PAPER ID: URP 0146

Brick Field Development Dynamics and Its Effect on Agriculture and Wetland in Narayangonj Sadar Upazilla

N. Sarker[1], A. N. Kakon[2]

[1]Department of Urban and Regional Planning, JU, Bangladesh, nabanitamituju2306@gmail.com
[2] Department of Urban and Regional Planning, JU, Bangladesh, kakonurp@juniv.edu

Abstract

Brickmaking has become the fastest-growing manufacturing sector nowadays. This study aims to locate the position of the brickfields and their expansion as well as their effects on agriculture and wetland in *Narayangonj Sadar Upazila*. The sources of data are the conduction of a structured questionnaire survey and the collection of satellite images through Google Earth Pro. To point out the location of the brickfields placemarks are added to the satellite image and the map is prepared using ArcGIS 10.6. A supervised classification method has been applied for documenting the change in agriculture and wetland because of the development of the brick industry in the study area. Though the number of brickfields was 98 and intensely concentrated in 2020, it has fatal consequences like the expanded brick industry has led to encroachment on the existing rivers, even though neither a single wetland can be used for fisheries nor suitable for domestic and irrigation purposes. Moreover, crop production began to decline during the research period with *Amon* being the most adversely affected. This study will help not only the legislators but also the administrators to enforce and monitor the law against the unplanned expansion of brick kilns.

Keywords: *Brickfield; Location; Expansion; Effect.*

1. Introduction

Bangladesh, a developed country, is transforming towards industrialization. Because of rapid urbanization, industrialization, and construction, the brick business is expanding quickly. Bricks are currently the most crucial building material used in residential construction and are an essential component of urbanization. According to UNDP (2016), Bangladesh produces about 8.66 billion bricks a year. Despite the sizeable contribution of brick-making to the economy, brick kilns are mostly situated on fertile agricultural land. Brick kilns are removing topsoil and subsoils of agricultural lands for brick manufacturing. Once the fertile layers of soil are removed from the arable lands of surrounding brick kilns, those lands cannot be used further for cultivation for many years, and land productivity declines in many ways (Khan et al., 2007)**.** It has a direct impact on agricultural crop production as it reduces the fertility status of the soil and the negative impact of topsoil removal results in a reduction in agricultural output (Bisht & Neupane, 2015). Water pollution of nearby water bodies hampered the production of fish and vegetables (Jerin et al., 2017). So, the aim of this study is to look at the location, and distribution of brickfields and how they affect wetlands and agricultural land and it has never been conducted until now. The objectives of the study are to visualize the brickfield's location and its expansion by using GIS software 10.6 and to identify the effect of brickfields on agriculture and wetlands in the Narayanganj Sadar Upazila.

2. Methodology

Narayanganj Sadar a fascinating fusion of the East and West has been popularly known as the 'Dundee of East' since the mid-19th century (History of NCC (Bangla), 2017). Mostly, this Upazila satisfies the demand for bricks in Narayanganj City. Moreover, variations of Land types and growth centers are available in Upazila and the surrounding region. It should be mentioned here that the Upazila is still considered a rural area, rather than an urban or peri-urban area.

First objective: Brickfield location and areal expansion

Google Earth Images have been used to identify and trace the shape, structure, and real functional area. Seven images, separated by a five-year interval, from seven different years (1998, 2003, 2008, 2013, 2018, 2019, and 2020), are used to illustrate the location and dimensions of brickfields. Using Google Earth Pro, a polygon has been created to demarcate the brickfield's area, and a placemark has been added to the image to indicate the

location. The image has been saved as a KML file, and exported as a layer, and a map showing the location of the brickfields has been created using ArcGIS 10.6. Another method known as nearest neighborhood analysis has been used to define the layout of the brickfields in the research area.

