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SUAEDETA DESERT VEGETATION IN AZERBAIJAN: GEOBOTANICAL ANALYSIS AND SUSTAINABLE UTILIZATION STRATEGIES

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SUMMARY

Field geobotanical studies revealed that desert vegetation (*Suaedeta*) has the dominance of the genus *Suaeda* Forsk. ex Scop. Species, conducted in 2024–2025 in the winter pastures of the Shirvan Plain, Azerbaijan. The studies recorded formations where *Suaeda* species acted as edificators, specifically within the formations of *Suaedeta-Halostachysetum*, *Suaedeta-Salsolosum*, and *Artemisieta-Suaedetum*. The species composition, structure, productivity, forage quality, and grazing capacity received analysis and measurement for their efficient use. In desert vegetation, such geobotanical study was of greater relevance for sustainable use of summer and winter pastures and hayfields and combating desertification in Azerbaijan. These results will improve the understanding of desert vegetation dynamics in semi-arid regions. They will also provide data relevant to the United Nations Sustainable Development Goals (UN SDGs), specifically SDG 2 through quantified grazing capacity and forage biomass and SDG 15 through the conservation of Red Book species and halophytic desert indicators. In previous studies on desert vegetation in Azerbaijan, specific data on phytocoenological structure, forage productivity, and grazing capacity of *Suaeda*-dominated communities was insufficient in the winter pastures of the Shirvan Plain. Therefore, this study will provide the first detailed phytosociological classification and quantitative assessment of specific formations' biomass and grazing capacity, establishing a vital baseline for sustainable pasture management and desertification mitigation.

Keywords: Suaedeta desert vegetation, formations, species, pasture, hayfield, edificatory, SDG-2, SDG-13, SDG-15

Key findings: Suaedeta desert vegetation, comprising winter pastures in the Shirvan Plain, Azerbaijan, appeared to be compositionally rich in valuable forage species, primarily cereal grasses, and especially legumes and forbs.

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INTRODUCTION

Geobotanical studies are of greater ecological and economic importance for environmental protection and the sustainable use of vegetation cover in winter pasture areas (Asadova, 2021 and 2026; Gurbanov et al., 2024). Presently, the conduct of geobotanical research is in accordance with the Clause 7.3.4 of the 'Action Plan of the Strategic Road Map on Production and Processing of Agricultural Products in the Azerbaijan,' approved by Presidential Decree No. 1138, dated December 06, 2016 (Strategic Road Map, 2016). Likewise, it aligns with the 'State Program for the Development of the Real Estate Cadastre System and the Increase of Efficiency in Land Use and Protection in the Azerbaijan for 2016–2020' (State Program, 2016).

In the winter pastures of the Shirvan Plain, the study comprised the efficient utilization of desert vegetation dominated by *Suaeda* species as the primary issue, especially as a natural forage resource for the development of sheep farming (Alosmanova and Bakhshiyev, 2024; Mammadova, 2024; Mammadova, 2025). The said task has undergone studies, as addressed in accordance with the abovementioned laws and programs. Therefore, these present results of the geobotanical (or phytosociological) studies can be beneficial for economic, regulatory, and ecological assessment, as well as for the development of the well-managed information system.

The Shirvan Plain, located within the Kur-Araz lowland, covers an area of 613,321 hectares (Figure 1). The formation of its relief has had considerable influences from the integrated activities of rivers flowing from the Greater Caucasus Mountains in the north, including the Alinjachay, Turyanchay, Goychay, Girdimanchay, Aghsuchay, and Pirsaaatchay. The elevation of the said area ranges from 180 to 200 meters above sea level (masl) in the north and gradually decreases to about 28 meters near the Kur River (Bakhshiyev, 2009).

