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Identification and Statistical Analysis of Landuse and Land Cover Patterns in Southern Haripur Tehsil, KPK with Techniques of Remote Sensing and GIS

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Abstract: This research was carried out to digitize and interpret the land use and land cover patterns of the southern Haripur tehsil with remote sensing and Geographical Information System techniques. Interpretation was done with the topographical map of Haripur district and online images of Landsat 7, 2012, Google earth 2016 and zoom level image of Landsat 8, 2015 (Urban unit, 2015). Global Positioning System (GPS) coordinates were collected via field work for ground verification of the features. For statistical analysis, Arc GIS 9.3 and Excel sheet 2010 was used. From the analysis it was found that the maximum agricultural area was 265.47 sq.km. The other two classes i.e. railway station and river bars covered minimum area of 0.01 sq.km. In this paper it was found the maximum area was covered by the agricultural land that was 265.47sq.km. The two other classes i.e. railway stations and river bars which covered a minimum area (0.01 sq.km). An area of 46.02 sq.km was without cover.

Keywords: Remote sensing, geographical information system, land use, land cover, statistical analysis.

Introduction

Remote sensing technique is very important to acquire spatial data. Very high-resolution satellites i.e IKONOS, GeoEye-1 provide good images to extract the land use pattern. The use of spectral, spatial and textural techniques to classify very high-resolution image data have increased the applications for the extraction of features and mapping (Bhaskaran et al., 2010).

The study by Kavita, et al. (2012) in the state of Tamil Nadu utilized images from Landsat1 (Multi Spectral Sensor, acquired in February 1973), Landsat 5 (Thematic Mapper) acquired on April 1990 and Landsat 7 (Enhanced Thematic Mapper+) acquired on January 2006 each with 30 m resolution to investigate land cover. Six land cover and land use classes such as agriculture, built up, forest, harvested land, fallow land and features related to water were interpreted. It was found that water bodies, forests and agricultural lands decreased, whereas built up areas and fallow lands are increasing in trend.

Another study was done in the sub-basin of Rio Jauca of Rio Grande de Arecibo watershed, Puerto Rico which is located in north of island. ERDAS Imagine software (1997) was used to process the IKONOS true color images. Sub-basin (Rio Jauca) was delineated into catchments using DEM (Digital Elevation Model). With ERDAS two unsupervised classifications were done. It was found that the classification results using minimum distance were better than maximum likelihood. The predominant land use class was forest with other classes i.e. agriculture, rangeland of herbaceous and little area of watershed comprising the urban area (Martinez, 2018).

Ahmed, et al., (2014) conducted research in Baghdad, located in the plain of Mesopotamia in central part of Iraq. Two Landsat images acquired on dates 11.8.2007 and 3.9.2007 were utilized to perform the classification of the image. Supervised classification techniques, maximum likelihood classifiers and parallel piped classifiers were used. The defined classes were vegetation, urban, barren land, built-up, water, and agricultural land. The accuracy of classification was found to be 93.70% and the Kappa coefficient was 0.8833.

A research was conducted about the Council area of Kwali, located on the west of the federal capital area, Abuja in Nigeria. Landsat-7 ETM (Enhanced Thematic Mapper) acquired on January 21, 2011 was used. A rectangular grid coordinates system having Northings and Eastings of topographical features and locations of research area were also used. Supervised classification was done using maximum likelihood. In this study it was found that 88% of tangible agreement exists by using supervised technique of classification against 77% of agreement by using method of iso-cluster technique of unsupervised classification. This research explained that the best results were from the supervised classification algorithm (Adejoke and Badaru, 2014).

Research related to the seven sacred groves of district Thiruvananthapuram was done. Two kilometers buffered area was marked around these sacred groves which were the part of remnant forests and the patches of vegetation. ArcGIS 9.3, Google Earth, ERDAS Imagine 9.3 software were used. Topographic sheets having scale of 1:25, 000 of Survey of India were also used. First unsupervised and then supervised classification was performed. Kappa test was also

performed to measure the accuracy of classification. Looks old beginial 69.09% was found accurate in the accuracy assessment. Kappa coefficient was found to be 0.42. For the area, a land use class database was developed. The findings of this study could be applied in management measures and conservation of ecosystem (Miranda, et al., 2016). A research was carried out in the basin of Naina Gorma, located in district Rewa of India. Field survey was done for this study. Using the clustering method of ISODATA, the unsupervised classification was done and nine land cover and land use classes were interpreted and identified. These land use classes were dense scrubs, forest, agriculture, stony/rocky, sandy, river, other water sources and settlements. Spatial patterns of land use and land cover mapping were assessed by unsupervised classification technique (Singh and Dubey, 2012).

