2.3. Extent of vegetation/ecosystem types

2.3.A. Extent of vegetation zones and current vegetation in Armenia

The assessment of the extent of vegetation types was made based on a vegetation map created by the project experts Alla Aleksanyan and Vardan Asatryan (Fig. 23A-1a). The map was created based on Barseghyan (2007) and other materials.

The current natural area of vegetation zones is defined as the potential area of a given vegetation type minus cropland and built-up areas based on ESRI land cover data 2023 (Fig. 23A-1b).

Academic vegetation maps cannot reflect small patches of tree cover located within non-forest zones. In Armenia, such patches are typically associated with specific landforms— such as canyons, gorges, and slopes — where atypical conditions for non-forest zones allow tree vegetation to persist. However, these tree cover patches are visible in land cover datasets. Integrating the vegetation map with land cover data makes it possible to account for forest distribution beyond the typical forest vegetation zone (Fig. 23A-1c).

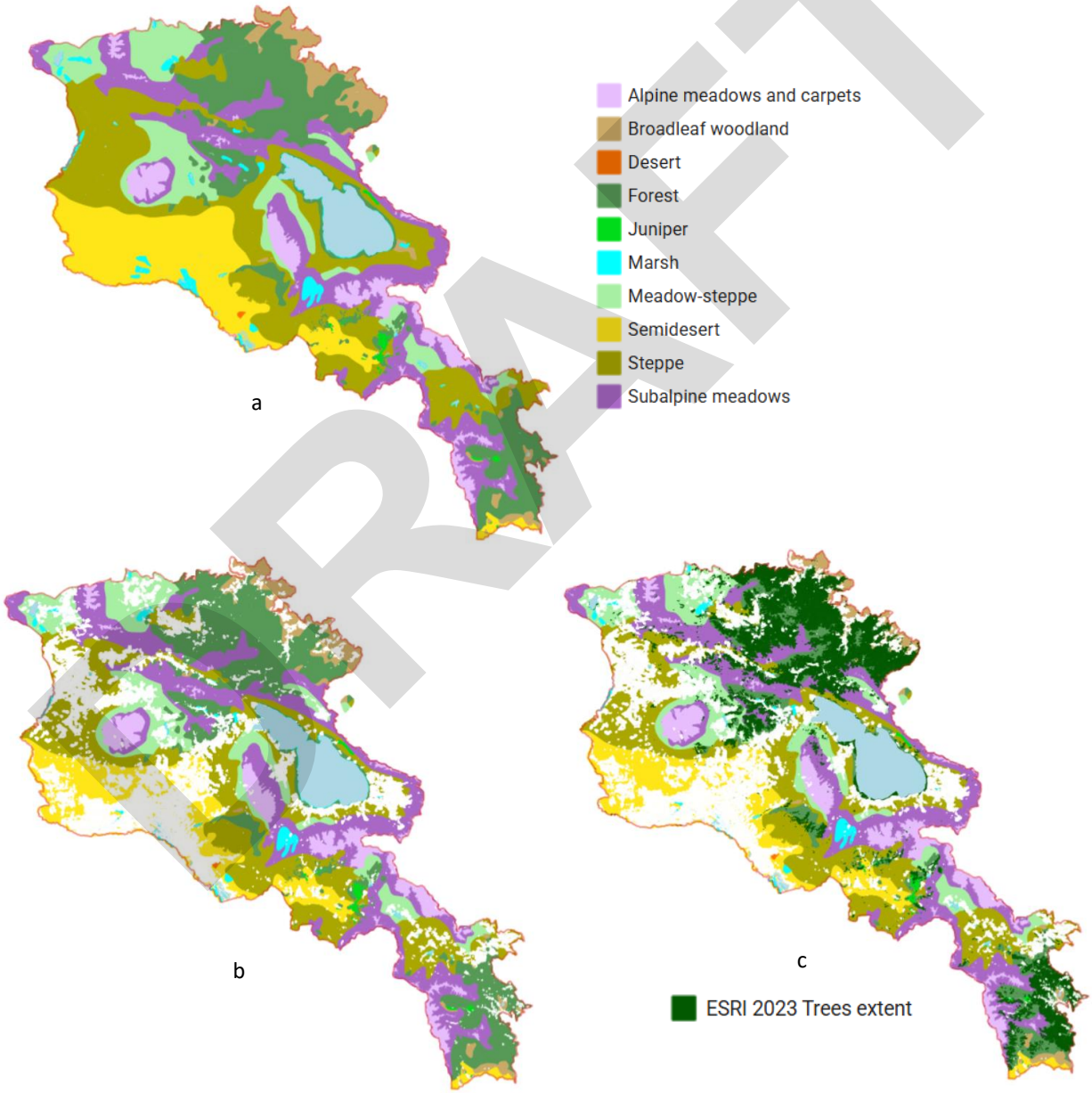

Figure 23A-1. Maps of vegetation: a) potential distribution of vegetation types; b) current natural area of vegetation zones; c) vegetation, including current tree cover [For detailed map see project Web-GIS, sections Ecosystem Extent/Vegetation/Vegetation map 2025]

According to ESRI data, the most human-transformed vegetation zone is semi-desert, where 57% of natural areas remain. It is followed by marshes and steppe with 71% and 76% of natural areas remaining, respectively.Tree cover occupies more than 40% of the forest zone and more than 20% of the broadleaf woodland zone. Significant forest patches are also present in subalpine meadows, meadow-steppe, and steppe zones. In the remaining zones, the tree cover identified by ESRI occupies a very small area — from 0 to 4 km². In the marsh zone, water bodies occupy a substantial area (Lake Sevan is excluded from the analysis) (Table 23A-1; Figure 23A-2).

