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Socio-economic Impacts due to Land-use changes of Kaliakair upazila derived from RS and GIS Technologies

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ABSTRACT: Changes of land use and land cover have significant socioeconomic impacts in the context of Bangladesh. This study investigates various socioeconomic impacts of land use and land cover changes in Kaliakair Upazila, Bangladesh using multi-date Landsat MSS/TM/OLI images of 1973, 1989 and 2014. Dominant land use features such as green crops, forest vegetation, urban/built up areas and water bodies have been identified using ISODATA clustering as well as supervised classification based on parallelepiped and maximum likelihood methods. These data has also been complimented with GIS techniques for settlements and forest features identification using 30m resolution Landsat image from the Google (SPOT) imagery and multi-spectral aerial photographs through on screen digitization technique. A rapid increase of urbanization has been observed in the study areas between 1973 and 2014. On the one hand, human settlement have been increased 36% – 40% from 1973 to 1989 and decreased 40% -35.9% from 1989 to 2014, but forest areas have been decreased by 9% – 5% from 1973 to 2014 on the other. These types of land use and land cover changes have tremendous impact on economic, social and cultural life of Kaliakair upazila.

Key Words: Socio-economic impact, Land use change, Remote Sensing, GIS.

Objectives:

The ultimate objective of this study was to assess the socio-economic impacts due to land use and land cover changes of Kaliakair Upazila, Bangladesh during the period 1973 to 2014. The following specific objectives have been pursued.

1. Generation of land use and land cover maps of Kaliakair upazila during the period 1973, 1989 and 2014 using Landsat data.
2. Preparation of land use and land cover change map during 1973-2014.
3. Identification of socio-economic impact due to land use and land cover changes

1. Introduction

Land use is characterized by the human activities that involve uses of land for habitation, agricultural, forestry and industrial development and all sorts of small and large scale livelihood activities (FAO/UNEP, 1999). Land use is a product of interactions between a society's cultural background, state, and its physical needs on the one hand, and the natural potential of land on the other hand. Often improper land use causes various forms of ecological imbalance and environmental degradation (*https://owlcation.com/stem/-Ecological-Imbalance-Its-Causes-and-Effects-in-the-Biosphere*). The human activities such as industrialization, expansion of urbanization caused the tremendous depletion of forest in Bangladesh. The expansion of population and need for increased food production and socio-economic development are the major drivers causing the land-use change in the country. Thus, it is of importance to map the land-use pattern and study the land-use and monitor the land cover changes. Such information is highly useful for planning the future land-use and industrial and urban development and management of natural resources.

Various techniques have been used for providing information about natural resource management. But use of remotely sensed data with the help of GIS may give the appropriate solutions for these problems in relatively small amount of time (Agarwal, 2000; Bakr, *et al*., 2010). For land-use mapping, supervised and unsupervised approaches are normally adopted for spectrally discriminate the surface features, well described in Campbell (2002), Kerle *et al*. (2004), Lillesand, *et al*. (2004), Jensen *et al.* (1996), Liu *et al.* (2002), Lunetta *et al*., (2004) and Coppin *et al*., (2004). In this study, an attempt has been made to construct socio-economic impacts due to land use and land cover changes of Kaliakair upazila, Bangladesh from 1973 to 2014 using Remote Sensing, GIS and GNSS technologies. This article is a follow of our previous article published on July 2015, Volume: 5, Issue: 7, which dealt with the land use changes of Kaliakair upazila (*Sarker et al, 2015*).

2. Study Area

Kaliakair is an upazila of Gazipur District in the Division of Dhaka, Bangladesh. It is located at 24° 00′ 25.20″ to 24° 14′ 58.30′ N and 90° 09′ 04.65 ″ to 90° 21′ 23.70′ E. It is bounded by Mirzapur and Sakhipur upazilas on the north, Savar and Gazipur Sadar Upazilas on the south, Gazipur Sadar and Sreepur Upazilas on the east, Mirzapur and Dhamrai Upazilas on the west. The Bangshi River is almost dead. Haola and Makash Beels are notable. Population of Kaliakair Upazila is 165000, 232000, 267000 and 503000 in the census year of 1981, 1991, 2001 and 2011 respectively (*Population Census 2011*). Figure 1 shows Kaliakir Upazila.