Second Objective: Expansion effect of brickfield on agriculture and wetland

Land Use and Land Cover Change: To record the spatial expansion of urban areas, agriculture, and wetland change scenarios, Landsat Images from 1998, 2003, 2008, 2013, 2018, 2019, and 2020 have been used for Land Use and Land Cover Classification. However, because it cannot detect the difference between the brickfield and barren land, this approach is not appropriate for counting the position of the brickfield. The Earth Explorer website (https://earthexplorer.usgs.gov/) has provided satellite data for the research region. The software ArcGIS 10.6 has been used to import these data sources and construct a false-color composite. The false color composite in the study area is produced using the band composite option in the raster processing toolbox. By using the georeferenced contour boundaries of Narayangonj Sadar Upazilla, clipping of satellite images has been performed to extract the study area from images. In ArcGIS software 10.6, the supervised classification method has been used to determine the classification.
Buffer analysis: According to "**Brick Manufacturing and Brick Kiln Establishment (Control) Act 2013**" (modified in 2019) No brick kiln is constructed within a 1sq. km radius of agriculture and wetlands. So, using ArcGIS 10.6, a 1 sq. km radius buffer has been taken to find out the actual situation of the most affected area.
Structured Questionnaire Survey: A questionnaire survey was conducted to perceive the effect on agriculture and wetlands within the 1 km. radius buffer zone which covers up to 50% land of adjacent brickfield. And the sample size is 60 and farmers and landowners are the sampling unit.

3. Result and Discussion

3.1 Brickfields Location and their Expansion

Table 3.1: Brickfield Expansion from 2003 to 2020

Year	Number of brickfields	Total Area (sq. km.)
2003	93	1.28
2008	92	1.44
2013	111	1.98
2018	107	2.12
2019	106	1.93
2020	98	1.96

Table 3.1 indicates the spatial expansion of the brickfield over the study period whereas the largest expansion occurred in 2013 when the number of brick kilns was 111 and it grabbed 1.98 sq. km. of land. In the years 2003, 2008, 2018, 2019, and 2020**,** the number of brickkilns was repetitively 93, 92, 107, 106, and 98 on the other hand, the amount of land that encroached for brickfields was 1.28 sq. km., 1.44 sq. km., 2.12 sq. km., 1.93 sq. km., and 1.96 sq. km. It was observed, in 2018, the largest amount of land was encroached on Brickfield. Though the number of brickfields decreased, the encroachment of land increased. Moreover, the built-up areas for brickfields increased proportionally from 2003 to 2020 and were grabbed from the riverbank of the study area means, the number of brick kilns was reduced, but the owners encroached on more land and expanded their space for keeping processed brick. Figure 3.1 explains in the year 1998, there was no brickfield in Narayangonj Sadar Upazilla. The development of the brickfield started after the year 2000. Brickfield's expansion from 2003 to 2020 was concentrated in the enclave of the Dhaleshwari and Buriganga rivers and was marked on the west side of Narayanganj Sadar Upazila. In 2003 and 2008 where it is noticed that brickfields mainly arose in Alirtek, Akbarnogor, Moddhonogor, Aftabnagar, Pagla, and Fatulla. But in 2008, some new brickfields were invented in the Shiddirgong, on the other hand, some of the brickfields were demolished in Pagla and Fatulla. Because development and demolition worked together, the number of brickfields slightly changed within these five years. The year 2013, hosted the highest number of brickfields. Narayanganj Sadar witnessed almost 21% growth of Brickfield from 2008 to 2013. But Shiddirgonj, Aftabnagar faced the abatement of brickfields during these five years. On the other hand, a noticeable number of brickfields developed in Akbarnagar, Moddonagar, Alirtek, and Baktaboli Union on agricultural land. Almost a 3% reduction of brickfield was observed in the study area in 2018. Notably the situation in 2019 where the trend of reduction was going on. The brickfield expansion rates were declining near to 1% from 2018 to the year 2019 whereas the built-up areas remain increasing and the previous year's trend reduction process is still running in 2020. The number of brickfields is 98 and the expansion rate is declining by almost 7% from the year 2019. There are several possible explanations for the declining trend.

