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Surface Water Quality Assessment of the Jirania Brick Cluster – A Case Study

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ABSTRACT
Along with the infrastructural development works, the demand for construction materials is increasing rapidly, which in turns lead to the rapid growth of brick manufacturing industries. Large demand of bricks in development and construction sectors has resulted in mushrooming of brick industries clusters at the outskirt of Agartala City. Jirania brick industries cluster is one of largest cluster of the Tripura State (India). Approximately 45% of total bricks of the State are being produced from the Jirania brick industries clusters. The use of conventional technology for brick making has resulted significant contribution of pollution load to the environment. The main components of environment which are being affected by the brick industries include but not limited to air, water, soil etc. The present study is carried out to identify the potential contribution of pollution load on surface water sources of the region from the mentioned brick industries. The surface water samples collected from nine sampling station located at different places in the area are analyzed and the experimental results of various quality parameters are presented in the paper. Such a study will help to estimate the total pollution load of the brick industry in the mentioned area.

Keywords - Brick industry, cluster, pollution load, impact, water quality parameters.

I. INTRODUCTION

Brick industries are playing vital role in the economic development of the State. Brick industries are necessary for meeting demand of bricks for many constructions & other developmental works. The growth in economy and population, coupled with urbanization, has resulted in an increasing demand of bricks for residential, commercial, industrial, and public buildings as well as other physical infrastructure. Due to large demand of bricks in development and construction sectors has resulted in mushrooming of brick industries clusters at the outskirt of major town & cities. The rapid increase in the brick production and the clustering of brick kilns has given rise up the environmental concerns. Improper/ inefficient combustion of coal being practiced in the brick kilns often posing air pollution problem results in emissions of particulate matter, hydrocarbon, sulphur oxides, oxides of nitrogen and carbon monoxide. The emission of these pollutants has an adverse effect on the health of workers and vegetation around the kilns. The other possible environmental threat may be disturbance of flow path of natural stream, river due to establishment of the brick kiln in the vicinity in the path leading to obstruction in downstream as well as for distribution on flow of water during rainy season. Due to excessive excavation of top soil in & around the brick industries for green bricks making causes land degradation, results in reduction in both crops production & fertility of soil. Vegetation around brick kilns is impacted not only by air pollution but also by land degradation which occurs as a consequence of utilization of best quality top soil in brick making, eroding this very precious natural resource. Particulate matter such as dust and carbon soot deposited on the vegetation can inhibit the normal respiration and photosynthesis mechanisms within the leaf.

Ahmed & Hossain [1] had studied applicability of air pollution modelling in a cluster of brickfields in Bangladesh. Air sampling was conducted and ambient pollutant concentrations were measured experimentally in 41 brick kilns using Industrial Source Complex (ISC3) model. Maithel et.al [2] in their study discussed about the various technological options available for pollution control & energy efficiency in the field of brick industry. Some important results of the field study carried by the TERI are also included in the study. Darain et.al [3] in their study emphasized that use of vertical shaft kiln technology instead of traditional technology as an alternate solution so as to meet the pollutant concentration within the prescribed limit. Drawback of existing traditional technologies was also presented in their study report. Environment and health impacts associated by the brick kilns industries were studied in the Kathmandu valley by Pariyar et.al [4]. Monga et al. [5] in their study shows the fact of high chance of respiratory diseases among the brick

