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The Condition of Flora and Vegetation in the Disturbed Lands of the Eastern Fore-Caucasus (As Exemplified by the Kuma Region Landscapes)

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***Abstract* – A large proportion of the Lower Kuma region shows large scale negative changes due to uncontrolled grazing, which are characterized by the emergence of non-stable communities. They feature a poorer composition, a simpler structure and lower values of projective cover, medium height of grass stand, along with its level differentiation. The steppes of the Lower Kuma region are at various stages of grazing succession. Due to this, plant communities that clearly reflect anthropogenic impacts in their structure are widely spread. They include grass and sage, sage (*Artemisia santonica*, *A. austriaca*), pyrethrum *Tanacetum achilleifolium*), and ephemeral communities with a large proportion and an abundance of annual and biennial plants. In these communities, edificators and *Poa bulbosa* that becomes more abundant due to the grazing load play a significant role. Apart from those, the areas affected by grazing are dominated by a group of seasonal ephemera and ophemeroids. In desert steppes, the synusia of primitive steppe subshrub and dwarf shrub is represented by *Ephedra distachya*, *Kochia prostrata*, *Thymus marschallianus*, *Artemisia austriaca*, *A. santonica*, *Tanacetum achilleifolium*. Subsaline soils are dominated by *Artemisia santonica*, and the worn-down pastures are dominated by the sobiliferous *A. austriaca*. Excessive grazing load leads to the quick disappearance of a large number of steppe species from the grass stand. The comparison of the floristic lists of plant communities at various stages of pastoral digression shows that there is a large proportion of low-value ungrazed plants that are resistant to trampling and have a wide tolerance range in the grass stand. Near the sheep pens and settlements, pasture species that cover most of the land are the main pricing factors. These species are indifferent to soil conditions, community types and can be encountered quite frequently.**

Keywords: the Kuma, Eastern Fore-Caucasus, anthropogenic pressure, steppe vegetation, pastoral digression

I. INTRODUCTION

It is a broadly known fact that in the steppe area, agricultural lands and natural landscapes are extremely unstable and degrade steadily. These processes run against the background of an acute shortage of pastures and hayfields, as well as the destruction of the steppe biome. In areas of intensive agriculture, an overwhelming proportion of steppe plots serve as hayfields and pastures. The question of preservation of the biodiversity and the ecosystem of steppes is often denied discussion. This problem is highly pressing for the Eastern Fore-Caucasus, a traditional center of transhumant grazing, where pastoral digression is a sustained phenomenon.

They main orographic unit of this region is represented by the alluvial plain of the river Kuma. Landscapes formed on the flat surface of the clay plain are intersected by the branching gullies formed by the spurs of the Kuma region elevation. In general, the Kuma region has man-acquired landscapes, whose natural functions are largely weakened by land management practices (irrigation, oil prospecting, grazing, etc). All of these result in the water table rise, salification, disturbance and degradation of soils and vegetation cover across a large territory.

The heaviest anthropogenic load is typical of the pasture ecosystems in the Lower Kuma valley. According to V. A. Shalnev [1], up to 65% of the landscapes in the lower Kuma region are used as distant pastures.

The previous publications on the flora and vegetation of the Kuma region are few in numbers and general and descriptive in nature, i.e. the vegetation itself is characterized quite poorly in them. The latest data on the vegetation cover in zoned and secondary steppes of the Kuma region are presented in the works by V. N. Belous [2, 3], V. N. Belous, K. Yu. Lotiyev [4]. They show the

differences in the character of the vegetation depending on the ecological conditions of the area.

The flora and vegetation cataloging of the remaining dry steppe landscapes shows that plant communities degrade and simplify in composition over a huge territorial span, and the natural and agricultural potential of the soils is being reduced. The land area proportion of barren and secondary low-yield soils with sparse grass stand is increasing [5].

The goal of our research is to evaluate the current condition of the flora and the vegetation of the disturbed territories as exemplified by the pastures in the lower Kuma region.