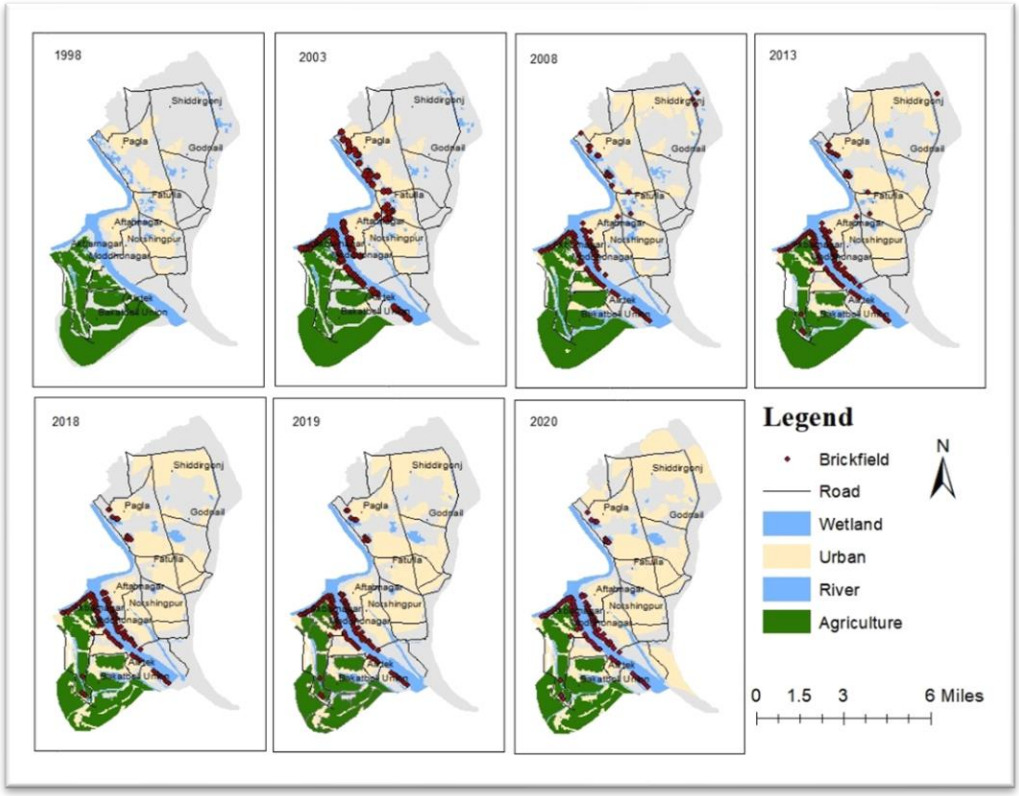


Figure 3.1: Brickfield Expansion from 1998 to 2020

According to the "**Brick Manufacturing and Brick Kiln Establishment (Control) Act 2013**" (modified in 2019), no owner can use the traditional fixed chimney where the kiln size is 120ft. Hence, the representative of the Department of Environment raided the brickfields and ordered them to close off those that could not follow the law, or brickfield growth had probably reached an optimal level; as a result, existing plants were enough to supply the demands of brick for the megacity.

3.1.1. Distribution Analysis of Brickfield Location

Table 3.2: Results of average nearest neighbor analysis that reveals the brickfield's location distribution

Year	Number of brickfields	Point Pattern	*p*-Value
2003	93	Clustered	0.01
2008	92	Clustered	0.01
2013	111	Clustered	0.01
2018	107	Clustered	0.01
2019	106	Clustered	0.01
2020	98	Clustered	0.01

Nearest Neighbour Analysis measures the spread or distribution of the brickfields over the study area. The results of this analysis (Table 3.2) reveal that these locations show signs of strong clustering. The *P-value* is 0.01 which indicates that the brickfields are spatially concentrated and the level of clustering increased over the years. In other words, the location choice of newly established brickfields was affected by previous brickfield locations.