According to a previous study, the genus *Suaeda*, with species belonging to the family Amaranthaceae, forms distinct plant communities in the plains of Shirvan, Salyan,

and Mughan (Asgarov, 2016). Based on this systematic approach, the genus *Suaeda* has 10 important species representing it in Azerbaijan. However, according to the *Flora of Azerbaijan* (eight volumes), the *Suaeda* genus distribution revealed a recording of seven species in these plains (Flora of Azerbaijan, 1950–1961). According to E.M. Gurbanov's monograph 'Vegetation of Azerbaijan,' the genus *Suaeda* species attained representations of 12 formation classes and 60 formation groups in saline desert vegetation (Gurbanov, 2024).

Earlier findings enunciated that these plants were particularly important for the improvement of natural forage lands in Azerbaijan (Gurbanov and Jabbarov, 2017; Gurbanov and Asadova, 2017; Alosmanova and Bakhshiyev, 2024; Alosmanova et al., 2025). With their highest forage value, these forage species can significantly enrich the herbaceous cover in the studied areas. Therefore, the following research in desert vegetation aimed to study the species composition and structure of phytocoenoses formed by the genus *Suaeda* in the Shirvan Plain, Azerbaijan.

MATERIALS AND METHODS

The pioneering study aimed to investigate the desert vegetation formed by the *Suaeda* genus species in the Shirvan Plain, Azerbaijan, especially the characteristic areas of the winter pastures numbered 7, 31, and 71 within the Yevlakh District, selected as research objects. Field research proceeded in accordance with the national guidelines and methodological instructions for the geobotanical study of natural pasturelands (Instruction, 2002 and 2004). The naming of geobotanical taxa, including formations and associations, was dependent on the genus and species. For each formation group, species composition and phytocoenological structure (abundance and stratification) and phenological phases, as well as biomorphological and ecological traits of the species, received analysis. The productivity of the formations, as determined, used mowing and model plot methods (Hatemo, 2000; Stevens, 2015).



Figure 1. Map of the Shirvan Plain.

The collected herbarium specimens entailed identification according to systematic taxa (Serebryakov, 1964; Novruzov, 2010; Mammadova *et al.*, 2017; Mammadova, 2020 and 2021), with the different plant names standardized using the APG IV system and the IPNI electronic database (<https://www.ipni.org/>). The study of rare and endangered plant species succeeded in using the guidelines provided in the references 'Vegetation of Azerbaijan' (Gurbanov, 2024) and the 'Red Book of Azerbaijan' (The Red Book of Azerbaijan Republic, 2023).

However, several research works by Azerbaijani botanists refer to *Suaeda*-dominated desert vegetation (Aghaguliyev, 2001; Aliyev, 2007). Therefore, according to these present research objectives, geobotanical investigations progressed at the selected sample plots (referred to as 'research objects') in the genus *Suaeda*-dominated phytocoenoses across the winter pastures of the Yevlakh District (Plan of Shirvan Steppe, 1982). All these studies continued in a semi-stationary manner along designated routes during 2024 and 2025.

For the field phase of geobotanical studies, the study used the 1:50,000 scale 'Soil Map of Yevlakh District,' as well as the 1:5,000,000 and 1:200,000 scale 'Map-schemes of Shirvan Winter Pastures.'. The research objectives included phytocoenological classification of vegetation by type, formation, and association; documentation of species

composition and structural characteristics of the formations using standard data sheets; assessment of the productivity, nutritional values, and grazing capacity of the vegetation formations; and the development of classical measures for improvement in the sustainable use of pastures based on geobotanical indicators. As a result of this study, one type, three formation classes, three formation groups, and three associations dominated by the *Suaeda* genus species obtained classification within the desert vegetation of the winter pastures in the Yevlakh Region, Azerbaijan.

The investigation of species composition, structure, and productivity of the *Suaeda*-dominated desert vegetation sought to establish representative sampling areas within the winter pastures Nos. 7, 31, and 71 of the Yevlakh District. Geobotanical descriptions and phytocoenological classifications took place on 10 m × 10 m sample plots. The random placing of 1 m × 1 m subplots within each main sampling area aimed to determine the aboveground phytomass (productivity), with 3 to 5 replications per plot. Accounting for variations in soil salinity and relief, studies ensued on representative plots totaling five to seven for each formation group.