II. Materials and Methods (Model)

The main factual basis of the research is the data collected by the authors in 2019 during the field research of the landscapes in the lower Kuma region (Levokumskiy district of the Stavropol territory).

The landscape of this territory is dominated by marine lowlands with fluctuations of the height of 20 m; the climate is continental arid; the average temperature for June is 25° C, for January it is -4–5° C; the humidity factor is 0.3-0.35, which is typical of an arid region [1]. The vegetation cover is formed under the conditions of arid continental climate with an acute shortage of soil moisture. The dominant vegetation is typical of desert steppe with light chestnut soils of various alkalinity and texture. The source beds are clay.

Natural communities are fragmentary and they are hemmed in between farming ecosystems and technologically disturbed lands. In the majority of the preserved areas, plant communities suffer from a significant grazing load, which is especially strong near settlements. These places also feature scant vegetation and degraded soils [6].

Our field research dealt with finding out the key patterns of flora composition and features of degraded community structure. This work is based on geobotanical descriptions of communities in seven key areas that represent key landscape facies along edaphic and ecological gradients and various types of soil and vegetation cover.

We analyzed plant communities using common geobotanical methods [7]. The proportion of a species in the vegetation was evaluated according to its coverage. The data received in geobotanical descriptions were presented in the master table. It shows the points of projective cover for plants included at the trial plot: + – specimens cover less than 1% of the plot; 1 point – specimens cover 1–4 % of the plot; 2 points – 5–9 %; 3 points – 10–24%; 4 – 25–49%; 5 points – 50–74%; 6 –75–100%. The research plots were 10×10 m in size. Each of the plots within the key areas had its coordinates, absolute altitude above sea level and general projective cover (GPC) calculated.

III. Results and Discussion

Location of the key areas.

Area 1: Stavropol territory, Levokumskiy district, 1 km to the southeast of the Nikolo-Aleksandrovskoye village. A derivative community of ephemera spurge and achilleafolious plants (*Achillea biebersteinii – Euphorbia seguieriana – Ephemeretum herbae*). This area underwent the strongest transformation by grazing. Poorly grass-lined spots are present. There are three levels to be found in the grass stand: the upper one (30-35 cm high), sublevel comprised of *Achillea biebersteinii*, *Euphorbia seguieriana*; the medium one (20-22 cm) of *Poa bulbosa*, *Ranunculus oxyspermus*; the lower one (5-7 cm) of smaller ephemera. Clay-loam soils. Communal pasture used for a long time; excessive grazing load (cattle and sheep). N 44º56´80"; E 44º31´25,4", 92 m above sea level.

Area 2: Stavropol territory, Levokumskiy district, 4 km to the northeast of the Nikolo-Aleksandrovskoye village. The flattened left slope of a small steppe gulch of Kurunta with small salt gardens. Sedge (*Carex stenophylla*) community, previously used for sheep feeding in free livestock management (natural pasture near sheep pens). The general height of the grass stand is 20-25 cm. Minimum grazing stage. Meadow chestnut soil, interspersed with salt gardens. N 44º58´45,6"; E 44º28´29,2", h = 93 m above sea level.

Area 3: Stavropol territory, Levokumskiy district, 3 km to the northeast of the Nikolo-Aleksandrovskoye village. Smaller salt gardens on the flattened left slope of a small steppe gulch of Kurunta. A community of wheatgrass, sedge, and pyrethrum (*Tanacetum achilleifolium – Carex stenophylla – Agropyron pectinatum*) with a significant proportion of *Achillea biebersteinii* and the plants of ephemera and ephemeroid groups. The upper sublevel (35-45, up to 50 cm) is formed by *Agropyron pectinatum*, *Achillea biebersteinii*; the medium level (25-30 cm) by *Tanacetum achilleifolium*, *Poa bulbosa*, species of the genus *Tulipa*; the lower one (20 cm) by *Carex stenophylla*. This community features a complex structure of the grass stand. This plant community is characterized by tesselation due to the horizontal heterogeneity of the topsoil and the subsequent spatial differentiation of vegetation. The typical elements of the tesselation are the aggregations of poorly halophilic dwarf shrub *Tanacetum achilleifolium*. They form small-scale plant groupings covering the community area in non-uniform patterns of spots of various sizes. This can be due to the contagious localization of saliferous soil. Up until recent times, the plot was used for free sheep farming (pastures near sheep pens). Meadow chestnut soil, interspersed with salt gardens. N 44º58´45,4"; E 44º28´31,1", 93 m above sea level.

