REMEDIATION OF CONTAMINATED BROWNFIELD THROUGH URBAN REDEVELOPMENT OR REGENERATION: A CASE STUDY ON HAZARIBAGH TANNERY AREA

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ABSTRACT

Hazaribagh area was started to grow as a potential industrial estate for the tannery. The effluents from industries with the wastewater were discharged to Buriganga river. Topsoil of the area and water of the Buriganga river are highly contaminated with Chromium (23148 mg/kg). Tannery has already relocated in Hemayetpur, Savar Upazila, Dhaka. Hazaribagh tannery area has the scope to have planned development for its high demand for commercial office and residential development due to adjacent to Dhanmondi Residential area. Making resilient city in Hazaribagh with self-sustaining emergency management and recovery system through the introduction of Urban Redevelopment or Regeneration. The process of regeneration includes PRA session with tannery owners, interviewing experts, consultation with local people, and professionals in every step and following existing guidelines in Detailed Area Plan (DAP). The soil must be excavated minimum 8 feet before using the area. 65% of the landowners are agreed on redevelopment in Hazaribagh. Redevelopment or regeneration is a solution to build disaster resilient community with mixed-use development construction and fire safety. Creation of public space through parks and open spaces can be used as an emergency shelter/space after any disaster. Landowners can be motivated by attracting FAR incentive and low rate finance from local or international investors. If the Government of Bangladesh (GoB) involves in this project, tannery owners, government and the Dhaka city will be benefited and that will make a resilient community.

Keywords: Disaster, Resilient, Emergency Management, Hazaribagh, Redevelopment, Regeneration.

Introduction

Hazaribagh area started to grow as a potential industrial estate for tannery from 1947. The effluents from industries with the wastewater were discharged into Buriganga River. Tannery has already been relocated to Hemayetpur, Savar Upazila, Dhaka leaving this area as a brownfield. Topsoil of this area and water of Buriganga River are highly contaminated with different heavy metals. This study illustrates obstacles of the development in Hazaribagh, gives the ways to eradicate the obstacles and finds out the design considerations.

Objective

The study has been carried out with the following objectives:

➢ To find out the process of the brownfield treatment in Hazaribagh.
➢ To find out the best possible use and development of the land in Hazaribagh tannery area.
➢ To create public space during emergency situation through urban redevelopment for earthquake and build a resilient community.

Literature Review and Definitions

Various agencies and scholars defined brownfield in different ways. The US Environmental Protection Agency (USEPA) and Department of Housing and Urban Development (HUD) defined brownfield as “abandoned, idled, or underutilized industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived contamination” (USEPA, 1997). The status quo of urban land use in China defined in the way that “the industrial and commercial lands, sites and facilities in urban areas, which are abandoned, idled or underused due to real or perceived environmental threats and other developing obstacles, and cannot be immediately put into use without treatment.” As our study area is a tannery area and tanneries

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had been relocated to Hemayetpur, Savar leaving Hazaribagh Tannery Industry as abandoned; this study considers the area as a brownfield.

A previous study revealed that most severe soil pollution up to a depth of 10-20 ft (3.048-6.096 m) is a serious threat to the environment and human health (Karim et al., 2013). Another study showed that the concentration of heavy metal in the samples crossed the maximum allowable concentration in both wet and dry season. The highest concentration of Cr (172792 ppm) was found at the main disposal point in the soil sample (Mondol and Asia, 2017). The author also stated that a high concentration of heavy metal in plant samples consequently affect the food chain, which is a major environmental concern. Another study gave an overview of Cr (Chromium) toxicity in the environment, particularly in water and soil (Oliveira, 2012). In this research, the diverse impacts of Cr (III) and Cr (VI) on plants were identified such as decrease of seed germination, reduction of growth, a decrease of yield, inhibition of enzymatic activity, nutrient and oxidative imbalances. Another study showed different health problems such as skin diseases, itch, rash, cough, fever, diarrhea, headache, asthma, dizziness etc. due to unplanned tannery waste disposal. This study also identified that tannery waste was the reason for the death of livestock and poultry indicated by 59% respondents. The study also derived outcome of 48% low livestock and fish production (Tinni et al., 2014).