A study was done on mapping the land cover and land use in a rural and urban areas in Canada by utilizing the remote sensing and GIS techniques. In specific areas of Canada, the rural and urban settlements were identified by using multispectral and HIV images. GPS was used to collect the data and then analyses on vector data were performed. Map of vector data was created. The vector map was digitally classified by using supervised technique. The results demonstrated that the floodplain covered the maximum area and the local construction covered the minimum area (Treitz, et al., 1992). Another study was carried out on the change in land cover and land use in Driefontein Grasslands, a Bird area in Zimbabwe. For this study, remotely sensed satellite images for the years 1995, 2000, 2005 and 2010 were used to identify land cover. It was found that the grasslands and wetlands decreased, whereas the under cultivated land area increased from 1995 to 2010. The area of wood land remained the same during the same period. It was found that with increasing human population the natural habitat of the study area will be degraded in future. It will impact negatively on sensitive habitats i.e. bird species, wetlands, and other biodiversity which can cause threats to human livelihoods (Fakarayi, et al., 2015). Satellite imagery is used in natural science communities for quantitative and qualitative analysis of land cover changes. The dominated research was monitoring the change in forest canopies and vegetation. The remote sensing is presently used along with GIS and GPS to interpret land cover changes more precisely than by the data of remote sensing only (Liu, J. et al., 2014).

Study Area

Southern Haripur tehsil was the focus of this study. Haripur is called “Vishnu or “The town of Hari. This district is located in Hazara division of the province Khyber Pakhtunkhwa. Its height, above sea level, is about 610 meters. Its geographical location is 72° 56′ 14.00″E longitude and 34°0′ 3.18″N latitude. The west to east extension of the study area is 72.547595°E (DMS:72° 32′ 51.34″E) to 73.223263°E (DMS:73° 13′ 13.75″E) and south to north extension is 33.716569°N (33° 42′ 59.65″N) to 34.440462°N (34° 26′ 25.66″N).

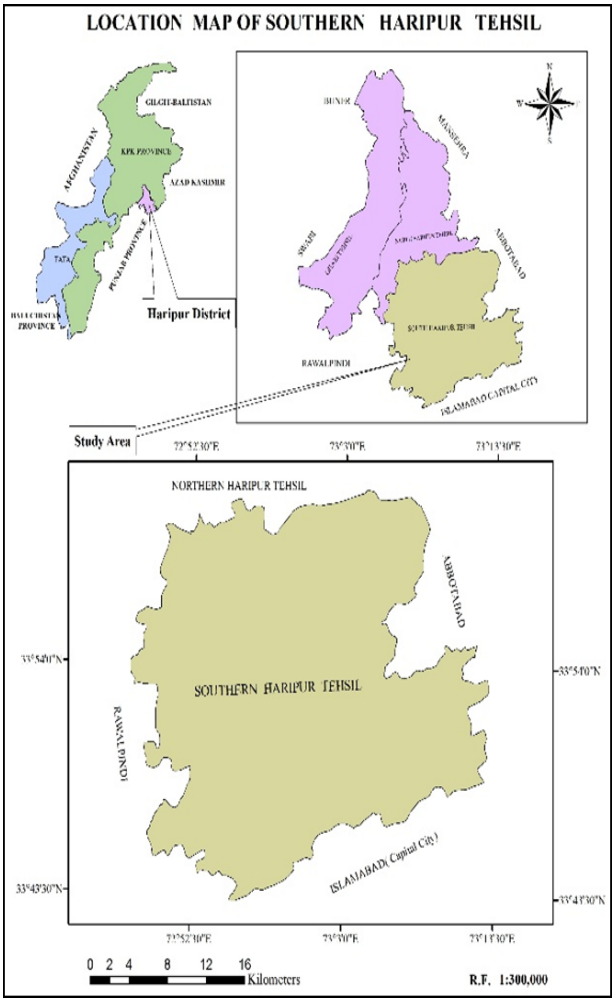

Fig. 1 Location map of study area.

