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# Effects of Industrial Agglomeration on Land-Use Patterns and Surface Water Quality in Konabari, BSCIC area at Gazipur, Bangladesh

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## Abstract

*Readymade garments sector of Bangladesh is playing a vital role in country's economic growth for last decade but not without an intangible cost of deteriorating the environment, biological resources and self-sufficiency in agricultural sector. Industrial activity causes one of the major environmental pollution problems in Bangladesh. This study was conducted to investigate the effects of industrial agglomeration on local land-use patterns and surface water quality of Turag River and its peripheral wetlands adjacent to Konabari, BSCIC area at Gazipur district, Bangladesh. To determine the land-use patterns, image processing and digitization were carried out using the Arc GIS 10 software. The Google images were obtained from open source ''Google Earth'' software. Statistical analysis was carried out in order to process and analyze the data. The water quality parameters (pH, DO, TDS and COD) were measured by using digital calibrated instruments and the BOD value was measured by standard 5 day BOD test method as described by APHA. The accretion of industrial development was found approximately four times in the year of 2010 compared with the year of 2004. The order of increasing patterns of land-use was industries > brick fields. The decreasing patterns of land-use were water bodies >Turag River > croplands > vegetation cover during the period of 2004 to 2010. Among different land-use types, the highest percentage of grabbed area by industries was croplands (49.44%; 356 acres) and the lowest percentage of grabbed area was water body (0.14%; 1 acres). The industrial agglomeration also grabbed 103 acres (14.31%) vegetation cover of the study area. The order of completely diminished land-use patterns of the area was, water body (44.29%) > croplands (31.90%) > vegetation (13.80%) >Turag river (11.10%). The values of pH, DO, BOD, COD, and TDS ranged from of 6.25 to 9.65, 0.55 to 2.98 mg/L, 65-142 mg/L, 192-445 mg/L and 1155-2085 mg/L respectively. Except pH, all the water quality parameters exceeded the prescribed limits set by local authority which indicates that the water of Turag River and its peripheral wetlands has been polluted severely and it should not be used in any purpose regarding human and animal life without proper treatment.*

**Keywords:** Industrial agglomeration, land-use change, water pollution, environmental degradation, Konabari.

## Introduction

Textile related industries are creating a huge opportunities for the uplifting of the economy of Bangladesh[1]. Textile industry is an enormous source of employment for this over populated country as decades earlier approximately 2 million employees (consisting 80% of female) were working this sector[2]. Currently readymade garments sector raised the employment scope to about 4.2 million people, primarily women from small income family[3]. Notably this sector is earning about 76% of our total foreign currency[4].

The readymade garments sector plays a vital role for proper economic functioning of Bangladesh because nearly 9.5% of the country's GDP comes from this sector[5]. But Bangladesh is paying serious environmental cost also for such economic growth experiencing environmental pollution, decrease in crop land, land fertility, water bodies etc. The manufacturing process of textile dyeing industries consumes huge volume of water to process the raw materials and substantial portions of the used water are released as effluent. According to World Bank estimation, textile dying and textile sectors are responsible for 17 to 20% of water pollution in Bangladesh. In our water seventy two numbers of toxic chemicals were detected exclusively from textile dying industries, among them thirty chemicals cannot be removed[6].

According to Sultana et al., 2012, "BISIC (Bangladesh Small and Cottage Industries Corporation) industrial area at Konabari were grown up and established along the bank of the River Turag of Gazipur area, Dhaka. Most significant environmental hot spot identified in Bangladesh has been grown up along the side of Rivar Turag"[7]. It is assumed that, most of the dying units of Konabari, Gazipur district have effluent treatment plant (ETP) as per their environmental clearance certificate, but most of the dying factories do not perform treatment of their entire generated wastewater except only a few factories. Most of the factories do not run the ETP regular basis, most of the generated wastewater discharged to environment directly without any treatment[8].