Area 4: Stavropol territory, Levokumskiy district, 2-2.5 km to the west of Nikolo-Aleksandrovskoye village. A community of chamomile, bluegrass and santonous sage (*Artemisia santonica – Poa bulbosa – Tanacetum achilleifolium*) with a significant proportion of ephemera. This area underwent the strongest transformation by grazing. This effectively single-leveled (30 cm), tessellating grass stand is formed by the dominant species of euxerophilous dwarf shrubs, such as *Artemisia santonica* and *Tanacetum achilleifolium*, as well as the hemiephemeroid *Poa bulbosa*. There are also scant specimens of bulbous geophytes (*Ornithogalum kochii*, *Tulipa biebersteiniana*, *T. gesneriana*). The moss-like cover is clearly present (up to 15% coverage). It is an old pasture located near sheep pens. Light loamy and alkaline soils. N 44º58´7,7"; E 44º28´32,9", 89 m above sea level.

Area 5: Stavropol territory, Levokumskiy district, 1.5 km to the north of Pravokumskoye village. The upland fringe of the Kuma. A community of poor herbage, sage, ephemera and camelthorn (*Alchagi pseudoalchagi – Poa bulbosa + Anisanta tectorum + Bromus squarrosus + Hordeum leporinum – Artemisia austriaca*) complemented with yarrow. The GPC is mostly maintained by poorly-grazed and ungrazed steppe herbage. There are two main levels in the grass stand: the upper one (50-60 cm high) comprised of *Alchagi pseudoalchagi*, *Elytrigia pseudocaesia*; and the lower one (20-30 cm) of *Artemisia austriaca*, *Achillea biebersteinii*, *Poa bulbosa*. Clay-loam soils. Communal pasture at a moderate grazing stage (cattle). N 44º47′8,1"; E 44º39′15,4", 54 m above sea level.

Area 6: Stavropol territory, Budennovskiy district, near the hamlet of Polynovskiy, Praskoveyskiye heights in the Kuma elevation. A gulch slope of up to 25-30° exposed to the north. A community of herbage (*Herbae stepposae*) and bunchgrass, close to autochthonous sub-zone plant communities. Remains in gulches only. This community is distributed locally in the region. The edificatory synusia is represented by bunchgrass graminoids: *Festuca valesiaca*, *Stipa lessingiana*, *Agropyron pectinatum*, *Koeleria cristata*. Steppe herbage co-dominates the area. The grass stand has a complex structure with level differentiation. There are three levels in the grass stand: the upper one (50-55 cm high) of *Agropyron pectinatum*, *Jurinea arachnoidea*; the medium one (25-30 cm) of *Alchagi pseudoalchagi*, *Festuca valesiaca* (generative shoots), *Stipa lessingiana*, *Artemisia santonica*, *Euphorbia seguieriana*, *Thymelaea passerina*, *Poa bulbosa*; the lower one (10-15 cm) of the leaves of *Festuca valesiaca*, *Medicago caerulea*, *Astragalus calycinus*, *A. pseudotataricus*, *A. dolichophyllus* etc.). The bulbous geophyte group is represented by single specimens (*Gagea pusilla*). The moss cover is clearly present (up to 20% coverage). Sandy-loam soils. Small traces of grazing. N 44º46′49"; E 44º17′39", 100 m above sea level.