3. Data used and methodology

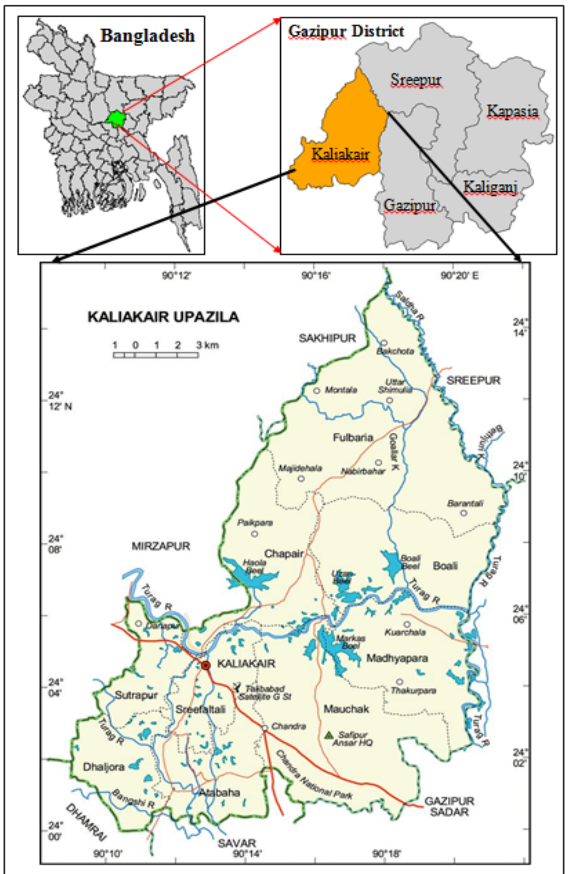

Figure 1: Study Area (Kaliakair upazila, Bangladesh)

3.1 Remote sensing data

Landsat MSS data of 80 meter resolution of 1973, Landsat TM and OLI data of 30 meter resolution of 1989 and 2014 of the study area have been used in the study. Table-1 shows the Landsat TM frame number & dates of study data and Figure 2 shows the 137/43 frame of Landsat 8, 2014 of the study area. Remote sensing data have been downloaded from glovis archive of USGS (http://glovis.usgs.gov). All the captured data are converted to IMG format.

Table-1: Data used in land use classification of Kaliakair Upazila

Satellite	Sensor	Number of spectral bands	Acquisition Date and Time		Frame
LANDSAT	MSS	4	02021973	Around 09:45 (local time)	147/43
			09111973		
	TM	7	28011989		137/43
			13031989		
	OLI	8	30012014		
			30032014		
Ancillary Data	Aerial (Multispectral)	3	1983		
	Aerial (Panchromatic)	1	2001		
	Google		2014		

3.2 Field survey data

Ground Control Point (GPS) data collected from field for geo-reference as well as field verification of satellite data interpretation are given below.

3.3 GIS data

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface (Weng, 2001, ArcGIS user guide). GIS can show many different kinds of data on one map, such as streets, buildings, and vegetation. This enables people to more easily see, analyze, and understand patterns and relationships Satellite remote sensing, in conjunction with GIS, has been widely applied and been recognized as a powerful and effective tool in detecting land use and land cover mapping (Kumar N et al., 2015).

The study has been complimented with GIS for inclusion of the settlement areas and features which could not be captured by 30m resolution Landsat image using the multispectral aerial photographs and Google (SPOT) imagery. This has been done through screen digitization technique.

3.4 Ancillary data

Google (SPOT) imagery of 2014 has been used for small area of settlement and forest delineation using on-screen digitization as a backup support for landsat image of 2014. Similarly, multi-spectral aerial photographs of 1983 have been collected from SPARRSO for the backup support of landsat image 1989. The GIS layer of Upazila boundary of Bangladesh has been used for sub-setting the area of interest (Kaliakair Upazila) from the digital Landsat frame of 137/43. Statistical data collected from the Bangladesh Bureau of Statistics (BBS) have been used for validation of remote sensing results. The field investigation has also been performed to validate the interpretation of the imagery as well as people's socio-economic condition.