3.2 Expansion Effect of Brickfield on Agriculture and Wetland

3.2.1 Land Use and Land Cover Change

Figure 3.2 indicates the change in land use and land cover from 1998 to 2020. In 1998, there was no brickfield and the land was used for agricultural production. As agricultural lands and wetlands were comparatively cheap, and resources of brickmaking were easily found near the riverbank brickfields started to be built on the agricultural land in this area after 2000**.**

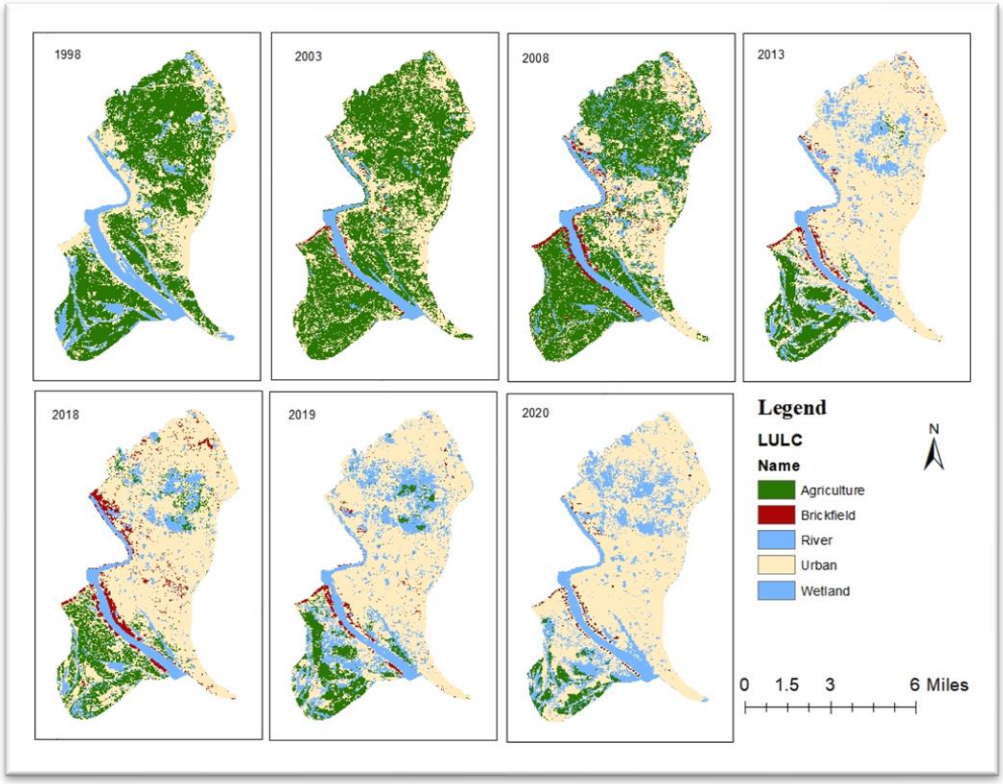


Figure 3.2: Land Use and Land Cover Change from 1998 to 2020

Table 3.3: Amount of Agriculture, Urban, and Wetland from 1998 to 2020

Year	1998	2003	2008	2013	2018	2019	2020
Agriculture (sq. km)	44615	38500	26085	17345	14299	13805	13420
Urban (sq. km)	3375	7254	11092	15982	17083	17221	17578
Wetland (sq. km)	15375	7852	7106	5586	4550	4300	4150