Yahaya et al., told that, "Hasty growth of readymade garments

industries in Konabari at Gazipur is leading clear degradation of total environment by using rivers simply for dumping purpose discharging the effluent directly or indirectly. The toxic substances present in wastewater generated from textile industries are polluting the water of surrounding rivers that could be used for human needs, industrial consumption, land irrigation, fish production or recreation. Overall epidemic and internal socio-economic pattern are seriously threatened by such pollution of aquatic syste''[9]. The agricultural lands, water bodies, vegetation cover, fertility of agricultural lands, crop production rates are decreasing gradually in these areas due to the ever increasing industrial growth in unplanned manner and constant pollution load generated by these industrial sectors. Considering all these concerns, the current study was designed to determine the present agglomeration scenario of textile dyeing and other industrial sectors in Konabari, Gazipur district, the changing land use pattern scenario and their possible socio-environmental effects on local land use patterns as well as surface water quality of these areas.

## Material and Methods

**Study area**: The present study was conducted in Konabari BSCIC (Bangladesh Small and Cottage Industries Corporation) industrial area of Konabari Union at Gazipur district,where numerous textile dyeing and other industries are located. Konabari union is located along the bank of Turag River and bounded by Kaliakair union on north and west, Kashimpur union on south and Basan union on east. The area was located approximately at the latitude of 24.022ºN to 23.968º N and longitude of 90.304ºE to 90.355º E. The altitude of the area was approximately 10 meters from the sea level and situated beside the Tangail-Gazipur highway.

**Samples collection:** The water was sampled collected from different points of the Turag River maintaining a distance of half mile and from the wetlands around its periphery by random selection. For collection of water samples plastic containers of 0.5 L were used. During sampling from different points of water was collected inside the sample bottle from 15-30 cm below the surface of water and labeled properly. Conc. $HNO_3$ was used for washing the samples bottles. Bottles were rinsed repeatedly with distilled water. At the sample collection spots, the bottles were washed three times also with the river water before water collection. Alkaline potassium iodide solution was used to protect water samples from any microbial attack after collection of water. The samples were stored in icebox and brought to the laboratory as early as possible for analytical analysis. Map of the study area and the sampling sites are shown in figure-1.

**Software used and data collection procedures:** The present study was conducted under the framework of Remote Sensing (RS) and Geographical Information System (GIS). The image processing and digitizing were carried out using Arc GIS 10 software. Remote sensing data used for this study including Google images were date of 13/11/2004 to 25/10/2010.The Google images were obtained from open source ''Google Earth'' software where the overall world's spatial images are added. The industries, rivers, wetlands and croplands were visited for onsite measurement, taking coordinate of the sites with hand GPS. Figure 2 shows the overall data generation procedures.

