Urbanization Impact on Agricultural Land of Manikganj Pourashova, Bangladesh

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Abstract

Manikganj Pourashova is one of the most important municipal area, which has a good communication system with the capital city Dhaka. This municipal area also offers better residential opportunity and food support for Dhaka city at the same time. This research was conducted on Manikganj Pourashova where the major focus to see the land use pattern change of the study area which is related to the socio-economic activity of increasing human population. For analyzing land use pattern change, we used GIS technique was used. After GIS data analysis, we found that the land use pattern of Manikganj Pourashova is changing; especially the agricultural land is decreasing in an alarming rate. The maps showed that between 2005 and 2014 settlement areas has been increased by +9.24%, while agricultural land use decreased by -8.25% and water bodies decreased by -1.75%. The study area has recorded a significant increase in settlement area to accommodate the Pourashova's rapidly growing migrate population from the surrounding rural areas.

Key words: Land use change; Manikganj Pourashova; Agricultural land; GIS.

1. Introduction

Dhaka city, the capital of Bangladesh, is expected to be the third largest city in the world by 2020 [1].and the rapid urban growth experienced by the city in recent decades is one of the highest in the world [2].

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The considerable growth observed in the population of Dhaka (Figure 1) is thought to have occurred in response to large scale rural–urban migration, which has contributed, significantly to the increased rate of urbanization [2]. The environmental and socio-economic sustainability of Dhaka, which is essential for development planning, has received relatively little attention. This has resulted in widespread environmental problems across the city, largely stemming from unplanned urbanization, extensive urban poverty and recurrent episodes of flooding, substantial growth of slums, exploitation of resources, and the mismanagement of limited land resources [3].

Dhaka city present population is150 million and it will be over around 190 million by 2030 when an extra 25% food grains will have to be produced in Bangladesh. But the additional harvests will have to be reaped from a much smaller area of cropland than is now available [4]. According to one projection, the country would have to grow an additional five to six millions tones of grains by 2020 in a land area but two million ha less than today. In this perspective land use changing pattern is a challenge for agricultural land [5].
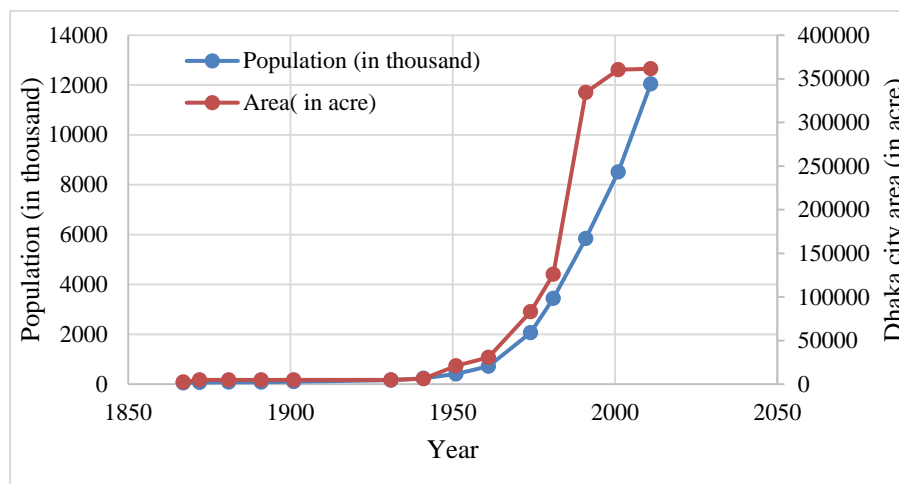

Figure 1: Increasing Population trend of Dhaka city

"Undoubtedly living conditions are getting worse in Dhaka city. Infrastructure, city service and public transport system need to be improved immediately," said Professor Nazrul Islam (University of Dhaka), eminent urban expert. However, he said every year around half a million people added to the existing population of Dhaka, making the 400 year old city vulnerable [6].