Materials and Methods

In this study Google earth 2016, the GIS of Arc GIS 9.3 version developed by ESRI and Online Landsat 7 imagery of USGS acquired on January 2012 were used. For the primary data sources, the field verifications and locations of features were obtained by using GPS techniques. A zoom level Landsat 8 image (Urban 2015) was also used as a primary data source. In the secondary data sources the road map of district Haripur and topographical map acquired from of Survey of Pakistan (SOP) was used. The processing of remote sensing and GIS based data is shown in the following diagram (Fig. 2).

Different categories of land use and land cover classes visually interpreted and validated through ground observations were as agricultural fields, bridges, factory areas, graveyards, industrial areas, Margala N1 Oil and Gas Company, nullahs, kiln areas, kas, large dam (Khanpur dam), bank of Khanpur dam, forest, grassy areas, grounds, highways, open areas, islands,

Margala National Park, Bismillah Power Plant, petrol pumps, reserve forests, railway stations, railway line, scattered trees, ponds, shrubs, small dams (Kahal dam, Rehana /Chuttri/Bhuttri dam and Mang dam), sandy areas, rocky surfaces, roads, rivers, river bars, settlements, terrace cultivation, tube wells, without cover areas, telephone exchange and tree clusters were identified and digitized. Very small features like single buildings, small islands and small dams were digitized at the scale of 1:1000 and major features at the scale of 1:2000.

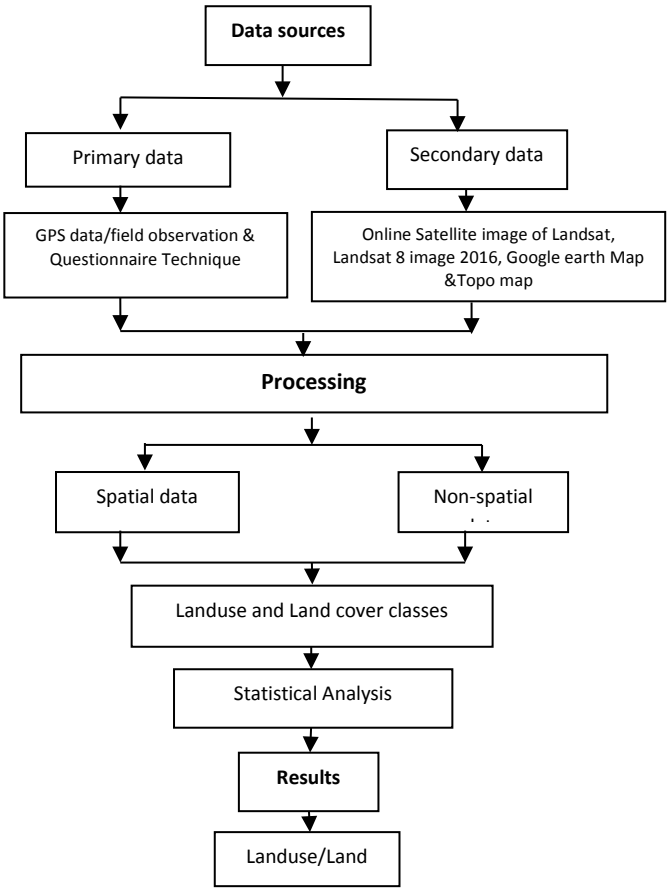

Fig. 2 Flow diagram.

Coordinates of study area taken from "Google earth" were added to its corresponding reference feature locations on the Road map of District Haripur to perform "absolute georeferencing" in ArcGIS 9.3 software. Topographical map of Haripur, zoomed map of Landsat8 image of Haripur District acquired in 2015 were superimposed on the "absolute georeferenced" road map of Haripur District by performing "relative georeferencing"(superimposing on the basis of corresponding locations) task in ArcGIS 9.3 (2010). To perform the statistical or measurement analysis in Arc GIS 9.3, the coordinate system of WGS-1984-UTM-Zone-43N was assigned to the all the sources of data in Arc catalog. In Arc Map, the online Landsat imagery acquired on January 17th, 2012 was added and all the classes were validated according to Google earth, 2016. "Ground truthing" was done about the doubtful areas through field observations and use of a Global Positioning System (GPS) as shown in Table 1.

