LAND COVER CHANGE ANALYSIS FOR BAYANKHONGOR PROVINCE IN MONGOLIA

Oyunbileg Erdenebadrakh[1], Byambasuren Damdinsuren[2], Batbileg Bayaraa[2], Enkhjargal Natsagdorj[1,3]

[1] *Policy research center, City government, Ulaanbaatar, Mongolia, oyunbileg1208@gmail.com*

[2] *Department of Land management, School of Agroecology, Mongolian University of Life Science (MULS), Ulaanbaatar, Mongolia, d_byambaa@muls.edu.mn; batbileg@muls.edu.mn*

[3] *Mongolian Geo-spatial Association, Ulaanbaatar, Mongolia, enhjargaln@gmail.com*

Abstract:

Mongolia has a vast land therefore, there is a need to map land cover classification using remote sensing technology. The purpose of the research is to classify the land cover of Bayan-Undur soum of Bayankhongor province based on remotely sensing data. To do that, land cover changes were first processed by downloading Landsat satellites data in 2005, 2015, and 2020 and processed using the classification method which was applied maximum likelihood method. Comparing the results of the land cover classification between 2005 and 2020, 14748.6 hectares or 0.87% of the area was classified as baren land, and 12641 hectares or 0.74% were classified as sparse vegetation. The results of the research were compared with several research work and Dr.Sh.Monkhtuya's research and were analyzed. Her research was made a land cover classification over Mongolia, and we compared the results of the land cover classification between 2005 and 2020, thus 14,748.6 hectares or 0.87% of the saxaul forest category was included into rocky and bare land, and 12,641 hectares or 0.74% is sparsely vegetated to the same category. We made land cover classification assessment and that was calculated 81.38% for the validation.

KEY WORD: Land cover classification, Landsat, validation, Mongolia

INTRODUCTION

Land cover is a remote sensing concept that combines natural and man-made geographic objects, such as vegetation and soil, that make up the earth's surface in aerial photographs. Land cover can generally be understood as a pattern indicating the pattern of land use and the spatial distribution of land with and without natural vegetation. Land cover structure and its changes are important factors that can be used to determine environmental change and sustainable development. [11] Land cover composition and its changes are important factors that can be used to determine environmental change and sustainable development. It is possible to control the condition of the landscape and the changes in a certain period of time by using the image data from the remote sensing satellite.[1]

PURPOSE

The main goal of this research is to classify the land cover of Bayan-Ondur soum of Bayankhongor province based on remote sensing using satellite data and to determine its changes. In order to achieve this goal, the following objectives were set.

- Download satellite data for 2005, 2015, and 2020 and perform initial processing;
- Land cover classification using Mongolia's land cover classification system;
- Compare and analyze the results of land cover classification;

OBJECT OF STUDY

Bayan-Undur soum of Bayankhongor province was founded in 1923, A total of 2516 people live in 715 households in 4 districts: Bulgan, Elgen, Idren and Ulaan uzuur. 909 km from Ulaanbaatar, of which 633 km are paved roads and 276 km are dirt roads. It is located 276 km from the center of the province. China borders with Bayantsagaan and Shinjinst of Bayankhongor Province and Erdene Sum of Gobi-Altai Province respectively. It is 1350-2450 m above sea level. In terms of physical geography, it is included in the Gobi steppe region at the southern end of the branch mountains of the Altai Mountains. The territory of soum is suitable for livestock farming with mountains and hills and deserts.