Manikganj Pourashova is one of the important municipal city that emerged in the suburban area of Dhaka city. This satellite city offers developed transportation facility, better residential opportunity and food support for Dhaka city at the same time. Consequently it has become a place where people of different social backgrounds and strata are residing. In recent decades, rapid economic development accelerated the process of urbanization, land reform, construction of roads; real estate development, industrial restricting, housing and industry have shown the tendency of extending. But this growth is performing in an unplanned way and therefore, leads to an urban sprawl development. This growth performing in an unplanned way and therefore, leads to the development which is insecure from disaster. Realizing this situation, this research was conducted on Manikganj Pourashova where the major focus to see the land use pattern change of the study area. Manikganj Pourashova is

one of the most important municipal area in Manikganj district which has a useful communication system with the capital city Dhaka, and this municipal area also offers better residential opportunity and food support for Dhaka city at the same time.

Because of better transportation network and suitable geographic location, Manikgonj Pourashava has a great potentiality to achieve development. In recent decades, due to unplanned development this area faced a haphazard development. Considering this situation the research has been done to take necessity steps for promoting sustainable development within the area. To achieve these goal, a suitable guideline for an appropriate land use plan is necessary for Manikgonj Pourashava.

There are only a few previous studies and maps on land use change has been done at the local government level. Nahrin and Aktar (2007) in their article "Problems of Urban Utilities in the Secondary Towns of Bangladesh: A Case Study of Manikgonj Pourashava" which essential traces the utility coverage and present land use pattern of the study area [7]. Local Government Engineering Department (LGED, 2010) published "Manikganj municipality map" and "Manikganj Sadar Upazila Road Network map" presented the current (2010) land use condition [8]. These reports and maps are not concerned with the temporal change of the socio-economic conditions of the study area. Land cover change (especially in agriculture land) of Manikganj Sadar Upazila due to unplanned urbanization [9].

2. Purpose

The objective of the study is to examine the spatial variations and temporal changes in various land use with GIS data and to find out the land use change with social background in Manikganj Pourashova, Bangladesh. Specifically, the purpose of the study is to analyze the temporal and spatial changes of land use in the study area concerning with urbanization of Dhaka city.
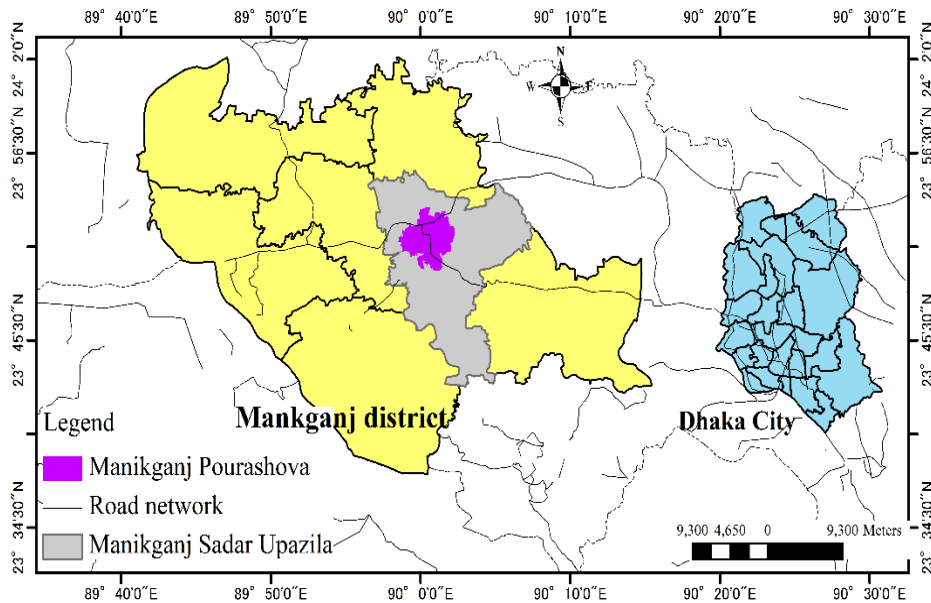

Figure 2: Location of the Study Area

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3. Geographical Settings of the Study area