The primary, secondary and tertiary roads of the study area were also digitized at the same scale (1:2000). In Arc Catalog, Multi-geodata base was created and in Multi-geodata base the "feature data set" was created. Then "Land use" shape file was imported into feature data set. After building the topology of shape file named "Land use" in Arc Map, the "Topological errors" were removed so that the accuracy of area calculations could be increased.

Areas in sq. km of all classes were computed by right clicking on "Area" field, then left clicking on the tool of "calculate geometry". After that multi-geodata base was saved and opened in Microsoft Excel spread sheet 2010 to create pie graphs and bar graphs according to the areas of all classes.

Results and Discussion

In this study the land use/land cover patterns were extracted and identified from the Landsat image. Ground truthing and interpretation techniques from the satellite image mentioned in methodology were used to extract land cover. Then these classes were validated through field observations and GPS receiver. After all, the features were digitized into ArcMap. 40 classes of land use/land cover were found in research area (southern Haripur tehsil). Out of the 40 classes, the settlements were found to be 10,499 which were highest in number. The terrace cultivation was 644 which ranks 2nd in order. Tree clusters were 551 ranking 3rd. The agricultural fields were 398 ranking 4th. There were 360 shrubs ranking 5th. The remaining classes were 85 open areas, 32 kiln areas, 10 nullahs, 7 kas, 20 reserve forests, 105 graveyards, 10 grassy areas, 42 bridges, 6 grounds, 266 scattered trees, 13 sandy areas, 22 rocky surfaces, 69 roads, 95 without cover areas, 13 factory areas, 3 small dams (Rehana/Chuttri/Bhuttri dam, Kahal dam and Mang dam), 83 Commercial areas, 29 ponds, 10 tube wells,1 bank of Khanpur dam, 4 forests, 1 highway, 2 industrial areas, 3 islands, 1 large dam (Khanpur dam), 4 petrol pumps, 1 railway line, 2 N1 Oil and Gas Company, 2 Margala National Parks, 1 power plant (Bismillah Power Plant), 3 railway stations, 1 telephone exchange, 1 University of Haripur, 4 rivers and 4 river bars were in the research area. After applying the measurement calculations in Arc GIS 9.3 software, it was identified that most of the area of southern Haripur tehsil was covered by the agricultural fields that were included in the flat area to the north west of research study which was about 265.47 sq.km out of the total research area (866.8 sq.km). The 75.62 sq.km area was of terrace cultivation on slopes. So, the maximum area covered by agricultural lands including plain and slopes was 341.09 sq.km. The two classes such as "river bars" and "railway station" covered the minimum area which is 0.01 sq.kms, whereas 46.02

