



Detailing rural land use of Coastal Bangladesh: A micro-level study

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Abstract

Bangladesh is a small country of 147,570 km² with a population of around 160 million. Using each parcel of land prudently is crucial for proper development. Information on existing land use is thus of utmost importance for better use of land. Present researches on land use are confined mainly to change detection or pattern analysis of mainly urban areas. As rural areas comprise more settlement areas than urban, this study attempts to depict the existing plot-to-plot use of land in rural areas of coastal Bangladesh. Two union *parishad* were selected randomly and base map of those areas were collected. For collection of detailed land use data, plot to plot survey was conducted by using fractional code method. Results show that agriculture is dominant in one union, and residential area is dominant in another area and like other parts of the country three seasonal variation of crop production occur here. Overall area proportions of the studied areas are also provided. The overall exercise provides a detailed and comprehensive scenario of the area which should help policy makers to plan accordingly, and fills a literature gap on Bangladesh land use.

Keywords: landuse analysis, landuse pattern, *parishads*, plot-to-plot survey, rural landuse, urban landuse

Introduction

Land is the basic resource of human society. The concept of land use and sustainable land management evolve since the world population began to explode. Knowledge about land use and land cover has become increasingly important as the Nation plans to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands, and loss of fish and wildlife habitat. Land use data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current levels (Anderson et al., 1976). One of the prime prerequisites for better use of land is information on existing land use patterns and changes in land use through time.

Land use is the surface utilization of all developed and vacant land on a specific point at a given time or space. In simple word, land use is the human use of land. According to UNEP (1999), land use is the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it. L. D. Stamp pioneered the land use survey. His monumental work in 1951 encouraged and provided guidelines to geographers all over the world. According to him, land use survey has the objective of recording the use of every parcel of land (Stamp, 1951). However, the United Nations' Food and Agriculture Organization (FAO) Water Development Division explains that "Land use concerns the products and/or benefits obtained from use of the land as well as the land management actions (activities) carried out by humans to produce those products and benefits" (FAO, 2013).

History of land use

Although land survey was initiated in Egyptian civilization, modern land use survey, with a purpose to find out the land utilization, was first acquainted in late 20th century by a British geographer. In England with the aid of Grammar School students, L. Dudley Stamp conducted a land use survey during 1930s. Mapping was carried out by volunteers at the scale of six inches to the mile (1:10,560) using around 20,000 six-inch field maps (Coleman & Maggs, 1965). An ordnance map of a small locality was the output of this survey. Thus, land use survey was introduced in England. And after the termination of the Second World War Stamp again conducted land use survey in that same area for detecting the change in the land use pattern in that area after fifteen years. Besides maps and regional summaries, publications leading from the surveys included Stamp's 1937 and 1948 books *The Land of Britain* (Stamp, 1937; Stamp, 1948).

The International Geographical Union (IGU) created a land use commission during the first decade of 1948 and in 1952 all the geographers of the world were invited by this commission to be trained in the field of land use survey. This is how land use survey was initiated and spread out across the globe.

Land use: Bangladesh scenario

Dudley Stamp introduced land use survey in Bangladesh during 1950s. He helped the Department of Geography, University of Dhaka, to create first land use map. Since 1980s Bangladesh government is assimilating land use data in every 10 years. Considerable number of researches on land use has been conducted on Bangladesh. However, almost all of them are either about temporal change detection of land use or land use classification.

Moreover, a number of researches have been conducted on urban areas, focusing on urban growth or environmental change because of urbanization. In their studies Dewan & Yamaguchi (2009; 2012), using the satellite images between 1975-2003 and socio-economic data, showed that substantial growth of built up areas, which is occurring mainly because of population growth and economic development, causes significant decrease of water bodies, cultivated land, vegetation and wetlands. Mamun (2013) identifies the change of land use pattern taking Dhaka, the capital, as a case study. A micro level study on a *thana* of capital Dhaka, conducted by Raihan & Kaisar (2012), detected the land use change occurring over 10 years (1997-2006). Another micro level study (Kumar & Ghosh, 2012) took an island as study area and detected the change occurred in the period of 22 years. The changes in homestead, agricultural and forest land over 30 years time period around the *Sundarban Mangrove Forest* area was detected by Rahman & Begum (2011). In addition to understanding the changing pattern of land use, Islam & Hassan (2011) focused on the agricultural condition of the study area and finds out that agricultural use of land is decreasing at an alarming rate. They assumed after 217 years agricultural land will be entirely replaced by other type of land use. However, they did not consider any other factor while assuming this definite year of replacement.

Chowdhury (2011) took the initiative to identify the LULC change of entire Bangladesh. However, they took a very short span of time for studying (2000-2008) and limited their study on land cover change detection. Another study on whole Bangladesh (Dey et al., 2012) focused on land erosion and loss of land because of natural and anthropogenic factors. While doing so, this study also identified whether this land degradation was changing land use. These studies are primarily focusing on land use change detection or analyses of changing pattern.

There are some studies which just do not emphasize on land use change detection; rather focus on the consequences or reasons of it. Dewan & Yamaguchi (2008) identified the relationship between land cover changes and river and their results revealed that rapid changes in land cover play a crucial role in intensifying the flood process. Factors influencing the development of land-use systems were explored in the study of Rasul (2004). They showed that institutional support, productive resource base and distance to the market and service center were the main factors responsible for the development of three different

types of land-use systems in Bandarban, a hilly district in Bangladesh. Ali (2006) examines the impact of shrimp farming on rice ecosystem while discussing the land use change by this activity.

Soil Resource Development Institute (SRDI), Ministry of Agriculture, Bangladesh has conducted *agricultural land availability* survey in 2013. SRDI has identified land use of whole Bangladesh. The area of Bangladesh represents 144,873, 145,306 and 145,778km² during 1976, 2000 and 2010 respectively. Overall land gain was 905km² (90,512ha) during 1976 to 2010 due to accretion in the southern coastal zone of Bangladesh. The following table denotes that cropland and forest are replacing by urban and rural settlement.