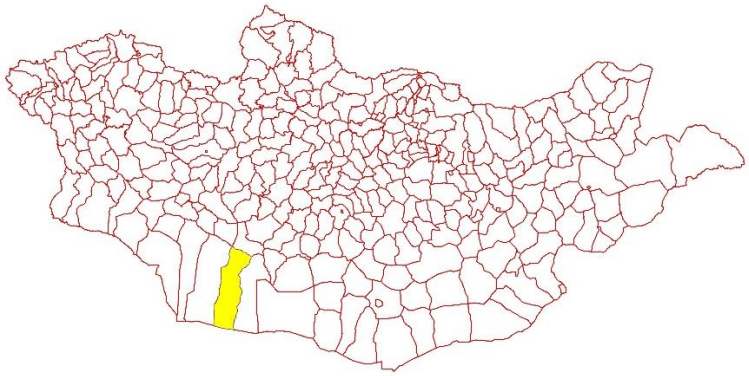


Fig1 Location map

SURVEY METHODOLOGY

Classification is used to categorize the objects in the satellite image into the partially corresponding levels based on their spectral similarity and their differences. According to international standards, land cover classification mapping has been done at multiple levels using data from different satellites in terms of resolution. [4] Image data pixels that can represent land cover classes from satellite data are selected as test areas (sometimes called training samples). Supervised classification is a classification based on the researcher's knowledge, while unsupervised classification is an automated, computer-based classification. Supervised classification methods can be implemented based on several key algorithms, such as parallelepiped, minimum distance, and maximum likelihood. Maximum likelihood algorithm is a more accurate method. The mean vector, which is the average value of the spectrum for all channels in the training area of the satellite data report, is used to calculate the variation and correlation for each land cover class in that test area. For each land cover class, the information is defined as a probability function of the mean vector neighborhood pixels with a mathematical statistical distribution.

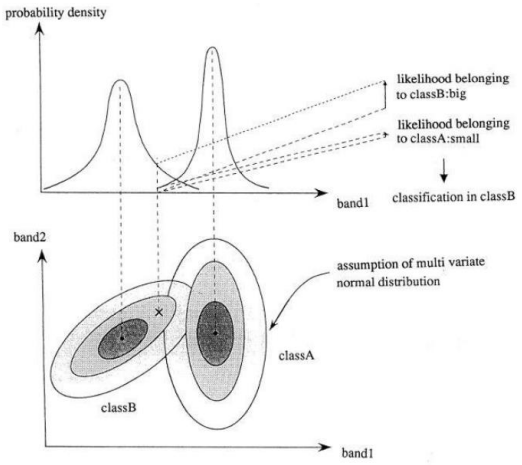
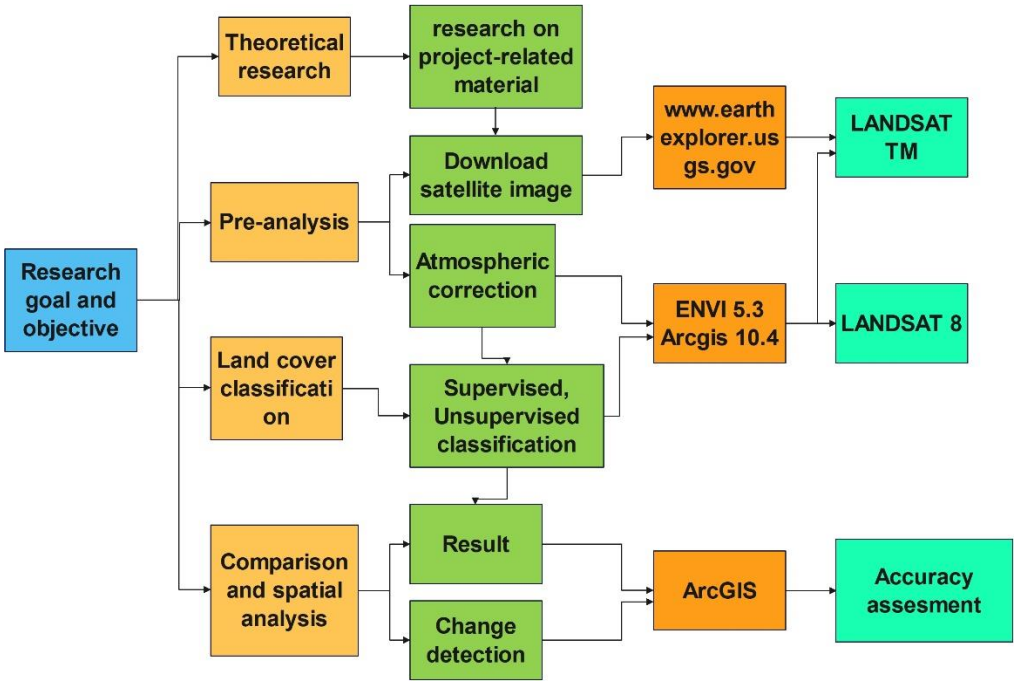