Manikgonj Pourashova is located between 23.8500°N 90.0111°E. Manikganj district has been divided into seven Upazilas[1]. Manikganj Pourashova[2] is bounded on the north by Saturia Upazila, on the east by Singair Upazila, on the south by Harirampur Upazila and on the west by Shivalaya Upazila and Ghior Upazila (Figure 2). The study area has a distance of 50 km from Dhaka city. Manikganj Pourashova has been divided into 9 wards [3]. The heights and the lowest average monthly temperature vary from 35.1℃ to 14.2℃. The level of humidity varies from 56% to 83%. The surface soil related with agriculture is mainly composed by the Young Active Brahmaputra flood plain representing silty and sandy alluvial soil. The Kaliganga River is the principal river that flow through the study area. In the study area, 43.43% of the dwelling households depends on agriculture as the main source of income with 27.49% cropping, livestock, forestry and fishery and 15.94% as agriculture labor [10]. The major agricultural crops are Rice, Jute, Wheat, Pulses, Oil seeds, Vegetables, Spices, Potato, Sweet potato. Among rice crops Boro covers the largest area followed by Aman and Aus.

4. Materials and Methods

In this study both primary and secondary data have been collected from Bangladesh Population Census book (1981, 1991, 2001 and 2011) published by Bangladesh Bureau of Statistics (BBS) [11,12]. The primary data and information relating to agriculture are obtained mainly from Bangladesh Agriculture Census 1984, 1996 and 2008. Primary data includes agriculture statistical data, the information regarding to the net cultivated area, agriculture labor household, gross cropped area and number of farm holding.

The land use categories are classified as, agriculture area, settlement area, Water body (river and pond area), commercial area, industrial area and road network. For GIS analysis, Manikganj Pourashova land use map, 2005 (Scale 1:40,000) and google earth time series map 2014 were used. At first, we have drawn the Keyhole Markup Language (KML) [4] file by using google earth. The KML files were exported to GIS for map production and generating land use statistics. We have also used ASTER Global Digital Elevation Model (GDEM) map, Manikganj Pourashova land level map by Geological Survey of Bangladesh (GSB) and road network map by Local Government Engineer Department (LGED) Bangladesh for evaluating the land use categories. After preprocessing the land use maps, we using the ground truth at the field survey to produce land use classes. The image processing and analysis has been carried out using ArcMap 10 software. Field work was carried out during October 2014 for collecting ground training and validating data and for defining the characteristics of each land use class.

5. Result

5.1 Settlement area

The highest number of changed occurred during the period of 2005 to 2014 in Manikganj Pourashova was in case of settlement area (Figure 3). With the passage of time, settlement area has been changed quite a lot. In 2005, it was 35.08% (2279.69 acre) of the total study area but it increased in 2014 to 44.32% (2871.68 acre). The total area of settlement increased 591.99 acre, which are about 9.24 % in of total area.

According to Table 1, the settlement area has been increased 9.24% since 2005 to 2014. This indicates the percentage of population increased along with other development activities, such as, industrialization, urbanization and also family dividation processed in rural as well as Pourashova areas.
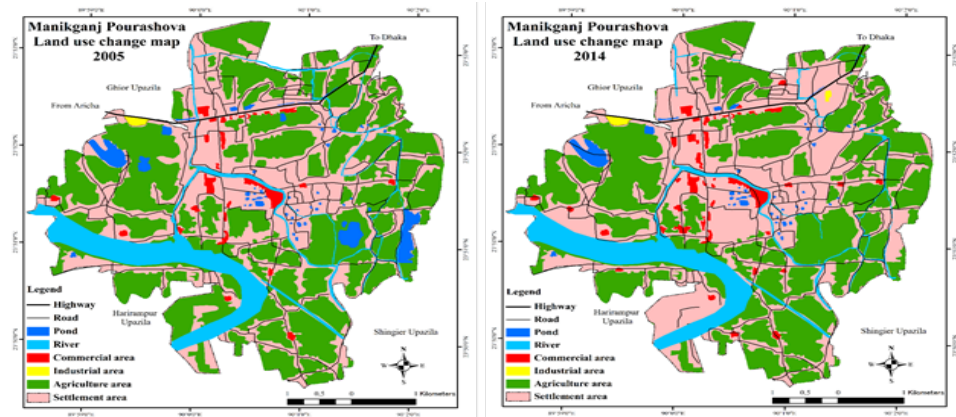