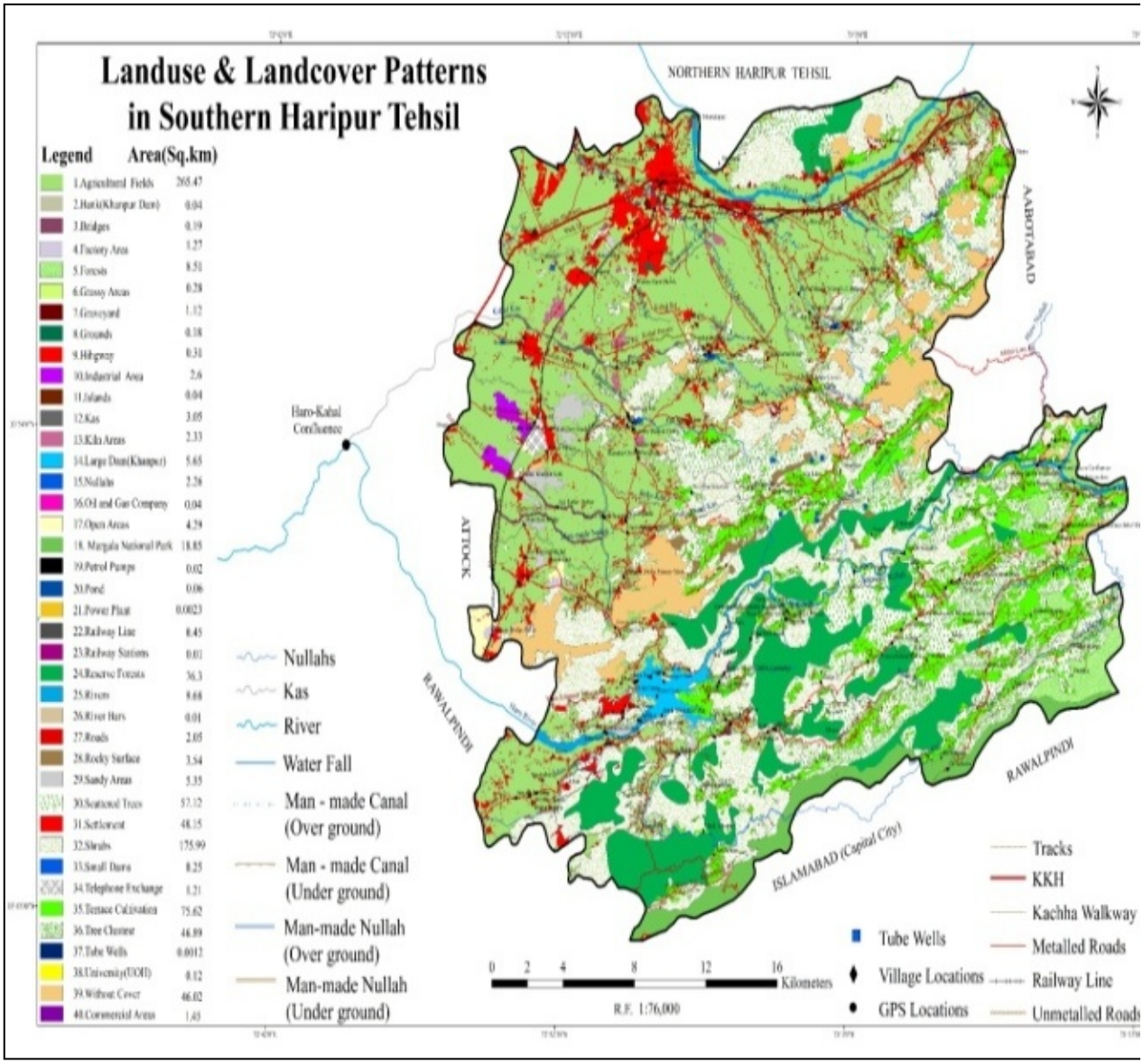

Fig. 3 Shows the 40-land use/land cover classes of southern Haripur tehsil.

sq.km area was "without cover" (Li X., and Yeh, 2003).

It was found through the techniques of questionnaire and ground verification that at the location of Kharala site, the drilling point of an American Oil and Gas Company (MOL) started to explore the oil in 2014. The area covered by this company was 0.04 sq.km (ID. no. 16 in Fig. 3).

The quantitative data of forty digitized classes were exported into the Microsoft Excel Spread sheet 2010 and calculated percentages of all classes. The maximum percentage area of all classes comprised of agricultural fields which was 30.63%. The minimum percentage (0.0001%) area was of the tube wells. 5.55% area was of settlement. While, the "Shrubs" covered 20.30 % of the area and 8.72% area was under terrace cultivation (Fig.5).

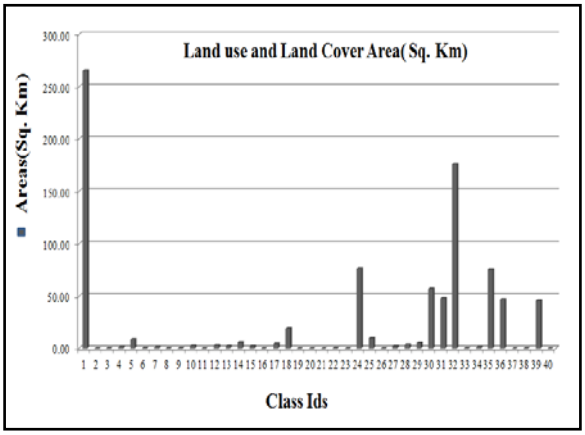

Fig. 4 Shows the areas of land use/land cover classes.

Table 1. GPS coordinates collected for ground truthing of land use /land cover during field work various land use and land cover classes and features were observed during the field survey and their GPS locations were also taken.