Area 7: Stavropol territory, Budennovskiy district, near the hamlet of Polynovskiy, Praskoveyskiye heights. Erosion desiccated gulch landscape. A south-facing gulch slope of up to 45° with poor grass lining. A wheatgrass (*Agropyron pectinatum*) community. Differentiating levels, species not numerous. The upper level (50 cm high) comprises xerophilous *Agropyron pectinatum*, *Kochia prostrata*; the lower one (25-30 cm) comprises *Alchagi pseudoalchagi*, *Allium paczoskianum*, *Artemisia santonica*, *Bromus squarrosus*, *Poa bulbosa*, *Thymelaea passerina*. The perennial steppe herbage group is poorly represented. Clay-loam, silt soils. Low grazing stage. N 44º77′95"; E 44º29′42,8", 100 m above sea level.

TABLE I. THE FLORISTIC LIST OF PLANTS FOUND IN THE RESEARCH PLOTS

General projective cover, %	up to 30	60-70	60-70	40-50	60-65	50-60	30-35
Number of species in plot	22	27	22	21	34	45	18
Description number	1	2	3	4	5	6	7
Subshrubs, dwarf shrubs							
Artemisia austriaca	.	+	1	.	1	1	.
Artemisia santonica	.	.	.	5	.	1	2
Ephedra distachya	.	.	.	.	.	+	.
Kochia prostrata	.	.	+	.	.	1	+
Tanacetum achilleifolium	.	2	4	3	3	1	.
Thymus marschallianus	.	.	.	.	.	1	.
Graminoids, sedges							
Aegylops cylindrica	+	+	.	+	+	+	+
Agropyron pectinatum	.	.	2	.	.	2	3
Anisanta tectorum	.	.	.	.	1	+	.
Bromopsis riparia	.	.	.	.	.	+	.
Bromus squarrosus	1	+	.	1	1	1	2
Carex stenophylla	1	4	1	1	1	.	.
Cynodon dactylon	1	.	.	.	1	.	+
Elytrigia pseudocaesia	+	.	.	.	1	.	.
Elytrigia repens	.	.	.	.	+	.	+
Festuca valesiaca	.	.	.	.	.	2	+
Hordeum leporinum	+	+	+	.	+	+	.
Koeleria cristata	.	.	.	.	.	1	.
Poa bulbosa	2	3	2	2	1	2	2
Stipa lessingiana	.	.	.	.	.	2	.
Legumes							
Alchagi pseudoalchagi	.	.	.	.	3	1	1
Astragalus calycinus	.	.	.	.	.	1	+
Astragalus dolichophyllus	.	.	.	.	.	1	+
Astragalus pseudotataricus	.	.	.	.	.	1	+
Medicago caerulea	.	.	.	.	.	2	.
Medicago minima	2	+	.	.	+	1	1
Melilotus officinalis	.	.	.	.	.	1	.
Trigonella monspeliaca	.	.	.	.	.	+	.
Trigonella orthoceras	1	.	+	+	.	.	.
Vicia sativa	.	.	.	.	.	+	.