3.5. Data analysis and preparation of land-use maps

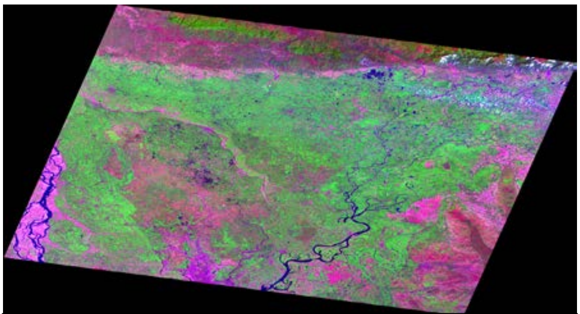

Figure 2: Geo-referenced image of Landsat8 (OLI)

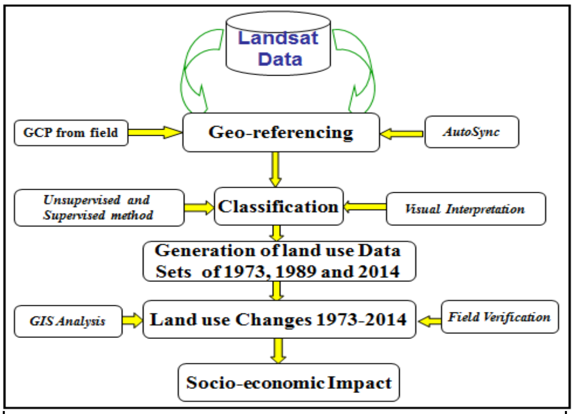

Figure 3: Procedure of Data Generation

The data analysis involved geo-referencing of the image. Ten ground control points (GCPs) were collected from field using GPS reference the respective points in the imagery of 2014. The rest of the images were geo-referenced using the image of 2014 as the base image.

The multi-temporal Landsat imagery has been used which helps identification of perennial and seasonally varying features of land-use. The RGB false colour composite has been prepared for visualizing the land features. Then the multi-spectral classification using unsupervised (ISODATA) and supervised classification (Parallelepiped and Maximum Likelihood techniques) were done and results have been compared. Based on the field investigation and secondary data, it is found from the Table 1a that the supervised classification using maximum likelihood provides best results for land use. The major classes such as forest, settlement, urban/built-up areas and crop lands have been identified through interpretation of the classified imagery.

Table 1a.Classifications and BBS statistics

Classification	Un-supervised (ha)	Supervised (ha)	BBS data (ha)	Remarks
Water	1450	1500	1505	Supervised Classification found best result
Multiple Crop	7045	6055	6053	
Boro Rice	8625	8514	8523	
Settlement	1012	11021	11015	
Forest	1583	1616	1625	
Urban	2110	2038	2045	

Field information, data collected from BBS and visual interpretation of Google (SPOT) images and aerial photographs. Different steps of preparation of land-use maps have been shown in Figure-3.

4. Results and Discussions

Changes of land-use such as settlement, forest, agriculture, water bodies, urban area have been analyzed based on the visual interpretation and multispectral digital classification of Landsat imagery. The results of the analysis are discussed below.

4.1 Visual Interpretation of Temporal Images of Kaliakair upazila

The false colour composite imagery (FCC) of 3 February, 1973, 13 February, 1989 and 30 January, 2014 has been shown in Figure-4. It is seen that the vegetation appear green, land areas light yellow and water blue. In the image of

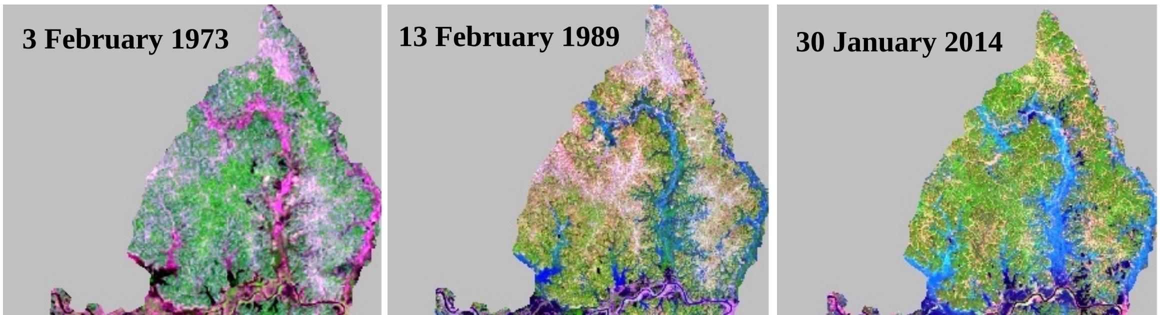

Figure-4: Extracted FCC 5(R), 7(G), 4(B) images of Kaliakair Upazila during 1973, 1989 and 2014.