The aboveground dry biomass determination used the mowing and model plot method. Plants within the 1 m × 1 m subplots received cutting at a height of 3–5 cm from the ground surface. The harvested biomass, sorted

into botanical groups (cereals, legumes, and forbs), underwent air-drying before being oven-dried at 105 °C to a constant weight to determine the dry mass (t/ha) (Mammadova et al., 2024).

RESULTS AND DISCUSSION

The study, comprising winter pastures in the Yevlakh Region, succeeded in the northwestern part of the Kur-Araz lowland, within the Shirvan Plain, Azerbaijan. The geographical position, relief, soil, and climatic conditions of the study area considerably influence the formation of *Suaeda*-dominated desert vegetation, including the formations *Suaedeta-Halostachysetum*, *Suaedeta-Salsolusum*, and *Artemisieta-Suaedetum*. The studied region has characteristics of a dry subtropical steppe climate with dry winters, low humidity, and an annual average temperature and precipitation of 14.6 °C and 322 mm, respectively. Past studies enunciated that these climatic features directly affect the species composition, structure, productivity, forage quality, and grazing duration of plant communities in the Yevlakh Region (Bakhshiyev, 2009). Similar ecological patterns in the Kur-Araz lowland emphasize that arid climate and soil salinity were the main contributing factors determining the formation and distribution of halophytic vegetation (Gurbanov, 2024). Past findings also revealed desert and semi-desert phytocenoses of this region have significant control from low precipitation and temperature regimes, influencing the existing species composition and productivity, which are consistent with the present results (Asadova, 2026).

Based on phytosociological principles, modern geobotanical classification of genus *Suaeda*-dominated vegetation at the formation level has reached development for the winter pastures of the Shirvan Plain, as presented below:

Type: *Suaeda*-dominated desert vegetation
I. Shrubby-subshrubby *Suaeda* desert formation class

I.1. *Suaedeta halostachysetum* formation group

A. *Suaedeta microphylla*-*Halostachysetum belangeriana* association

II. Shrubby-semi-shrubby *Suaeda* desert formation class

II.1. *Suaedeta salsolatum* formation group

A. *Suaedeta dendroides*-*Salsolatum dendroides* association

III. Perennial-annual herbaceous *Suaeda* desert formation class

III.1. *Artemisieta-Suaedetum* formation group

A. *Artemiseta lerchiana*-*Suaedetum confusa* association

Hierarchical classification of vegetation based on phytosociological principles has received wide support in geobotanical studies, where using diagnostic species and ecological conditions sought to differentiate the formation units (Novruzov, 2010; Gurbanov and Jabbarov, 2017). Moreover, recent similar classification approaches for desert and semi-desert vegetation of Azerbaijan have been applicable, confirming the differentiation of *Suaeda*-dominated communities at formation and association levels (Alosmanova and Bakhshiyev, 2024). These pastures had boundaries by Pasture No. 71. The pastureland comprises three main sections: a) Pasture No. 7 'Guneyyataq' (168.0 ha), located to the right of the Yevlakh-Khaldan highway; b) Pasture No. 31 'Qushchu' (744.0 ha), to the left of the highway; and c) Pasture No. 71 'Ojaqli' (1718.0 ha), located to the south of the Mingachevir Reservoir.

During the study, the formation indices within the *Suaeda*-dominated desert vegetation type underwent determination, along with their species composition (including biomorphological and ecological groupings), as well as the abundance, stratification, and phenological phases of plant species. The shrubby-subshrubby *Suaeda* desert formation class has the representation of the formation group *Suaedeta-Halostachysetum*, specifically by the *Suaedeta microphylla*-*Halostachysetum belangeriana* association. This phytocoenosis attained its recording on saline soils in the winter-pasture area No. 31 on April 25, 2025.