Id	Landuse/Landcover classes	GPS location Name	Latitude	Longitude
1	Agriculture fields	Ajji Sarkar Darbar Pind Muneem	33.875571°	72.872078°
2	Bank of Khanpur dam	Bank of Khanpur dam	33.801013°	72.937283°
3	Bridge	Tarnawa Bridge on Haro River	33.793989°	72.903887°
4	Factory area	KotNajeebullah Rd	33.857005°	72.853290°
5	Forests	Near Jamia Masjid Ali Murtaza	33.885497°	73.187469°
6	Grassy Area	DhalaKas	33.848055°	72.848820°
7	Graveyards	Ayubia graveyard	33.948534°	73.023353°
8	Grounds	Near WadiayRaraChowk	33.956414°	72.917260°
9	Hihgway	UC Ali Khan	33.990133°	72.960924°
10	Industrial Area	Hattar Industrial Estate	33.905945°	72.857502°
11	Islands	Large island near Khanpur dam mosque	33.816050°	72.938236°
12	Kas	Madrassa Kas	33.910377°	72.914023°
13	Kiln areas	Near Kahal Bridge	33.926908°	72.907113°
14	Large Dam	Khanpur Dam	33.813383°	72.938220°
15	Nullahs	NilanNullah, Chhai Bridge	33.786911°	72.947719°
16	Oil and Gas Company	Margla N1 OGC (MOL Company)	33.817467°	72.975489°
17	Open areas	Govt.Girls High School,Mang	33.907881°	72.915087°
18	Margala national parks	PirSohawa	33.784342°	73.110886°
19	Petrol pump	PSO near Alshifa medical centre	33.904710°	72.917694°
20	Ponds	Bahadurchowk	33.894221°	72.920799°
21	Power plant	Bismillah Ice factory	33.799789°	72.913718°
22	Railway line	Railway bridge Hattar	33.828363°	72.833444°
23	Railway station	Haripur RS	33.984757°	72.928502°
24	Reserve forests	Dabhoola village	33.796084°	73.001574°
25	Rivers	Jabbri Main Bridge	33.895663°	73.162783°
26	River bars	River Bar Sokakas	33.882361°	72.953334°
27	Roads	Abbasichowk(Jabbri-PirSohawa Rd)	33.867404°	73.173458°
28	Rocky surfacea	Alfruqan Public Primary Shool	33.850941°	72.913039°
29	Sandy areaa	Well Khanpur spillway	33.799223°	72.922900°
30	Scattered Trees	Begum Mahmooda Memorial Hospital	33.838601°	73.090543°
31	Settlement	SeraiSala	33.984821°	72.982970°
32	Shrubs	Khanpur Dam View Point	33.829747°	72.990404°
33	Small dams	Kahal dam	33.933270°	72.962286°
34	Telephone exchange	Hattar Railway Line	33.905945°	72.857502°
35	Terrace cultivation	DatianNullah	33.837010°	73.011741°
36	Tree cluster	Marri Village	33.829519°	73.075864°
37	Tube wells	Ganaya	72.867017°	33.962361°
38	University (UOH)	University of Haripur	33.977632°	72.913346°
39	Without cover	SurajGali	33.832388°	72.908384°
40	Commercial areas	Fried Fish Farm	33.812862°	72.920407°

Table 2. Shows the classes of land use and land cover of the study area.