kiln workers due to the emission of particulate matter and gaseous pollutants in the brick industries. They also pointed out the fact of implementing personal protection equipments to cope with such problems. Khan & Vyas [6] evaluate the impact of brick making process on environment and human health. The study was conducted in many brick kilns situated on the bank of Kshipur River in Ujjain, India. Blackman & Bannistar [7] studied the pollution caused the informal industrial sector, brick industry in the developing countries and introduced four root plant in order to mitigate the said problem, which includes effective participation of public and government sector along with effective management plan & environmental monitoring. The control strategy also includes the use of low cost sustainable technology. Guttikunda et al. [8] studied the pollution and health hazard caused by brick industry in the Dhaka region. Using the Atmosphere Transfer Modelling System, they estimated the pollution load dispersion in the Dhaka Metropolitan Area. The effect of brick kiln emissions on heavy metal content of soil and plants around the brick kiln chimneys was studied in the year 2006 by Ismail et. al [9]. Mabroor Hassan et al. [10] studied application of air dispersion model for estimation of air pollutant from the coal fired brick kiln industries in Gujarat. Narasimha & Nagesha [11] assess the pollution levels based on the consumption of material/energy inputs used, nature of technology in use and the skill levels of the employees. It is intended to estimate pollution generated at the cluster level based on the data gathered from the sample units. For this purpose, standard pollution coefficients (emission factors) were worked out based on material and energy carriers and the combustion technology used.

The present study is an effort to present a preliminary idea regarding the prevailing environmental condition in and around the Jirania Brick Industries Cluster. In the current study, only the experimental results of surface water quality of the area is incorporated.

II. DESCRIPTION OF STUDY AREA

The site of Jirania Brick Industries cluster has been located at Jirania Sub-Division under the West Tripura District. Topographically, the area has been a gently to moderately undulated upland intersected by numerous rivulets, gullies and gutter etc. followed by numerous hillocks. The site is located along the National Highway-44. The National highway joins Tripura to Assam and other states. There are almost 62 brick industries are located in the Jirania brick cluster. The map collected from Land & Settlement Department is shown in the figure 1. The temporal increment of brick industries is shown in figure 2.

Fig.1. Jirania Brick Cluster Region

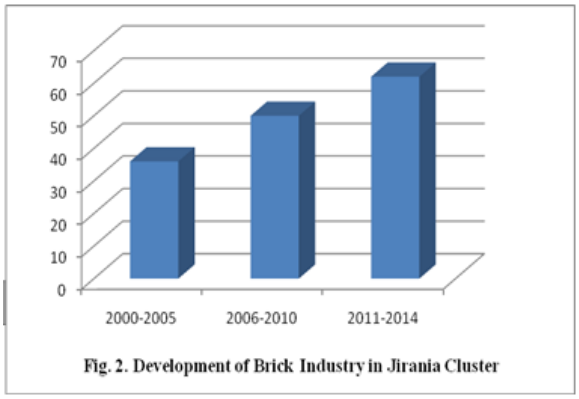

Fig. 2. Development of Brick Industry in Jirania Cluster

III. TOPOGRAPHICAL DESCRIPTION

The site of Jirania Brick industries cluster is characterized by moderately weathered undulating plain comprising of many domal shaped eroded mounts locally known as "tilla land". The slopes are varying between 8.5% and 15%. However, there is no hill of high altitude around the site except few small hillocks. Howrah River is flowing near the Jirania Brick Industries cluster, which is the only perennial river, but with little water. Existing drainage pattern is basically situated on the water divided by two micro watersheds. Adjacent watersheds of the site comprise of numerous second & third orders seasonal streams/rivulets; some of them joined to the Howrah River. River Howrah crosses the International boundary and enters in to Bangladesh.

The climate of Jirania Brick Industries cluster is tropical monsoon type. The average annual rainfall is around 22 cm. the ambient temperature varies from $4.5^{O}C$ – $37.5^{O}C$. The winter season is from November to early March. Summer is from March to May & monsoon is from June to September. It has moderate temperature and highly humid atmosphere. In summer, the average temperature is around 28 ^{O}C fluctuating with rainfall. There is a short mild winter from mid November to early March with most dry condition and average temperature around 18 ^{O}C.