Table 1. Land use (in percentage) of Bangladesh

Land Cover/Use		Area in % (1976)	Area in % (2000)	Area in % (2010)
Agricultural Land	Cropland	67.38	64.96	60.04
	Forest	12.11	9.02	9.84
	Mangrove	3.12	3.35	3.03
	River	6.29	6.11	6.44
	Lake	0.35	0.40	0.35
	Beel-Haor	1.66	1.73	1.72
	Aquaculture	.004	0.99	1.21
	Tea	0.83	0.95	0.66
	Salt pan	0.08	0.17	0.25
	Total Agricultural Land	91.83	87.69	83.53
Non-Agricultural Land	Rural Settlement	6.11	10.03	12.12
	Urban & Industrial	0.18	0.33	0.60
	Accreted Land	1.87	1.95	3.75
	Total Non- Agricultural Land	8.17	12.31	16.47
Total Land Area:		100.0	100.0	100.0

Source: SRDI (2013)

Objective of this study

After doing a rigorous literature review, we found that most of the studies are on change detection. These studies did not emphasize on rural areas, instead on urban or ecologically important areas. However, studying the rural land use is crucial as 12.12% of total area of Bangladesh is rurally populated in comparison to only 0.60% of urban area. Detail existing or present land use study of an area can be vital for planning purpose. We also found that literature covering coastal areas of Bangladesh is dearth (see Rahman & Begum 2011; Kumar & Ghosh 2012). For this reason this study discusses land use of rural areas of coastal Bangladesh by selecting two *Union Parishads* (smallest administrative center) of two coastal districts- Chittagong and Cox's Bazar.

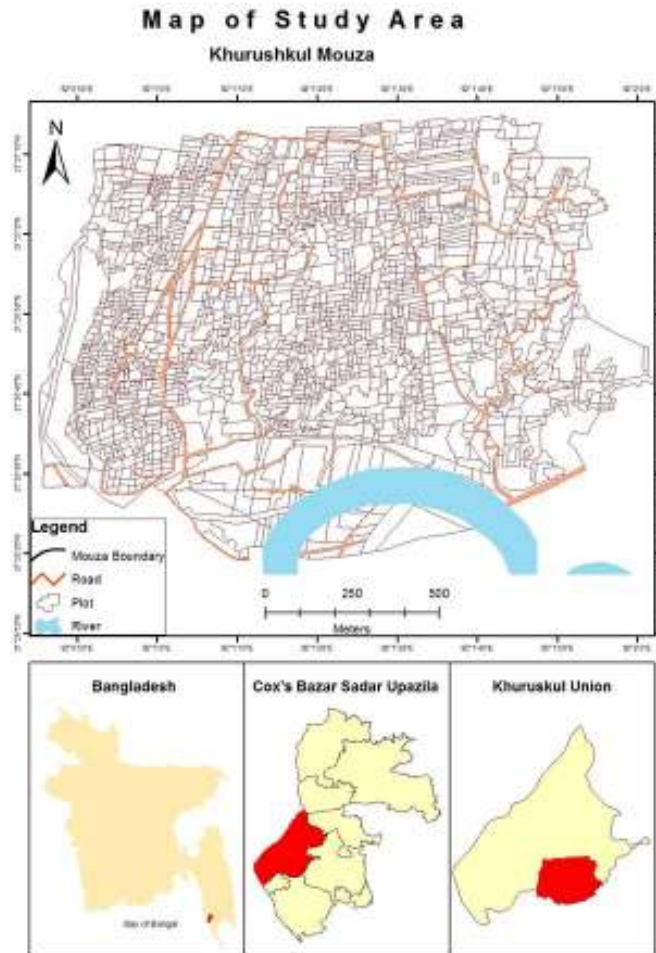
Methodology

Study area selection

There are total 204 Union Parishads in Chittagong district and 71 in Cox's Bazar. This study chose two districts for land use study in two different years. Because of resource limitation this study confined its study on part of one Union Parishad from each district. Union Parishad data were collected from Local Government Engineering Department's (LGED) website.

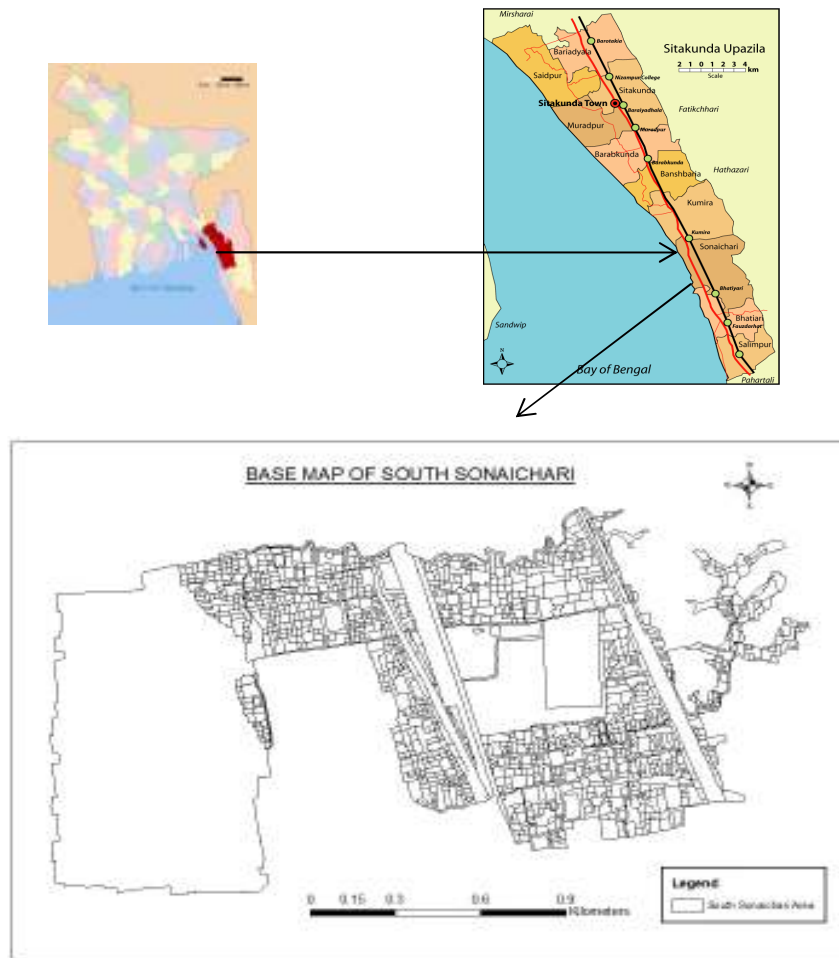
In Cox's Bazar, *Khurushkul Union* of Sadar upazilla and in Chittagong *Sonaichari* of Sitakunda upazilla were selected randomly for land use study. Field survey was conducted in South Khurushkul in 2011 and in South Sonaichari in 2013.

Our study area Khurushkul mouza of Khurushkul union is located within 21°26' North to 21°31' north latitude and 91°57' East to 92° 2' East longitude. According to Mouza map, this area's J. L. no. 15.



Map 1. *South Khurushkul*

Our another study area South Sonaichari mouza of Sonaichari upazilla was located in 22° 14' 53" N and 92° 02' 44" E. According to Mouza map, this area's J. L. no. 54, sheet no. 2 & 3.