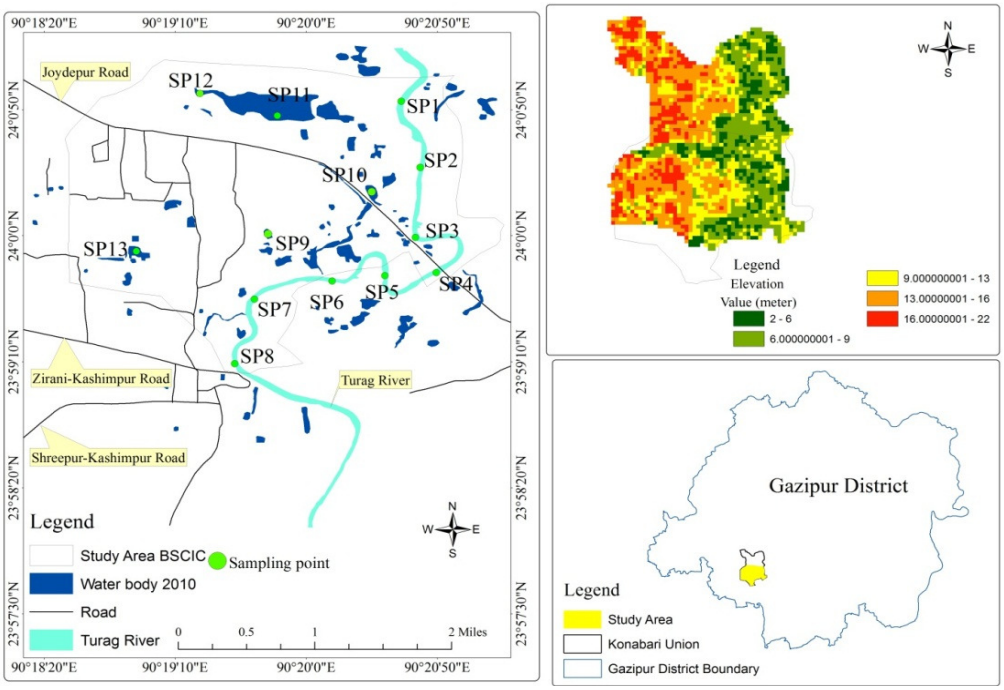


**Figure-1**
**Shows the map of the study area and the sampling sites**

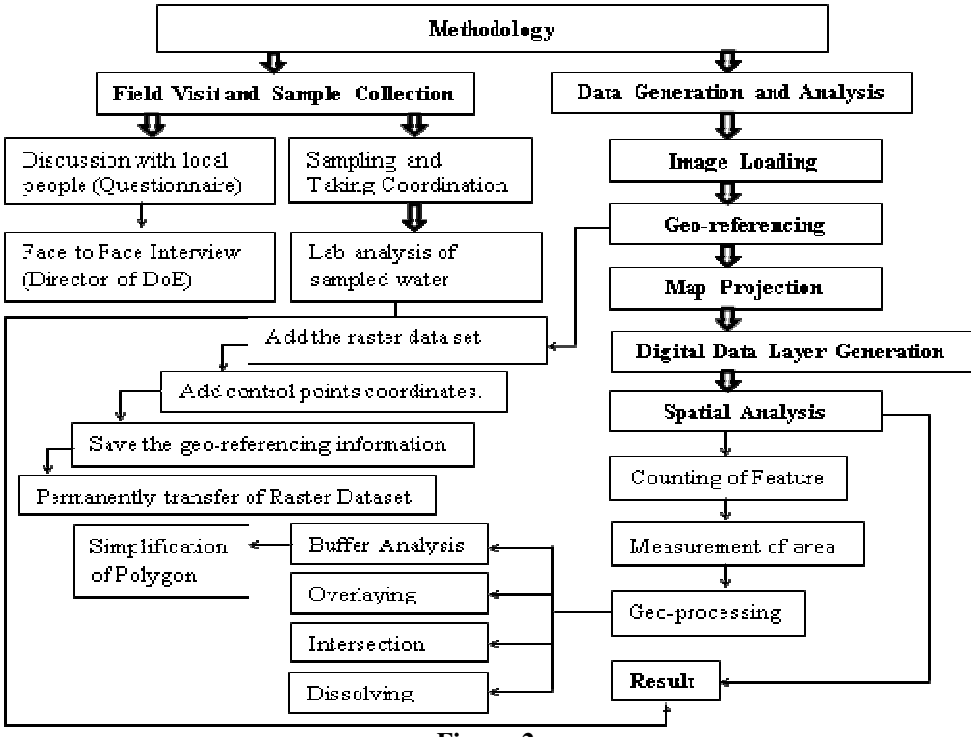


**Figure-2**
**Flow diagram of data generation procedures**

**Determination of water quality parameters (pH, DO, BOD, COD, and TDS)**: DO (Dissolved Oxygen), pH, and TDS (Total Dissolved Solid) of surface water were measured onsite by using pH meter (Model- HI 211, HANNA), DO meter (Model- DO 110, ECOSCEN), TDS meter( Model - HI 8734, HANNA) respectively. Biological Oxygen Demand ($BOD_5$) was measured by 5-days incubation (Incubator model: FTC90E, HACH, Italy) at 20ºC described by the APHA method[10]. COD (Chemical Oxidation Demand) of the water samples were measured by closed reflux colorimetric method, using a Colorimeter (HACH, DR/890). Standard solution was used to calibrate the instruments before use and the chemicals used were of analytical grade.

