Global Scientific JOURNALS

GSJ: Volume 8, Issue 12, December 2020, Online: ISSN 2320-9186
www.globalscientificjournal.com

Land use Land cover dynamics vis-a- vis to political changes in paktya province of Afghanistan

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Abstract

Land cover of the earth's surface has been changing since time immemorial and it will continue. In recent decades the land use land cover change due to anthropogenic factors has been proceeding very faster than natural changes and these changes caused different global environmental problems. The two main forces responsible for these changes are technological development and drastically increment of population. The study have been conducted in paktya province of Afghanistan to assess the changes in different LULC classes which occurred together with political changes by using of Remote Sensing and Geographic Information System (GIS). The change was analysed for a period of two decades, i.e., 1998 to 2018. Landsat TM and OLI satellite images of 30m resolution for the years 1998 and 2018 were used respectively. The overall classification accuracy of the mapping was estimated as 82.67% and the kappa coefficient was estimated as 0.8081. The study area was delineated via visual image interpretation technique into 11 LULC classes' viz., closed forest, open forest, forest, scrub, grassland, agriculture, Agroforestry, horticulture, habitation, water body, wasteland and snow respectively. The comparison of maps 1998 and 2018 revealed that the total area under closed forest, open forest, agriculture, habitation and horticulture shown an increase of 0.43%, 0.73%, 0.75%, 0.33% and 0.78% respectively. While the areas under forest scrub, grassland, snow and wasteland shown a decline of 0.30%, 0.25%, 0.11% and 2.40% respectively during study period (1998-2018). The area under water body remained same during two decades.

Keywords: Land use/ Land cover (LULC), remote sensing, GIS, Landsat, paktya, Afghanistan.

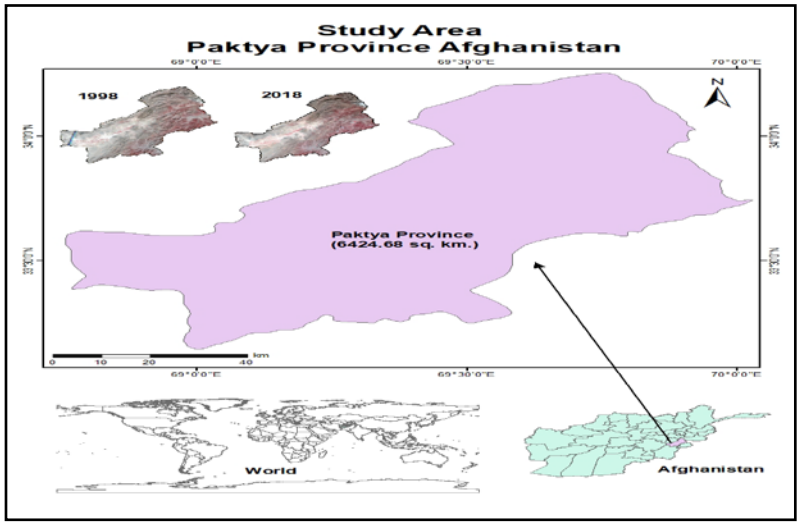
Introduction

Land cover is the observed biological and physical assemblage of earth's surface and land use is the way or manner in which the people use or occupy the land (Mayer and Tuner, 1992). Land use/ land cover change are important factors of global climate change (Vitousek, 1992).The information of LULC changes is helpful for natural resource management and monitoring global environmental changes and there consequences (Loveland and Belward, 1997). Land-cover plays essential role in global carbon cycle, both as a source and sink (Loveland and Belward, 1997; Moore, 1998), and in the exchange of greenhouse gases between lithosphere and atmosphere.With the recent advancement in remote sensing and geographical information system (GIS) and computer technology, it is possible now to asses and monitor land-use/land-cover changes at multiple spatial and temporal scale (Hansan and Defries, 2004). Remote sensing offers several advantages. It is an economically and rapid method of acquiring up-to-date information over a large geographical area owing to its synoptic coverage and repetitive measurements (Turner, 2002). Remote sensing data usually procured in digital form, so it is easy to manipulate and analyse it; it can be acquired not only from visible but also from spectral ranges that are invisible to human eyes; the can be acquired from remote areas where accessibility is a major problem; and they provide unbiased view of land use/ land cover (Houghton *et al*,. 1999; Jankins *et al*,. 2001).