Map 2. South Sonaichari

Data collection

Using the base map of the study areas plot to plot land use survey was conducted. In this case we followed *fractional code method*. A list, comprising various types of land use represented by distinct code, was prepared and the survey was done using that list. After compiling all the data a number of maps were produced, using ArcGIS 9.3.1, which represented the land use of the studied areas.

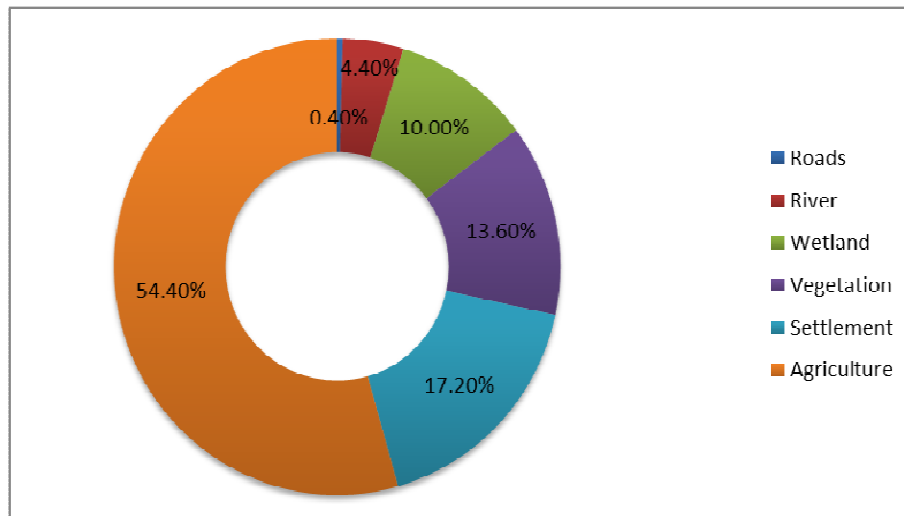
Result and discussion

General land use

Our field study found following types of land use in our studied two areas:

- Agriculture related land use
- Settlement related land use
- Vegetation coverage
- Wetland
- Roads & communication related land use
- River/Ocean

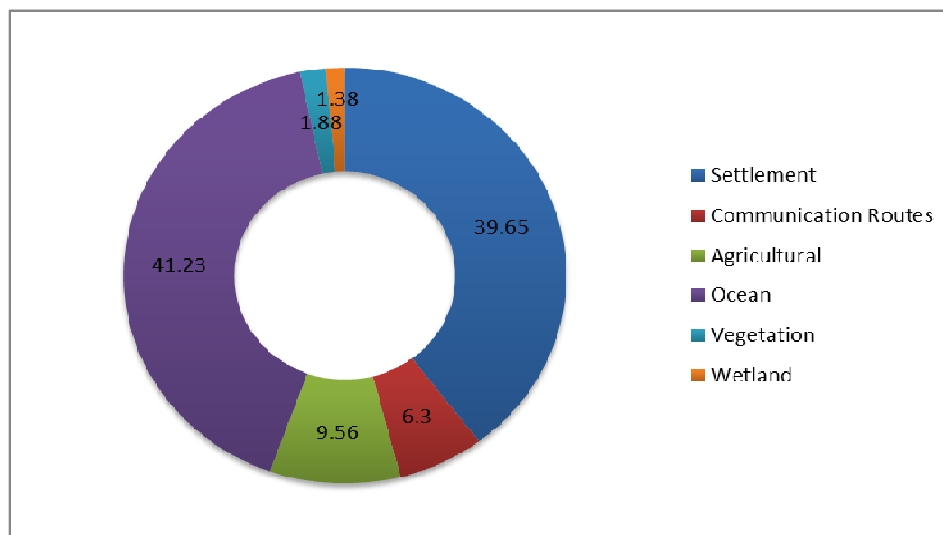
In Khurushkul, more than half of the total area is covered by agricultural land use. About 17% land are used for settlement purposes. Both natural and man- made vegetation coverage are found in that area which are about 12% of total area. Khurushkul is located on north bank of a river called Bakkhali. Along the river bank there are some wetlands. Most of the roads are constructed along north south direction.



Source: Field survey (2011)

Figure 1. Area proportion (in %) of South Khurushkul

In Sonaichari, two-fifth of area is ocean, while agricultural use of land is very low in comparison to Khurushkul. Settlement and communication routes occupy a significant portion of land. Residential use of land is high in this region. Vegetation & wetland comprise a tiny portion of land.



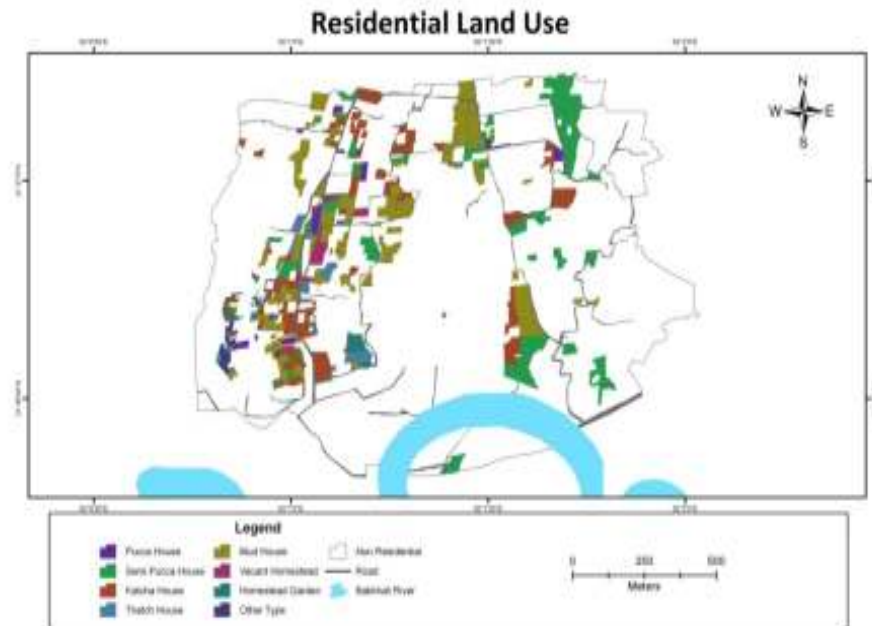
Source: Field survey (2013)

Figure 2. Area proportion (in %) of South Sonaichari

Residential land use

Residential land use of Khurushkul shows diversification in building materials and types of usage. About one-third of the total household is mud-house followed by semi-pucca house which is about 28%. Katcha house occupy about 22% of residential land use. Pucca house and thatch house occupy equal area which is about 4% of total residential area.

