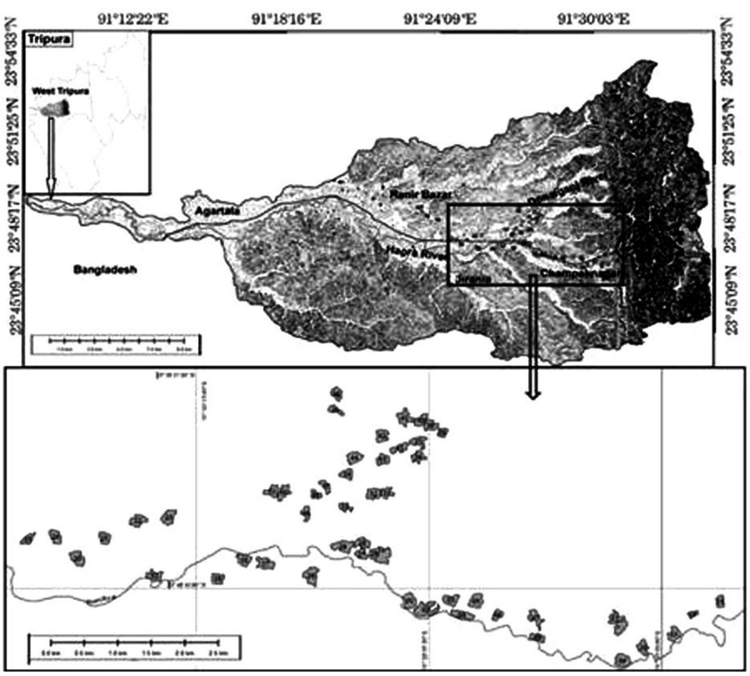

Fig.1 : Location map of the study area

46 brick fields are located along the right bank of the river. Seven fields, (out of 57) located far from the main river, have not been considered in the present study as they do not have any direct impact on the river. The latitudinal and longitudinal extension of this zone is between 23˚48′10″ N and 23˚50′37.50″ N; and 91˚26′15″ E and to 91˚30′12″ E.

From the fault map it is clearly found that a number of lineaments extend in a NE-SW direction throughout the Haora Basin. Some of the tributaries of the river, surrounded by *tillalands*, are flowing through such lineaments. These *tilla* lands are mainly composed of unconsolidated sediments and are the main source of raw material of the brick fields. Donaigang, a tributary to the river Haora, is such a fault guided river surrounded by *tilla* lands. Unconsolidated sediments of *tillas* is Probably the main cause behind the concentration of brick fields along the river.

Result and Discussion

Status of Brick Fields in the study area

The first brick field in the study area, namely Jyoti Brick Industry was established at Nowabadi, Jirania in 1978. On the other side Bihar Brick Field located near Champaknagar West Khamarbari, is the latest one and was established in 2009. Before 1991 there were only 8 brick fields within the whole basin. 20 new brick fields were constructed between 1991 and 2000 and the total number has reached to 50 by the year 2010. The status of these brick fields can be understood with the help of the area they occupy, the labour they employ, the raw material they use and their production levels.

Areal extent of the brick fields

Area of the brick fields within this basin varies from 0.0025 to 0.12 sq. km. Out of 34 brick fields 23 brick fields are small in size and their area ranges between 0.033 and 0.06 sq. km. 12 brick fields are considered as medium sized as their area ranges between0.063 and 0.09 sq. km. There is only one brick field having an area of 0.12 sq. km. and is considered as large brick industry of this basin area.

Labour employed in brick fields

As production of brick is a labour intensive sector**,** a large number of efficient work force is needed for this industry. All of the brick industries in the study area employ both local and migrated labourers (**Yeasmin Farhana, 2012)**. In the brick fields of the study area number of labourers ranges from 50 to 410. On an average 101-200 labourers are employed in majority of the brick fields. These are considered as medium scale industry in terms of labour force.

On the whole, the number of migrated labourers is quite high in the brick fields of this basin area (Khandoker R.U., 2007). Most of the brick fields absorb more migrant labour than the local. The migrated labour comes from Bihar, Chhattisgarh, Orissa and Uttar Pradesh. Among which Bihar shares the highest proportion and Uttar Pradesh shares the lowest. Among the 50 brick fields, 22 can be classified as large (>100), 26 as medium (in between 40 to 100) and only two as low (<40 l) brick fields in terms of migrated labour

As these labourers live in temporary houses and construct 'Kachha (Hanging toilets)' toilets along the river for their daily use, the number of migrated labourers in the area is of a major concern. Huge amount of excreta is supplied directly into the river regularly that pollutes the river to a greater extent.