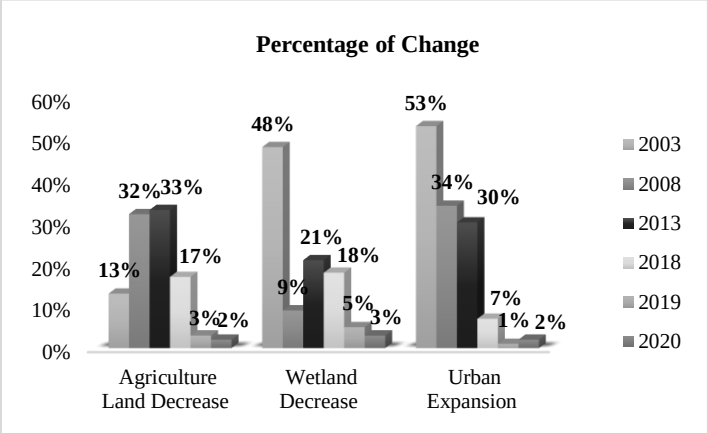


Figure 3.3: Percentage of Change from 2003 to 2020

Table 3.3 presents the amount of agricultural, urban, and wetland from the year 1998 to 2020. On the other hand, figure 3.3 describes the percentage of agricultural land reduction after the development of brickfields. According to Table 3.3 in 1998 the area occupied for agriculture, wetland, and urban expansion was 44615 sq. km, 15375 sq. km, and 3337 sq. km. But in 2003, 13% of agricultural land and 48% of wetland decreased due to brickfield expansion, and notably, 53% of urban expansion increased. In 2008, 26085 sq. km. was for agriculture and 7106 sq. km. the wetland, whereas 11092 sq. km. was occupied for urban expansion which indicates around 32% of agricultural land and 9% of wetland decreased on the other hand, 34% of urban land expanded from the year 2003. Repetitively, 17345 sq. km of agricultural land and 5586 sq. km of wetland, and 15982 sq. km expanded urban

area in 2013, and 14299 sq. km of agricultural land and 4550 sq. km of wetland, and 17083 sq. km of urban area in 2018 were discovered that indicates within these five years, 17% of agricultural land and 18% of wetland decreased and at the same time, 7% urban area increased. It is noticed that from 2019 to 2020, within this one year, 2% of agricultural land and 3% of wetlands were decreased and 2% of the urban area was expanded.

3.2.2 Results from Buffer Analysis

Table 3.4: Affected Agriculture and Wetlands

	Total Land (sq. km.)	Land inside the buffer zone	Land outside the buffer zone
Agricultural Land	13805 sq. km.	1518.55 sq. km. (11%)	12286.45 sq. km (89%)
Wet Land	4300 sq. km.	602 sq. km. (14%)	3698 sq. km. (86%)

Table 3.4 summarizes that a total of 13805 sq. km. of land in the western part of the study area is used for agriculture crop production which is 1518.55 sq. km. of agricultural land lying inside a 1 km radius buffer zone that is almost 11% of the total agriculture land of Narayangonj Sadar Upazilla. On the other hand, a total of 4300 sq. km. of wetlands are situated in the study area where 602 sq. km. which is only 14% of total wetlands are placed inside the buffer zone. In one word these lands are placed under the aggression and the most affected lands by the awful claws of the brickfield industry.

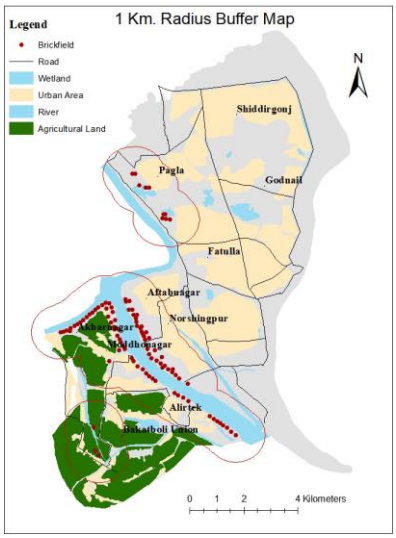
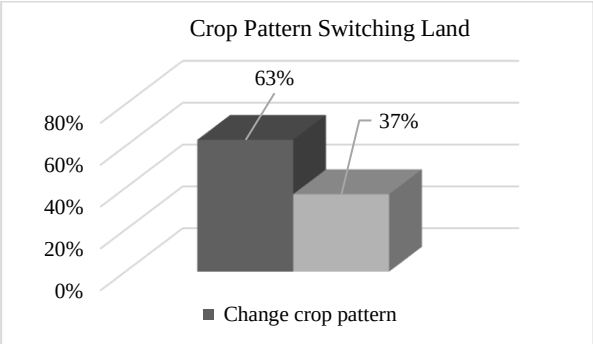