Notably, the studied phytocoenoses serve as critical habitats for several rare and endangered species listed in the Red Book of Azerbaijan (3rd Edition, 2023), including

Table 1. Geobotanical description based on species composition and structure of *Suaedeta-Halostachysetum* formation.

No.	Biomorph species	Ecological groups	Abundance	Average height (cm)	Phenological phases
1	2	3	4	5	6
<i>Shrubs</i>					
1	<i>Halostachys caspica</i> (Moq.) Batsch.	halophyte	3-4	I (130)	veg.
2	<i>Tamarix ramosissima</i> Ledeb.	mesoxerophyte	1-2	I (200)	fl.
3	<i>Lycium ruthenicum</i> Murr.	xerophyte	1	I (150)	fl.
4	<i>Halocnemum strobilaceum</i> (Pall.) Bieb.	halophyte	1	II (60)	veg.
<i>Semishrub</i>					
5	<i>Caroxylon dendroides</i> (Pall.) Tzvelev	mesoxerophyte	1-2	II (70)	veg.
<i>Subshrubs</i>					
6	<i>Suaeda microphylla</i> Pall.	halophyte	2-3	II (40)	veg.
7	<i>Caroxylon ericoides</i> (M.Bieb.) Akhani&Roalson	halophyte	1-2	II (50)	veg.
8	<i>Kalidium caspicum</i> (L.) Ung.-Sternb.	halophyte	1	II (35)	veg.
<i>Perennials</i>					
9	<i>Limonium scoparium</i> (Pall. ex Willd.) H.Arnaud	halophyte	1-2	II (45)	veg.
10	<i>Artemisia lerchiana</i> Web.	xerophyte	1-2	III (30)	veg.
11	<i>Alhagi pseudoalhagi</i> (Bieb.) Fissch.	mesoxerophyte	1	II (50)	veg.
12	<i>Capparis herbacea</i> Willd.	xerophyte	1	II (40)	fl.
13	<i>Aeluropus litoralis</i> (Gouan.) Parl.)	halophyte	1	II (35)	fl.
14	<i>Cynodon dactylon</i> (L.) Pers.	mesophyte	1	III (30)	fl.
<i>Biennials</i>					
15	<i>Erysimum cuspidatum</i> (Bieb.) DC.	mesoxerophyte	1	III (25)	fl.
<i>Annuals</i>					
16	<i>Petrosimonia brachiata</i> (Pall.) Bunge.	halophyte	1-2	III (30)	veg.
17	<i>Bromus japonicus</i> Thunb.	xerophyte	1-2	III (25)	fl.
18	<i>Climacoptera crassa</i> (Bieb.) Botsch.	halophyte	1-2	III (20)	veg.
19	<i>Eremopyrum orientale</i> (L.) Jaub. et Spach.	halophyte	1-2	III (15)	fl.
20	<i>Xanthium strumarium</i> L.	xerophyte	1	II (40)	fl.
21	<i>Lolium rigidum</i> Gaudin.	xerophyte	1	II (35)	fl.
22	<i>Psylliostachys spicata</i> (Willd.) Nevski.	halophyte	1	III (25)	veg.
23	<i>Halimocnemis malacophylla</i> (M.Bieb.) C.A.Mey.	halophyte	1-3	III (15)	fl.
Total projective cover 40%–70%.					

Neotorularia contortuplicata (Steph.) Heage. et J.leonard. The presence of these protected species further emphasizes the ecological significance of the Shirvan Plain's winter pastures and highlights the urgent need for their sustainable management and conservation in line with the SDG 15 (Life on Land).