Material and method

1- **Study area:** Paktya is a south eastern province of Afghanistan with a total area of 5583.2 km^2, which contribute only 0.9% of the total area of Afghanistan. The total population is about 590668, out of that 301873 male and 288795 female. The population density of this province estimated to be 106 persons per square kilometers (CSO, 2018). The climate of the study area is cold semi-arid Mediterranean with heavy snow in the winter (NEPA, 2014). Gardiz which is the capital of the

paktya province having maximum annual temperature of 31.9 ^{0}C and minimum temperature of -10.8 C^0 with an elevation of 2503 MSL. The province has diverse topography: 32.3% flat, 52.0% Mountains, 13.1%



Hill and 2.5% Semi flat(AQUASTAT, 2012).

Fig-1: Location of the study area.

2. **Data:** Landsat OLI and TM satellite images of 30m resolution of the year 1998 and 2018 were used in this study. Mapping was performed in 1:50000 scale by using ArcGIS software and ERDAS imagine software for image enhancement. Extensive ground trothing was employed to supplement accuracy assessment and a total of 75 ground truth points were taken for data collection. The study area was delineated via visual image interpretation technique into 11 LULC classes' viz., closed forest, open forest, forest, scrub, grassland, agriculture, Agroforestry, horticulture, habitation, water body, wasteland and snow respectively.

Results

The percentage of the area under different LULC classes in 2018 and 1998 of paktya province have been shown in table.1 and table. 2 respectively. Land use/Land cover map (2018) reports that there has been a notable change in Land use/Land cover during two decades (1998-2018) in Paktya province of Afghanistan. Among all the LULC classes, wasteland occupied

the maximum area of the map i.e. 51.07%, while as snow with the area of 0.25% occupied the minimum portion of the map. The percentage of area under agriculture has shown an increase from 7.12% in 1998 to 7.87% in 2018. The habitation area also increased from 1.81% in 1998 to 2.14% in 2018. The area under horticulture shown an increase from 0.12% in 1998 to 0.91 in 2018. Agroforestry has also increased from 0.26 in 1998 to 0.29 in 2018. Area under different classes of forest also shown a positive change during the study period. The area under closed forest has increased from 3.42% in 1998 to 3.85% in 2018, open forest increased from 10.53% in 1998 to 11.26% in 2018, area under forest scrub also shown a change from 21.45% in 1998 to 21.16% in 2018. The area which was covered by snow decreased from 0.36% in 1998 to 0.25% in 2018. Wasteland area has shown a decrease from 53.47% in 1998 to 51.07% in 2018. The percentage of the area under water bodies has remained constant at 0.78 through the two decades. Different colors have been assigned to represent various Land use/Land cover classes in LULC map of 1998 and 2018. Land use/ Land cover map of 1998 and 2018 reveals the area under different LULC classes as shown in Fig. 3 and Fig. 4 respectively.

Table-1: Land use, land cover classes of Paktia province of Afghanistan 1998

LULC	**Area (ha)**	**%**
Agriculture	45748.34	7.12
Agroforestry	1700.93	0.26
Closed Forest	21979.5	3.42
Forest Scrub	137885.78	21.45
Grassland	4373.82	0.68
Habitation	11619.39	1.81
Horticulture	795.24	0.12
Open Forest	67683.72	10.53
Snow	2319.45	0.36
Wasteland	343676.59	53.47

Water body	4992.34	0.78
Grand Total	**642775.1**	**100.00**

Table-2: Land use/land cover classes of Paktia province of Afghanistan 2018

LULC	Area (ha)	%
Agriculture	50563.94	7.87
Agroforestry	1833.47	0.29
Close Forest	24740.75	3.85
Forest Scrub	135986.04	21.16
Grassland	2739.16	0.43
Habitation	13762.12	2.14
Horticulture	5831.76	0.91
Open Forest	72388.89	11.26
Snow	1634.66	0.25
Wasteland	328279.88	51.07
Water body	5014.43	0.78
Grand Total	642775.1	100.00