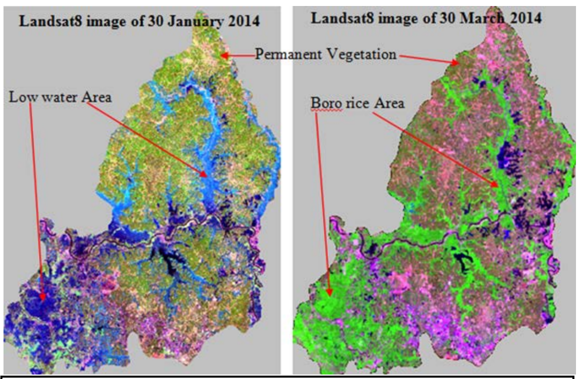

Figure 5: Multi-temporal FCC (7, 4 and 2) of Landsat8

2014, the built-up area is found to have magenta color.

Figure-5 compares the FCC (7, 4, 2) of 30 January and 30 March 2014 with a temporal gap of 2 months. The imagery demonstrates the dynamic change of surface feature. It is clearly seen that the some areas which are seen to have water, has been covered by green vegetation (boro rice) in 30 March. Some areas, which were found to have green vegetation in 30 January have been found to be harvested and then have the signature of bare soil. The green tone appearing in both the images indicate the forest and settlement areas.

4.2 Land-use maps

For preparing the land-use maps for the year 1973, 1989 and 2014, the multi-spectral classification of the imagery of the respective years has been performed. On comparing the results, it is found that the supervised classification provides the best results. The major land-use classes were identified in the classified imagery based on the spectral signatures. The features such as settlement and built-up areas which are not captured by Landsat imagery are obtained through on-screen digitization of aerial photographs and Google (SPOT) imagery. Using GIS technology, the layers generated by satellite data interpretation and on screen digitization are stacked together and the land use maps are prepared (Figure-6, 7 and 8). The area coverage of the land-use features are then calculated for the reference years and displayed in Table-2. The year-wise discussions of the land-use maps are described below.

a) Land use of 1973

The land-use map (Figure 6) shows that, five broad types of land use of Kaliakair upazila in the year 1973. It is clearly seen from the table 2 that in 1973 area of settlement occupied maximum about 11117 hectares and built up area was minimum about 15 hectares only. Multiple crops/bare land area was observed about 10756 ha. Water bodies were almost double about 6016 hectares compare to

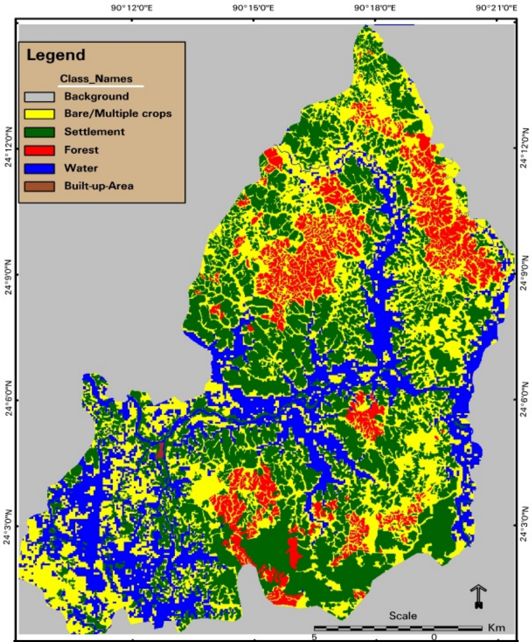

Figure 6: Land-use map of 1973

forest area. Boro rice was not visible during this time.