Table 23A-1. Current area of land cover classes across vegetation zones, km²

	Trees	Rangeland	Bare ground	Snow/Ice	Water/ flooded veg.	Crops	Built area	No data/ clouds	Total	Share of natural LC classes, %
Alpine vegetation	0.61	1632.30	10.32	11.65	1.97	3.46	0.78	2.83	1663.92	100
Subalpine meadows	254.58	4266.55	5.53	0.27	3.03	84.53	24.84	19.79	4659.12	98
Meadow-steppe	76.39	2549.78	0.22	0.04	7.25	451.65	91.45	22.66	3199.42	83
Steppe	94.59	5217.84	3.25	0.00	5.05	1302.02	399.16	27.97	7049.88	76
Forest	2397.98	2888.01	3.92	0.00	30.51	154.96	197.66	21.76	5694.79	94
Juniper	4.23	130.60	0.12	0.00	0.09	0.17	0.89	0.05	136.15	99
Broadleaf woodland	263.67	691.61	2.65	0.00	7.28	123.48	82.12	27.23	1198.03	83
Semidesert	3.46	2462.38	9.03	0.00	33.04	1211.12	715.19	50.39	4484.59	57
Desert	0.00	6.67	0.22	0.00	0.00	0.52	0.28	0.00	7.69	90
Marsh	0.82	228.14	1.01	0.00	49.54	85.19	32.46	3.09	400.25	71
Armenia	3096.34	20073.85	36.27	11.96	137.74	3417.09	1544.83	175.76	28493.85	83

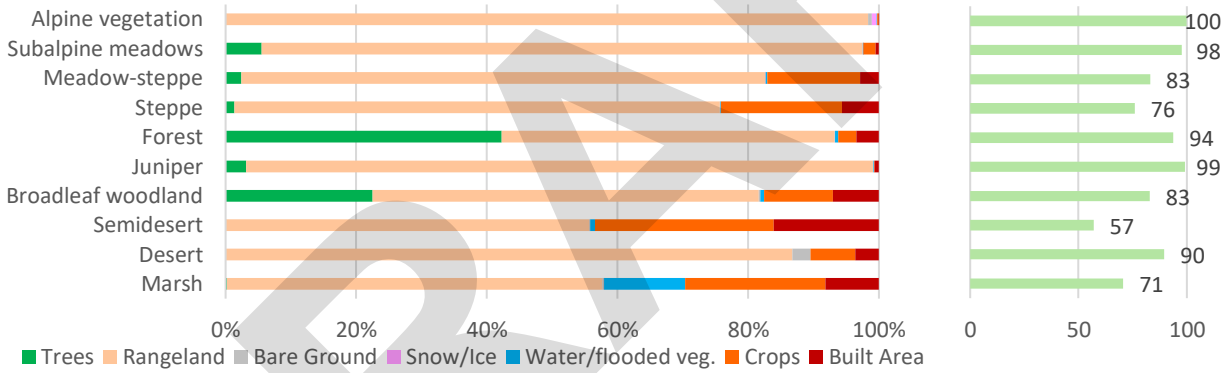

Figure 23A-2. Share of land cover classes across vegetation zones, %

After excluding the area of croplands and built-up areas, zones A and B occupy the largest area in Armenia — each exceeding 5,000 km². The subalpine meadow zone is also extensive, covering more than 4,500 km². The smallest zones by area are marshes and juniper woodlands (283 and 135 km², respectively), as well as the extreme small desert zone, which consists of a single patch covering only 7 km² (Table 23A-2; Figure 23A-3a). Considering all tree-covered areas as forest, the most widespread vegetation types are steppe and subalpine meadows, followed by forests in all vegetation zones and grasslands in forest zone each covering approximately 3,000 km². The areas of other vegetation zones change little, as tree cover within them is minimal (Figure 23A-3b).

Table 23A-2. Natural area of vegetation zones in 2017 and 2023 and changes in it, km²

Vegetation types	*Area in 2023, km²*	*Area in 2017, km²*	*Changes 2023-2017, km²*	*Changes, % relative to 2017*
Alpine meadows and carpets	1660.84	1662	-1.16	-0.07
Subalpine meadows	4552.95	4601.92	-48.97	-1.06
Meadow-steppe	2658.2	2906.94	-248.74	-8.56
Steppe	5352.42	5571.67	-219.25	-3.94
Juniper	135.2	135.38	-0.18	-0.13
Forest	5345.91	5394.29	-48.38	-0.90
Broadleaf woodland	993.16	985.22	7.94	0.81
Semidesert	2560.1	2575.06	-14.96	-0.58
Desert	6.89	7.11	-0.22	-3.09
Marsh	282.79	291	-8.21	-2.82