According to the geobotanical description, the species composition of this association comprised 23 species of higher flowering plants (Table 1). Out of these, four species (17.4%) were shrubs, one species (4.35%) was a semi-shrub, three species (13.0%) were subshrubs, six species (26.1%) were perennial herbs, one species (4.35%)

was a biennial herb, and eight species (34.8%) were annual herbs. The ecological analysis of these different species revealed that 12 species (52.2%) were halophytes, six species (26.1%) were xerophytes, four species (17.4%) were mesoxerophytes, and one species (4.4%) was a mesophyte.

The structural analysis of the phytocoenosis revealed the following stratification:

- In the first layer (upper stratum), the dominant shrubs include the species *Tamarix ramosissima*, *Lycium ruthenicum*, and *Halostachys caspica*.
- The second one includes the species *Caroxylon ericoides*, *Caroxylon*

dendroides, *Suaeda microphylla*, *Halocnemum strobilaceum*, *Kalidium caspicum*, among others.

- The third (lower) herbaceous layer comprises halophytic species such as *Artemisia lerchiana*, *Limonium scoparium*, *Cynodon dactylon*, and *Aeluropus littoralis*.

The total vegetation cover ranged from 40% to 70%, while the average height of the herbaceous layer was 30–50 cm. The results also enunciated that within the species composition of this formation on saline soils, the species *Caroxylon ericoides* appeared in sparse quantities (abundance scores 1–2), which serves as an indicator species marking the transition toward *Suaeda*-dominated desert vegetation. Further research revealed the shrubby-semi-shrubby *Suaeda* desert formation class has the representative species *Suaedeta Salsoletum* formation group, specifically by the *Suaedeta dendroides-Salsoletum dendroides* association. This association also gained a recording in the winter-pasture area No. 7. Previous studies similarly highlighted the stratified structure of winter pasture phytocoenoses in the Mil and Shirvan plains, emphasizing that halophytes govern the lower and mid-layers, while shrubs prevail in the upper stratum (Gurbanov and Asadova, 2017).

In this phytocoenosis, the composition included 28 species of higher flowering plants (Table 2). Among these species, four species (14.3%) were shrubs, one species (3.6%) was a semi-shrub, three species (10.7%) were sub-shrubs, eight species (28.6%) were perennials, two species (7.1%) were biennials, and 10 species (35.7%) were annual herbs. According to the ecological grouping, 13 species (46.4%) were xerophytes, seven species (25.0%) were halophytes, five species (17.9%) were mesoxerophytes, and three species (10.7%) were mesophytes. In the formation, the dominant species was *Caroxylon dendroides*, with an abundance score of 3–4, while the subdominant species was *Suaeda dendroides*, with an abundance score of 2–3.

Structurally, in the phytocoenosis, the first layer included the species *Tamarix ramosissima*, and the second layer comprised

the species *Lycium ruthenicum*, *Suaeda dendroides*, *Caroxylon dendroides*, *Glycyrrhiza glabra*, and *Alhagi pseudoalhagi*. The third (lower) layer showed the species *Artemisia lerchiana*, *Aeluropus reflexaristata*, *Suaeda confusa*, *Lolium rigidum*, and other xerophytes. The average height of the herbaceous layer reaches 40–60 cm, and total vegetation cover ranges from 30% to 80%. During the study, we also established that within the perennial-annual herbaceous *Suaeda* desert formation class, the *Artemisieta-Suaedetum* formation group only had representation from one association, *Artemisieta lerchiana-Suaedetum confusa*.

The species composition of the phytocoenosis comprises 21 species (Table 3). These flowering plants consisted of three species (14.3%) shrubs, one species (4.8%) semi-shrub, one species (4.8%) sub-shrub, seven species (33.2%) perennials, one species (4.8%) biennial, and eight species (38.1%) annual herbs. Ecological grouping analysis detailed that among these higher flowering species, 12 species (57.1%) were xerophytes, six species (28.6%) were halophytes, and three species (14.3%) were mesoxerophytes. A previous study highlighted that *Suaeda*-dominated associations exhibited an obvious vertical stratification, with shrubs and semi-shrubs in upper layers and halophytic herbs in lower layers (Alosmanova and Bakhshiyev, 2024), which corresponds closely with the structural observations in the presented study.