Methodology

Study area selection

Hazaribagh tannery area has a high demand for commercial office and residential development because it is very adjacent to Dhanmondi residential area. Because of the demand, any illegal building construction can be started without taking land use clearance from RAJUK. As Hazaribagh Tannery Area is vulnerable to human health, any type of construction must be prohibited without proper treatment of contaminated soil. For these reasons, this site is taken as the study area of this study.

Data Collection

Primary data collection was carried out for the study. A questionnaire survey of local people, Participatory Rural Appraisal (PRA) of landowners and Key Informant Interviews (KII) of experts were included in primary data collection. Simple Random Sampling was used to select the sample size of the local people. Hazaribagh Thana has 185639 population according to the District Statistics 2011. So, with 95% confidence level and 10% confidence interval the sample size is 96 respondents from 185639 population. One PRA session was conducted to know the views and requirements of landowners. Ten KII were conducted for suggestions on the development of the land. In this study, Key Informant Interviews were functioned to get the best considerations for the treatment of contaminated soil and creating a resilient community in Hazaribagh Tannery area.

Findings and Discussions

Findings and discussions are based on the analysis of the survey data.

Findings and Discussions

Pollution in Hazaribagh Tannery Area

Soil

In Bangladesh, there are no standard regulations for soil contamination. So, the concentration of heavy metal in the sample of soil has been compared with the European standard. The maximum permissible limit of Cr concentration is 150 mg/kg in EU standard. Where a high amount of Chromium ranging from 34.85 to 23148 mg/kg was found in the samples of the tannery area. (Juel et al., 2016). Previous studies (Karim et al., 2012; Shams et al., 2009; Zahid et al., 2006) also reported that topsoil of Hazaribagh area is containing a higher concentration of chromium ranging from 1000 to 30000 mg/kg. Where most of the Chromium accumulated in the soil has been found as Cr(III) (Saha and Ali, 2001) and very low amount (maximum 1 mg/kg) of Cr has been found as Cr(VI) (Shams et al., 2009). Another study revealed that 10-20 ft depth of soil of Hazaribagh tannery area is highly contaminated with heavy metals (Karim et al., 2013).

Water

Different chemicals and effluents are discharged from Hazaribagh Tanneries in the nearest channel and rivers through drains. This waste in form of liquid are discharged in Burigannga and eventually, it pollutes the water
and harms fishes and other species in the water. Moreover, the toxic materials in the waste sip into the cropland and surrounding groundwater (Ahmed, 2013). As a result, the tannery waste is poisoning the soil, water, and air around the clock. Tannery wastes also cause harm to the health, houses, and utensils of those situated around the area (Bhowmik and Samiul, 2009).

**Effects and removal of Chromium**

The concentration of Cr(VI) in the soil of Hazaribagh is very low and so the soil of Hazaribagh is less hazardous for Human health. Cr(III) is less toxic than Cr(VI) for both acute and chronic exposures. (EPA, 2000) But high level of Cr(III) and Cr(VI) by inhalation or oral exposure effects liver, kidney, gastrointestinal and immune systems, and possibly the blood. Chromium (VI) is considered as a human carcinogen. (Sun et al., 2016) Chromium is easily soluble in water, so the groundwater in the tannery may contain a high concentration of Chromium. So, drinking or using this water for daily use is not safe. This groundwater cannot be used without a minimum level of filtration or removal of chromium.

**Treatment of Brownfield**

If the soil contains Cr(VI) at a higher level then a huge reduction will be required but if it is Cr(III) then it will be very easy to bring it down to the tolerance level. One way is that Cr(VI) can be converted to Cr(III) by some chemical reactions. The process of decreasing Cr(VI) to Cr(III) consists of using Ferrous Sulfate followed by coagulation and filtration. This removal system is now at the laboratory level and may not be suitable for a mass level project (Gang et al., 2005). Second way of removing toxic Cr(VI) from the contaminated environment is the process of bacterial isolation from the soil. It can be done by one bacterial isolate (Bacillus sp. ES 29) which is capable of reducing 90% of Cr(VI) aerobically in six hours (Camargo et al., 2003). Another way to reduce the direct contact with the Cr(VI) soil is to excavate the contaminated soil and a case study shows that excavating up to 35 feet depth and filled up with uncontaminated soil had removed the vulnerability of heavy metals in soil (EPA, 2012). But according to Karim et al., a depth of up to 10-20 feet of Hazaribagh tannery area is contaminated. Considering these points, Detailed Area Plan (DAP), Dhaka Metropolitan Development Plan (DMDP) 1995-2015 suggests to excavate the topsoil of eight feet of the study area can be a solution. Using Bacillus sp. ES 29 will help to reduce Cr(VI). This new layer of soil will keep away from direct human contact. But according to experts, in the case of plantation, any type of vegetable or fruit plantation must be prohibited because these trees will intake Cr from the groundwater.