Production status

According to the production most of the brickfields within the Haora River Basin are considered as medium scale industry. The average production of these 50 brickfields is 27.88 lakhs bricks/year. In the year 2010 the two brick fields recorded the lowest production (about 10 lakhs) whereas five recorded production of about 50 Lakhs. There are 40 brick fields that produced more than 20 lakhs/year and there are only 10 brick fields whose production is less than 20 lakhs (Fig.-2).

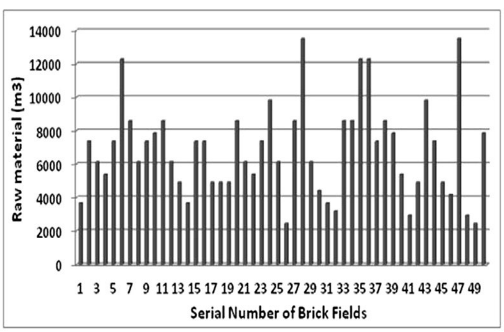

Fig.2 : Production (number in lakhs) of bricks in different brickfields

Raw material status

The raw materials, mainly used for brick production, are local mud, sand and fuel material (Technical note on Brick Construction, 2006). All of the brickfields within the Haora River Basin use coal as fuel for burning bricks which is imported mostly from Meghalaya. They collect sand from the river bed and mud from the *tilla* lands along the roads, especially along the National Highway 44. Due to cutting of such *tilla* lands, roads are being damaged. It is also found that top soils of agricultural land are extensively used in production of bricks. Due to over exploitation of top soils, the agricultural lands are becoming infertile.

About 342653.5 m^3 of mud per year is used by these 50 brick fields for the production of bricks. The average amount of mud that is used by these brick fields is about 6853.07 m^3 (Fig-3). There are 24 brick fields that used mud below average level. On the other hand 26 brick fields have used mud more than 6853.07 m^3 yearly.

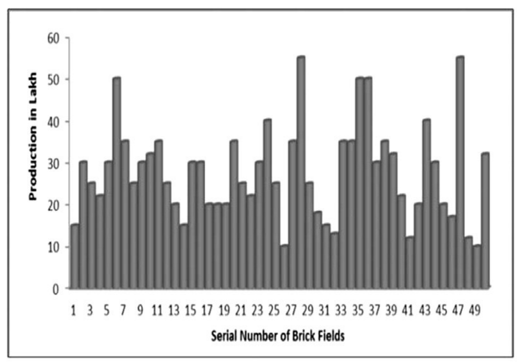

Fig.3 : Raw materials used by different brick fields

Impact of Brick Fields on the river

Cutting of tilla and agricultural land

All the *tilla* land in Haora River Basin possess Dupitila group of rock in their upper part. The composition of Dupitila group is sandy clay, clayey sandstone; ferruginous sandstone with pockets of plastic clay, silica, and laterite (Menon, 1975). Most of these rocks of Dupitila group are so soft and fragile that they are very easy to extract. Thus, most of the brick fields within this river basin collect mud from the surrounding *tilla* lands (Fig.-4) unscientifically that create several problems to the study area.

The birck fields (pink spots) and degraded *tilla* lands (yellow spots) have been demarcated by GPS during intensive field survey. Both of these two maps have then been superimposed on the 3D terrain model of the area. From the figure it is clearly noticed that the brick fields are located either in low lyning areas between the tillas or at the foot of the tillas (Fig.-4), whereas, degraded lands clearly belong to the tilla areas. Thus, it is clear that the brick fields collect their raw materials from the surrounding tilla lands. From the satelite image, a total of 1.45 sq. km of tilla lands can be demarcated those are affected by these brick fields.