## Results and Discussion

**Changing scenario of land use patterns over the period of 2004 to 2010:** Figure-3 and figure 4 represent the patterns of land use in the Konabari, BSCIC area of the year 2004 and 2010 respectively. Occurring of rapid industrial agglomeration, decrease of agricultural fields, vegetation cover and water body are clear in this area comparing the land uses from the year 2004 to 2010. Figure-5 shows the changing scenario of land use patterns in the study area from the year 2004 to 2010. Among the feature of cropland, water body, Turag River, land covered by industries, brick and brick fields, the highest was the area of cropland (38.34%) in 2004 and industrial area was lowest (4.16%).The accretion of industrial development was more than five times in the year of 2010 (23.68%) compared with the year of 2004 (4.16%). 13.61% increase in brickfield area was measured in 2010 compared to brickfield area in 2004. The percentages of croplands, vegetation cover and Turag River were decreased to a substantial amount within the year of 2004 to 2010. Among them decreasing scenario of Turag River and water bodies within the study area were worst. More than half portion (57.62%) of the Turag River and the three forth part (74.80%) of water bodies were diminished over the period of 2004 to 2010.

The increasing and decreasing amount and percentages of land use during mentioned period are shown in table 1 compared with the area of land use in 2004.

**Measurement of grabbed areas by different sectors during the period of 2004 to 2010:** Rapid industrial agglomeration grabbed different croplands, water bodies, vegetation cover and encroached river widely during the period of 2004 to 2010 in Konabari, BSCIC industrial areas. Figure-6 and table-2 show the patterns of grabbed areas and percentage by industries, brickfields and increased local residential area due to industrialization respectively. The total water body grabbed by brick fields and other industries were 11.94% and 0.14% respectively. Industrial activities grabbed 49.44% of croplands during the period of 2004 to 2010. A substantial portion of the Turag River in the study area was encroached by brick fields and other industries. 14.31% of vegetation covers were grasped by industrial establishment. A significant portion (20.69%) of vegetation cover was also grabbed by the settlement of local residents increasing as a result of industrial growth.

**Table-1**
**Land use area in the year of 2004 and 2010 with percentage of changes during this period**

| Land use category | Year- 2004 | Area(acres) 2004 | Year- 2010 | Area(acres) 2010 | Change in Land use from 2004 to 2010 |
|---|---|---|---|---|---|
| Cropland | 38.34% | 1965 | 32.88% | 1422 | 27.63% decrease |
| Vegetation Cover | 19.21% | 985 | 17.34% | 756 | 23.25% decrease |
| Water Body | 19.12% | 980 | 5.71% | 247 | 74.80% decrease |
| Turag River | 6.4% | 328 | 3.21% | 139 | 57.62% decrease |
| Brick Fields Area | 12.76% | 654 | 17.17% | 743 | 13.61% increase |
| Land covered by Industry | 4.16% | 213 | 23.68% | 1024 | 380.75% increase |
| Total | 100% | 5125 | 100% | 4331 | |