Herbage							
Achillea biebersteinii	3	1	1	.	1	.	.
Achillea nobilis	.	.	.	.	.	1	.
Ajuga chia	.	.	.	+	.	.	.
Allium paczoskianum	.	.	.	+	.	.	+
Alyssum desertorum	1	1	1	.	1	1	1
Amaranthus blitoides	+	+	+	.	.	.	.
Anthemis ruthenica	.	.	.	.	1	.	.
Arenaria serpyllifolia	+	.	.	.	+	.	.
Asparagus officinalis	.	.	.	.	.	+	.
Cardaria draba	1	.	.	.	1	+	+
Carduus acanthoides	+	+	.	.	+	.	.
Carlina vulgaris	.	+	.	.	1	.	+
Centaurea diffusa	.	.	.	.	+	+	.
Cerastium glutinosum	+	.	.	.	.	+	.
Ceratocarpus arenarius	.	.	.	.	.	+	.
Chondrilla juncea	1	+	.	+	.	.	.
Chorispora tenella	.	+	+	.	.	.	.
Chorispora tenella	.	.	.	.	.	+	.
Colchicum laetum	.	.	.	.	.	+	.
Consolida orientalis		.	.	.	+	.	.
Convolvulus arvensis	+	+	.	.	+	.	+
Cynanchum acutum	.	.	.	.	.	+	.
Descurainia sophia	.	.	.	.	.	+	.
Dianthus pallens	.	.	.	.	.	1	.
Erodium ciconium	.	.	+	.	.	.	.
Erodium cicutarium	+	.	.	.	+	+	+
Eryngium campestre	.	.	.	.	.	+	+
Euphorbia humifusa	+	+	.	+	.	+	.
Euphorbia seguieriana	2	1	.	+	.	1	.
Falcaria vulgaris	+	1	.	.	.	+	.
Gagea pusilla	.	.	.	.	.	+	.
Galium humifusum	.	.	+	+	+	1	.
Galium tenuissimum	.	.	.	.	.	1	.
Geranium pusillum	+	+	.	.	+	.	.
Herniaria besseri	.	.	.	+	.	.	.
Holosteum umbellatum	+	.	.	.	.	+	.
Inula britannica	.	.	.	.	+	.	.
Jurinea arachnoidea	.	.	.	.	.	1	.
Lactuca serriola	+	.	.	.	.	+	.
Lagoseris sancta	+	.	.	.	+	.	+
Lappula patula	.	+	.	.	.	+	+
Linum austriacum	+	.	.	.	.	.	.
Nonea lutea	.	.	.	.	.	.	+
Malva neglecta	.	.	.	.	.	.	+
Matricaria recutita	.	.	.	.	.	.	+
Meniocus linifolius	.	.	.	.	.	.	+
Microthlaspi perfoliatum	+	.	.	.	+	.	.
Onopordon acanthium	+	+	.	+	.	.	+
Ornithogalum kochii	.	.	+	+	.	.	.
Peganum harmala	1	.	.	.	.	+	.
Phlomis pungens	.	+	+	1	.	+	+
Pleconax conica	.	.	.	.	.	+	.
Podospermum laciniatum	+	+	.	.	+	.	.
Polygonum aviculare	.	+	+	+	.	.	.
Polygonum bellardii	.	.	.	.	.	.	+
Ranunculus oxyspermus	1	.	.	1	+	1	.
Rochelia retorta	.	.	.	.	+	.	.
Salvia tesquicola	.	.	.	.	.	+	.
Scorzonera stricta	.	.	.	.	.	.	.
Senecio vernalis	+	.	.	.	.	+	.
Sisymbrium altissimum	.	+	+	+	.	.	.
Sisymbrium loeselii	.	.	.	.	.	.	+
Solanum cornutum	+	.	.	+	.	.	.
Taraxacum erythrospermum	+	+	+	+	+	.	.
Thymelaea passerina	.	.	.	.	.	1	1
Tragopogon dasyrhynchus	.	.	.	.	.	+	.
Tragopogon dubius	.	+	.	.	.	.	.
Tribulus terrestris	+	.	.	.	.	.	.
Tulipa biebersteiniana	.	.	1	.	.	.	.
Tulipa gesneriana	.	.	+	.	.	.	.
Veronica polita	+	.	.	.	.	.	.

Veronica spicata	.	.	.	.	.	+	.
Veronica verna	1	1	1	1	+	1	+

Note. 1. +, 1, 2, 3 points are given for species found beyond the plot; 2. Description authors:

1-5 – V. N. Belous, A. V. Lykhvar (01.VI.2019); 6-7 – V. N. Belous (05.VI.2019).