Figure 3: Land use change maps of Manikganj Pourashova between 2005 and 2014

Table 1: Dynamics of land use change in Manikganj Pourashova between 2005 and 2014

| Land use category	2005		2014		Change (%)
	area in acre	%	area in acre	%	
1.Settlement area	2279.69	35.08	2871.68	44.32	9.24
2.Commercial land use	94.1	1.44	135.71	2.08	0.64
3.Industrial land use	12.36	0.19	20.06	0.31	0.12
4.Water body					
a. River	530.15	8.16	530.15	8.16	0
b. Pond	188.1	2.89	107.23	1.64	-1.25
c. Cannel	132.35	2.03	99.78	1.53	-0.5
5.Agriculture land use	3270.3	50.21	2742.48	41.96	-8.25
Total	6507.05	100	6507.09	100	
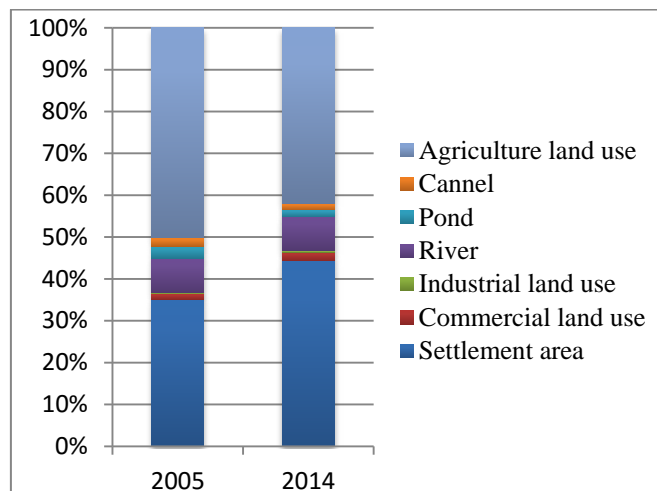
Figure 4: Dynamics of land use change in Manikganj Pourashova between 2005 and 2014.

As the built up area of the study area has been increased at a very high rate between the study period (2005-2014), and as the total area did not increase, so it can be said that, agricultural land as well as exposed area have been changed into built up area.

5.2 Commercial and Industrial land use

Commercial function is one of the most important functions of Manikganj Pourashova area. So, commercial land use and its changes have been observed with the growth of the area. During the time period of 2005-2014 (Table 1), the area of commercial land use of Manikganj Pourashova has been increased by 0.64 %.

Mixed type of land use has been observed at the regional center of Mnaikganj Pourashova are. Due to lack of better agriculture technology people are not feeling interest about the agricultural activity and they are not started commercial activity. Number of shops, banks, hotels, restaurants, office of the different institutions, cinema halls etc. have been established gradually. Thus, the presence of this type of land use has been enhanced in the city expansion.

A small amount of land use change has been observed in land use pattern of the Manikganj Pourashova in respect of industries. Industrial land use of Manikganj Pourashova has been increased by 0.12 percent during the time period of 2005-2014.

5.3 Water body

Water resources of the study area have suffered significantly from the impacts (decreased by -1.75%) of a rapidly increasing human population, together with some other causes expansion of human settlements, urbanization and industrialization, unplanned development activities etc. Apart from changes in the land use pattern, increased human activities in the water body areas have put on pressure on ecosystem. Water body change of Manikganj Pourasova brings the most serious impacts upon its hydrological sector as the surface of flood plain. Hydrological condition of the study area has been changing gradually with the increase of land filling areas in low-lying part of the study area and the buffer zone of flooding retarding has been smaller than before.