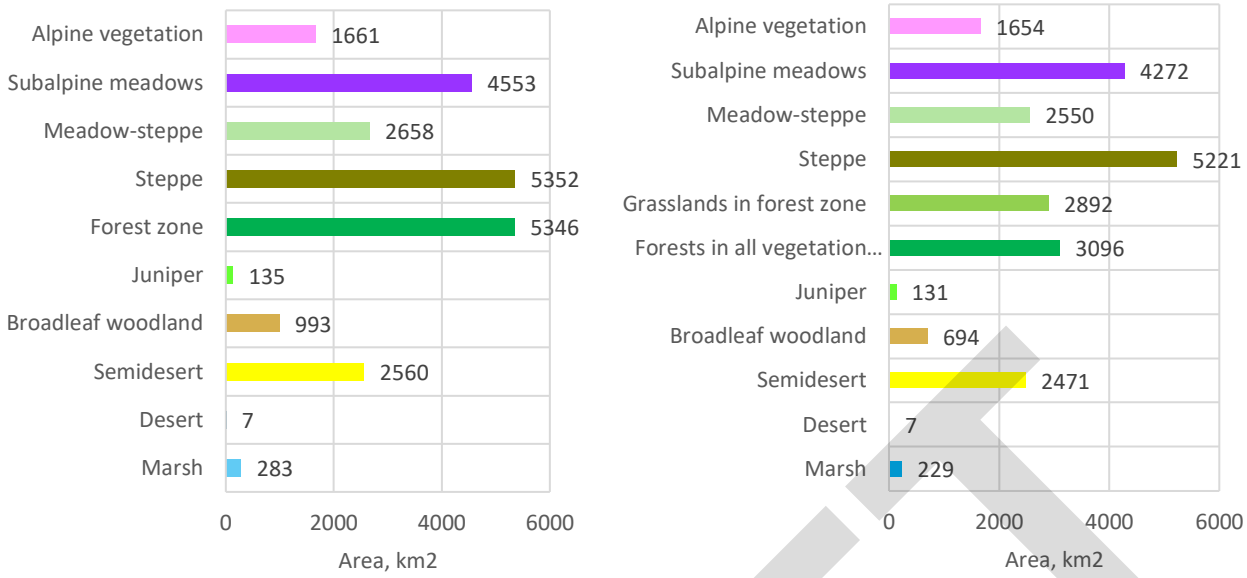

Figure 23A-3. Natural area of vegetation zones (a) and area of vegetation types including current tree cover, km²

2.3.B. Rarity of vegetation/ecosystem types in Armenia

Currently, zones of desert, juniper woodlands, and marshes have the smallest natural areas (less than 1% of Armenia's area), while the most widespread are zones forest and steppe (each is around 18% of Armenia's area). Treating all tree cover as forest change a little the overall picture introducing one more relatively common vegetation type — grasslands in forest zone, which accounts for 10% of Armenia's territory. Total forest area in all vegetation zones (about 10%) is significantly smaller than the area of the entire forest zone (18%), which is visible at rarity maps (Fig. 23B-2).

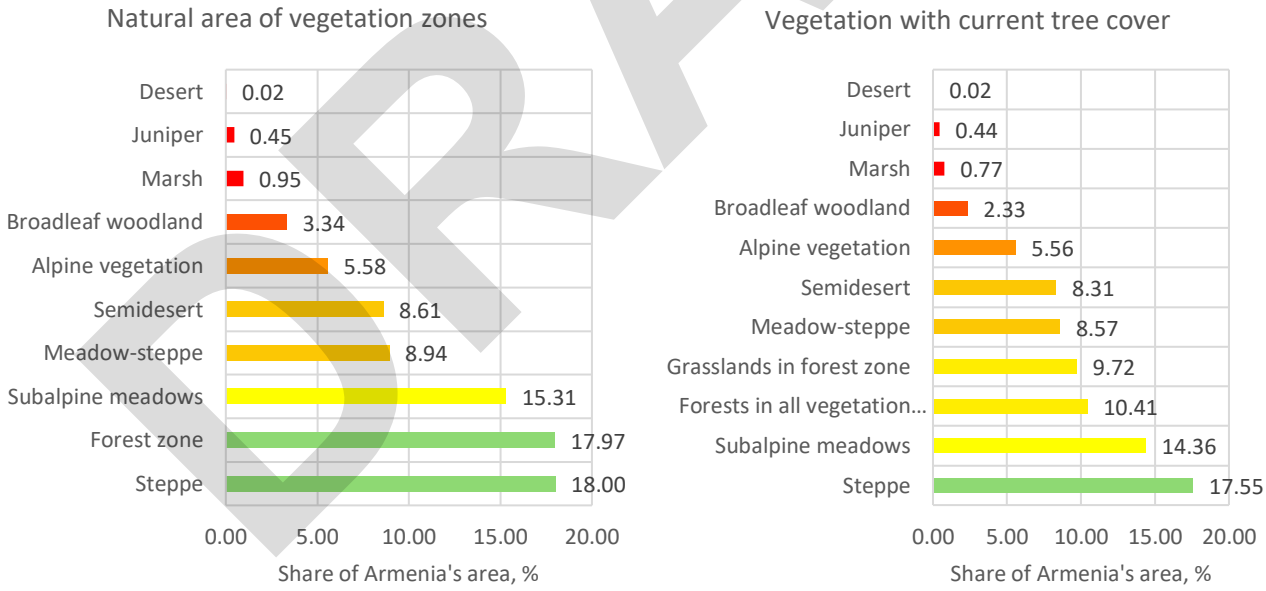

Figure 23B-1. Ranking of vegetation types by rarity: a) natural area of vegetation zones; b) vegetation with current tree cover.