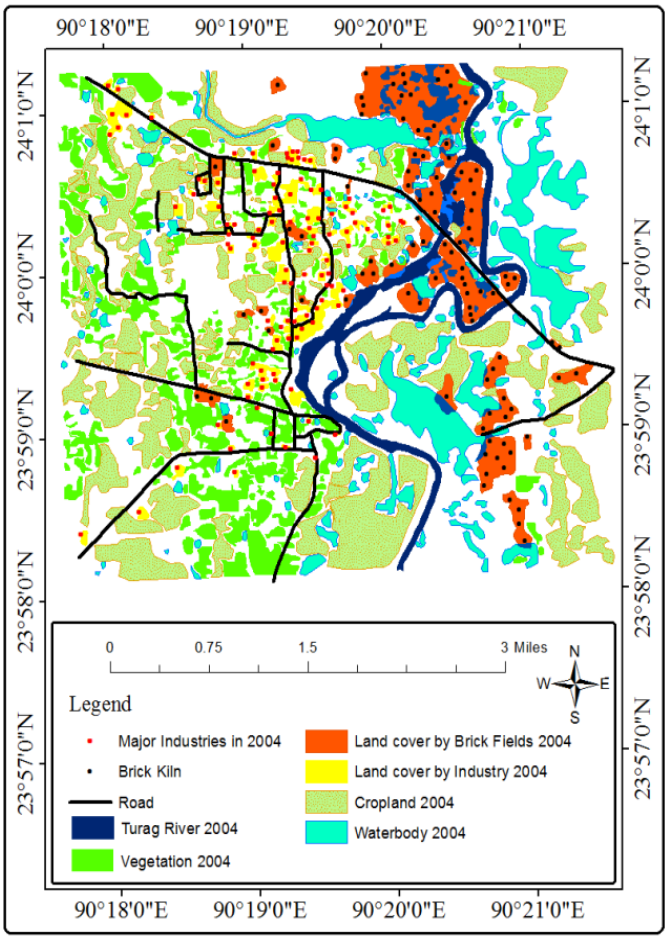


**Figure-3**
**Land use patterns in the year of 2004**

**Diminished part of different land use types and water reservoirs:** Due to the growth of unplanned industrialization several land use feature were vanished completely from the study area. Among them water bodies were affected most. 44.29% of the water body diminished from that area during the period of 2004 to 2010. Figure 7 and table-3 represent the diminishing scenario of different land use types and water reservoirs.

**Deteriorated water quality of Turag River and its peripheral wetlands:** Water was collected from thirteen sampling points, among them 8 samples were from Turag River and rest of them are from peripheral wetlands of the study area. Table-4 shows the values of all the water quality parameters comparing with the standard values. The dissolved oxygen (DO) concentration of all the examined samples ranged from 0.55 mg/L to 2.98 mg/L. The DO values of every sample were found far lower than the standard values set by local authority, Department of Environment (DoE).

The mean value of DO was found 1.49 mg/L, which is three times lower than the local standard to discharge into inland surface water. Same scenario was observed for BOD (Biological Oxidation Demand) and COD (Chemical Oxidation Demand) values of the examined water samples. BOD values of surface water were found exceeding the local standard for each sampling point as well as for COD concentration (except one sampling point measured 192 mg/L, nearly close to standard limit value). BOD concentrations of the tested samples were found within the range of 65 mg/L to 142 mg/L with a mean value (110.23 mg/L) two times higher than the local standard. Mean concentration (357.62 mg/L) of tested samples was also higher than the limit (< 200 mg/L) set by DoE ranging from 192 mg/L to 445 mg/L. High biological and chemical load of the surface water clearly indicate that the industries of this area do not treat the liquid effluent properly which is received by these surface water bodies and river. TDS values of sampled water were found below the range of local standard. The pH values were within the range except two sampling point exceeding the standard value of 9.00.