b)Land use of 1989

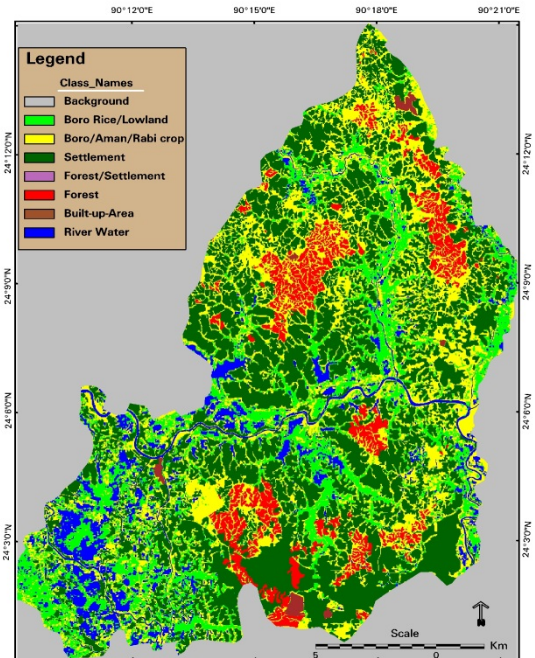

Figure 7: Land-use map of 1989

In 1989, observation and data analysis shows that seven broad types of land use of Kliakair upazila (figure 7). It is clearly seen from the table 2 that in 1989 area of settlement occupied also maximum about 12293 hectares and built up area was minimum about 161 hectares. Multiple crops/bare land was observed about 8189 ha. Boro rice plantation activities were found about 5471 hectares. Water area was about 2563 hectares and forest found about 2071 hectares.

c) Land use of 2014

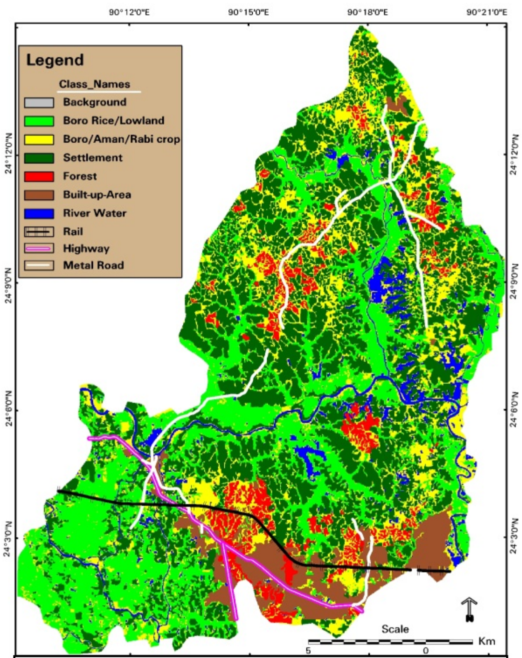

Figure 8: Land-use map of 2014

In 2014, data analysis shows that land use of Kliakair upazila (figure 8). It is clearly seen from the figure 8 and table 2 that, in 2014 area of settlement occupied maximum about 11021 hectares and water area was minimum about 1501 hectares. Boro rice area was observed about 8514 hectares. Multiple crops area was found about 6054 hectares. Forest area was found less about 1617 hectares compare to developed area about 2038 hectares.

4.3 Land use changes 1973 to 2014

It is clearly seen from the table 2 that, during the year 1973, 1989 and 2014, the area of settlement occupied maximum about 11117 hectares, 12293 hectares and 11021 hectares respectively. Observation and data analysis shows that during 1973 to 1989 increase of settlement due to increasing of population (*Population census 2011)* and during 1989 to 2014 decreased of settlement due to rapid increasing tendency of built up area (**0.52% to 6.62%**)

Built up area was found about 15 hectares (0.05%), 161 hectares (0.5%) and 2038 hectares (6.62%) of total land during the year 1973, 1989 and 2014 respectively. Data analysis observed that most of the built up areas are visible in south, south-east part of the Kaliakair upazila (figure 8) but a number of scattered industry was also observed inside forest during the field visit.

Boro rice was not visible in 1973 (table 2) because during this time Boro rice plantation activities were not established. Agriculture extension office and local people also gave same statement during the field visit. Boro rice plantation activities were observed about 5471 hectares (**17.79%**) and 8414 hectares (**27.69%**) of total land during the year

Table 2: Land use changes, Area in (ha) and % of coverage during 1973, 1989 and 2014

Land Use	Season-wise Area (ha) and Percentage (%)		
	1973	1989	2014
Water	6016.11 (19.51)	2563.46 (8.34)	1500.56 (4.88)
Bare/Multiple Crops	10756.14 (34.88)	8189.31 (26.63)	6054.6 (19.69)
Only Boro		5471.17 (17.79)	8514.10 (27.69)
Settlement	11117.00 (36.05)	12293.48 (39.98)	11020.98 (35.85)
Forest	2930.20 (9.50)	2071.01 (6.74)	1616.65 (5.26)
Built up Area	15.13 (0.05)	160.96 (0.52)	2038.38 (6.62)

1989 and 2014 respectively (table 2).