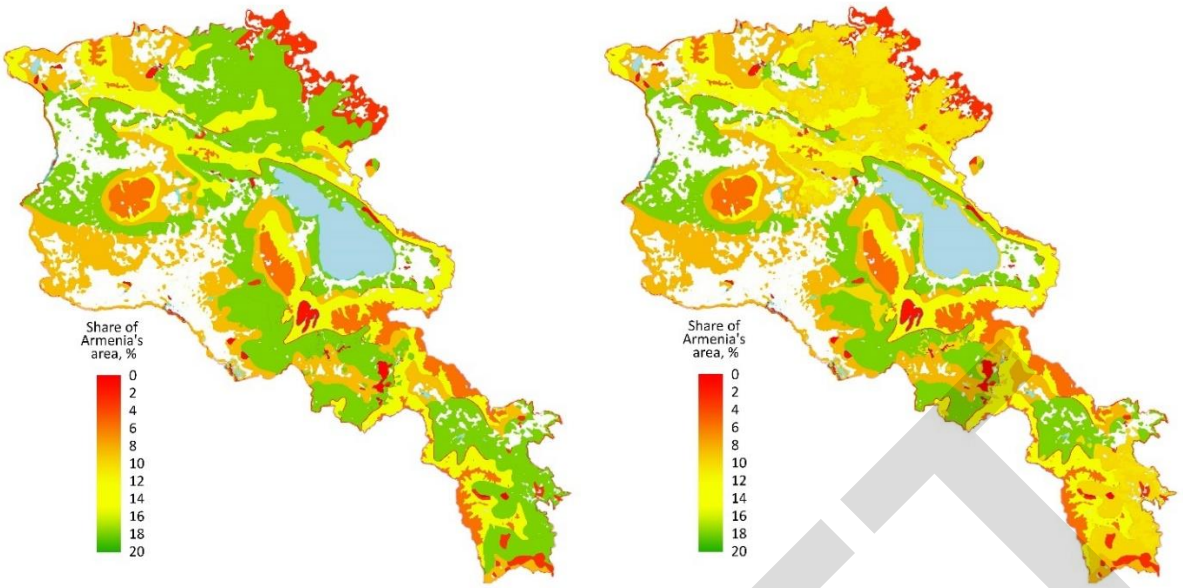

Figure 23B-2. Rarity maps: a) natural area of vegetation zones; b) vegetation with current tree cover.

2.3.C. Changes in natural area of vegetation zones from 2017 to 2023 in Armenia

From 2017 to 2023, the area of all zones not occupied by croplands and built-up areas decreased. The only exception is the broadleaf woodland zone, where anthropogenic areas slightly declined, allowing more space for ecosystems. The most significant reductions, both in absolute and relative terms, occurred in the meadow-steppe and steppe zones (Table 23A-2; Figure 23C-1).

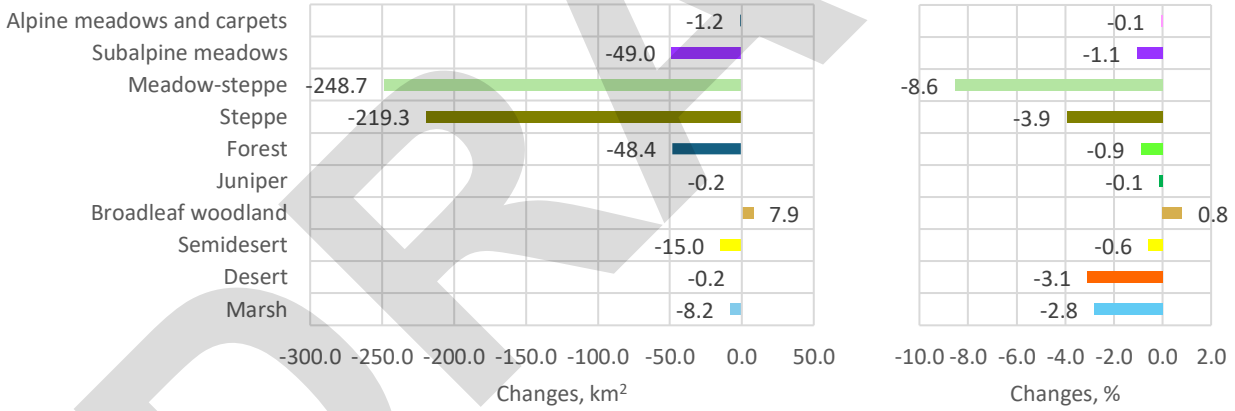

Figure 23C-1. Changes in area of natural vegetation zones from 2017 to 2023

Table 23C-1. Natural area of vegetation zones in Armenia in 2017 and 2023, and changes in it

Vegetation types	*Area in 2023, km2*	*Area in 2017, km2*	*Changes, km2*	*Changes, % relative to 2017*
Alpine meadows and carpets	1660.84	1662	-1.16	-0.07
Subalpine meadows	4552.95	4601.92	-48.97	-1.06
Meadow-steppe	2658.2	2906.94	-248.74	-8.56
Steppe	5352.42	5571.67	-219.25	-3.94
Juniper	135.2	135.38	-0.18	-0.13
Forest	5345.91	5394.29	-48.38	-0.90
Broadleaf woodland	993.16	985.22	7.94	0.81
Semidesert	2560.1	2575.06	-14.96	-0.58
Desert	6.89	7.11	-0.22	-3.09
Marsh	282.79	291	-8.21	-2.82

2.3.D. Marz level

The natural extent (i.e., the area not occupied by croplands or built-up areas) of vegetation zones is greatest in Syunik marz and smallest in Armavir marz (Figure 23D-1). The forest zone (including forests and grasslands within the boundaries of the forest vegetation zone) occupies the largest areas in the provinces of Lori, Syunik, and Tavush. Alpine and subalpine zones are most extensive in Syunik and Gegharkunik marzes. Steppe and meadow-steppe occupy substantial areas across all marzes except Armavir and Tavush, with the greatest extents in Gegharkunik and Shirak. The largest areas of natural semidesert have been preserved in the provinces of Aragatsotn, Armavir, and Ararat.