Fig2 Maximum likelihood method

As part of the research work of Dr. Sh. Monkhtuya, by analyzing and comparing the land cover classification systems for Mongolia, Mongolia's land cover was divided into 7 land cover classes and 38 sub-classes according to the total area up to the second level. After the registration of land resources according to land classification, changes in land use are detected and recorded, and cadastral data updating is done only according to official classification.

Table1 Land cover classification system of Dr. Sh. Munkhtuya



№	Газрын бүрхэвчийн ангилал	
	Үндсэн бүлэг	Дэд бүлэг
1	Өвслөг ургамалтай газар	Уулын тундр
		Уулын нугын хэвэр
		Уулын хээр
		Хөндийн хотгорын хээр
		Тал хээр
		Шатсан тал, хээр
		Голын хөндийн нуга
		Сийрэг ургамалтай газар
2	Хагалсан газар	Тариалангийн талбай
		Үрийш
		Атаршсан газар
3	Ой	Шилмүүст ой
		Навчит ой
		Сийрэг ой
		Сөөг, сөөгөнцөр бүхий газар
		Холимог ой
		Шатсан ой
		Өвчилсөн ой
4	Нүцгэн газар	Хад асга
		Моңх цас, мөсөн гол
		Шал
		Цөл
		Элс, элсэрхэг газар
		Элсжиж байгаа газар
		Чулуурхаг гадарга
		Хуурай сайр
		Уул уурхайн газар
5	Чийглэг газар	Намаг
		Нүцгэн шавар, хужир маргтай газар
		Зэгс
6	Усан гадарга	Давстай нуур
		Цэнгэг нуур
		Тойром
		Гол, горхи
		Ус хуримтлуулах сангууд
7	Хот суурин газар	Суурин газрууд
		Зам шугам сүлжээ
		Суурингийн гаднах ариля байгууламжийн газар

Fig3 Land cover classification methods

RESULTS OF THE RESEARCH

Land cover change research was conducted using satellite data from different time periods covering the same area to detect areas that have undergone certain changes. Because the land cover classification made by the research region was difficult to apply directly when comparing the land cover changes in

three different time periods, the classes were combined and the number of classes was reduced. For example, a general water surface class was created by combining rivers, lakes, and surroundings, and the following classes were used to create the following classes: bare land without vegetation.

- A dry ravine
- Water surface
- Shrub area
- Sandy ground
- Rocks, barren places / places without plants/
- Area with sparse vegetation
- Zagan forest
- Humid salt and marz land

1. Unsupervised classification

Pixels with similar spectral values are distinguished from satellite data. This classification method is mainly used in cases where there is little information and knowledge about the land cover classification. It belongs to the cluster classification method because the unsupervised classification method classifies the values of satellite data pixels by grouping (natural ~ 26 ~ gruoping). This is the result of grouping by analyzing the signature value of the resulting class, grouping the classes together and making corrections such as adding and subtracting, and differentiating the land cover classes. The following results were obtained when the 2005, 2015, and 2020 news were classified by the untrained classification method. The Landsat TM satellite data were classified into 8 land cover classes corresponding to the study area.