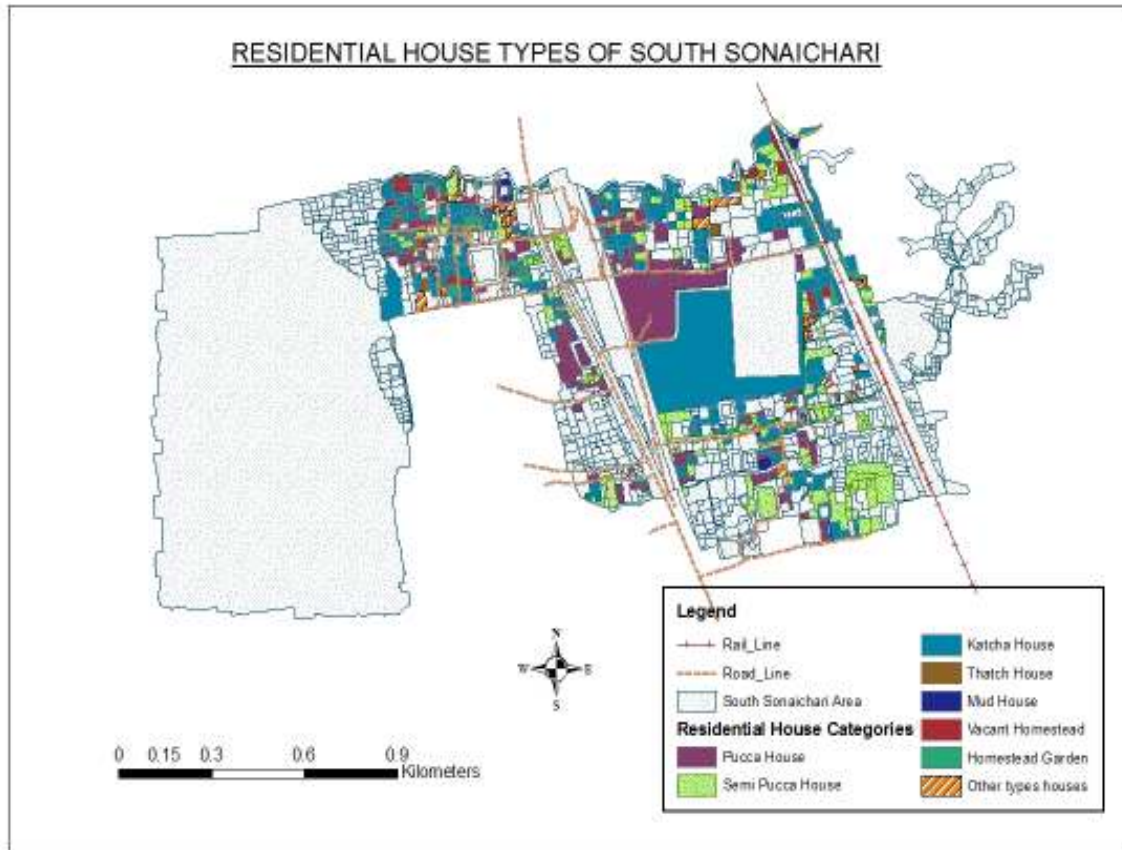
Moreover, homestead garden and vacant homestead are also available in our study area which is about 2% of total residential area. The residential condition of Khurushkul mouza is shown in a map (Map 3).



Source: Field survey (2011)

Map 3. Residential land use of South Khurushkul

South Sonaichhari is not a large area but varieties of dwellings were observed here. Kathca houses are dominant in this area while pucca and semi-pucca houses are almost similar in amount. Around 47% of houses are katcha household. Mud houses are significantly less in Sonaichhari than in Khurushkul. However, in Sonaichhari, houses are situated in clustered pattern. The residential land use of South Sonaichhari is shown in the following map (Map 4).



Source: Field survey (2013)

Map 4. Residential land use of South Sonaichari

The following table represents the comparative discussion of residential land uses of two areas.

Table 2. Residential land use comparison between two studied areas

Homestead Categories	Khurushkul (2011) (% of total residential area)	Sonaichari (2013) (% of total residential area)
Pucca House	4.80	21.29
Semi Pucca House	28.60	20.04
Katcha House	21.40	46.62
Thatched House	4.80	0.91
Mud House	33.33	0.81
Vacant Homestead	2.40	2.88
Homestead Garden	2.40	3.61
Other Type	2.40	3.83
Total	100.0	100.0

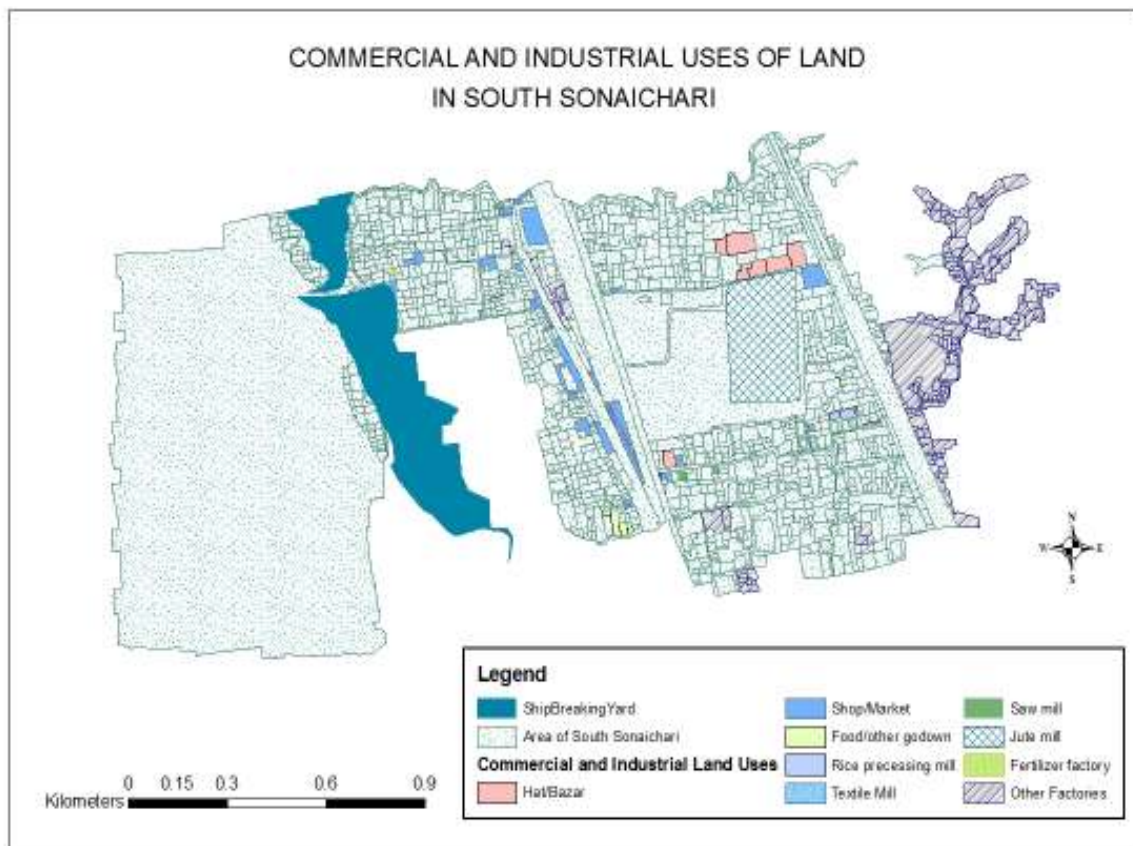
Source: Field survey (2011 & 2013)