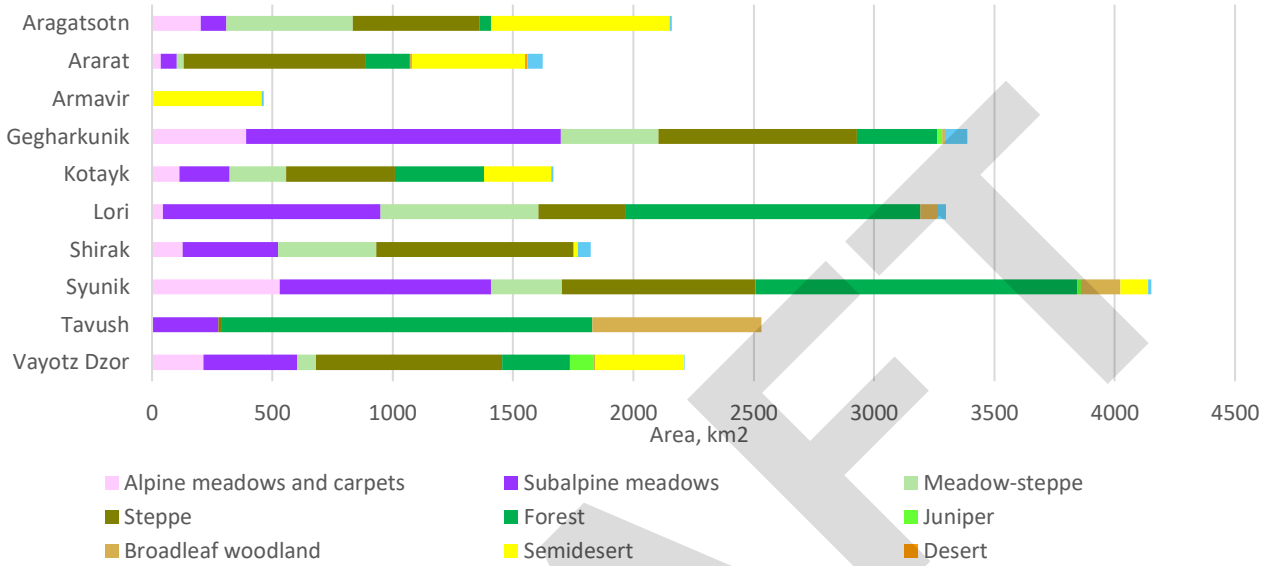

Figure 23D-1. Natural area of vegetation zones by provinces in 2023

Changes in the natural area of vegetation zones from 2017 to 2023 are small in absolute terms—on the order of tens of square kilometers or less. The most noticeable losses of natural area occurred in the steppe and meadow-steppe zones, especially in the provinces of Shirak, Gegharkunik, and Lori (Fig. 23D-2a; Table 23D-1). However, when expressed as the share of area lost or gained relative to 2017, the gain of open woodlands in Gegharkunik and the loss of marshes in Shirak and Aragatsotn become evident (Fig. 23D-2b; Table 23D-1).

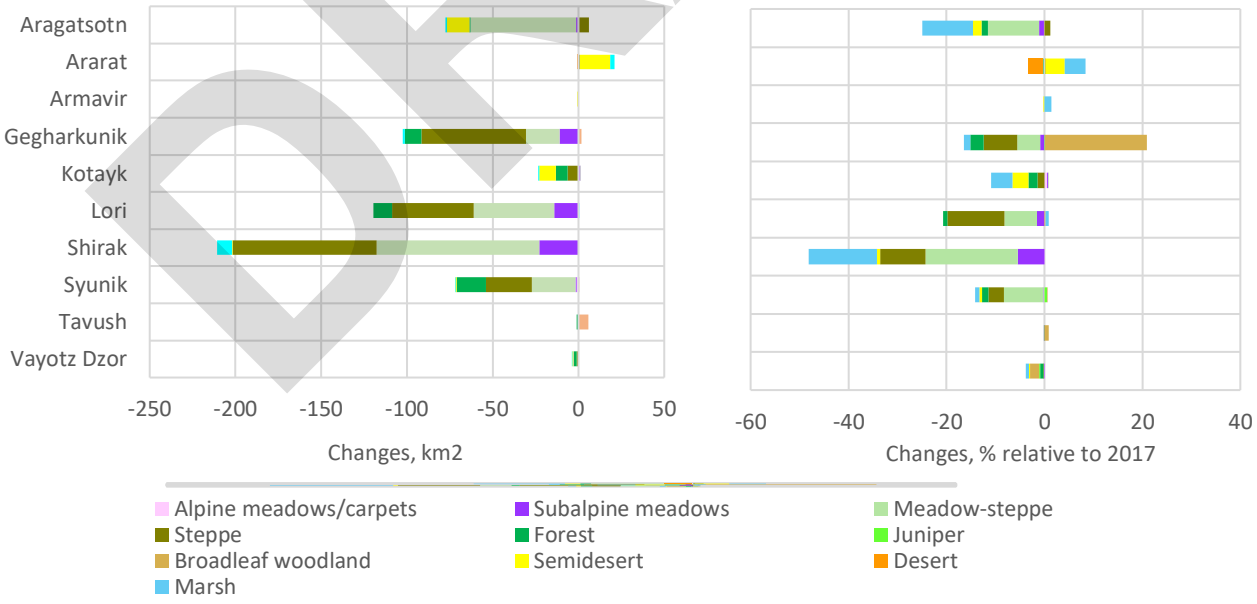

Figure 23D-2. Changes in matural area of vegetation zones by provinces from 2017 to 2023: a) absolute changes, km2; b) chare of lost/gained area, % relative to 2017.