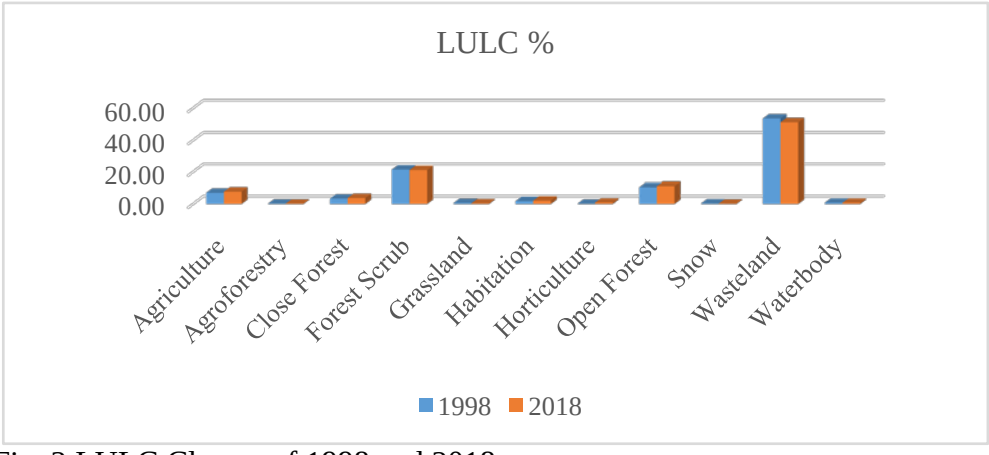


Fig. 2 LULC Classes of 1998 and 2018.