IV. METHODOLOGY

In the present study preliminary survey work was done in Jirania brick cluster to understand brick making process. During such survey the topographical condition of the study area is also evaluated. Along with survey, an effort is also made to estimate the theoretical potential of those brick industries in creating environmental degradation in the mentioned area. During present study the surface water quality of the study area is also evaluated. Water samples were collected from nine sampling stations to evaluate the water quality of the study area. Total eight water quality parameters have been analysed in the laboratory using the standard method for testing of Water and Waste Water as adopted by APHA.

V. PROBABLE IMPACT ON THE ENVIRONMENT

For firing of green bricks, coal is used as main source of fuel which leads to particulate matter and other gaseous pollutants emission. The primary raw material used for bricks is the soil, which is often taken from the prime agricultural land causing land degradation as well as economic loss due to diversion of agricultural land. Use of traditional technologies in firing the bricks results in significant local air pollution. Emission of huge quantity of toxic elements from the stack of brick kilns is causing serious environmental health hazards. The brick kilns emit toxic fumes containing suspended particulate matters rich in carbon particles and high concentration of carbon monoxides and oxides of sulphur that are harmful to eyes, lungs and throat. These toxic fumes also affect crops and plants located in the areas adjacent to brick fields. Brick burning are largely influencing the concentrations of greenhouse gases in the atmosphere. Across most of the developing countries like India, it is seen that brick kilns mostly use low cost waste material as primary source of fuel. The inappropriate design of kilns, use of low cost fuel and lack of complete combustion and pollution control technology at source are causing release of contaminants and high concentration of pollutants from brick kilns in the form of flue gases. The flue gases which are emitted from the stacks of brick kilns mainly comprise of ash, SO_2, CO_2, NO_X, CO, particulate matter, respirable particulate matter many a times having high concentration of toxic metals and volatile organic compounds. Being one of the largest consumers of coal in the country, it is one of the important sources of carbon dioxide emission in the country. Dust pollution is mainly during removal and lying down of fired coal ash layer, blowing of ash stacked. The disposal of fired coal ash from brick industries including solid wastes from the labour colony to the nearby water bodies degrades the natural water quality. Various water quality parameters including TDS, TSS, Turbidity, pH, hardness, metal concentration etc may alter due to the disposal of brick industry waste water into natural water bodies.

VI. RESULT & DISCUSSION

Surface water samples are collected from nine different locations of the study area. The trend of surface water quality of the project area is evaluated by laboratory testing. Eight water quality parameters are considered in the study. The laboratory analysis result of the collected water samples are presented using the bar diagrams given in figure 3 -10. It is obvious from the analysis of the results that the pH of the surface water of different locations of the study area is within the permissible range that is within the neutral range. The turbidity of some stations is much higher and a maximum turbidity of 36.4 NTU is encountered during the study. The hardness of surface water in the study area ranges between the lowest levels of 50.5 mg/l to a maximum level of 141 mg/l. The alkalinity also ranges between 59 mg/l to 146 mg/l. The total dissolved solid (TDS) value is found at a highest level of 180 mg/l which is much more than the usual. The TDS values at all the stations are in a higher level. The DO level at all the stations is satisfactory and more than the minimum permissible limit of 4 mg/l. The BOD test of the collected surface water samples indicates that in some places the BOD level is zero whereas in some other locations there is considerable BOD which indicates the presence of pollution in such areas. The chloride content ranges between 9-14 mg/l. A further analysis of other remaining water quality parameters will reflect the actual scale of pollution in the area.