Notably, xerophytes and halophytes were predominantly evident in the phytocoenoses of the studied area, revealing the tendency toward desertification. The dominant species of the formation was *Suaeda confusa*, with an abundance score of 3–4, while the subdominant species was *Artemisia lerchiana*, with an abundance score of 2–3. Structurally, in the phytocoenosis, the first layer has the dominance of the shrub *Rhamnus pallasii*; the second layer includes *Atraphaxis spinosa*, *Suaeda dendroides*, and *Salsola dendroides*; and the third layer consists of halophytic herbs, such as *Caroxylon nodulosa*, *Capparis herbacea*, and *Petrosimonia brachiata*. The total projective cover ranged between 30% and 70%, with an average

Table 2. Geobotanical description based on species composition and structure of *Suaedeta-Salsolietum* formation.

No.	Biomorph species	Ecological groups	Abundance	Average height (cm)	Phenological phases
1	2	3	4	5	6
<i>Shrubs</i>					
1	<i>Suaeda dendroides</i> (C.A.Mey) Moq.	halophyte	2-3	II (80)	veg.
2	<i>Lycium ruthenicum</i> Murr.	xerophyte	1-2	I (90)	fl.
3	<i>Tamarix ramosissima</i> Ledeb.	mesoxerophyte	1-2	I (150)	fl.
4	<i>Caragana arborescens</i> Lam.	xerophyte	1	II (70)	fl.
<i>Semishrubs</i>					
5	<i>Caroxylon dendroides</i> Pall.	mesoxerophyte	3-4	II (60)	veg.
<i>Subshrubs</i>					
6	<i>Caroxylon nodulosa</i> (Moq.) Iljin.	halophyte	1-2	II (40)	veg.
7	<i>Suaeda microphylla</i> Pall.	halophyte	1	II (50)	veg.
8	<i>Caroxylon ericoides</i> Bieb.	halophyte	1	III (35)	veg.
<i>Perennials</i>					
9	<i>Artemisia lerchiana</i> Web.	xerophyte	1-2	III (30)	veg.
10	<i>Glycyrrhiza glabra</i> L.	mesoxerophyte	1	II (70)	veg.
11	<i>Limonium meyeri</i> (Boiss.) O.Kuntze.	halophyte	1	II (60)	fl.
12	<i>Alhagi pseudoalhagi</i> (Bieb.) Fissch.	mesoxerophyte	1	II (50)	veg.
13	<i>Cichorium intybus</i> L.	mesophyte	1	II (45)	fl.
14	<i>Plantago lanceolata</i> L.	mesophyte	1	II (40)	fl.
15	<i>Aeluropus reflexiaristata</i> (Nevski.) Nevski.	mesophyte	1	III (30)	fl.
16	<i>Capparis herbacea</i> Willd.	xerophyte	1	III (20)	fl.
<i>Biennials</i>					
17	<i>Tragopogon dubius</i> Scop.	mesophyte	1-2	II (40)	fl.
18	<i>Melilotus albus</i> L.	mesoxerophyte	1	II (30)	veg.
<i>Annuals</i>					
19	<i>Suaeda confusa</i> Iljin.	xerophyte	1-2	III (20)	veg.
20	<i>Lolium rigidum</i> Gaudin.	xerophyte	1-2	III (15)	fl.
21	<i>Phleum phleoides</i> (L.) Karst.	xerophyte	1-2	III (10)	fl.
22	<i>Petrosimonia brachiata</i> (Pall.) Bunge.	halophyte	1	III (30)	veg.
23	<i>Neotorularia contortuplicata</i> (Steph.) Heage. et J.leonard.	xerophyte	1	III (25)	fl.
24	<i>Hordeum leporinum</i> Link.	xerophyte	1	III (20)	fl.
25	<i>Torilis nodosa</i> (L.) Gaertn.	xerophyte	1-3	III (15)	veg.
26	<i>Filago pyramidata</i> L.	xerophyte	1	III (10)	fl.
27	<i>Eremopyrum orientale</i> (L.) Laub. et Spach.	halophyte	1	III (5)	fl.
28	<i>Medicago minima</i> (L.) Bartalini	xerophyte	1	III (3)	Bean spill-g
Total projective cover- 30%–80%					