Figure 3.4:1 km. Radius Buffer Map

3.2.3 The Result from the Questionnaire Survey



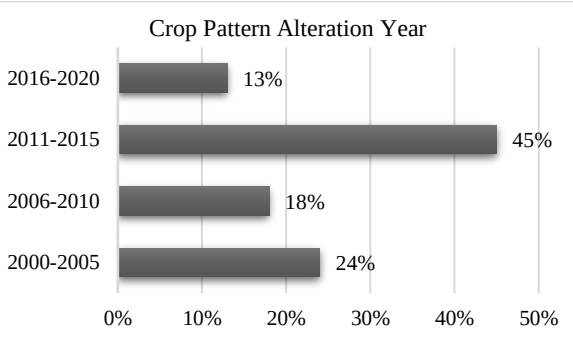


Figure 3.5: Percentage of Crop Pattern Switching Land Figure 3.6: Year of Crop Pattern Alteration

According to Figure 3.5, the crop pattern of 63% of lands within the buffer zone had been changed by the landowner on account of brickfield expansion**.** Before the development of brick kilns, those lands were usually involved in producing rice. However, after the development of the brick industry, the owner suffered from a great loss of production and was forced to change the pattern of the crop. Nowadays these lands are used for producing potatoes. On the other hand, only 37% of land inside the buffer zone is still used for rice production. The graph (Figure 3.6) indicates that the switching of crop patterns started in the year 2000 and about 24% of lands were switched crop patterns from 2000-2005. This alteration was on pick from the year 2011 to 2015. It is seen that almost 45% of the land was involved in the alteration from 2011 to 2015. Moreover, 18% of the land was changed from 2006 to 2010. Only 13% of lands started to shift from 2016 to 2020.

Change in Production

Table 3.5 indicates the production of rice from the year 1998 to 2020. In the year 1998, the production of *Aus, Amon, and Boro* was 19.03 kg, 16.68 kg., and 20.05 kg. per gonda but after the expansion of Brickfield, the production of those crops was 18.37 kg., 15.37 kg., and 18.37 kg. per gonda in the year 2003 which means the production had decreased 3.46%, 9.86%, and 8.37% from the year 1998. Notably, the scenario remained the same in the years 2008 and 2013. The production of *Aus*, *Amon*, and *Boro* in the year 2008 was 17.20 kg, 14.75 kg, and 17 kg which means the crop production decreased 6.37%, 1.86%, and 7.45% from the year 2003. On the other hand, in 2013 the production was 14.03 kg (*Aus*), 14.18 kg (*Amon*), and 15.45 kg (*Boro*), where 18.43% (*Aus*),

3.86% (*Amon*), and 9.11% (*Boro*) crop production decreased from 2008. Repetitively, the production of *Aus*, *Amon*, and *Boro* was 13.86 kg, 12.56 kg, and 13.39 kg in 2018, and 1.21%, 11.42%, and 13.33% production decreased within these five years.

Table 3.5: Rice Production within Buffer Zone

Year	1998	2003	2008	2013	2018	2019
Aus Production (Per kg)	19.03	18.37	17.20	14.03	13.86	12.50
Amon Production (Per kg)	16.68	15.03	14.75	14.18	12.56	10.11
Boro Production (Per kg)	20.05	18.37	17	15.45	13.39	10.76

The amount of crop production decreased in pick level in the year 2019, where the production of these crops was 12.50 kg, 10.11 kg, and 10.76 kg and decreased by 9.18%, 19.50%, and 19.64% from the year 2018. It is observed that in 2019, the production of *Aus*, *Amon*, and *Boro* was almost half from 1998 which is alarming.