There were a large number of canals, lakes, and depression in the study area that carried excess rainfall water from the study area to for a way through its surrounding rivers. However, at present unplanned development activities, the drainage system of the study area is in vulnerable condition.

5.4 Agriculture land use

In 2005, agricultural land use amounted 3,270.3 acre (50.2%) and decreased to 2,742.5 acre (41.96%) in 2014 (Table 1), from the above Table 1, it can be said that, the agricultural land of the study area has been decreased at a slower rate comparison to settlement area. The agricultural lands' being low-lying area is susceptible to flood risk (Figure 4). However, with the increase of population and scarcity of food, the exposed fallow land areas are cultivated by the farmers to meet their necessary foods although the

percentage of agricultural land in two different periods was decreased.

Urban agriculture is one of the ways to the supply of food grains and vegetables to the residents of the cities in the country. The nature, type and magnitude of transformation of agricultural lands to non-agricultural activities may have a profound effect on food security of Manikganj Pourashova.

The farmers are also influenced by the various types of commercial activity, for example, in the recent years the land value of Manikganj Pourashova is getting higher and higher and the result of this, farmers are selling their land to the developers. And later the developers make not only settlements but also commercial buildings, in this way the agricultural land is changing to the commercial land in the study area.

In 1984, farm household[5] was 67.07% of total household area and it became 59.27% in 1996. According to the agriculture census (2008), farm household has been decreased to 50.99%. From 1996 to 2008, during recent 12 years, the decreasing rate is higher because of urbanization greatly contributed to the loss of agriculture land. In opposite in 1984, small farm household[a] was 13,941 (74.01%) of total household and 19,370 (85.81%) in 1996. In 2008, small farm household has been increased to 28,996 (90.21%).

From the agriculture census 1996, the percentage of non-farm holdings[6] family were 40.73% and in 2008 it became 39.82 which is decreased because in recent years people are not interesting about agriculture, moreover lack of agriculture technology people are not feeling any interest to their agricultural activity.

Small farmers have the potential to raise their incomes by switching from grain-based production systems to high-value agriculture. Although the production of high-value agriculture is labor-intensive and thus more suitable for small farm holders, they face a number of constraints. In addition, small farmers have low volumes of marketable surplus and the land they cultivate is mostly located in remote areas with poorly developed infrastructure. As a result, small farm holders face high transaction costs and risks in production and marketing of such commodities. They also face poor access to credit, and stringent food safety and quality standards. And end of the day, they don't have any other option without sell their land to the developers.