**Land Owners’ View on Redevelopment**

There are around 187 Tannery industries in Hazaribagh. (RAJUK, 2010) The landowners of those Tanneries were invited in a PRA session. In the PRA session, 40% of total landowners attended. Where 65% of the attendee landowners were agreed about redevelopment in Hazaribagh Tannery Area. Finance from GoB, local or international investors will be welcomed by the landowners and these investments will help to undertake and implement a redevelopment project in Hazaribagh in a more smooth way.

**Need Assessment of Local People**

Need assessment is based on a questionnaire survey of local people.

**Employment Facilities**

Because of shifting the tannery industry many people become unemployed. Some of the labors of tanneries have also shifted in Savar with industry but a big number of people are still living in Hazaribagh being jobless. To remove the scarce job opportunities, the local people want some commercial activities in this area which may create a scope of employment for them.
Park and Open Space
Compared to other areas of Dhaka city, Hazaribagh tannery area and its surrounding area do not have enough open space. Nearest park or lake is Dhanmondi Lake which is not within the walking distance from that community. As a result, the tannery area can be redesigned and redeveloped for creating large open space and playground.

Health Care Center
Hazaribagh was a tannery industry with very poor health security for the workers. The workers worked in those industries suffered from many diseases. A study discovered that 25.3% of the workers from the sample were facing skin problems. Other diseases like gastrointestinal problems (8.5%) and chronic headache (8.2%) have been confronted by the tannery workers. The environmental condition of the working place was not significant enough for maintaining good health of the tannery workers. There is no specialized hospital or health center near to this area. So local people living in that area need a hospital in the tannery area (Islam et al., 2017).

Transportation Network and Accessibility
Connecting roads to Hazaribagh tannery area are very narrow and drainage, electricity, the gas network are poorly circulated. Some existing roads are less than eight feet in width. In emergency situations, ambulance and fire service cannot go through them. A well-designed road network must be constructed in the tannery and residing area. New road network must include spacious walkways as community people want non-motorized transport and pedestrian facilities in the new community.

Future Best Use of the Land
In the DAP (2016-2035) proposal, Hazaribagh Tannery Area’s proposed land use is open space or green space. So, the tannery owners cannot construct any kind of infrastructure in this area. In this situation, considering the need assessment and DAP proposal, RAJUK is trying to develop this area with new kind of city development approach. RAJUK is trying to apply Urban Redevelopment in Hazaribagh Tannery area. In redevelopment approach, an existing buildup area can be reconstructed with open spaces, lakes, better housing and commercial facilities, service, and community facilities and well-designed transportation and accessibility. The main reason for adopting redevelopment for Hazaribagh area is to preserve green space to a large extent which is very similar to the DAP (2016-2035) proposal.

Design Considerations for Building Hazaribagh as a Resilient Community
Before preparing the plan it requires to consult with experts from different fields related to this project. A detail design consideration was prepared by consulting with university professors and professional according to their expertise. They gave their expert opinion on soil treatment and the best way to heal soil and water through the plantation. Most of the experts suggested a green network within the community with water body and restricted forest land for creating its own biodiversity.