Table 23D-1. Natural area of vegetation zones by provinces in 2017 and in 2023 and changes in it

	Araga-tsotn	Ararat	Arma-vir	Geghar-kunik	Kotayk	Lori	Shirak	Syunik	Tavush	Vayotz Dzor
Area in 2017, km2										
Alpine meadows/carpets	202.91	37.22	0	391.14	113.09	44.06	126.15	531.77	0.31	212.53
Subalpine meadows	107.04	64.63	0	1318.69	207.76	918.78	420.54	878.41	275.63	390.67
Meadow-steppe	586.56	30.74	0	425.1	234.72	703.85	503.67	320.9	0	78.76
Steppe	519.54	751.04	0	884.92	458.07	410.25	903.53	830.27	11.81	774.26
Forest	49.49	187.2	0	343.67	377.1	1235.36	0	1354.65	1542.98	282.16
Juniper	0	0	0	20.6	0	0	0	13.67	0	101.06
Broadleaf woodland	0	9.46	0	8.8	1.68	73.27	0	163.98	696.06	4.74
Semi-desert	756.42	453.14	456.89	0	288.68	0	17.25	116.41	0	370.26
Desert	0	7.11	0	0	0	0	0	0	0	0
Marsh	7.87	61.66	7.62	94.09	8.55	31.68	61.9	13.07	0	1.48
Area in 2023, km2										
	Araga-tsotn	Ararat	Arma-vir	Geghar-kunik	Kotayk	Lori	Shirak	Syunik	Tavush	Vayotz Dzor
Alpine meadows/carpets	202.59	37.16	0	391.05	113.68	44.06	126.14	530.55	0.31	212.47
Subalpine meadows	106.04	64.63	0	1307.91	208.24	904.53	397.7	878.07	275.54	390.5
Meadow-steppe	524.94	30.77	0	405.23	234.95	656.93	408.82	295.18	0	78.74
Steppe	525.73	751.66	0	824.14	451.72	362.86	819.41	803.66	11.81	773.48
Forest	48.88	187.13	0	334.03	370.1	1224.23	0	1337.58	1541.85	280.41
Juniper	0	0	0	20.62	0	0	0	13.74	0	100.79
Broadleaf woodland	0	9.46	0	10.63	1.68	73.41	0	164.17	701.92	4.65
Semi-desert	743.31	470.97	456.02	0	279.08	0	17.15	115.78	0	369.73
Desert	0	6.89	0	0	0	0	0	0	0	0
Marsh	7.05	64.27	7.73	92.94	8.18	31.88	53.23	12.95	0	1.47
Changes 2023-2017, km2										
	Araga-tsotn	Ararat	Arma-vir	Geghar-kunik	Kotayk	Lori	Shirak	Syunik	Tavush	Vayotz Dzor
Alpine meadows/carpets	-0.32	-0.06	0	-0.09	0.59	0	-0.01	-1.22	0	-0.06
Subalpine meadows	-1	0	0	-10.78	0.48	-14.25	-22.84	-0.34	-0.09	-0.17
Meadow-steppe	-61.62	0.03	0	-19.87	0.23	-46.92	-94.85	-25.72	0	-0.02
Steppe	6.19	0.62	0	-60.78	-6.35	-47.39	-84.12	-26.61	0	-0.78
Forest	-0.61	-0.07	0	-9.64	-7	-11.13	0	-17.07	-1.13	-1.75
Juniper	0	0	0	0.02	0	0	0	0.07	0	-0.27
Broadleaf woodland	0	0	0	1.83	0	0.14	0	0.19	5.86	-0.09
Semi-desert	-13.11	17.83	-0.87	0	-9.6	0	-0.1	-0.63	0	-0.53
Desert	0	-0.22	0	0	0	0	0	0	0	0
Marsh	-0.82	2.61	0.11	-1.15	-0.37	0.2	-8.67	-0.12	0	-0.01
Changes 2023-2017, % relative to 2017										
	Araga-tsotn	Ararat	Arma-vir	Geghar-kunik	Kotayk	Lori	Shirak	Syunik	Tavush	Vayotz Dzor
Alpine meadows/carpets	-0.16	-0.16	0.00	-0.02	0.52	0.00	-0.01	-0.23	0.00	-0.03
Subalpine meadows	-0.93	0.00	0.00	-0.82	0.23	-1.55	-5.43	-0.04	-0.03	-0.04
Meadow-steppe	-10.51	0.10	0.00	-4.67	0.10	-6.67	-18.83	-8.01	0.00	-0.03
Steppe	1.19	0.08	0.00	-6.87	-1.39	-11.55	-9.31	-3.20	0.00	-0.10
Forest	-1.23	-0.04	0.00	-2.81	-1.86	-0.90	0.00	-1.26	-0.07	-0.62
Juniper	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.51	0.00	-0.27
Broadleaf woodland	0.00	0.00	0.00	20.80	0.00	0.19	0.00	0.12	0.84	-1.90
Semi-desert	-1.73	3.93	-0.19	0.00	-3.33	0.00	-0.58	-0.54	0.00	-0.14
Desert	0.00	-3.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Marsh	-10.42	4.23	1.44	-1.22	-4.33	0.63	-14.01	-0.92	0.00	-0.68

2.3.E. Reduction of the potential distribution area of vegetation types identified on the 1961 vegetation map

For this analysis, the vegetation map from the 1961 Atlas of the Armenian SSR (1961), digitized by Vardan Asatryan, and the ESRI land cover data for 2023 were used. The current distribution of vegetation types was considered as potential vegetation zones (Figure 23E-1a), excluding croplands and built-up areas based on ESRI data for 2023 (Figure 23E-1b).