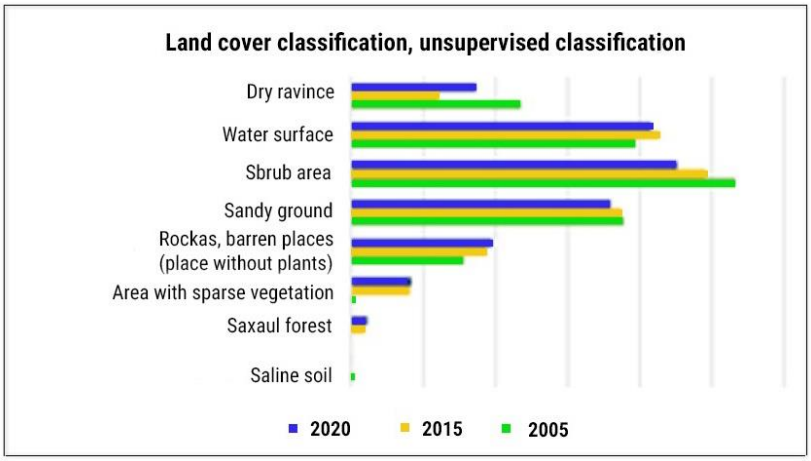


Table2 Land Cover Classification (With Untrained Classification Method)

Class	2005		2015		2020	
	Area,ha	%	Area,ha	%	Area,ha	%
Water surface	2969.1	0.17	548.19	0.03	391.23	0.3
Rocks, barren places (place without plants)	3.25	0.01	18342.54	1.08	22153.32	1.3
Saline soil	2526.39	0.15	81285.54	4.78	83196.09	4.9
Sandy ground	155803.23	9.16	81285.75	11.01	195090	11.5
Shrub area	377568.99	22.21	187200.6	22	359678.1	21.2
Dry ravine	532479.15	31.32	374137.5	28.87	451641.6	26.6
Saxaul forest	394261.83	23.19	490842.4	25.1	415264.9	24.4
Area with sparse vegetation	234714.15	13.8	426727.5	7.13	172909.9	10.2
Total	1700326.09	100	1700326	100	1700326	100

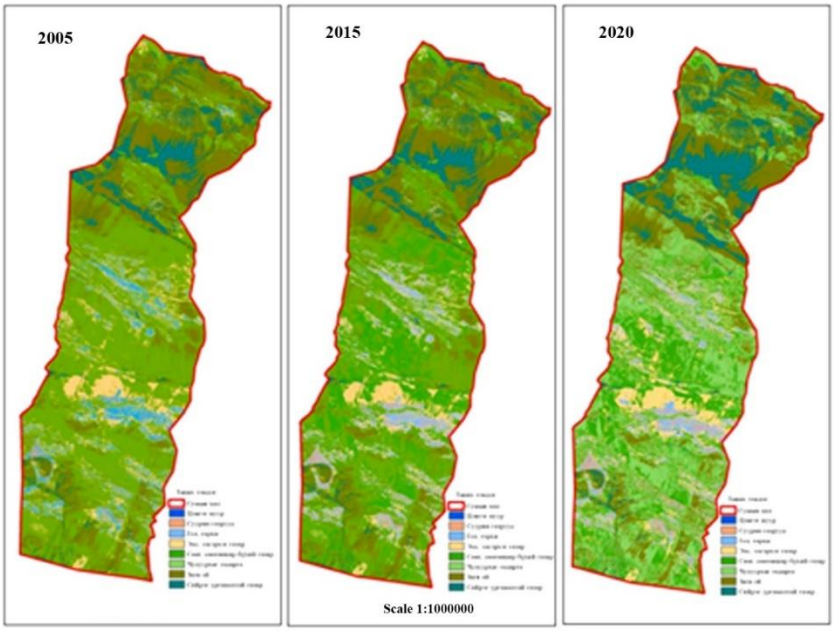
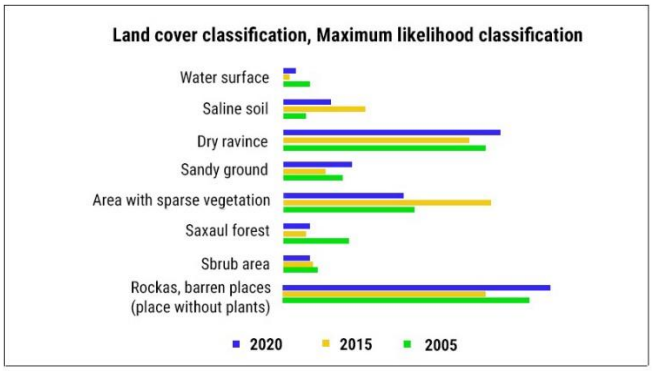