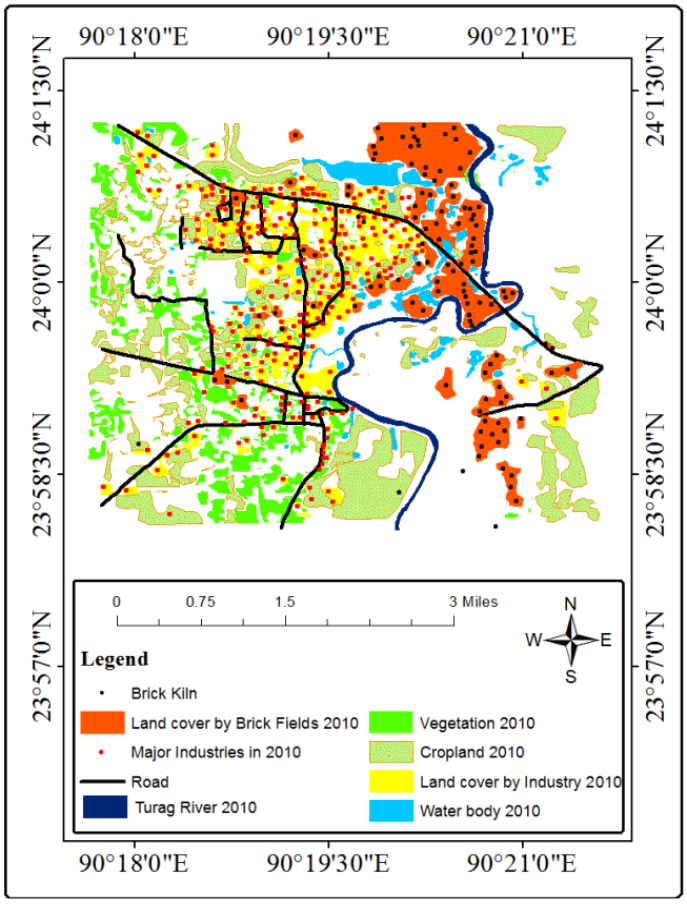


**Figure-4**
**Land use patterns in the year of 2010**

**Table-2**
**Measured grabbed areas by different sectors over the period of 2004 to 2010**

| Grabbed areas by different sectors | Percentage of areas grabbed | Area of grabbed part by different sectors (acres) |
|---|---|---|
| Water body grabbed by brick fields | 11.94% | 86 |
| Water body grabbed by industries | 0.14% | 1 |
| Cropland grabbed by industries | 49.44% | 356 |
| Turag river grabbed by brick fields | 1.67% | 12 |
| Turag river grabbed by industries | 1.39% | 10 |
| Vegetation grabbed by industries | 14.31% | 103 |
| Vegetation grabbed by brick fields | 0.42% | 3 |
| Vegetation grabbed by residence | 20.69% | 149 |

**Table-3**
**Area of diminished land areas and water bodies**

| Feature | Percentage of diminished part | diminished part area in acres |
|---|---|---|
| Turag river | 11.10% | 189 |
| vegetation | 13.80% | 235 |
| water body | 44.29% | 733 |
| cropland | 31.90% | 543 |
| Total | 100% | 1700 |

## Conclusion

It is clearly depicted that the hasty and unplanned industrialization in study area leads to decrease in agricultural field, vegetation cover and deterioration of surface water quality in an alarming way. Many portions of Turag River and water bodies were damaged to substantial extent that would hinder the proper functioning of natural ecosystem as well as generate enormous level of socioeconomic and socio-environmental problem for the local residents. The economic importance of that specific industrial activity is unavoidable but its impact on environment, human health and society cannot be denied also. Environmental damage must not be continued by the accretion of industries and its impacts. The cost of decreasing in food sufficiency, biological resource damage, cropland decrease must be considered and assessed. The availability of fresh water and water resource (e.g. aquatic organism, fish etc.) are great resources of Bangladesh. The adverse effects and socio-environmental impacts of industrialization should be mitigated in a sustainable manner. No more industries should be permitted to establish in this zone. Decentralization of industrial development is urgently needed. Proper layout, identification of industrial cluster is needed nationwide. The geographic location, socio-environmental significance should be considered in policy making. Impact of land use pattern change, river and water body destruction decrease in land fertility and cultivable land, damage of fish productivity and the loss or cost should be compared with the outcome of industrialization, though it is not easy but important. To improve the environmental scenario and performance, every industry should be under frame of proper EMS (Environmental Management System) and local rules.