Commercial land use

Khurushkul union is not commercially locus of the region. Few shops in local market is all about commercial use of land. Approximately 2% of total area is commercially occupied mainly by road side small shops.

However, in Sonaichari, the picture is quite different, although commercial uses of land in South Sonaichhari are not that prevalent in amount. In some places a little commercial uses of land, arranged in a clustered pattern or linear pattern, are observed. The most dominant commercial uses are involved with hat/bazaars and shops.

Another important feature of land use of Sonaichari is- industrial use of land. A large area is occupied by a jute mill known as Hafiz Jute mill. Other mills are also possess a large amount of area. From our field survey it has been estimated that more than 10% of the total area of South Sonaichhari is being used for industrial purposes. These industries have boosted up the employment opportunity in this area. On the other hand, ship breaking yards unleashed a new dimension in the industrial sector of South Sonaichhari. It occupies 154420.2 square meter area of the total area of South Sonaichhari. It creates employment opportunity to the people of this area and thus indicates huge prospect.



Source: Field survey (2013)

Map 5. Commercial and industrial land use of South Sonaichari

Land use for communication routes

In Khurushkul, road consists of only 0.4% of total study area. There is only one pacca road which runs north-south direction across Khurushkul area. This road connects Khurushkul with Cox's Bazar district town across the river. However, other parts of Khurushkul are inter-connected with semi pacca and katcha road.

In Sonaichari, people mostly use katcha roads for internal communication. Pucca roads occupy almost 2.5% of the area which is the Dhaka-Chittagong highway. Almost 2% area is covered by railway tracts also.

Agricultural land use

Agricultural land use includes crop cultivation, vegetables cultivation, horticulture, grazing land, farms and fellow land. Not all lands are used throughout the year rather seasonal variation is found. In Khurushkul more than 50% of total area is under agricultural activities whereas in Sonaichari it is only around 6-10%.

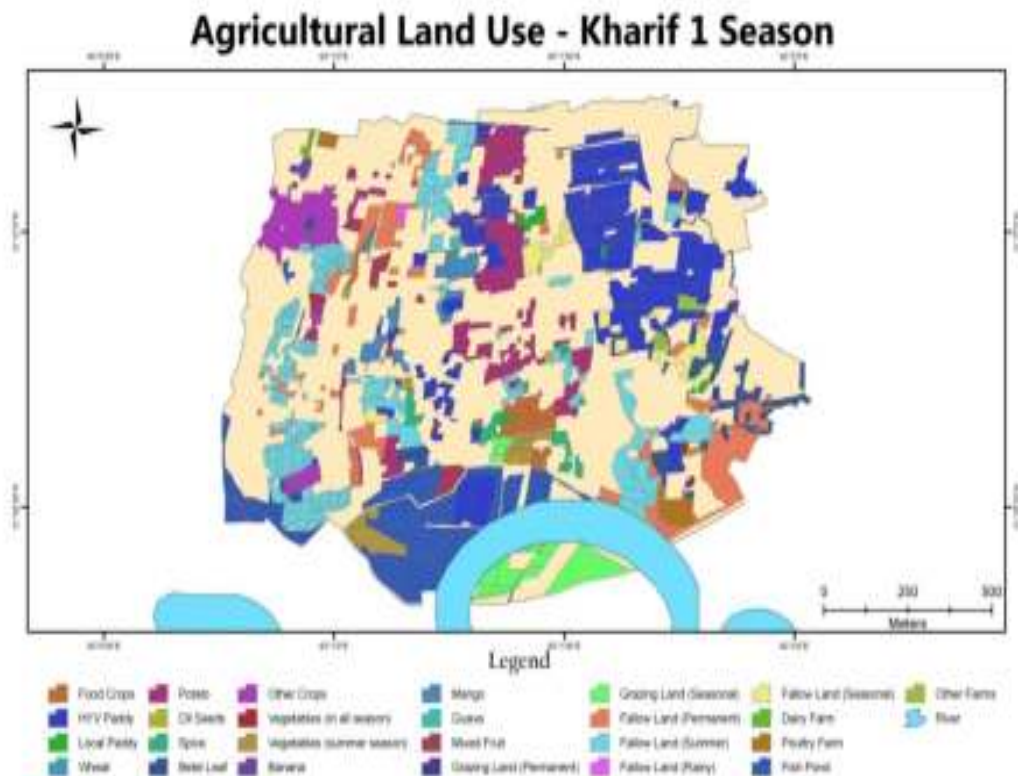
Mostly crops are cultivated here throughout the year and it is the most popular agricultural practice here in Khurushkul & Sonaichari. HYV paddy, local paddy, wheat, potato, pulse, oil seeds, betel leaf and others agricultural products are cultivated here. Like other part of the countries, there are three main cropping seasons are found in coastal areas too. These are:

1. Kharif 1 season: March to June
2. Kharif 2 season: June to November
3. Robi season : November to March

Agriculture in Khurushkul:

About 0.75 sq km land are used for crop cultivation in Kharif 2 seasons. The total cultivated area under crop cultivation, decrease to 0.5 sq km and 0.45 sq km in Kharif 1 and Robi season respectively.