Fig4 Land cover classification, per hectare (by untrained classification method)

2. Maximum likelihood classifition

The spectral value distribution of satellite data pixels is obtained by inter-channel correlation. Correlation distributions determine which land cover classes are better distinguished between the two channels, and distribution probabilities can be calculated from this distribution. The results of classifying the 2005, 2015, and 2020 news using the maximum similarity method of the trained classifier are as follows. The Landsat TM satellite data were classified into 8 land cover classes corresponding to the study area.



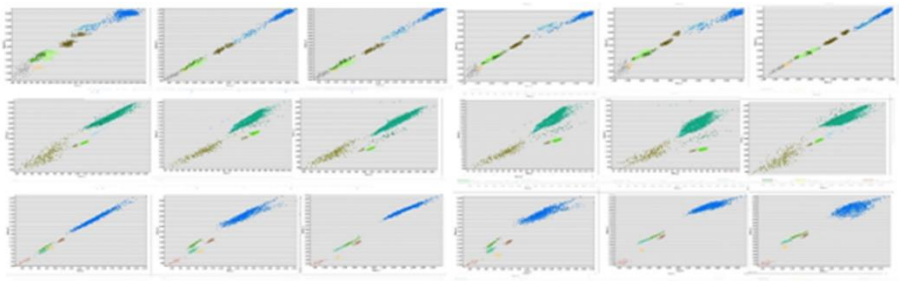


Table3 Land cover classification (Most similar classification- Maximum likelihood classifition method)

Class	2005		2015		2020	
	Area,ha	%	Area,ha	%	Area,ha	%

Rocks, barren places (place without plants)	535143.24	31.47	446339.52	26.25	585200	34.42
Shrub area	75151.98	4.42	64080.54	3.77	54278.82	3.19
Saxaul forest	140095.98	8.24	46785.24	2.75	52721.28	3.1
Area with sparse vegetation	288449.46	16.96	451977.84	26.58	260700	15.33
Sandy ground	123712.65	7.28	90658.17	5.33	147800	8.69
Dry ravine	436259.25	25.66	409896.72	24.11	469700	27.62
Saline soil	49908.33	2.94	177766.2	10.46	104000	6.12
Water surface	51557.94	3.03	12774.6	0.75	25897.86	1.52
Total	170027279	100	170027279	100	170027279	100

A number of challenges arose during the quantitative process of land cover classification. For example, we could not eliminate the effect of clouds in this study because we could not detect the object under the cloud in the passive detection study. In addition to cloud effects, cloud shadows were also quite difficult to distinguish from other classes. For example, in some areas, clouds were classified on wet and salty ground and some were classified on water surface. 6 The figure below shows the 2020 satellite data (A) is a part of classification using untrained classification (B) and maximum similarity classification (B). Classification varies depending on the effect of clouds on the ground.