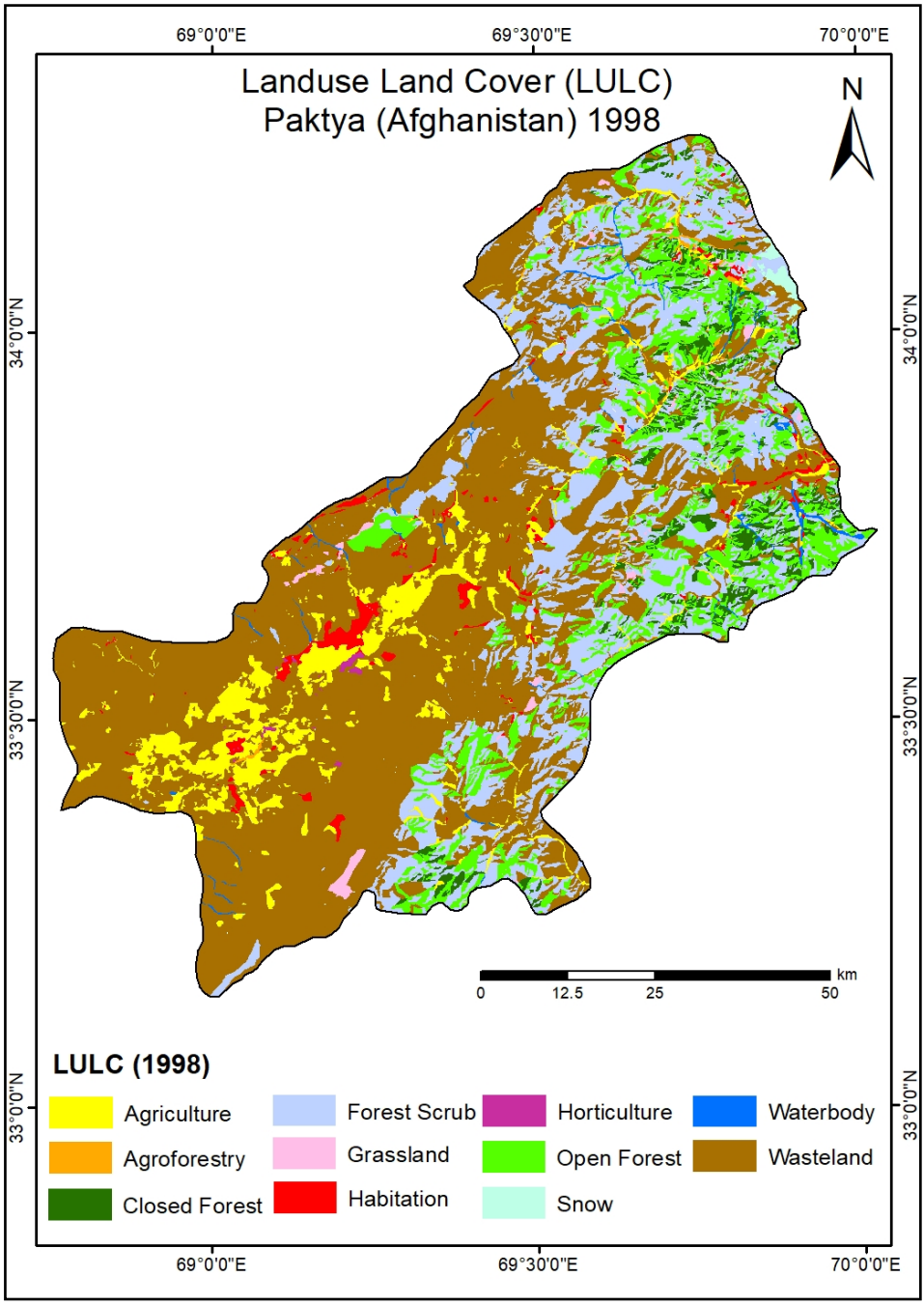


Fig-3: LULC map 1998

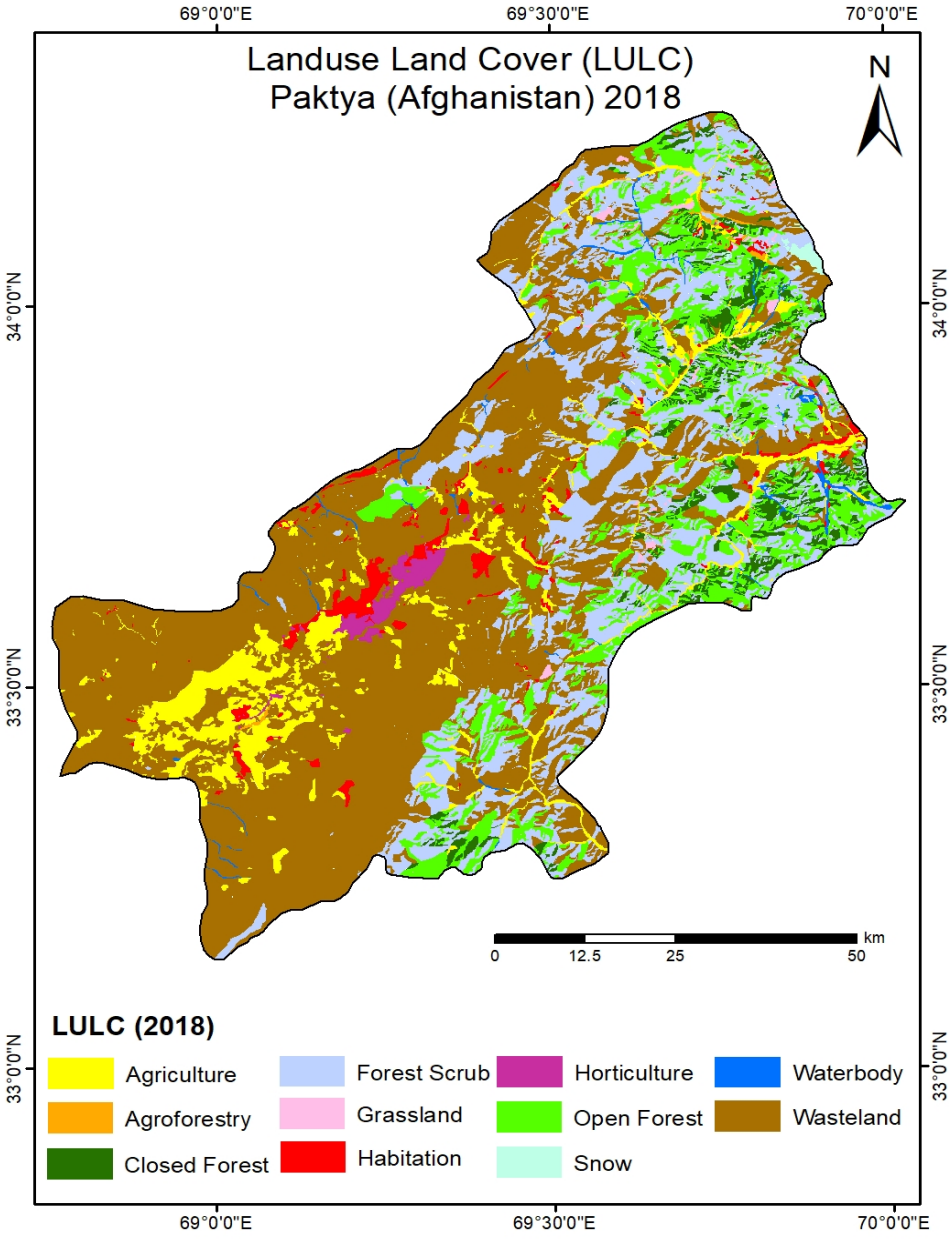


Fig-4: LULC map of 2018

Land use/land cover (LULC) change matrix

Land use/Land cover change matrix from 1998 to 2018 of Paktya province of Afghanistan has been shown in Table. 3 which reveals that, out of the total 642775.10 ha, wasteland occupied maximum portion of the province *viz*., 343676.59 ha, while as minimum area of 1700.93 ha was occupied by snow in 1998. Out of 45748.34 ha area under agriculture in 1998, 38988.8 ha remained unchanged during two decades, the rest got converted into Agroforestry (44.18 ha), habitation (1745.11 ha), horticulture (4859.8 ha), wasteland (88.36 ha) and water bodies (22.09 ha) respectively. The total area under agroforestry and closed forest in 1998 were 1700.93 ha and 21979.5 ha respectively which remained unchanged. However the area covered by forest scrub in 1998 was estimated as 137885.78 ha; Out of that 130331 ha remained unchanged through the study period while the rest of the area converted into agriculture (110.45 ha), closed forest (198.81 ha), open forest (7046.71 ha) and wasteland (198.81 ha). The result also shown that the area under grassland in 1998 was 4373.82 ha; out of this 2231.09 ha was remaining constant during two decades while the rest 2142.73 ha converted to wasteland. The area under habitation category and horticulture in 1998 were 11619. 39 ha and 795.24 ha, but in 2018 it have increased to 13784. 21 ha and 5831.76 ha respectively. The area which was occupied by open forest in 1998 was 67683.72 ha, out of this area 65077.1 ha remained constant during the time, while the rest got converted to closed forest (2562.44 ha) and forest scrub (44.18 ha) respectively. The land which was occupied by snow in 1998 was 2319.45 ha, out of this1634.66 ha remained constant from 1998 to 2018 while as the rest have converted to forest scrub (198.81 ha) and wasteland (485.97 ha). The maximum portion of the study

area (343676.59 ha) was wasteland in 1998; out of this 325364 ha remained constant, while the rest converted to agriculture (11442.6 ha), agroforestry (88.36 ha), forest scrub (5412.05 ha), grassland (508.07 ha), habitation (419.71 ha), horticulture (176.72 ha) and open forest (265.08 ha) respectively. The area under water bodies in 1998 was 4992.34 ha, which remained constant during study period (1998-2018). All of the positive and negative changes which is occurred in different LULC classes during two decades are shown in Table 4 as well in Fig.5.