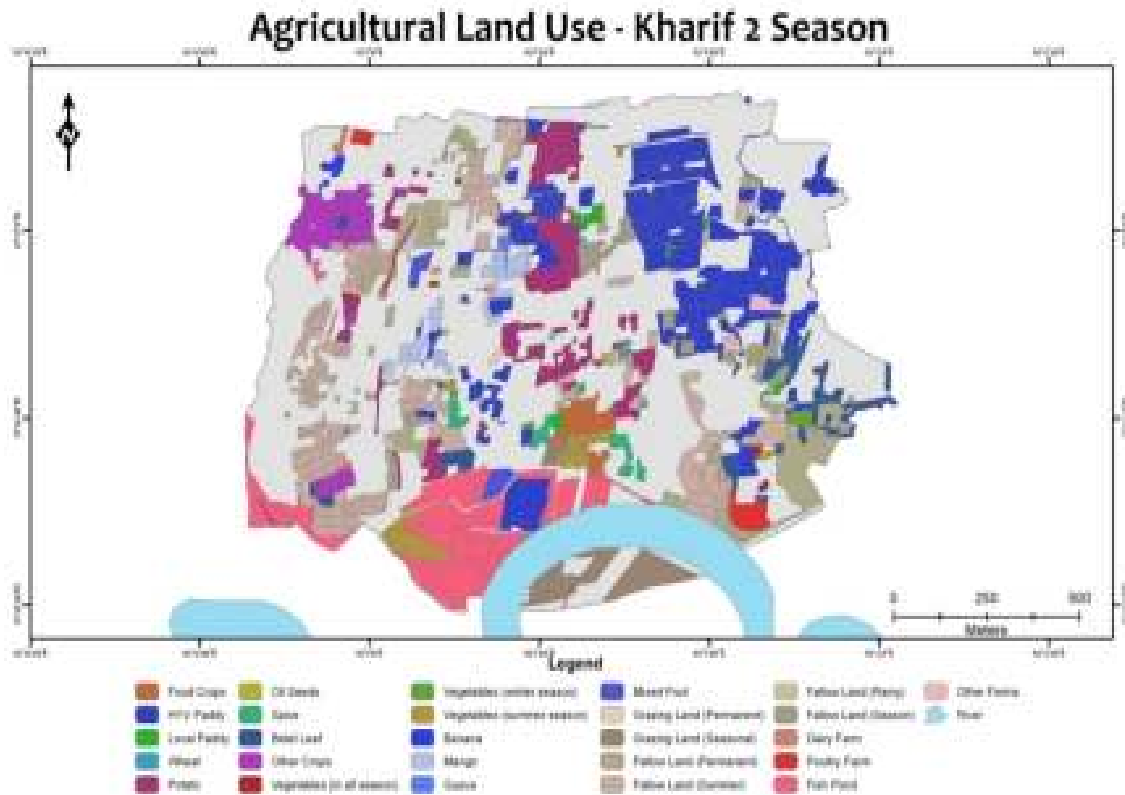
Kharif 1 season is also dominated by HYV paddy cultivation. About 50% of total cultivated land is under HYV paddy cultivation. Moreover, pulses are also grown in this season which is about 20% of total cultivated area in this cropping season. Some food crops are also available in this season.



Source: Field survey (2011)

Map 6. Agricultural land use in Khurushkul (Kharif-1 Season)

Kharif 2 season is dominated with paddy cultivation. Both HYV and local paddy are cultivated here. These two types of paddy cultivation occupy about 90% of total cultivated land in Kharif 2 season that is between June and November. As this season provides enough rainfall due to monsoon, this season is the best period for paddy cultivation.

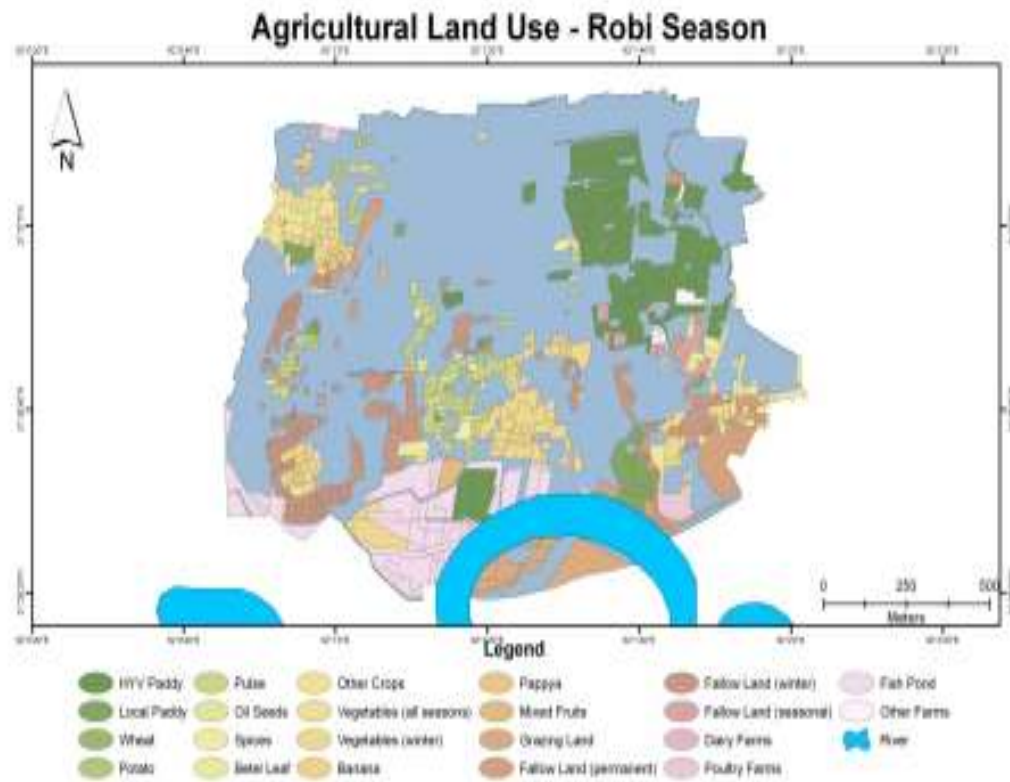


Source: Field survey (2011)

Map 7. Agricultural land use in Khurushkul (Kharif-2 Season)

Different types of cropping pattern are found in three different cropping seasons. In Robi season, HYV paddy is prominent crop that cultivated in about half of total cultivated area. Besides, Robi crops like pulses, spices are also cultivated here.

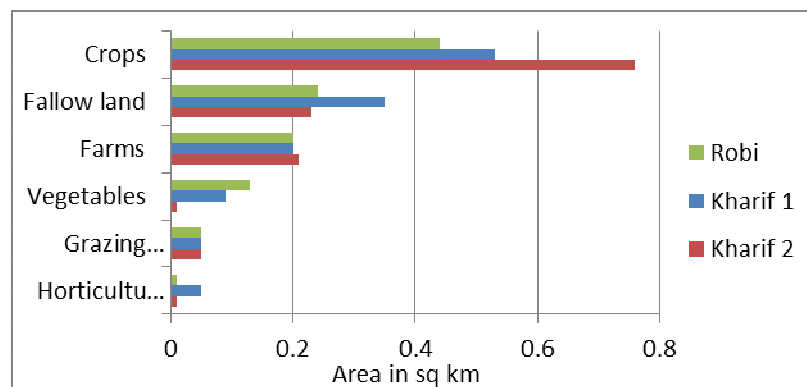
Vegetables cultivation is high in Robi season than the other two seasons. The amount of grazing land usage remains same all over the year. Aqua culture is popular type of farming in this area. Fish farming and shrimp cultivation is found in this area. Mostly, river side ponds are used for fish cultivation. The largest farm is ‘Allwala Hatchery’ which is famous for ‘mono sex Telapia’ cultivation.