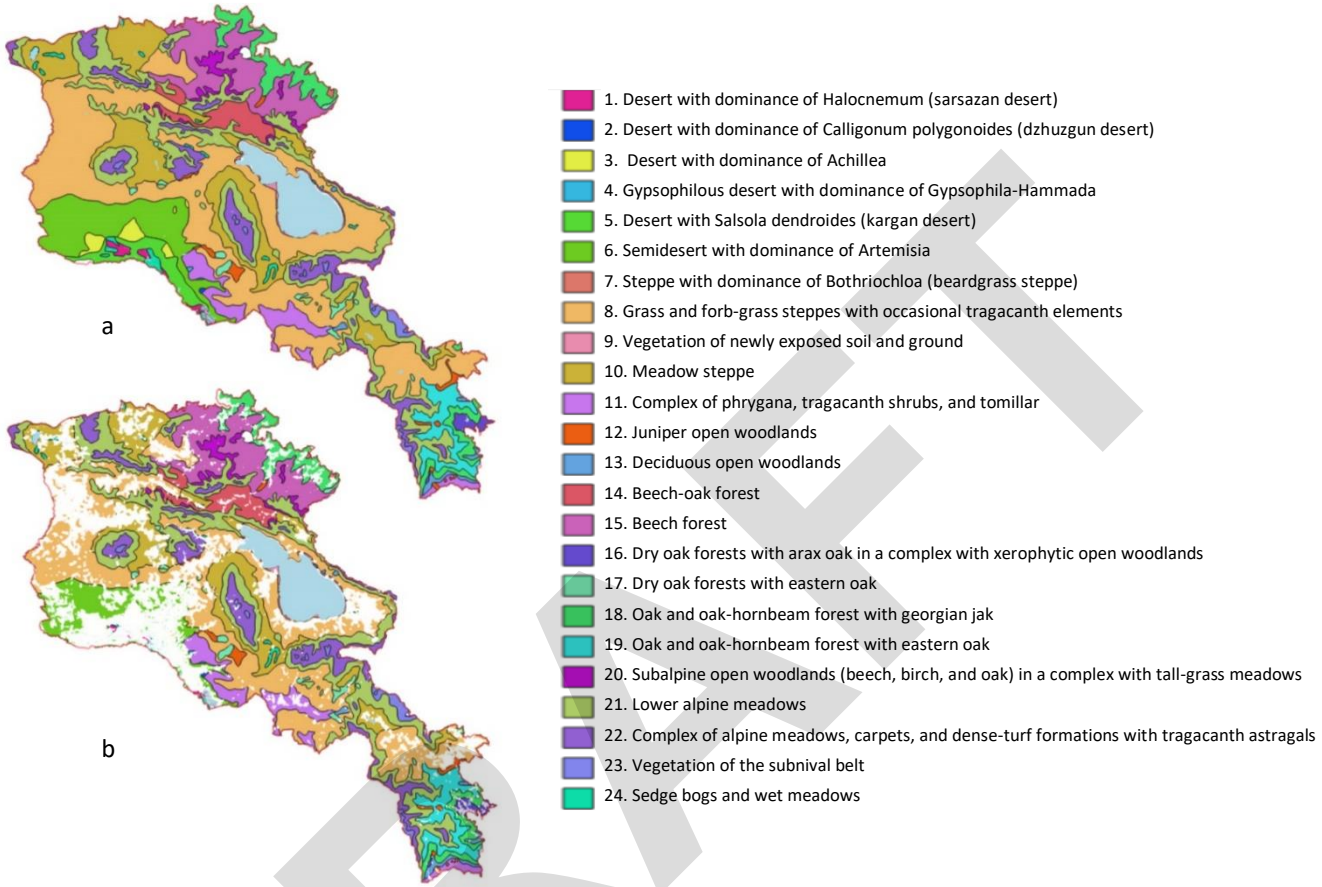

Figure 23E-1. Vegetation map of 1961: a) potential vegetation; b) vegetation excluding croplands and built-up areas in 2023. For detailed maps see in the Section Ecosystem Extent/Vegetation

Ranking of vegetation types by their current rarity (Figure 23E-2) shows that, at present, all desert types (1–5) as well as steppe with dominance of Bothriochloa (type 7) are the rarest. Each of them occupies less than 100 km². The potential distribution areas of the two rarest desert types (2 and 4), each occupying less than 10 km², have largely preserved and mostly not covered by croplands or built-up areas according to ESRI data. The distribution area of steppe with dominance of Bothriochloa (7) also appears to be relatively well preserved.

The most severely affected was the distribution area of desert with dominance of Achillea (3), of which only 7% remains, as well as desert with Salsola dendroides (5), with only 16% remaining. The distribution area of desert with dominance of Halocnemum (1) has also been significantly reduced, with 43% remaining. These three vegetation types have experienced the greatest decline among all types shown on the map.

Relatively rare vegetation types occupying between 100 and 200 km² — deciduous and juniper open woodland (12, 13) and variants of oak forests (16, 17) — have relatively well-preserved distribution areas, with 85–99% remaining.

Among the more widespread vegetation types, occupying between 200 and 1,000 km², a significant reduction was observed only for sedge bogs and wet meadows (type 24), which declined to 63%. The distribution areas of other types — subnival vegetation, subalpine open woodlands, variants of oak and birch-oak forests, as well as shrublands — have been largely unaffected by human activity, with 94–100% of their area remaining intact.

Among the common and widespread vegetation types occupying more than 1,000 km², significant reductions have occurred in semi-desert with dominance of Artemisia (type 6) with 57% remaining and the most widespread vegetation zone - grass and forb-grass steppes (type 8) with 75% remaining, both of which are located in areas of arable agriculture.