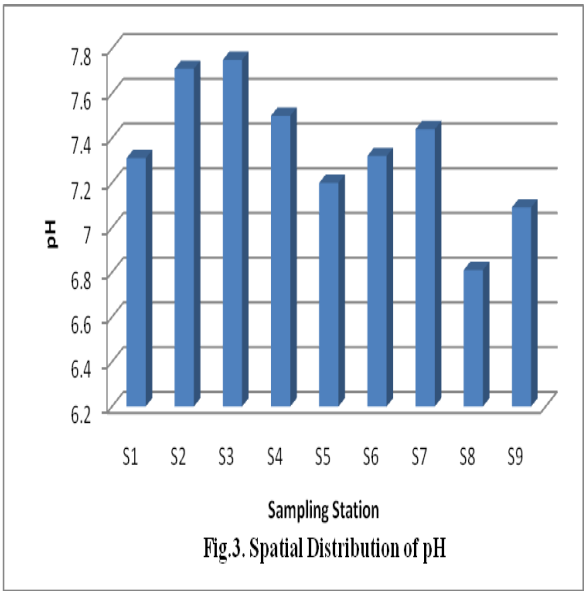

Fig.3. Spatial Distribution of pH

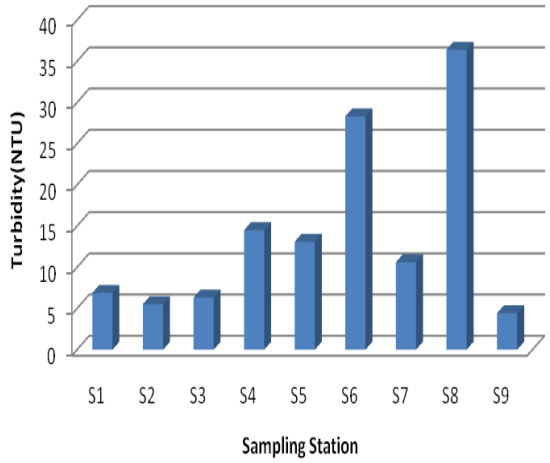

Fig.4. Spatial Distribution of Turbidity

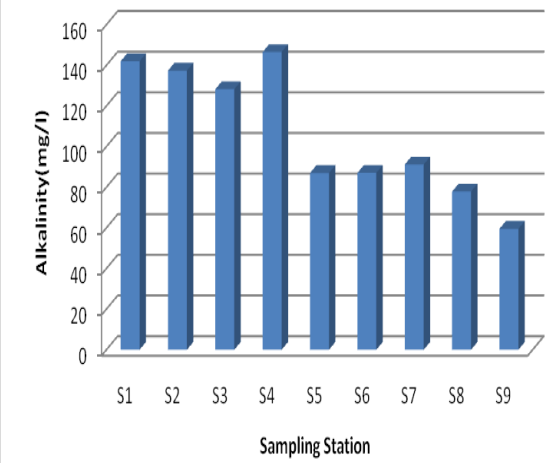

Fig.7. Spatial Distribution of Alkalinity

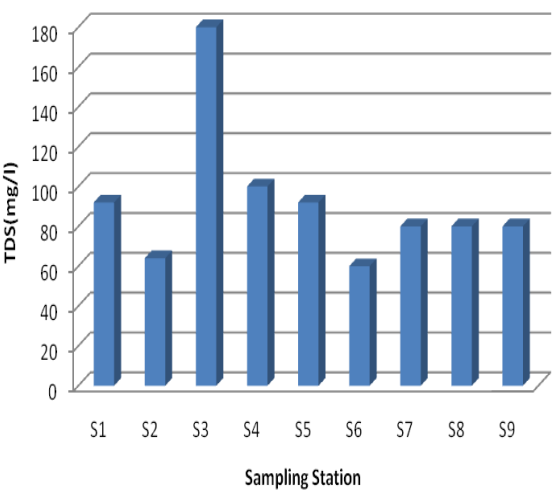

Fig.5. Spatial Distribution of TDS

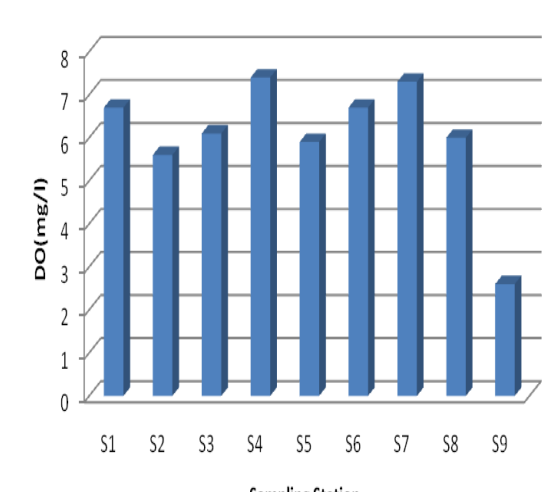

Fig.8. Spatial Distribution of DO

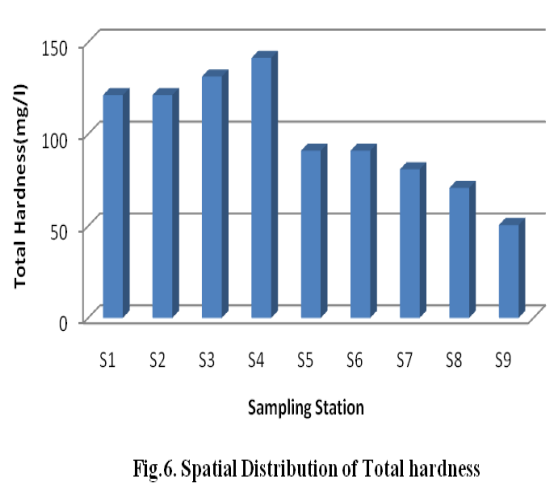

Fig.6. Spatial Distribution of Total hardness

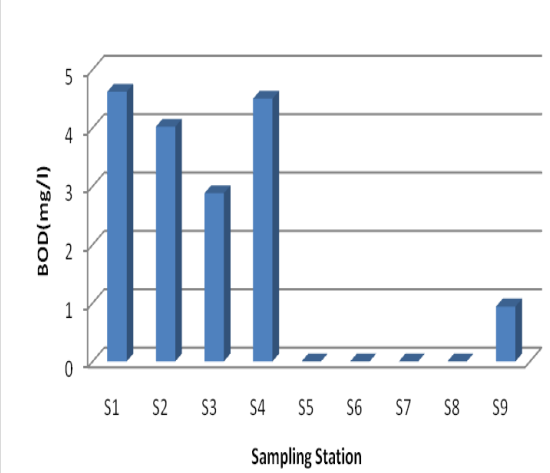

Fig.9. Spatial Distribution of BOD

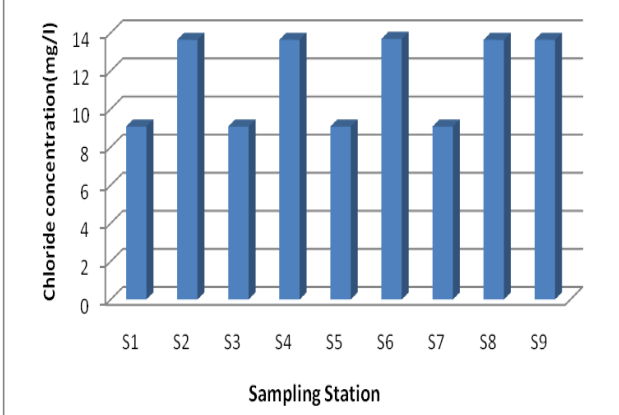

Fig.10. Spatial Distribution of Chloride concentration

VII. CONCLUSION

The study will help to give an idea about trend of deterioration of the surface water quality of Jirania Brick cluster region. The present evaluation is made during the manufacturing season (January to May 2014) when all the brick industries are in operation. Thus, this data can also be used to compare with the baseline data to estimate the surface water pollution load. Moreover these data can also be used to determine the gradual increase in pollution level with the increase in the number of industries in the area. Evaluation of remaining water quality parameters along with air quality and solid waste analysis in future will help in determining actual pollution caused by the brick industries in the area.

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