Land and Infrastructure
- Any type of contaminated land can be usable after 15-20 years of plantation. Banyan tree for greater ecosystem also small size restricted forest should design for greater recovery of soil and environment. Conifer or Christmas tree is very effective to reduce air pollution.
- Topsoil of the whole area must be excavated for a certain layer. According to the Dhaka Metropolitan Development Plan 1995-2015, first 8 feet top soil of this area should be removed before the construction.
- Other chemicals like Cr may be treated by the give solutions above or through further research with the help of experts.
- Because of scarce land, plot allotment cannot be permitted and the ground coverage of buildup area should remain as low as possible.
- Rainwater harvesting and using renewable energy technology must be installed.
- The area will be designed as mixed use zone incorporating height zoning.
• High rise buildings will be built adjacent to wider roads and low rise buildings will be built at the inner side of the community so that the neighborhood has less car pressure. No parking facilities will be provided in the residential buildings. At the entrance of the neighborhood, a multi-storied building is highly recommended which helps to create an NMT based community and walking friendly environment in the community.

• A modern, environment-friendly and residential neighborhood can be created by low Job-house mismatch as employment opportunities can be created in the community.

• Cr(VI) is soluble in the water and it is harmful to human health. So, water supply from the neighboring community or water supply from WASA from outside of Tannery area may be a solution to drinking water.

**Environment**

• If the major road is designed to make underground then there will be an opportunity to create a car-free community.

• It will be possible to create a livable environment with open space, lakes, and playgrounds.

• The project design should ensure maximum Social welfare.

• Major features of the area will be creating Green Development, Waterbody Creation, Pedestrian Friendly Community, Separate Parking Facility, and Car-free Community.

• Old or encroached canals need to reconstruct in its old path.

**Social benefit and Recreational facilities**

• Provision of School, college, community clinic and consultancy, Tannery Museum, Amphitheatre, Library, Cultural belt in the redeveloped area will enrich the area as a self-sustained community.

• The new lakes will be excavated and no human access to these lakes.

• Walkways and cycle lanes will be designed for creating a public space.

• A multipurpose building complex can be built with all social and citizens facilities. This building may have ward councilor’s office, community clinic, community center, swimming pool, day care center, women's club, gym etc. This building complex will be disable friendly. Open space should be reserved in front of this building. This is a place where the elected representatives can affiliate with the local people.

• Secondary Transfer Stations (STS) for Solid Waste Management must be built. Reduction of waste production can be achieved through reuse, recycle and practice of reducing wastes in the community.

• The design should be consistent with the affordability and accessibility of low-income people.

• Provision of field may not be possible in every school but community open spaces can be used as playgrounds.

**Disaster Management**

• During Earthquake Emergency, open spaces and playfields will serve as Emergency Shelter or Evacuation area.

• Decreased amount of paved area and increased amount of unpaved area with vegetation, plantation and water bodies will reduce the urban heat island effect.

• Water bodies can be used during fire extinguishing.

• Ladders or Steers must be included in each building for emergency evacuation.

**Economic**

• Mixed use development will create more job opportunities also discourse mono-functional land use.

• Limited informal activity should be allowed and for this, temporary structure may allowable.

**Transportation**

• Inner transportation network of the community should be walking friendly.
• Encouraging pedestrian and NMT (non-motorized transport) within the community will help to reduce the need of motorized vehicles. Extension of Sher-E-Bangla road will ensure better accessibility with the community.
• To avoid through traffic, ring road or underground major road is essential.
• Community Based Transportation (CoTI) can be introduced providing necessary stoppage, garage, and parking area. This garage may be located in the multi-purpose building complex.

Creating Public Space for Building Disaster Resilient Community as an Outcome

After the completion of Redevelopment in Hazaribagh, the newly developed community will work as a disaster resilient community because of the following design considerations. Firstly, large open space for the shelter of evacuation during an earthquake or other disasters. Secondly, emergency exit facility with ladders and steers and built-in fire extinguishing system. Thirdly, the large green community with a variety of vegetation and plantation. Fourthly, a wider road with Non-Motorized Transport (NMT).

Conclusion

The main obstacle of development on a brownfield is to treat the soil. Without making the soil uncontaminated, any type of land use can be harmful to human health. Being a brownfield, Hazaribagh Tannery area needs proper treatment to the heavy metals especially hexavalent chromium (VI) as it is most harmful to human health. For development, urban redevelopment process can be used to meet the demand of local people, and the city dwellers. Public spaces, sufficient open spaces, encouraged community-based non-motorized transport network can be introduced in the urban redevelopment in Hazaribagh Tannery area. Open spaces, lakes, canals and natural environment will increase the disaster resiliency of the community.

References