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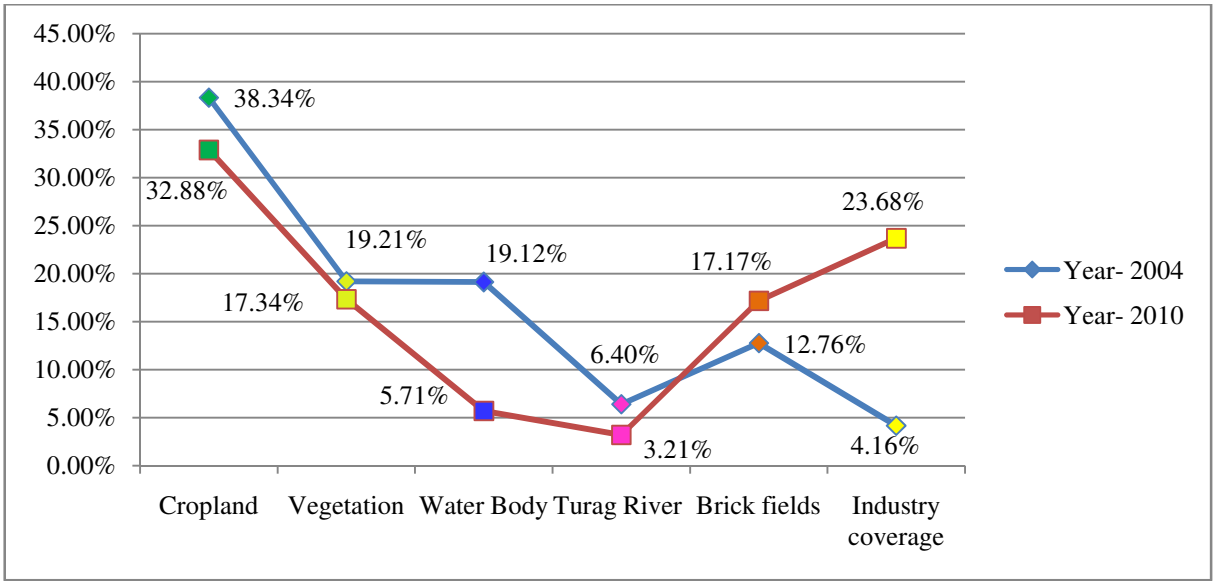


**Figure-5**
**Percentages of different land area in the year of 2004 and 2010 representing the changing scenario of land use patterns during this period**