In most of the cases it is found that tilla lands are degrading (Eswaran, H., 1993, 1999) at an alarming rate. During the field

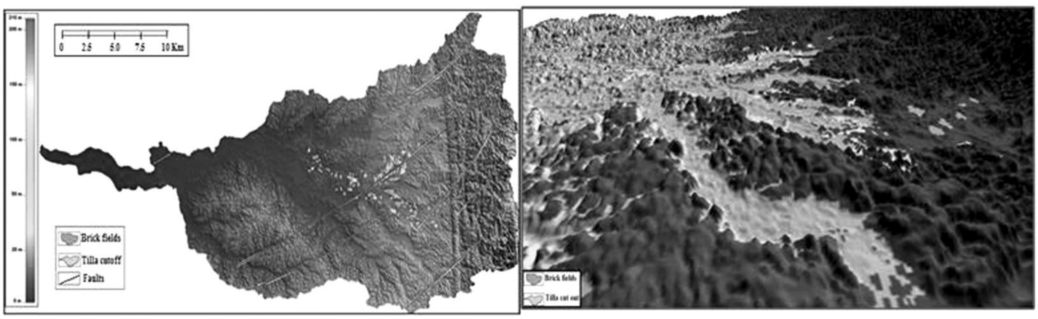

Fig.4 : Location of brick fields and cut off lands in 3D model

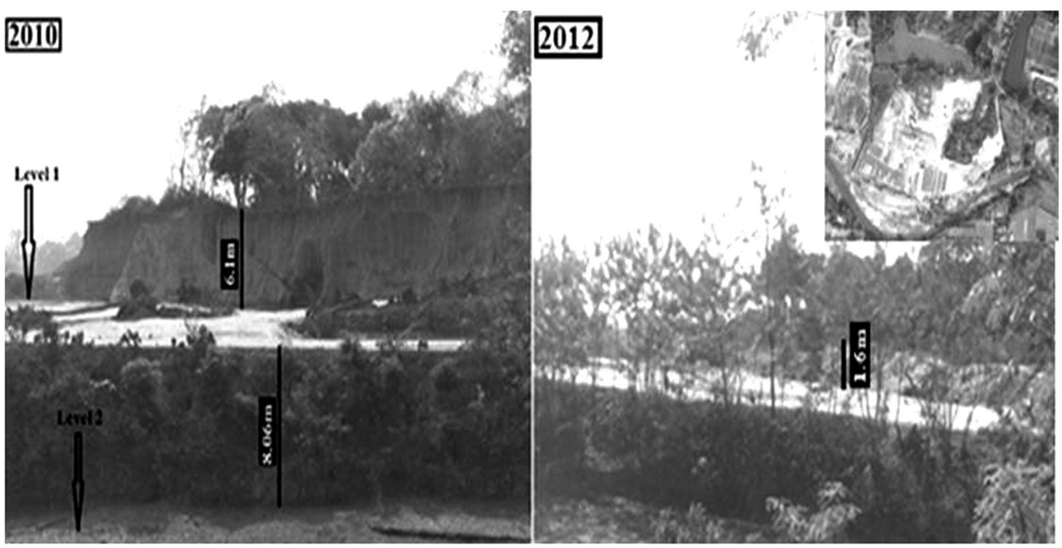

Fig.5 : Evidences of step by step sequential degradation of tilla lands

survey it was found that one such *tillaland* having an initial height of about 20m in 2010 was completely cut down to collect the raw material.

The 1st tier, having an area of about 5521.8 sq.m,was at the same level as that of the NH44 and the next tier, having an area of 3594.1 sq.m,was excavated further downward upto a depth of 8.06 m. This amounts to a total of 33682.98 cubic m volume of material from the 1st tier and 28968.446 cubic m from the 2nd tier that has already been removed. Furthermore, it is found that the 1st tier *tillaland* which was having a height of about 6.1m above the NH44 level in 2010 has been reduce to a height of 1.6 m in 2012 (Fig.-5).

It may be noted that they are collecting raw material (soil) not only from the tilla lands but also from the agricutural land (***Khan H. R, et. al, 2007***; Rahman and Khan, 2001). Most of these brick fields are sorrounded by agricultural land upto a greater distance (Fig.-9). Soil texture within the basin varies from loamy to clayey with slight acidity and high compactness for which they are commonly used as the raw material in the brick fields. Although it is very diificult to demarcate areas and extents of the affected agricultural lands in Google or Sattelite images but these are very clearly seen from field photographs.

Obstruction of river course

In most cases the brick fields, located along the left bank of the river are not well connected with the NH44. As this NH44 is situated at the right bank of the river they have to cross the river for reaching on it. But in between Champaknagar to Jirania there are only two bridges for heavy vehicles. Thus in order to get the acess of those bridges all the tracks, carrying raw materials as well as the finished produst of the brick fields, have to travel a greater distances. That increases the cost of their production. That is why in most cases those brick fields have constructed some temporary roads and sometimes they use the river bed itself as a road for their transportation.