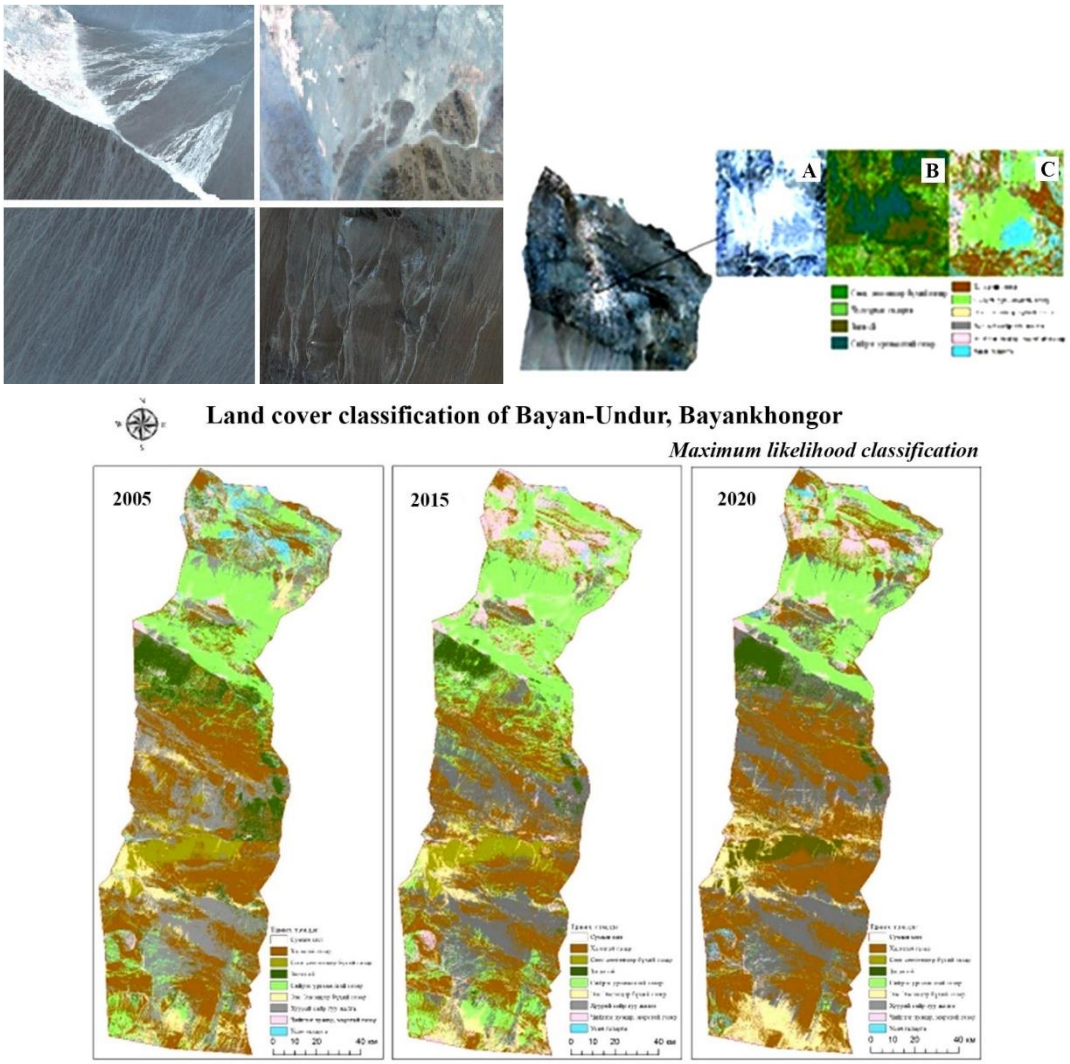


Fig5 Land cover classification map (using maximum similarity classification method)

3 . Changes in land cover classification

Comparing the results of land cover classification for 2005-2020, 14748.6 ha area or 0.87% of the area is rocky and bare land, and 12641 ha area or 0.74% of the area is sparsely vegetated. In the above years, the category of water surface has been changed by 0.17% to the category of dry ravines, 1.53% to the category of wet saltmarsh, 0.31% to the category of sparsely vegetated land, and 0.04% to the category of sandy soil.