5.5 Population migration

In the study area from 2005 to 2014 there is a large number of people migrate from rural to urban area. Because of rapid rural to urban migration the study area has already experienced the land use transformation mainly from agriculture to residential and commercial uses. In Manikganj sadar upazila there has been rapid conversion of agricultural areas to non-agricultural uses especially in manikganj pourashova, krishnapur, betila mitara and putail area. The built-up area has increased in all directions. The study area has recorded a significant increase in residential area to accommodate the city's rapidly growing migrate population, but this increase has been more pronounced in unplanned residential areas than in planned residential areas. From the questionnaire survey, about 50% people are migrate from rural to urban area for doing job purpose. Rural to urban migration is much more prominent in the hatipara, garpara, nabagram and atigram area. Which is very clear to understand from the above figure (Figure 5). And from the questioner survey it was also found that from 2005 to 2014, there is a large number of framers sold their land and migrated to the city area for job. And most of the cases the
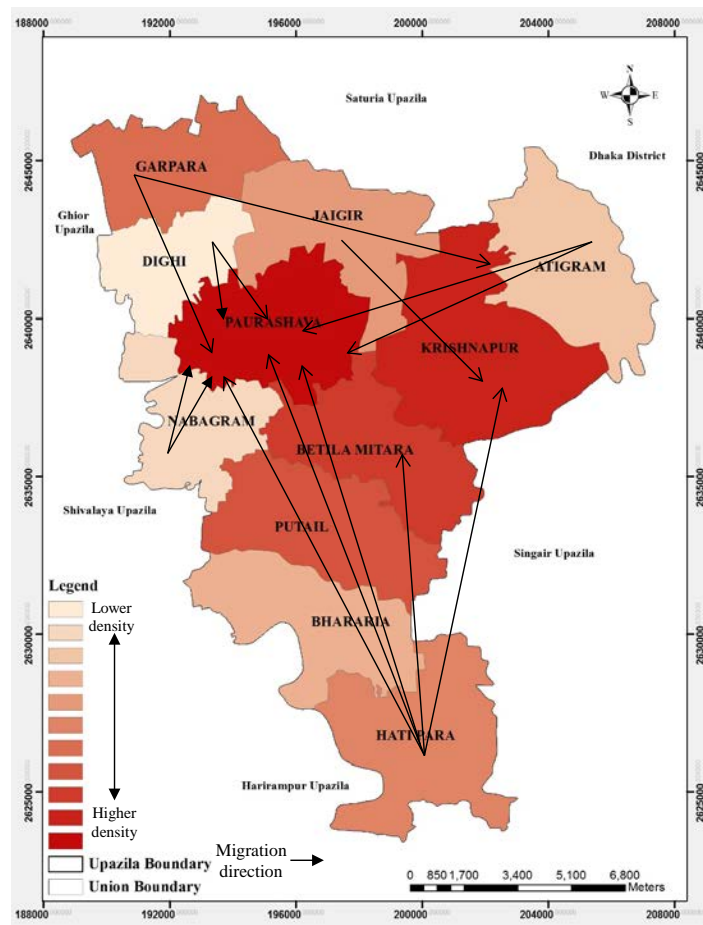
migration pattern is from rural to urban.

Figure 5: Population migration scenario in Manikganj Pourashova between 2005 and 2014.

6. Conclusion

This study evaluated the temporal and spatial changes of land use in the study area respecting with urbanization of Dhaka city. In the study area, urban land use has been increased by 10.0% during 2005 to 2014, which resulted in a significant decrease in the area of agriculture land use and water surface. In the study area, the growing population and faster economic activities has been increased. But in opposite, the amount of agricultural land has reduced substantially, largely as a result of the increasing demand of land for urban land uses. The significant change in agriculture land use has been observed in the south-eastern and north eastern site of the study area because of nearest distance and better transportation network with Dhaka city.

In the study area, during the above mentioned 10 years, a significant urban land use expansion has been largely driven by population growth and economic activity. Comparatively the growth rate and the number of population of the study area are much greater than all other Upazilas on account of locational advantage linking Dhaka city. The average per capita income from agriculture sector is poor, so in recent decades people are involving themselves to the service and business activity for healthy income. Urban land use expansion should be restrained on agriculture land use, vegetation cover and water surface. Agriculture land must be prohibited

from any kind of development activity. Agriculture land use must be preserved for food support for both Dhaka city and Manikganj Pourashova. Existing natural canals, ponds and other water surface should be kept for ecological balance. Moreover, regional and local land use management policy should be needed to be revised for proper land use management. The land use maps produced in this study will contribute to both the forecasting possible future changes in growth patterns and also for the development of sustainable urban land use planning decisions.

7. Recommendations and limitations

A land use zoning model should be prepared by the planning authorities for identifying specific areas for different purposes. Land use policy or law should be made by the government authorities. For instance, agriculture land use should not grabbed by commercial or industrial use. There should be sufficient amount of land for agriculture land use, because of study could provide food support to the surrounding city like Dhaka city.

This research has been faced some limitations during this research work, There were shortages of statically data resources in the local city office, since there are only a few research has been done before in this area. Moreover lack of digital base maps which related to interpretation and analysis.

8. Appendix

1. Upazila: Upazila is the sub-units of districts. The Upazilas are the second lowest tier of regional administration in Bangladesh.

2. Union or Pourashova: Union is the smallest rural administrative and local government unit in Bangladesh. Pourashova is the Upazila city center or smallest urban administrative and local government unit in Bangladesh

3. Ward: In Bangladesh, a ward is an optional division of a city or town, especially an electoral district, for administrative and representative purposes. It is an elective unit of a City Corporation or Municipal Corporation, created for the purpose of providing more direct representation, from which a single council member is elected.