Collection of sand

Collection of sand (used as a raw material for brick production) from the river bed as well as from the river bank causes different types of hydrological changes within the river system. Collection of sediment from the river bed is commonly treated as a good practice that reduces the sedimentation problem of a river. But in the present case it creates further problem to the river becuase the sediments are collected unscientifically between Champaknagar and Khayerpur areas that makes the river bed becomes irregular and fargile and generates further sediment to the lower stretch of the river. Sometimes they use pump machine for lifting sand from the river bed.

In order to find out the of effect sand collection within the river channel, 3 cross section have been taken from two different places of sand collection from the river bed in the years 2010-2012. The 1st cross section has taken near Mohonpur Bazar. In the year 2010 the width of the river was about27.75m and depth was 0.51m. but the width has come down to 24.6mand the depth had increased to 0.65m in 2011.

The condition has further been deteriorated in 2012, when the river has become more narrower (21.05m) and the depth (1.4m) has increased considerably

(Fig.-6). Continous scouring of river bed due to sand collection not only affecting the bed itself but also along the right bank the river experiencs erosion, too. Moreover, from this 3 years trend it is found that the main course of the river is shifting towards its right. Same type of scenario is also found in the 2nd cross section which is taken at 100 m upstream from the Khayerpur Bridge where width of the river bed is reducing with the corresponding in depth. At this place the right bank is experiencing erosion and sever bank failure during monsoon season (Fig.-6).

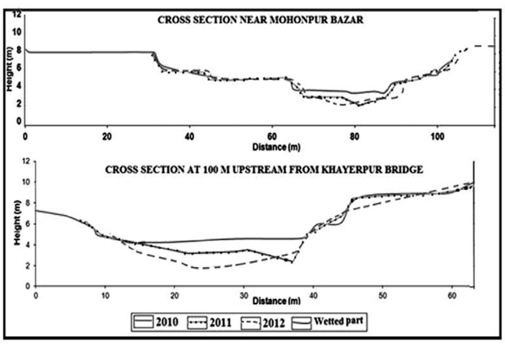

Fig.6 : Seuqential changes within the river bed

Changes in river course

During field surveys between 2010-2012 a typical feature was found in the Haora River course near Debendranagar area. As this part of the Haora River Basin belongs to upper portion of its middle course, the depositional material of this area is mainly of sandy-silty composition. In the year 2010 there was a point bar of silty composition along the left bank. But from the year of 2011 it was found that earlier bar was getting eroded but in its frontal part a new bar of purely clay deposit has been formed. This formation was causing the reduction of the channel width. In the year 2012 it is found that a newer bar has further developed (Fig.-7). At present the channel is becoming so much narrower that it fails to carry its discharge. As a result now it has shifted to a newer location through the left side of the earlier sandy point bar. This kind of scenario is also found in several places upto 1-1.5km downstream from that partculat place.

Fig.7 : Evidence of river course change near Debendranagar (2010, 2011 & 2012)

In order to find out the cause behind such deposition a survey has been carried out in the upstream site along the river upto a distance of 500m and is found that a brick field namely R.B.I, situated along the right bank of the river is dumping all its waste product along the river bank. In order to find out the impact of such deposits 3 sediment samples have been collected from upstream side of the brick field, near the brick field and also from the downstream part of the brick field (from the caly bar in Debendranagar)

The 1st sample, has been collected from 500 m upstream side from the R.B.I brick field, It is composed of structureless clay. This type of sediment is usually found in suspended form in water, transported upto a long distance and finally deposited in the lower course of the river where the velocity becomes very less. The 2nd sample has been collected near the brick field area. In the field it was found in lump form but when it was crushed in the laboratory, some tiny particles of bricks were detected. Finally in the 3rd sample, collected from the bar near Debendranagar, tiny particles of brick were found in metamorphosed form.

From the structural characteristics of the samples it can be stated that although the textural composition of the aforesaid sample are same, intrusion of tiny brick particles within this clay is making the structure different. These brick particles are acting as the lumping nuclei and leading deposition of these clay in the form of bars which cannot be eroded by the river. Apart from this micro scale impacts, the entire course of the Haora river is also affected by the brick fields in different ways.

In order to study temporal change of the Haora River course two maps of the year 1932 and 2005 have been superimposed (Fig.-16A). From the superimposed map it is found that there is no general trend of changes of course as a whole excepting such three places (Fig.-16A) among which one place is located near the brick field areas (Fig.-16B).