Table4 Land cover change by maximum similarity classification method, in

Class	2005-2020	2005-2015	2015-2020
Rocks, barren places (place without plants)	50056.76	-88803.72	138860.5
Shrub area	-20873.16	-11071.44	-9801.72
Saxaul forest	-87374.7	-93310.74	5936.04
Area with sparse vegetation	-27749.46	163528.38	-191278
Sandy ground	24087.35	-33054.48	57141.83
Dry ravine	33440.75	-26362.53	59803.28
Saline soil	54091.67	127857.87	-73766.2
Water surface	54091.67	-38783.34	13123.26

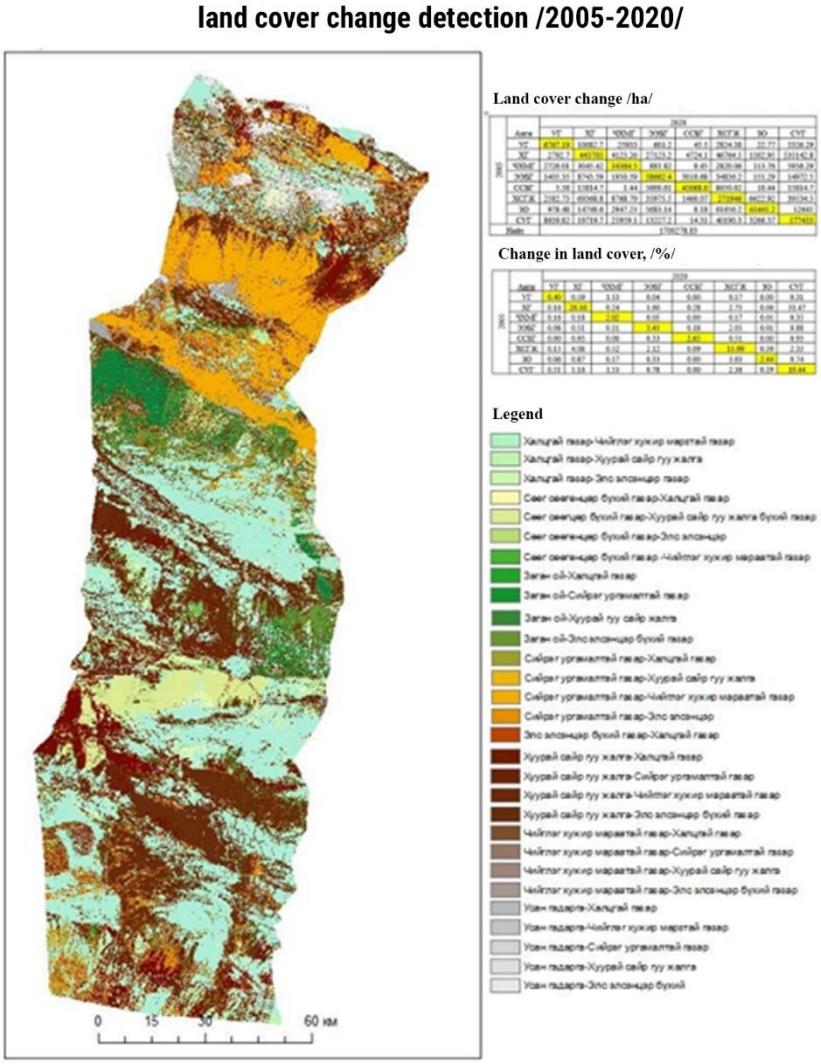


Fig6 Land cover change map (2005-2020)

4. Map of land cover changes (2005-2020)

Land cover classification evaluation using Landsat satellite data showed 81.38% agreement with the combined assessment of the most similar classification. The rating of the category was calculated in the following way.