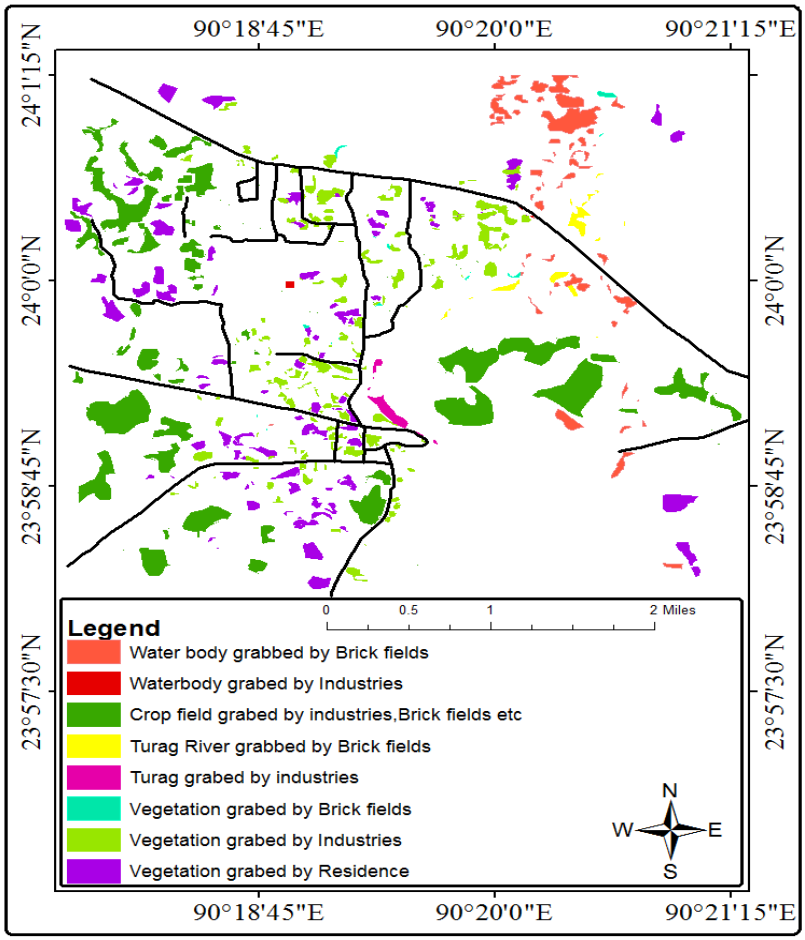


**Figure-6**
**Patterns of grabbed areas during period of the year 2004 to 2010**

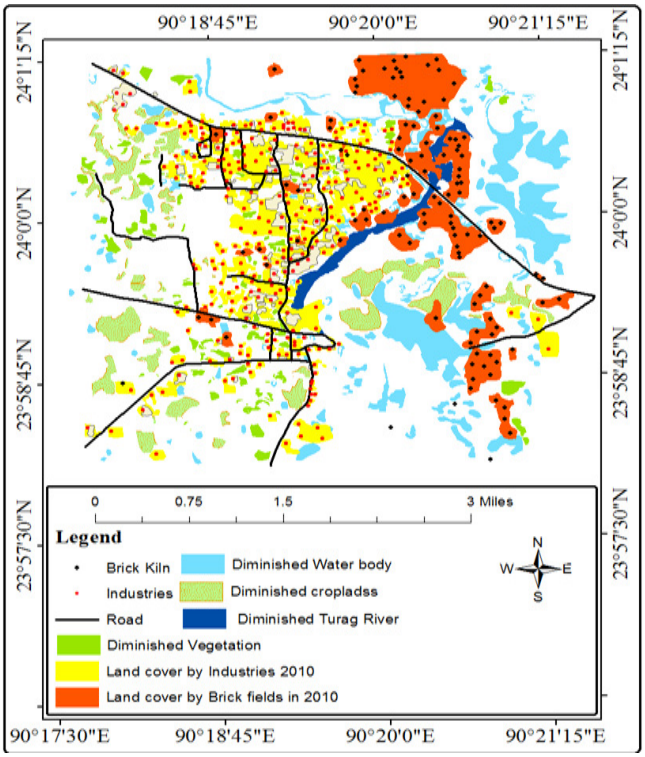


**Figure-7**
**Diminishing scenario of different land use types and water reservoirs during the period**

**Table-4**
**Value of Investigated water quality parameters of Turag River and its peripheral wetlands**

| Sample ID | Water Quality Parameters | | | | |
|---|---|---|---|---|---|
| | pH | DO (mg/L) | BOD (mg/L) | COD (mg/L) | TDS |
| SP-1 | 6.25 | 1.27 | 130 | 408 | 1691 |
| SP-2 | 8.70 | 1.53 | 107 | 390 | 1372 |
| SP-3 | 7.94 | 0.94 | 134 | 422 | 1344 |
| SP-4 | 7.84 | 2.98 | 65 | 192 | 2085 |
| SP-5 | 8.83 | 1.65 | 126 | 410 | 1501 |
| SP-6 | 8.72 | 1.77 | 125 | 380 | 1448 |
| SP-7 | 9.65 | 1.13 | 129 | 416 | 1907 |
| SP-8 | 8.96 | 0.78 | 137 | 428 | 1464 |
| SP-9 | 8.90 | 1.23 | 114 | 396 | 1609 |
| SP-10 | 8.05 | 1.76 | 70 | 248 | 1205 |
| SP-11 | 7.92 | 2.73 | 68 | 204 | 1799 |
| SP-12 | 9.38 | 0.55 | 142 | 445 | 1360 |
| SP-13 | 8.80 | 1.00 | 86 | 310 | 1155 |
| Mean | 8.46 | 1.49 | 110.23 | 357.62 | 1533.84 |
| SD | 0.86 | 0.71 | 28.23 | 88.39 | 274.03 |
| Standard* | 6-9 | 4.5 to 8.00 | <50 | <200 | <2100 |
| Range | 6.25-9.65 | 0.10-2.98 | 65-142 | 192-445 | 1155-2085 |

*Local standard for discharging of industrial wastewater into inland surface water (ISW-BDS, ECR, 1997)[11]. ISW-BDS-ECR= Inland Surface Water in Bangladesh

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