Fig.-16 (A) Superimposed map showing the places of sequential changes noticed in Haora River course, (B) changes of Haora River course near brick field areas

Impact of Brick fields on the pollution status of the river

Brick fields also have a major impact on the quality of the river water. As there is higher concentration of brick fields within the particular stretch between Chandrasadhubari and Jirania and most of them dumptheir waste material along the river bank (Fig-17), there is higher risk of pollution of the river water than other stretches.

Fig.-17 Evidences of pollutant waste coming out from the brick fields

In order to study the pollution status of the river within the brick field areas two water samples have been collected. The 1st sample was collected from the area before the concentration of the brick field near Chandrasadhubari in Champaknagar, where the river water is more or less pollution free. The 2nd sample has been collected from the Mohonpur bazar, immediately after brick fields. These samples were tested in the Tripura State Pollution Control Board laboratory. From the test report it is clear that within these two sampling areas (a distance of 10 km) there are massive changes in water quality, particularly in total Suspended Solid (TSS), Turbidity, Chloride, Alkalinity, Hardness, Dissolve Oxygen (DO) and Total Coliform (Table-1).

Table 1 : Pollution status of the collected samples

PARAMETERS *	**S1**	**S2**
Temperature(°c)	28.5	30.5
Total Suspended Solid(mg\l)	26	53
Total Dissolved Solid(mg\l)	144	152
pH	7.65	7.73
Turbidity(NTU)	5	14
Chloride	7.2	9.6
Alkalinity(mg\l)	69.34	95.34
Hardnass (mg\I)	59.55	79.4
Calcium (mg\ I)	15.91	19.88
Magnesium (mg\ I)	4.8	7.23
DO(mg\I)	7.2	5.6
BOD(mg\I)	1.9	2.1
COD(mg\I)	8	10
Total Coliform MPN\100 ml	110	180
S1 : Chandrasadhubari in Champaknagar, Haora River, West Tripura **S2** : Mohanpur, Haora River, West Tripura		

*Water samples were tested inTripura State Pollution Control Board laboratory

Turbidity is the haziness in water caused by the individual particles of artificial sediments coming from the urbanisation, industries and mining areas. Hardness of water caused due to heavy concentration of metals. Both TSS and turbidity are high in sample 2 due to the presence of tiny particles of bricks, coal as well as fragment of ashes coming from those brick fields. Higher concentration of Chloride and alkalinity in river water of this place is mainly due to the brickfields effluents and also coming from the truck wheels, containing road de-icing salts. Total Coliform in the sample 2 is also higher in proportion as those brick field release several acidic pollutants (e.g. ashes). Naturally higher concentration of Total Coliform leads reduction in dissolve oxygen level.

Concluding Remarks

Brick fields are considered as the indicator of increased urbanisation as well as of a growing economy. However, unscientific manufacturing leads to severe environmental problems and the present study area is no exception to this general rule. From the aforesaid analysis it is found that the main flow of the river is gradually narrowing along with sedimentation in the lower stretches down to Jirania. Water quality is also deteriorating leading to several health hazards. The following hazardous problems can be sorted more specifically:

i. The unscientific way of mud collection is creating some big depression or hollows along the *tilla* side slopes and within agricultural land. This kind of depression receives water during monsoon period forming temporary lakes and reducingthe amount of discharge to the main stream. In addition to this, unscientific cutting of such slopescasuing severe soil erosion, slope failure and supply sediment to the river. The river is becming imcompetent to carry such excess sediment load and gradually becoming sick.

ii. Use of the river bed as a road for movement of heavy vehicles over it is affecting the river bed to a greater extent. Frequent movement of trucks making the river bed abnormally hard and also obstracting the natural flow of river and the river is becoming unstable.

iii. Unscientific quarrying of sand from the river bed and from the bank is increasing the roughness of the river bed. Moreover, combining effect of sand collectoin and deposition of waste bricks, ashes within the river leads to changes in the course of the channel by forming pools, ripples and bars.

iv. Pollutants emmitted from the brick fields causes high risk of gastrointestinal diseases to the people who are using the water for drinking purpose. This is especially problematic for poor people, because contaminants like viruses or bacteria can become attached to the suspended solid. The suspended solids help to disinfect water with chlorine because the particles act as shields for the virus and bacteria.