IV. CONCLUSIONS

1. A large proportion of the territory in the Lower Kuma region experiences adverse changes due to the depletion of the composition and the simplification of the structure of the local plant communities against the background of uncontrolled grazing [7], [8]. This, in its turn, leads to the formation of unsteady communities and possibly a new succession that is not balanced with the given environment factors. Taking into consideration the exceedance of anthropogenic impact standards, the role of the human factor in these processes should not be underestimated. It must be considered significant as compared with natural external processes taking place in the ecosystem of Fore-Caucasus steppes.

2. Regarding the degree of disturbance of the vegetation and soil cover, the anthropogenically-changed plant communities of the landscapes of the Lower Kuma region can be classified as moderately and heavily transformed. Depending on the composition of the edificator species and the stages of pastoral succession, the steppe communities of the Lower Kuma region are represented by the main regional formations: poor herbage and graminoid (wheatgrass, needlegrass, sheep fescue); graminoid-sage; sage; pyrethrum and ephero-ephemeroid, that succeed each other [9]. These plant community groups make the anthropogenic impact clear in their structures, and they are widely spread in the region and are a typical element of the vegetation cover in local landscapes.

In these communities, edificators and such assectators as *Poa bulbosa* that becomes more abundant due to the grazing load play a significant role. In the landscapes with satisfactory preservation of vegetation, subzonal graminoids and herbage (including leguminose grasses) increase their presence. Due to the excessive grazing load, a large number of steppe species quickly disappear from the grass stand.

3. The synusial plant community structure is one of the features of vegetation structure and composition patterns of the landscapes in the Lower Kuma region. Seasonal synusia of various ephemera is clearly evident (*Ajuga chia*, *Alyssum calycinum*, *Anisantha tectorum*, *Bromus squarrosus*, *Cerastium glutinosum*, *Chorispora tenella*, *Holosteum umbellatum*, *Lappula patula*, *Medicago minima*, *Rochelia retorta*, *Trigonella monspeliaca*, *Veronica dillenii*, etc.). These species are the dominant life forms in the areas affected by grazing. Some of the species are quite abundant, but they make up a large proportion of the vegetation cover only in late spring and early summer. A common plant group uniting the communities in question is xeromorphic arborous forms that shape the synusia of primitive steppe subshrubs (*Ephedra distachya*) and dwarf shrubs (*Kochia prostrata*, *Thymus marschallianus*, *Artemisia austriaca*, *A. santonica*, *Tanacetum achilleifolium*). The last three, as a rule, form mono- or oligodominant communities of poor floristic composition: santonous sage (*Artemisia santonica*), sage (*A. austriaca*), pyrethrum (*Tanacetum achilleifolium*), (depending on the degree of grass stand digression) with a large proportion of annual bromes (*Bromus squarrosus*, *Anisanta tectorum*) and other annual and biennial plants. Subsaline soils are dominated by *Artemisia santonica*, and the worn-down pastures are dominated by the sobiliferous *A. austriaca*. Virgin land species are sparse and non-abundant.

4. The plant communities under investigation feature relatively low values of projective cover, medium grass stand height and level differentiation [10], [11].

5. The comparison of the floristic lists of plant communities at various stages of pastoral succession shows that there is a large proportion of low-value weeds that are resistant to trampling and have a wide tolerance range in the grass stand (thorny, poisonous and other ungrazed plants): *Solanum cornutum*, *Peganum harmala*, *Phlomis pungens*, виды родов *Achillea* и *Artemisia*, *Carduus acanthoides*, *Carlina vulgaris*, *Centaurea diffusa*, *Cynanchum acutum*, *Eryngium campestre*, *Salvia tesquicola*, *Thymus marschallianus*, etc. In a number of plots with degraded grass stand, near sheep pens and settlements, pastoral species act as the main pricing factors because they have a significant proportion of the total biomass.

Weed synusia is always clearly evident; the species of this group are mostly indifferent to soil conditions, community types and can be encountered quite frequently.

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