Source: Field survey (2011)

Map 8. Agricultural land use in Khurushkul (Robi Season)

Betel leaf is cultivated year round in our study area. The area used for betel leaf cultivation experienced very little seasonal variation. About 10% of the total cultivated area used for betel leaf cultivation throughout the year. Some other crops are also cultivated in Robi and Kharif 1 season but they are not available in Kharif 2 cropping season.

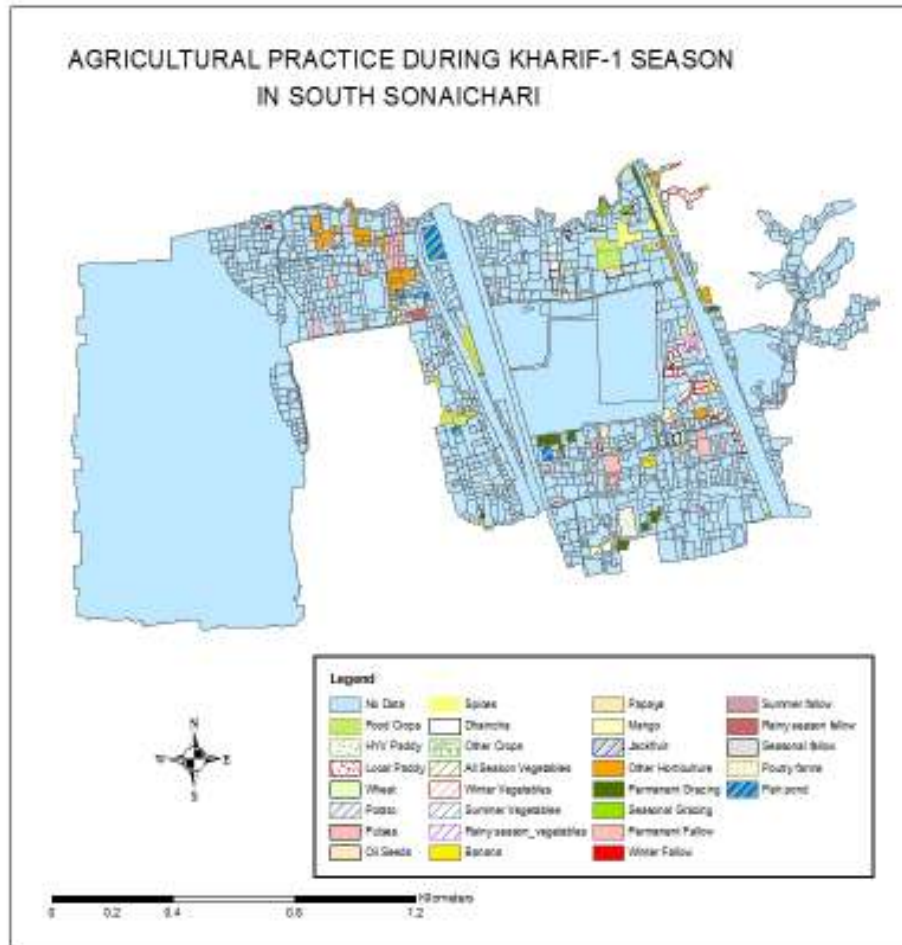


Source: Field survey (2011)

Figure 3. Agricultural area (in sq km) in South Khurushkul

Agriculture in Sonaichari:

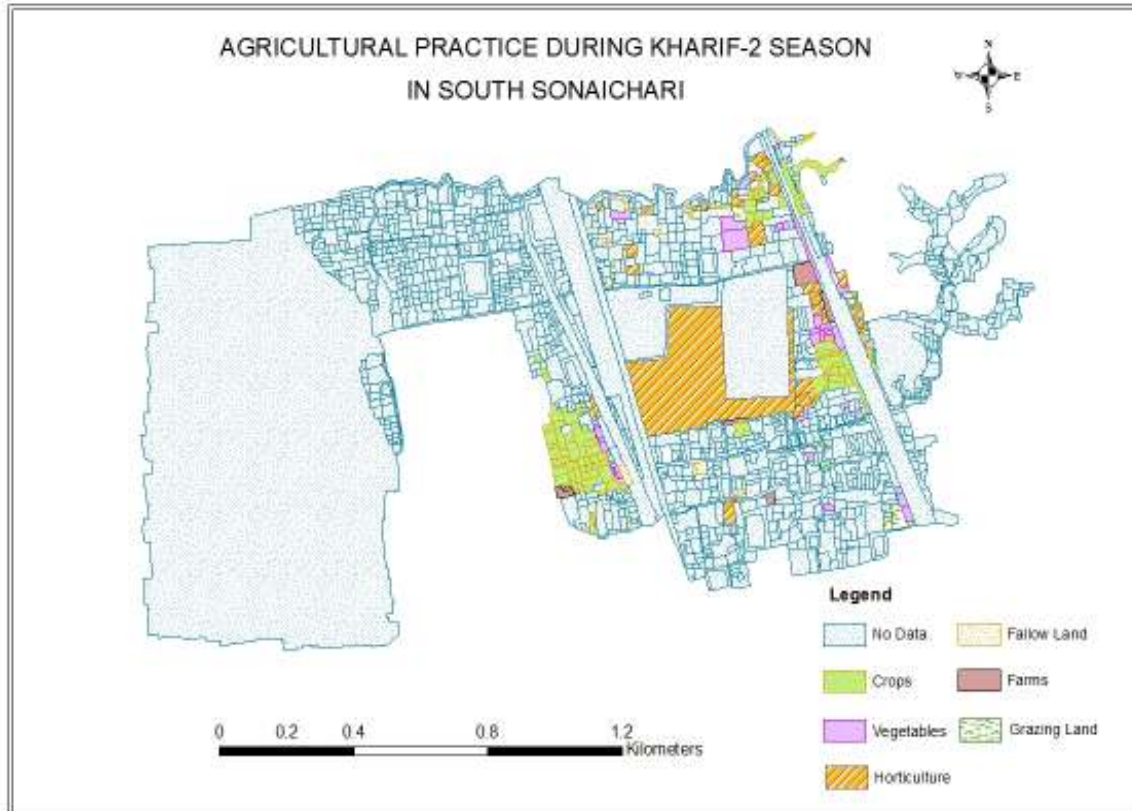
Agricultural production in Kharif-1 include crop cultivation, horticulture especially banana cultivation. The other types of agricultural practices also prevail. Following map (Map 9) shows agricultural land use during Kharif-1 season. *No data* denotes non-agricultural areas.