Id	Landuse/Landcover Classes	Area (Sq.Km)	Area % age	Area (Sq.M)	No. of Features
1	Agricultural Fields	265.47	30.63	265470	398
2	Bank (Khanpur Dam)	0.04	0.0043	37	1
3	Bridges	0.19	0.02	189	42
4	Factory Area	1.27	0.15	1266	14
5	Forest	8.51	0.98	8506	4
6	Grassey Area	0.28	0.03	282	10
7	Graveyard	1.12	0.13	1123	105
8	Ground	0.18	0.02	185	6
9	Highway	0.31	0.04	310	1
10	Industrial Area	2.60	0.30	2603	2
11	Islands	0.04	0.0044	38	3
12	Kas	3.05	0.35	3051	7
13	Kiln Area	2.33	0.27	2330	32
14	Large Dam (Khanpur)	5.65	0.65	5646	1
15	Nullahs	2.26	0.26	2259	10
16	Oil and Gas Company	0.04	0.0049	42	2
17	Open Area	4.29	0.50	4294	83
18	Margala National Park	18.85	2.17	18851	2
19	Petrol Pumps	0.02	0.0020	18	4
20	Ponds	0.06	0.01	60	29
21	Bismillah Power Plant	0.0023	0.0003	2	1
22	Railway Line	0.45	0.05	452	1
23	Railway Stations	0.01	0.0014	12	3
24	Reserve Forests	76.30	8.80	76304	21
25	Rivers	9.68	1.12	9681	4
26	River Bars	0.01	0.0013	12	4
27	Roads	2.05	0.24	2048	69
28	Rocky Surface	3.54	0.41	3537	22
29	Sandy Area	5.35	0.62	5350	13
30	Scattered Trees	57.12	6.59	57122	267
31	Settlement	48.15	5.55	48150	10,499
32	Shrubs	175.99	20.30	175992	360
33	Small Dams	0.25	0.03	253	3
34	Telephone Exchange	1.21	0.14	1206	1
35	Terrace Cultivation	75.62	8.72	75624	644
36	Tree Cluster	46.89	5.41	46892	551
37	Tube Well	0.0012	0.0001	1	10
38	University (UOH)	0.12	0.01	118	1
39	Without Cover	46.02	5.31	46020	95
40	Commercial Area	1.45	0.17	1450	83

The bar of “Agricultural fields” in Fig.4 having Id No.1 reaches very high. “Shrubs” having Id No.32 reaches 2nd highest class. Third class was “Reserve forests” having Id No.24. Fourth class was of “Terrace Cultivation” having Id No.35 in Figure 4.

In the following Fig. 5 (Pie graph) the “Agricultural fields” comprised of highest % age area (30.63%) and the "River bars" possessed lowest % age area (0.0013%) as shown in Table 2. It was found that total area of “Vegetation cover” including shrubs, forests, grassy areas, tree clusters, reserve forests, Margala National Park and of scattered trees was 441.07 sq.km.

The “total cultivated area” was 341, 09 sq.km and the “total uncultivated area” was 46.02 sq.km, whereas the remaining area covered by all other classes was 38.62 sq.km (Table 2).

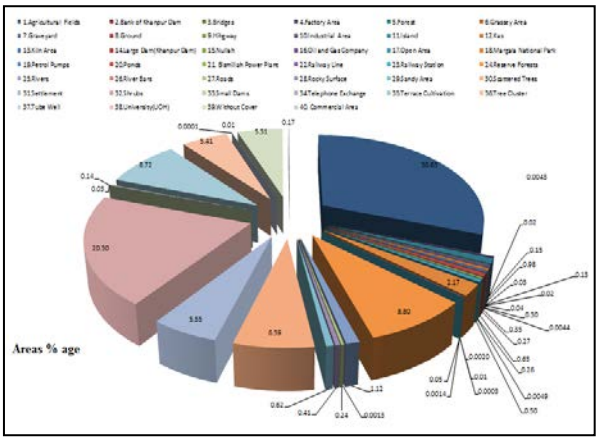

Fig. 5 Following Pie graph shows the % age areas of land use and land cover classes.

Table 3. Merged categories of main land use classes.

Id	Main Classes of Vegetation	Area (Sq.Km)	Area % age	Area (Sq.M)
	i.Forest	8.51	0.98	8506
	ii.Grassey Area	0.28	0.03	282
	iii.Scattered Trees	57.12	6.59	57122
	iv.Reserve Forests	76.30	8.80	76304
	v.Shrubs	175.99	20.30	175992
	vi. Tree Cluster	46.89	5.41	46892
	vii.Margala National Park	18.85	2.17	18851
1	**Total Vegetation Area**	**383.95**	**44.29**	**383949**
	Main Classes of Cultivated Area	**Area (Sq.Km)**	**Area % age**	**Area (Sq.M)**
	i. Agricultural Fields	265.47	30.63	265470
	ii. Terrace Cultivation	75.62	8.72	75624
2	**Total Cultivated Area**	**341.09**	**39.35**	**341094**
3	**Total Uncultivated Area**	**46.02**	**5.31**	**46020**
4	**Total Area of Minor Classes**	**95.86**	**11.05**	**38620**

Table 4. Four main land use and land cover classes the "Vegetation cover" was highest land cover class and "Without vegetation cover" was lowest class that was shown as "Uncultivated Area" in the graph 3 shown below.