In conlusion it can be stated that brick manufacturing has become a basic requirment of the modern civilised society and it is not possible to stop such activity. However, several measures can be taken for such activity to save the environment. Those can be considered as eco-friendly as well as cheaper in nature such as:

1. The problem of cutting *tilla* and agricultural lands can be solved by the successful introduction of a selective blend of solid by-product wastes into the feedstock replacing quarried raw materials. The lesser the use of primary raw materials the lesser will be the environmental footprint of a production process (Mödinger, Fritz, 2002A; Mödinger, Fritz 2002B: Mödinger, Fritz, 2003).
2. Recycling of the waste products (Annon,1999; Greentech Knowledge Solutions, 2012) and purposeful use of it, such as, brick particles in the fire kiln, can reduce the waste products disposal problems. Except using in brick fields, fragmented brick can also be used in road construction or any other activity. Ultimately waste products should be dumped in a particular place away from the river channels by creating disposal tanks.
3. Sand quarrying should be done in the scientific way by using the dredging techniques.
4. Government should take some necessary measures for preventing and controlling all these unscientific and illegal activities in order to protect the environment.

Acknowledgement

The authors are thankful to the Tripura State Pollution Control Board, specially the Chairman Prof. Mihir Deb for extending financial assistance and laboratory facilities. We deeply acknowledge the suggestions given by Dr. Srikumar Chattopadhyay, CESS, Kerala; Prof. Arabindo Ghosh, Department of Geological Sciences, Jadavpur University.

References

Annon., 1999. CBRI develops eco-friendly technology for brick making. The Hindu, Sunday, pp. 26-32.

Greentech Knowledge Solutions, 2012.Brick Kilns Performance Assessment &A Roadmap for Cleaner Brick Production in India;A report prepared by Greentech Knowledge Solutions, New Delhi.

Eswaran, H., 1999. Recommendation in the proceedings ofthe 2nd international conferenceon land degradation. KhonKaen, Thailand. 9, pp 127-129.

Eswaran, H., Virmani, S.M., Spivey, L. D., 1993. Sustainableagriculture in developing countries: constraints, challenges and choices. In Technologies for Sustainable Agriculture inthe Tropics, (*Eds.)* J. Ragland and R. Lal. ASA Sp. Publ. 56,Madisin, WI, pp. 7-24.

K.D. Memnon, 1975. Tripura District Gazetteers. Department of Education. Govt. of Tripura. pp.8-17.

Khan H. R., Rahman K, AbdurRouf A. J. M., Sattar G. S., Oki Y., Adahi T., 2007. Assessment of degradation of agricultural soils arising from brick burningin selected soil profiles. Int. J. Environ. Sci. Tech., 4 (4),pp. 471-480.

Khandoker R.U., 2007. Parameters of the status of the workers in the Brickfield industry.Available at http:// www.rasheeka.wordpress.com/.

Mödinger, Fritz, 2002A. The use of fruit marl ash in Low Density Ceramic Matrix Composite Hollow Bricks – FACMC bricks. PROGRES Sevilla, Spain, pp. 46-55.

Mödinger, Fritz 2002B. Recycling and Reuse of Waste Materials as Raw materials within the Framework of Integrated Product Policy IPP, Thomas Telford Book, pp. 117.

Mödinger, Fritz, 2003. 49th Brick Forum, American Brick Institute Clemson, Clemson S.C. USA. Sustainable brick production, pp.128-133.

Rahman, M.K., Khan, H.R., 2001. Impacts of brick kiln on topsoil degradation andenvironmental pollution. Project report submitted to the Ministry of Science and Information and Communication Technology, Bangladesh Secretariat (Dhaka), pp. 210.

Technical Notes on Brick Construction, 2006. The Brick Industry Association.

Tripura State Pollution Control Board (TSPCB), 2004. A Survey of Brick Fields in Tripura, pp. 25-98.

YeasminFarhana and Khan A.A, 2012. Livelihood Pattern of Brickfield Workers in Bangladesh. Asian Journal of Research In Business Economics and Management. vol 2 (3), pp. 142-153.

Shreya Bandyopadhyay,
Kapil Ghosh,
Sushmita Saha
Research Scholars

Sunil Kumar De*
Reader
[1]Department of Geography and Disaster Management,

Sumanto Chakravorti
Deputy Registrar, NIT, Agartala
(*Corresponding Author: desunil@gmail.com)
Tripura University, Agartala,Tripura