Table 23E-1. Potential and current areas of vegetation types and the degree of their preservation

Vegetation zones	*Total potential distribution area, km2*	*Area not occupied by croplands and built-up areas in 2023, km2*	*Area share not occupied by croplands and built-up areas relative to the total potential distribution area, %*
1. Desert with dominance of Halocnemum (sarsazan desert)	135.1	57.5	42.5
2. Desert with dominance of Calligonum polygonoides (dzhuzgun desert)	7.4	6.6	89.6
3. Desert with dominance of Achillea	256.0	17.6	6.9
4. Gypsophilous desert with dominance of Gypsophila-Hammada	9.8	8.1	82.6
5. Desert with Salsola dendroides (kargan desert)	582.7	95.3	16.4
6. Semidesert with dominance of Artemisia	2107.2	1201.5	57.0
7. Steppe with dominance of Bothriochloa (beardgrass steppe)	39.1	31.3	80.0
8. Grass and forb-grass steppes with occasional tragacanth elements	8614.1	6464.9	75.1
9. Vegetation of newly exposed soil and ground	124.5	107.8	86.6
10. Meadow steppe	3347.4	2781.2	83.1
11. Complex of phrygana, tragacanth shrubs, and tomillar	944.1	886.5	93.9
12. Juniper open woodlands	209.5	198.9	94.9
13. Deciduous open woodlands	153.5	151.6	98.8
14. Beech-oak forest	650.5	625.7	96.2
15. Beech forest	1934.6	1884.0	97.4
16. Dry oak forests with arax oak in a complex with xerophytic open woodlands	143.1	121.1	84.6
17. Dry oak forests with eastern oak	200.9	199.1	99.1
18. Oak and oak-hornbeam forest with georgian jak	1252.1	1088.1	86.9
19. Oak and oak-hornbeam forest with eastern oak	737.8	728.2	98.7
20. Subalpine open woodlands (beech, birch, and oak) in a complex with tall-grass meadows	360.6	360.5	100.0
21. Lower alpine meadows	4398.9	4370.6	99.4
22. Complex of alpine meadows, carpets, and dense-turf formations with tragacanth astragals	1932.9	1919.6	99.3
23. Vegetation of the subnival belt	246.7	245.7	99.6
24. Sedge bogs and wet meadows	327.8	207.2	63.2

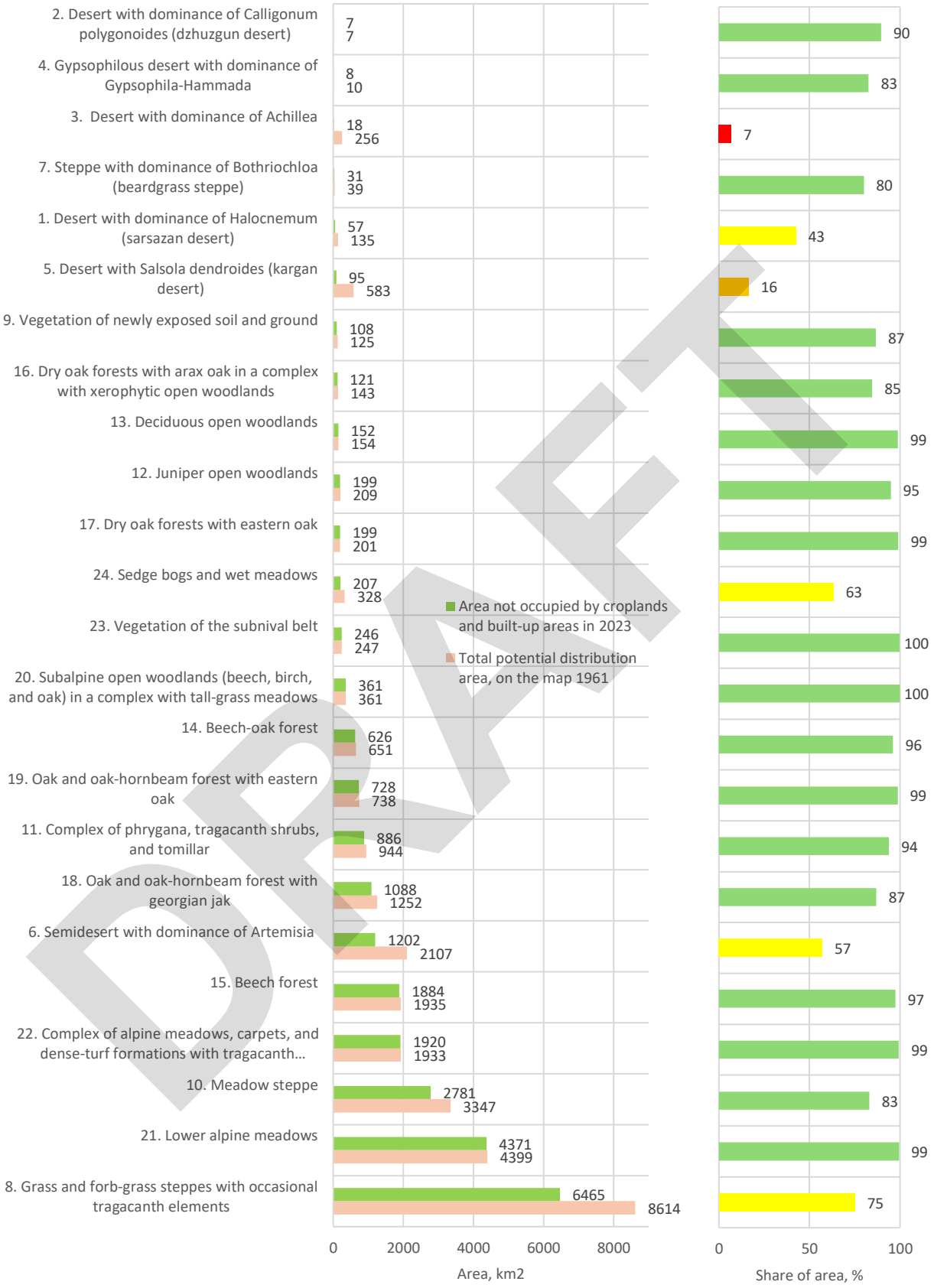

Figure 23E-2. Potential area of vegetation types and their current state: a) potential area of each vegetation type and the area remaining as of 2023; vegetation types are ranked by their rarity in 2023; b) share of the area not occupied by croplands and built-up areas relative to the total potential distribution area, %.