Id	Main Land use Classes	Area (Sq.Km)	Area % age	Area (Sq.M)
1	Total Vegetation Area	383.95	44.29	383949
2	Total Cultivated Area	341.09	39.35	341094
3	Total Uncultivated Area	46.02	5.31	46020
4	Total Area of Minor Classes	95.86	11.05	95860
	Total Study Area	**866.92**	**100.00**	**866922**

Some merged categories of main land use classes were shown in Table 3 and Fig. 6.

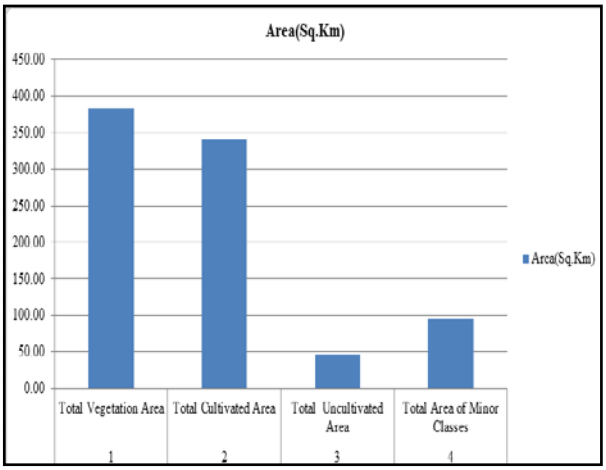

Fig.6 Main Land use/Land covers Classes of Study Area.

The "Total vegetation cover" area was of 44.29% that was highest in this research area. 39.35% was of the "Total cultivated area". "Uncultivated area" was 5.31%. The remaining classes that were shown had covered 11.05% area as shown in following pie chart (Fig.7).

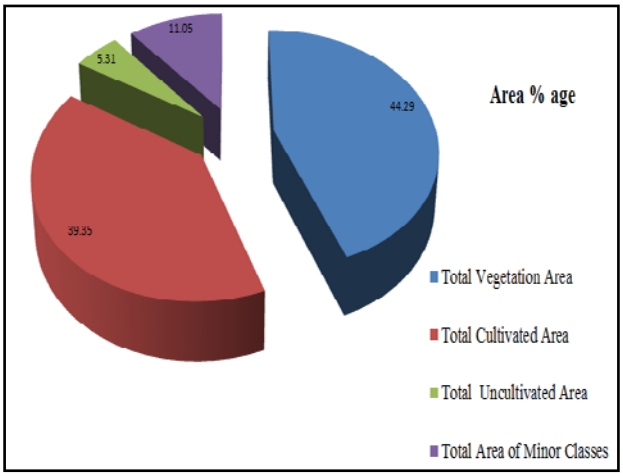

Fig.7 Main land use/land cover classes of study area.

Conclusion

In this research the forty-land use /land cover categories were extracted, identified and then digitized in Arc Map by using the various data sources i.e. online Landsat7 image of January, 2012, Landsat 8 image of USGS (2015) of study area. All the classes of land use and land cover were validated by conducting field survey, Google Earth (2016) and the use of point

data from GPS receiver. After verification, all the classes were digitized in Arc GIS 9.3 software. By applying measurement analysis techniques in Arc GIS 9.3 it was found that the class of “agricultural fields” covered the maximum area (265.47 sq.km). Two other classes “river bars” and “railway station” covered the minimum area (0.01 sq. km). The area which comprised of "without cover” class was 46.02 sq.km. Four main land use and land cover classes were created by merging some small classes as “vegetation cover” having highest percentage area (44.29%). The “total cultivated area” was 39.35%. "Total area of Minor classes" was 11.05%. “Uncultivated area” (without cover) was 5.31% which is minimum out of these four main classes. The remaining classes were shown in Table 2, which covered the area of 11.05%. In this research it is demonstrated that the use of statistical analysis and RS/GIS techniques were proved very useful to classify the land use and land cover which will be helpful for decision makers for future policy making which will be better for the development of study area.

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