height of 15–25 cm. In desert and semi-desert phytocoenoses of the Mil and Shirvan plains, the xerophytes and halophytes dominate both herbaceous and shrub layers under saline conditions (Hatemo, 2000).

Thus, the species composition and structure of the *Suaeda*-dominated desert vegetation formations—*Suaedeta-Halostachysetum*, *Suaedeta-Salsolosum*, and *Artemisieta-Suaedetum*—in the winter pastures

of the Yevlakh District vary based on the soil and climatic conditions. Correspondingly, the productivity, nutritive values, and grazing capacity of these formations entailed studies. According to the results, the dry biomass productivity of the *Suaedeta-Halostachysetum* formation in 2024 and 2025 had the distribution among botanical groups as follows: cereals (0.32 t/ha, 26.4%), legumes (0.14 t/ha, 11.6%), and various herbs (0.75 t/ha,

Table 3. Geobotanical description based on species composition and structure of *Artemisieta-Suaedetum* formation.

No.	Biomorph species	Ecological groups	Abundance	Average height (cm)	Phenological phases
1	2	3	4	5	6
<i>Shrubs</i>					
1	<i>Rhamnus pallasii</i> Fisch. et C.A.Mey.	xerophyte	1-2	I (150)	veg.
2	<i>Atraphaxis spinosa</i> L.	xerophyte	1-2	II (80)	fl.
3	<i>Suaeda dendroides</i> (C.A.Mey) Moq.	halophyte	1	II (70)	veg.
<i>Semishrubs</i>					
4	<i>Caroxylon dendroides</i> Pall.	mesoxerophyte	1-2	II (65)	Veg.
<i>Subshrubs</i>					
5	<i>Caroxylon nodulosa</i> (Moq.) İljin.	halophyte	1	III (30)	veg.
<i>Perennials</i>					
6	<i>Artemisia lerchiana</i> Web.	xerophyte	2-3	II (40)	veg.
7	<i>Elymus repens</i> (L.) Nevski.	xerophyte	1-2	II (60)	fl.
8	<i>Zygophyllum fabago</i> L.	xerophyte	1-2	III (35)	fl.
9	<i>Eremostachys laciniata</i> (L.) R.Kam. et Machmedov	xerophyte	1-2	III (30)	fl.
10	<i>Alhagi pseudoalhagi</i> (Bieb.) Fissch.	mesoxerophyte	1	II (50)	veg.
11	<i>Achillea biebersteinii</i> Afan	xerophyte	1	III (25)	veg.-bud.
12	<i>Capparis herbaceae</i> Willd.	xerophyte	1	III (20)	fl.
<i>Biennials</i>					
13	<i>Cirsium vulgare</i> (Savi.) Ten.	mesoxerophyte	1-2	III (30)	fl.
<i>Annuals</i>					
14	<i>Suaeda confusa</i> İljin.	halophyte	3-4	III (30)	veg.
15	<i>Petrosimonia brachiata</i> (Pall.) Bunge.	halophyte	1-2	III (25)	veg.
16	<i>Centaurea solstitialis</i> L.	xerophyte	1-2	III (20)	fl.
17	<i>Bromus japonicus</i> Thunb.	xerophyte	1-2	III (20)	fl.
18	<i>Aegilops triuncialis</i> L.	xerophyte	1-2	III (10)	fl.
19	<i>Anisantha tectorum</i> (L.) Nevski.	halophyte	1	III (25)	fl.
20	<i>Salicornia europaea</i> L.	halophyte	1	III (15)	veg.
21	<i>Galium setosa</i> Laub et Spach.	xerophyte	1	III (10)	fl.
Total projective cover- 30%–70%					

Table 4. Productivity of *Suaedeta-Halostachysetum*, *Suaedeta-Salsoletum*, *Artemisieta-Suaedetum* formations on botanical groups.