3.3 Summary of Findings

Huge amounts of occupied land, mainly on the Dhaleshwari and Buriganga riverbanks, are subject to erosion and flooding during the rainy season. On the contrary, comparatively cheap land for brick manufacturing yards and the necessary resources of the earth and natural fuel are found across the Dhaleshwari and Buriganga river banks, so these became the hotspots for brick manufacturing sites. Moreover, due to the development of the brickfields, the agricultural lands and wetlands are noticed to have been converted into urban lands. The seasonal employee and the owner of the brickfields begin to live in this area. As a result, the expansion of urban areas and the number of agricultural lands and wetlands changed simultaneously. Besides, brickfield expansion has reduced, but more land is being taken for fields, indicating that the proprietors of these brickfields are encroaching on additional areas to grow their company. After the brickfield's expansion, it is observed that production in the buffer zone began to decline and not a single wetland is useable for fish and other cultivation. 96% of owners of the wetland condemned that they had not earned profit from fish cultivation after the expansion of the brickfield as a result they had stopped their cultivation. On the other hand. most of the landowners claimed that this reduction was due to the increase in brickfields. During the study period, the production of *Aus*, *Amon*, and *Boro* was falling, with *Amon* being the most damaged crop, and the major cause of this drop was smoke released from the brick kiln. After 2013, the brickfield's expansion began to slow down, although the production of crops is still falling.

4 Conclusion

Though brickmaking is a significant economic activity in Bangladesh, this sector is not yet controlled adequately. It is driven by outdated technologies with high emissions. The research is conducted within a small area with a small sample size which highlights not only wetlands and agricultural lands decreased but also the production of different crops reduced due to brickfield expansion. Despite a modest decrease in the number of brickfields, their impact remains the same. So, it is an opportunity to conduct this research within the whole of Bangladesh with a huge sample size, where the exact scenario will be found that will help the legislator and the administrator in imposing and monitoring the law against the unplanned expansion of brickfields.

References

Bisht, G., & Neupane, S. (2015). Impact of Brick Kilns' Emission on Soil Quality of Agriculture Fields in the Vicinity of Selected Bhaktapur Area of Nepal. *Applied and Environmental Soil Science*, *2015*, 1–8. https://doi.org/10.1155/2015/409401

Brick Manufacturing and Brick Kiln Establishment (Control) Act, 2013. (2019, January 15). Retrieved January 20, 2020, from https://doe.mymensingh.gov.bd/en/site/law_policy

History of NCC (Bangla). (2017, September 10). In *Narayanganj City Corporation*. Retrieved January 20, 2020, from https://ncc.gov.bd/site/page/c33d8363-e2f4-49e7-803c-5e191f0d437b/-

Jerin, M., Mondol, S., Sarker, B., Rimi, R., & Aktar, S. (2017, April 14). Impacts of Brick Fields on Environment and Social Economy at Bagatipara, Natore, Bangladesh. *Journal of Environmental Science and Natural Resources*, *9*(2), 31–34. https://doi.org/10.3329/jesnr.v9i2.32148

Khan, H. R., Rahman, K., Abdur Rouf, A. J. M., Sattar, G. S., Oki, Y., & Adachi, T. (2007, September). Assessment of degradation of agricultural soils arising from brick burning in selected soil profiles. *International Journal of Environmental Science & Technology*, *4*(4), 471–480. https://doi.org/10.1007/bf03325983

UNDP. (2016, October). *UNDP/GEF Project: Improving Kiln Efficiency in Brick Making Industry (IKEBMI) (GEF PIMS 1901)*. Department of Environment Ministry of Environment and Forest Government of Bangladesh. Retrieved January 25, 2020, from https://info.undp.org/docs/pdc/Documents/BGD/20161028%20IKEBMI%20TE%20Final%20Report.pdf