From bar diagram (Figure 9), it is clearly seen that water bodies, bare/multiple crop area and forest area are decreasing during 1973 to 2014. On the other hand Boro rice area and build up areas are increasing tendency during the same period. Bar diagram also shows that during 1973 to 1989 increasing trend of settlement and during 1989 to 2014 decreasing trend of settlement.

Production of Boro rice was found around 3.773 M. ton/ha (BBS) and price per kilogram of rice (paddy) were found about 5.25 and 20 taka (Food Department) for the 1989 and 2014 respectively (Table -3).

Table 3: Socio-economic impact for Boro rice production

Year	Boro rice Area (ha)	Production (M. Ton)	Price (Tk)
1973	0	0	0
1989	5471	20642	10,83,70,500
2014	8514	32123	64,24,60,000

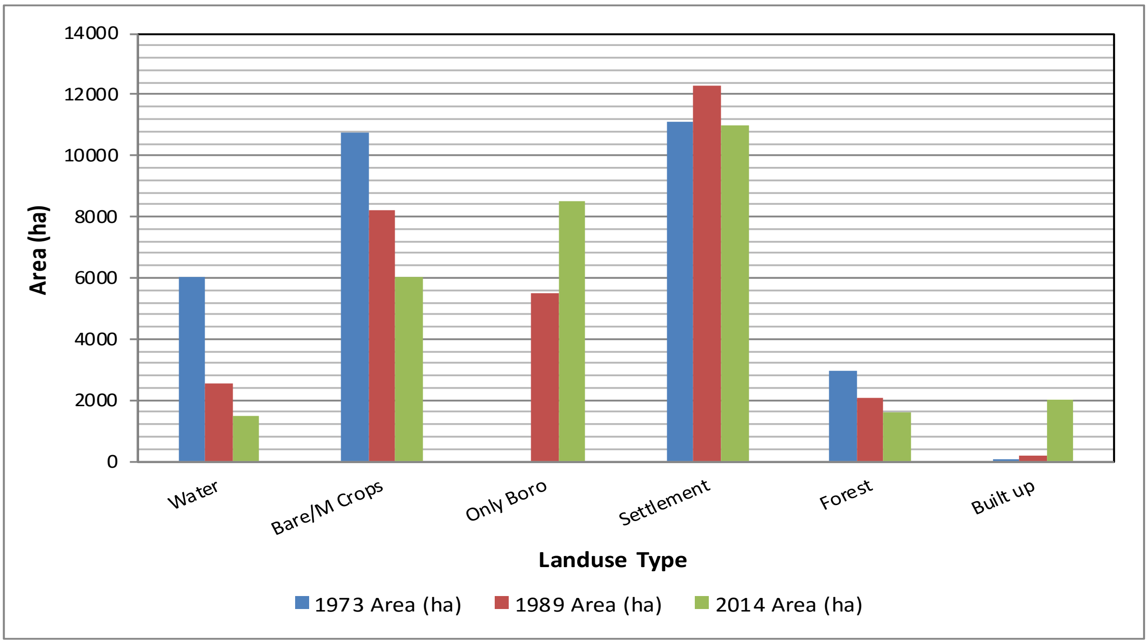

Figure 9: Bar diagram of different land use type during 1973, 1989 and 2014

It is clearly seen from the table 3 that production of Boro rice around 20642 and 32123 M. tons were observed during 1989 and 2014 respectively. Price of Boro rice during the above period was around 108 and 642 million Taka respectively (Right now 1 USD = ~80 taka). So, socio-economic condition of the people of Kaliakair upazila was rising due to Boro rice production increasing from 1989 to 2014.

Although Bangladesh is predominantly an agricultural country but a large number of large-scale industries based on both indigenous and imported raw materials have been set up. Among them ready-made garments is one of them. A vast number of poor people are working (table 4) and maintain their family as a standard level. It is noted that we don't have any published factory establishment data in

Table 4: Socio economic impact for Industrialization

Year	Urban Area (ha)	Number of Factory Established	Number of Employees
1973	15	No Data	No Data
1989	161	No Data	No Data
2001	No Data	8343	43701
2014	2038	24201	169382

Source: Bangladesh Bureau of Statistics(BBS)

kaliakair upazila during 1989 but published data is available on 2001 which has shown in table 4. So, socio-economic impact was increasing due to large-scale industrialization from 2001 to 2014 compare to 1973.