4. KML file: Keyhole Markup Language (KML) is an XML notation for expressing geographic annotation and visualization within Internet-based, two-dimensional maps and three-dimensional Earth browsers. KML was developed for use with Google Earth, which was originally named Keyhole Earth Viewer. It was created by Keyhole, Inc., which was acquired by Google in 2004. KML became an international standard of the Open Geospatial Consortium in 2008. Google Earth was the first program able to view and graphically edit KML files. Other projects such as Marble have also started to develop KML support.

5. Farm holding: A farm holding is defined as being an agricultural production unit having cultivated land

equal to or more than 0.05 acres. Farm holdings are classified into following three broad groups:

(a) Small: Farm holdings having minimum cultivated land 0.05 acre but operated land more than this minimum but up to 2.49 acres, Medium: Farm holdings having operated land in between 2.50 to 7.49 acres and Large: Farm holdings having operated land 7.50 acres and above. Small cultivated land 0.04 acre or less is generally used for kitchen garden growing mainly vegetables. Often seeds of white gourd, water gourd, pumpkin, and other strains are sown on households; but these creepers spread out around house roofs and other structures. As such, the minimum cultivated land considered for qualifying to be a farm holding is 0.05 acres.

6. Non-farm holdings: A non-farm holding is defined as being the one which has neither cultivated or operated land or has cultivated land less than 0.05 acre.

References

[1]. World Bank "Indonesia: Agricultural Transformation Challenges and Opportunities". Report No. 1054-IND, Washington, 1992. http://www.wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/1992/09/01/000009265_3961002205515/Rendered/PDF/multi_page.pdf

[2]. Islam, N. "Dhaka from city to megacity: Perspectives on people, places, and planning and development issues". Dhaka: Urban Studies Program, Department of Geography, University of Dhaka, 1996.

[3]. Hasan, S., & Mulamoottil, G. "Environmental problems of Dhaka City. Cities", 11(3), 195–200, 1994.

[4]. Dewan A.M. and Yamaguchi Y. "Land use and land cover change in Greater Dhaka, Bangladesh: Using remote sensing to promote sustainable urbanization" Applied Geography, Vol. 29, pp. 390-401, 2009.

[5]. Dewan A.M. and Yamaguchi Y. " Using remote sensing and GIS to detect and monitor land use and land cover change in Dhaka Metropolitan of Bangladesh during 1960-2005" Environmental Monitoring and Assessment, Vol. 150, pp. 237-250,2009.

[6]. The Daily Star "Dhaka Least Liveable City: Study" 2012. http://cbe.thejakartapost.com/news/2012/08/15/dhaka-least-liveable-city-study.html .

[7]. Nahrin, K. and Aktar, M. "Problems of Urban Utilities in the Secondary Towns of Bangladesh: A case study of Manikgonj Pourashava". Jahangirnagar Planning Review, Vol. 5, pp. 75 – 84, 2007.

[8]. Local Government Engineering Department (LGED) Digital Map Download, English, http://www.lged.gov.bd/ViewMap.aspx, (2015, April 23)

[9]. Sayed, M.B. and Haruyama, S. "Dynamics of Land Use/Cover Change in Manikganj District, Bangladesh: A Case Study of Manikganj Sadar Upazila". Journal of Geographic Information System,

7, 579-587, 2015. http://dx.doi.org/10.4236/jgis.2015.76046

[10]. Bangladesh Bureau of Statistics (BBS) "Population Census 1991, 2001, 2011". Dhaka: Ministry of Planning, 1991, 2001, and 2011.

[11]. Bangladesh Bureau of Statistics (BBS) "Agricultural Census of Bangladesh 1996". Dhaka: Ministry of Planning, 1996.

[12]. Bangladesh Bureau of Statistics (BBS) "Agricultural Census of Bangladesh 2008". Dhaka: Ministry of Planning, 2008.