Source: Field survey (2013)

Map 9. Agricultural land use in Sonaichari (Kharif-1 Season)

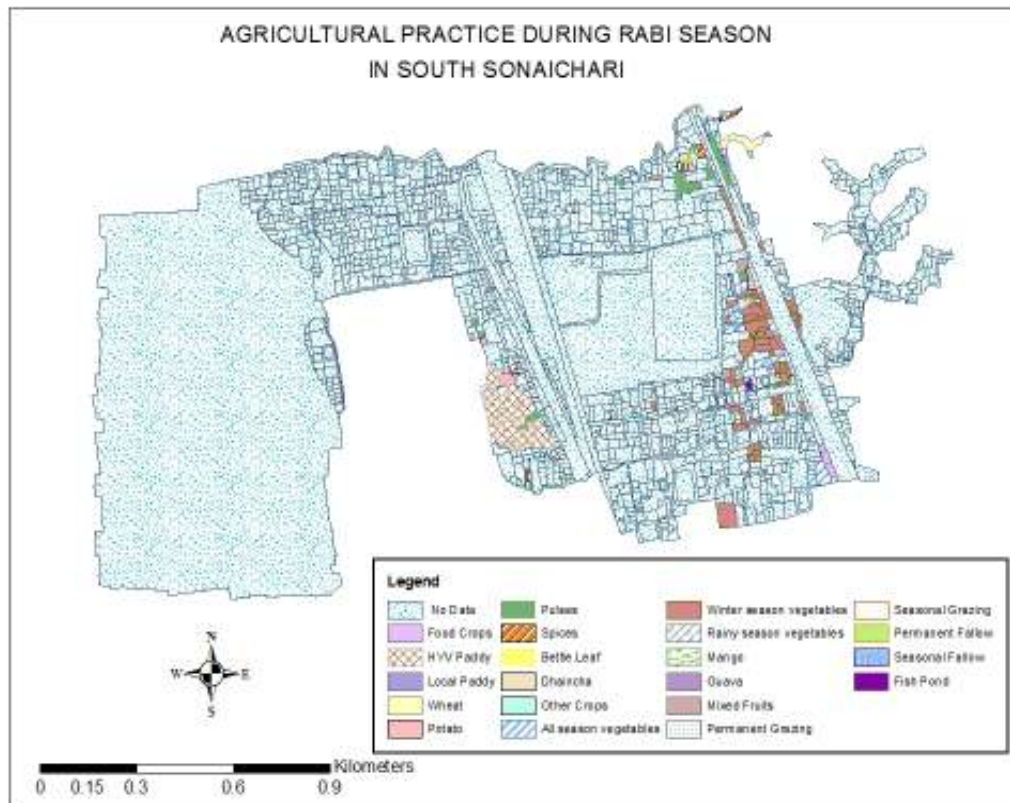
In Kharif-2 the dominant agricultural productions in South Sonaichhari are various types of crops and variety of fruits. Vegetables are also cultivated in a large amount of area. Following map (Map 10) shows agricultural land use during Kharif-2 season.



Source: Field survey (2013)

Map 10. *Agricultural land use in Sonaichari (Kharif-2 Season)*

Agricultural production is dominant in South Sonaichhari during Rabi season. The prevalent most product of agriculture at this time is HYV Boro paddy. Vegetables are also cultivated during this period. Pulses, Spices and Betel Leaf were also observed in the agricultural fields during that time while doing the field survey and these have been cultivated every year during this season.



Source: Field Survey (2013)

Map 11. Agricultural land use in Sonaichari (Rabi Season)

From these three maps of three seasons it can be said that South Sonaichhari is an area where horticulture is the predominant practice. Amongst the crops HYV Boro paddy is mainly grown. Varieties of vegetables are also cultivated in all the three seasons. A comparative study among these three seasons can be made from the following table:

Table 3. Agricultural Areas (in %) in South Sonaichari

Kharif-1	Area (in %)	Kharif-2	Area (in %)	Rabi Season	Area (in %)
Crops	2.1561	Crops	3.3614	Crops	2.6217
Vegetables	0.7316	Vegetables	1.2334	Vegetables	2.3231
Horticulture	1.2215	Horticulture	5.5329	Horticulture	0.1986
Grazing Land	0.5679	Grazing Land	0.38	Grazing Land	0.0473
Fallow Land	1.8343	Fallow Land	0.4436	Fallow Land	0.0662
Farms	0.7273	Farms	0.3682	Farms	0.0191
Area not under cultivation	92.7612	Area not under cultivation	88.587	Area not under cultivation	94.6685

Source: Field survey, 2013

In the light of this table it can be stated that the highest amount of area remain under cultivation is during the kharif-2 season but, still only about 11.5% area hold agricultural activities. The lowest amount of agricultural practice takes place during the Rabi season. However, it can be concluded that South Sonaichhari is not an agro-based region. Most of the people are not involved in agricultural activities in this area for their livelihood. This is why the amount of land uses for agricultural practice is comparatively insignificant in amount in this area.

Conclusion

Land use and land cover change have become a central component in current strategies for managing natural resources and monitoring environmental changes (Wilkie & Finn, 1996). As a micro level study, this study covers two rural areas and finds out the plot to plot detail land use of those areas. This study finds that agricultural use of land is predominant in rural areas, though in Sonaichhari presence of ship braking industry caused non-agricultural income opportunity. In Khurushkul most of the lands are used for agricultural purpose, while in Sonaichhari for residential purpose. Because of non-agricultural source of income, people of Sonaichhari do not rely on agriculture very much. In case of residence, people of South Khurushkul mainly live in mud house or semi-pucca house, while in South Sonaichhari, they live in pucca or semi-pucca house. Commercial use of land is more in Sonaichhari than in Khurushkul.

Plot- to- plot survey is crucial because it provides a detail and comprehensive scenario of an area and helps the policy makers to plan accordingly. This study tries to identify the detailed land uses and thus shows how each plot is being used. By so doing this study endeavors to fill a literature gap on Bangladesh land use.

Acknowledgement

Authors would like to thank Department of Geography & Environment, University of Dhaka, Bangladesh, for helping in survey. Students from 52nd and 54th batch are cordially thanked for their assistances.

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