Table-4: LULC changes % (1998-2018)

LULC CLASSES	1998	2018	Increase	Decrease
Agriculture	7.12	7.87	0.75	0.0
Agroforestry	0.26	0.29	0.02	0.0
Close Forest	3.42	3.85	0.43	0.0
Forest Scrub	21.45	21.16	0.0	-0.30
Grassland	0.68	0.43	0.0	-0.25
Habitation	1.81	2.14	0.33	0.0
Horticulture	0.12	0.91	0.78	0.0
Open Forest	10.53	11.26	0.73	0.0
Snow	0.36	0.25	0.0	-0.11
Wasteland	53.47	51.07	0.0	-2.40
Water body	0.78	0.78	0.00	0.0
Grand Total	100.00	100.00	0.0	0.0

Table.4: LULC Change matrix(1998-2018)

		2018											
	LULC	**Agriculture**	**Agroforestry**	**Close Forest**	**Forest Scrub**	**Grassland**	**Habitation**	**Horticulture**	**Open Forest**	**Snow**	**Wasteland**	**Waterbody**	**Grand Total**
1998	**Agriculture**	38988.8	44.18	0	0	0	1745.11	4859.8	0	0	88.36	22.09	45748.34
	Agroforestry	0	1700.93	0	0	0	0	0	0	0	0	0	1700.93
	Closed Forest	0	0	21979.5	0	0	0	0	0	0	0	0	21979.5
	Forest Scrub	110.45	0	198.81	130331	0	0	0	7046.71	0	198.81	0	137885.78
	Grassland	0	0	0	0	2231.09	0	0	0	0	2142.73	0	4373.82
	Habitation	0	0	0	0	0	11619.39	0	0	0	0	0	11619.39
	Horticulture	0	0	0	0		0	795.24	0		0	0	795.24
	Open Forest	0	0	2562.44	44.18	0	0	0	65077.1	0	0	0	67683.72
	Snow	0	0	0	198.81	0	0	0	0	1634.66	485.98	0	2319.45
	Wasteland	11442.6	88.36	0	5412.05	508.07	419.71	176.72	265.08	0	325364	0	343676.59
	Waterbody	0	0	0	0	0	0	0	0	0	0	4992.34	4992.34
	Grand Total	**50541.85**	**1833.47**	**24740.75**	**135986.04**	**2739.16**	**13784.21**	**5831.76**	**72388.89**	**1634.66**	**328279.88**	**5014.43**	**642775.1**