5. Conclusions

The study shows that socio-economic condition of the people of Kaliakair upazila is rising due to Boro rice production during the period 1989 to 2014. A large-scale industrialization was also noticed during the same period. The Landsat multi-date and multi-spectral imagery in association with high resolution multispectral aerial photographs and Google (SPOT) images were used to draw high quality land-use maps.

The land-use maps were produced for Kaliakoir upazila for 3 time frames 1973, 1989 and 2014. The broad land-use features identified are forest, settlements, agriculture, urban/built-up areas and water bodies. The results show large changes in the forest and built-up areas. The area of forest has decreased and that of built-up area has increased. The study further reveals that about 2023 hectares area of land has been converted urban area during the last 41 years (1973-2014). About 1313 hectares forest converted to settlement as well as urban area. The area of water bodies in 1973 was about 6016 hectare but it decreased to about 2563 hectare in 1989 and about 1501 hectare during 1989 to 2014. The cause of intensive land use changes of Kaliakair Upazila may be attributed to rapid increase of population due to the large-scale migration of rural poor people. This happened mainly as a result of the growth of the export-oriented garment industries, which in turn is the effect of economic globalization.

Field observation showed that an unregulated industrial growth has contributed to poor working conditions in this Upazila, which have acted as an obstacle to sustainable development and resulted in some of the worst industrial disasters. Unless a comprehensive set of labour market and social policies are introduced, this Upazila will be unable to maintain its economic momentum and improve living standards in a sustainable way.

References

1. ArcGIS user guide.
2. Agarwal, C.S., (2000), Textbook on Remote Sensing, in Natural Resource Monitoring and Management U.P., Ground Water Department, Lucknow, India.
3. Brammer H (2002). Land use and land use planning in Bangladesh, The University Press Limited, Dhaka.
4. Campbell, J. B. (2002) *Introduction to Remote Sensing*, London and New York, Taylor and Francis.
5. Coppin, P., Jonckheere, I., Nackaerts, K. & Muys, B. (2004) A review: Digital change detection methods in ecosystem monitoring: a review. *International Journal of Remote Sensing*, 25**,** 1565-1596.
6. FAO/UNEP, (1999) The Future of our land: facing the challenge. Guidelines for integrated planning for sustainable management of land resources. 71p.
7. Hadjimitsis, D. G., Papadavid, G., Agapiou, A., (2010) Atmospheric correction for satellite remotely sensed data intended for agricultural applications: impact on vegetation indices, In *Natural Hazards And Earth System Science* 10 (1), 89-95.
8. Kerle, N., Janssen, L. L. F. & Huurneman, G. C. (Eds.) (2004) *Principles of Remote Sensing*, Enschede, International Institute for Geoniformation Science and Earth Observation.
9. Liu, X., Skidmore, A. K. & Van Oosten, H. (2002) Integrationof classification methods for improvement of land cover map

accuracy. *ISPRS Journal of Photogrammetry and Remote Sensing,* 56**,** 257-268.

10. Lillesand, T. M., Kiefer, R. W. & Chipman, J. W. (2004) *Remote Sensing and Image Interpretation, Fifth ed*, New York, John Wiley and Sons.
11. Lunetta, R. S., Johnson, D. M., Lyon, J. G. & Crotwell, J. (2004) Impacts of imagery temporal frequency on land-cover change detection monitoring. *Remote Sensing of Environment,* 89**,** 444-454.
12. Jensen, J. R. (1996) Introductory Digital Image Processing: A Remote Sensing Perspective, US, Prentice Hall.
13. Kumar N., Yamaç S.S. and Velmurugan A. (2015) Applications of Remote Sensing and GIS in Natural Resource Management. *Journal of the Andaman Science Association Vol. 20(1):1-6*
14. Sarker M H, Rahman S M M, Akhand M R, M H Uddin and Dr D A Quadir, (July. 2015); "Land-use Changes of Kaliakair upazila of Bangladesh using Remote Sensing and GIS Technologies," *The Indian Journal of Applied Science*. ISSN: 2249-555X, Vol. 5, issue 7 July 2015, P (532-537).
15. Weng, Q. (2001). A remote sensing-GIS evaluation of urban expansion and its impact on surface temperature in the Zhujiang Delta, China. *International Journal of Remote Sensing, Forthcoming.*
16. Website: *https://owlcation.com/stem/-Ecological-Imbalance-Its-Causes-and-Effects-in-the-Biosphere*