Хамгийн их төсөөтэйн ангилал /Ангиллын үнэлгээ/												
		Хээрийн хэмжилт								Нийт	Дутуу (omnission)	Хэрэглэгч
Хиймэл дагуулын мэдээ		УГ	ХАХГ	ЧХМГ	ЭЭБГ	ССБГ	ХСГЖ	ЗО	СУГ			
	УГ	24	1	2	0	1	0	0	0	28	0.86	86
	ХАХГ	0	114	1	0	2	0	0	0	117	0.97	97
	ЧХМГ	2	2	13	0	0	3	0	0	20	0.65	65
	ЭЭБГ	0	0	0	24	2	1	0	0	27	0.89	89
	ССБГ	0	0	0	2	21	0	3	2	28	0.75	75
	ХСГЖ	1	2	1	0	18	25	1	3	51	0.49	49
	ЗО	0	0	0	0	1	2	16	0	19	0.84	84
	СУГ	0	0	2	0	2	1	1	21	27	0.78	78
	Нийт	27	119	19	26	47	32	21	26	**317**		
	Илүү (commission)	0.89	0.96	0.68	0.92	0.45	0.78	0.76	0.81			
	Үйлдвэрлэгч (Producer's accuracy) %	89	96	68	92	45	78	76	81			
Нэгдсэн дүн 81.38%												

Ангиллын үнэлгээг тооцох

Нэгдсэн үнэлгээ **OA**= $\frac{aA+bB+cC\ldots}{N} = \frac{24+114+13+24+21+25+16+21}{317} \approx 81.38$

Дутуу алдаа **OE**= $\frac{(aB+aC)}{\Sigma a} = \frac{24}{28} \approx 0.86$

Илүү алдаа **CE**= $\frac{(bA+cA)}{\Sigma A} = \frac{24}{27} \approx 0.89$

Хэрэглэгчийн нарийвчлал **UA**=0.86 - 100= 86

Үйлдвэрлэгчийн нарийвчлал **PA**=0.89 - 100= 89

Randomly, from the Google Earth image, 28 points were found on the surface of the water, 24 points were found, 1 point was found in rocky and barren land, 2 points were found in humid salt marsh land, 1 point was found in an area with shrubs and fungi, and 27 points were found in sandy land. 2 points are in the area with shrubs and fungi, 1 point is in the area with dry ravines, 117 points are found in the rocky area, 114 points are matched, 1 point is in the area with humid khujir marz, 2 points are in the area with shrubs and fungi, 20 points are in the area with moist khujir marz. 13 points were found, 2 points were found in water areas, 2 points were in rocky areas, 1 point was in dry ravines, and 28 points were found in areas with shrubs and fungi. 21 points were found. 25 of 51 points were found in forested areas, 2 points in areas with sparse vegetation, 25 points in areas with dry ravines, 18 points in areas with shrubs and fungi, 1 point in water surface, 2 points in rocky and barren areas, 1 point in wet areas. 3 ha in sparsely vegetated areas zart, 19 points in the area with zagan forest, 16 points, 2 points in the dry gully area, 27 points in the sparsely vegetated area, 21 points, 2 points in the wet khujir marz area, 2 points in the area with shrubs, 1 point 1 point corresponds to the area with dry ravines and 1 point corresponds to the area with sand.

CONCLUSION

- Using Landsat satellite data, data from 2005, 2015 and 2020 were first digitized.
- In the category of 2020, water surface is 25,897.86 ha or 1.52%, rocky and barren land is 585,200 ha or 34.42%, wet salt and marl land is 104,000 ha or 6.12%, sparsely vegetated land is 260,700 ha or 15.33%, and sand and sandy land is 147,800 ha or 8.69%. , 54,278.82 ha or 3.19% of the land with shrubs and mushrooms, 469,700 ha or 27.62% of dry ditches and ravines, and 52,721.28 ha or 3.10% of sedge forest respectively.
- Comparing the results of land cover classification for 2005-2020, 14,748.6 hectares or 0.87% of the area is rocky and bare, and 12,641 hectares or 0.74% of the area has been classified as sparsely vegetated.
- Land cover classification using Landsat satellite data showed 81.38% agreement.

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