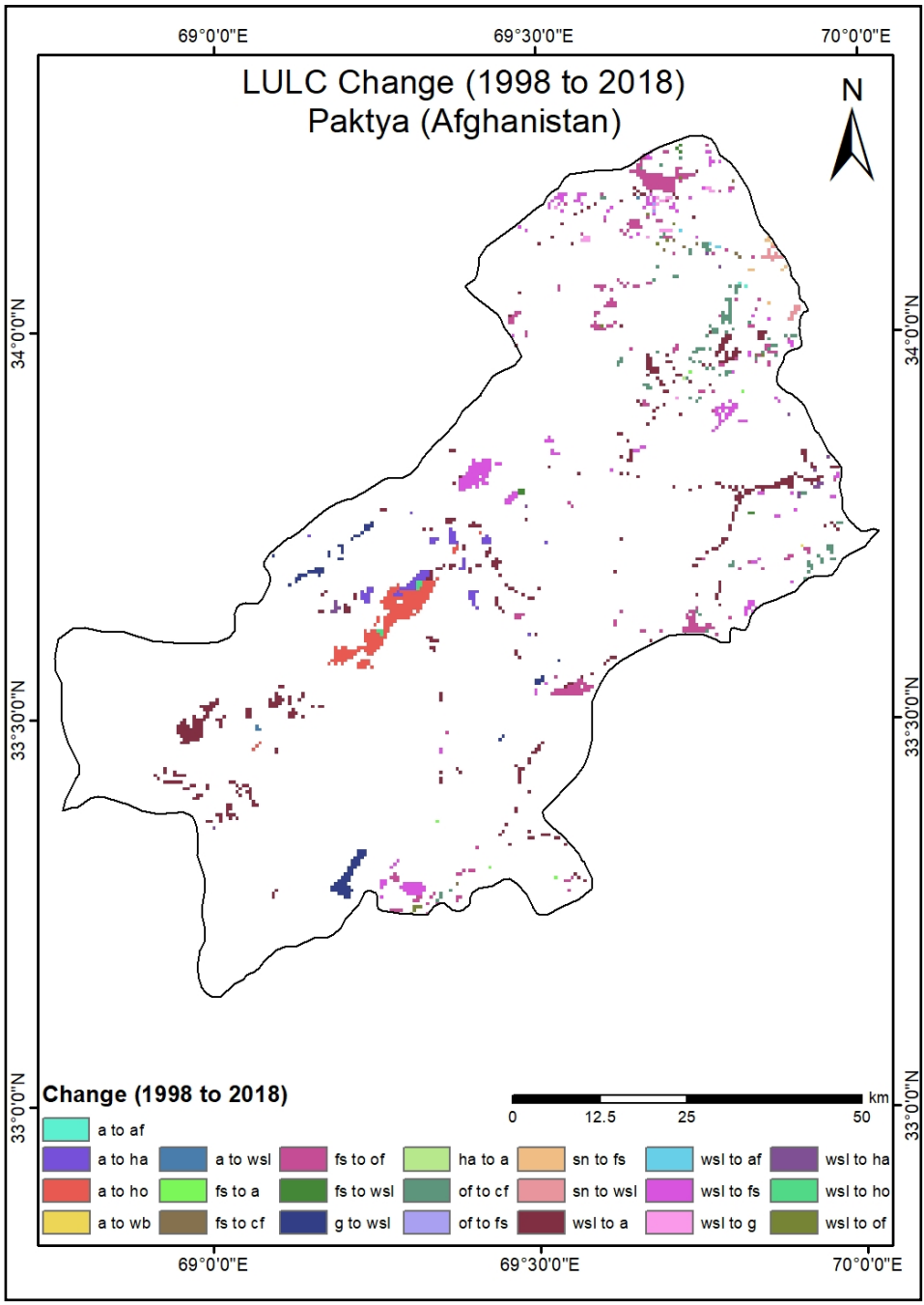


Fig-5: LULC change map (1998-2018)

DISCUSSION

The Land use/Land cover map 2018 shows that there has been a considerable changes in Land use/ Land cover from 1998 to 2018 in paktya province of Afghanistan. In LULC, waste land has recorded a Sharp decline of 2.40% from 1998 to 2018; this might be due to the conversion of these lands to habitation, forest scrub and grassland, similar result were obtained by (wani *et al*, 2009). Agriculture also shows an increase of 0.75% from 1998 to 2018 due to conversion of waste land that was not cultivated during 1990s war and area about 110.45 ha of forest scrub also converted to agriculture; the conversion of other land classes to agriculture is to provide foods for increasing population. Khairandish *et al*, 2020 also reported an increase of 4.3% in agriculture land in Kabul zone from 1972 to 2019. The increase in agriculture land is also supported by Negassa *et al*. (2020), he also reported an increase of 9.82% from 1991-2019 in agriculture land; Ru *et al*. (2018); Othow *et al*. (2017) also reported same results while they studied LULC changes in Ethiopia. In other hand there is a light increase of 0.78% in horticulture from 1998 to 2018 which came due to conversion of agriculture to horticulture, because after 2000 the demand for horticulture crops is increased due to high income from horticulture crops and government also provide facilities for people to establish gardens for socio-economic development of people. Omid *et al*, (2018) studied, the dynamics of Land Use/Cover and the statistical assessment of cropland change drivers in the Kabul river basin, Afghanistan also reported an increase of 13% in cropland from 2001-2010. The area under habitation also shows an increase of 0.33% from 1998 to 2018, this is due to conversion of waste land and agriculture to habitation because of increasing population. The same result is reported by Fayaz *et al*, 2020; wani *et al*, 2016, that shows significant increase in horticulture and habitation in North Kashmir India from 1992-2018. There is a difference of 0.11% in the area under snow between 1998 and 2018, so some of the area which was under snow in 1998 is converted to grassland or waste land due to the increase in temperature in global scale. The decrease in the area under snow is supported by several studies: Li (2020) studied the Glacier changes and their Linkage to the climate-topographic context in the Borohoro

Mountains; he also highlighted that there was a decrease of 0.41% in glaciers from 1977 to 2018. Tielidze *et al*, 2020 also reported a decrease of about 15% from 1986 to 2014 in supra-glacial debris.The area under agroforestry increased by 0.03% during two decade (1998-2018); this increment is due to the realizing of the importance of agroforestry system as a sustainable land management system by the people.

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