Botanical groups	Formations					
	<i>Suaedeta-Halostachysetum</i>		<i>Suaedeta-Salsoletum</i>		<i>Artemisieta-Suaedetum</i>	
	Dry mass		Dry mass		Dry mass	
	tons/ha	with %	tons/ha	with %	tons/ha	with %
Cereals	0.32	26.4	0.24	25.5	0.17	25.0
Legumes	0.14	11.6	0.18	19.2	0.08	11.8
Various herbs	0.75	62.0	0.52	55.3	0.43	63.2
Total	1.21	100.0	0.94	100.0	0.68	100.0

62.0%) (Table 4). Productivity patterns reported that *Suaeda*-dominated winter pastures in Azerbaijan exhibited the higher herbaceous biomass than in cereals and legumes due to arid climatic conditions and soil salinity (Aliyev, 2007). Halophytic formations

in the Kur-Araz lowland showed variable annual productivity influenced by seasonal precipitation and soil characteristics, supporting the current findings of differential biomass distribution among the botanical groups (Gurbanov et al., 2024).

The fodder value of this formation was 37.9 feed units per 100 kg of forage. Considering a grazing period of 210 days and a daily feed requirement of 1.3 feed units for small livestock, the grazing capacity of the pasture reached a calculation of 1.7 heads of small livestock per hectare. Based on productivity and nutritive values, the formation *Suaedeta-Halostachysetum* sustained a classification within the II (medium) quality group. During the study, the productivity of the *Suaedeta-Salsolietum* formation also entailed investigations by the present research team. According to dry biomass measurements, the vegetation cover comprised cereals with 0.24 t/ha (25.5%), legumes with 0.18 t/ha (19.2%), and forbs with 0.52 t/ha (55.3%).

The productivity of this formation's vegetation cover obtained a measurement in the No. 7 winter pasture area of the Yevlakh District, Azerbaijan. The phytocenosis productivity (dry biomass) emerged to be 0.94 t/ha, with 32.8 feed units per 100 kg of dry forage. Considering a grazing period of 210 days and a daily feed requirement of 1.3 feed units for small ruminants, the grazing capacity of the respective pasture area had the calculation of 1.1 heads of sheep per hectare. Based on productivity and forage quality (nutritive value) parameters, the *Suaedeta-Salsolietum* formation classification can be within the II (medium) quality group.

Additionally, the productivity of the *Artemisieta-Suaedetum* formation succeeded in its determination in this present research. According to dry biomass measurements by botanical groups, cereals accounted for 0.17 t/ha (25.0%), legumes for 0.08 t/ha (11.8%), and various herbs for 0.43 t/ha (63.2%) (Table 4). The biennial productivity of the vegetation cover corresponded to 0.68 t/ha of dry biomass. Considering these data, to determine the grazing capacity of the pasture—assuming a grazing period of 210 days, with a productivity based on dry biomass of 0.68 t/ha, 41.7 feed units per 100 kg of forage, and a daily feed requirement of 1.3 feed units for small livestock—the grazing capacity calculation was one head per hectare.

The results revealed that, based on productivity and forage quality (nutritive

value), the *Artemisieta-Suaedetum* formation classification can be in the III (medium) quality group. Dry biomass and grazing capacity of saline pastures received considerable effects and control from soil type and seasonal conditions (Aghaguliyev, 2001). These findings also supported the productivity and forage quality results obtained in the presented study. During the research, it was noteworthy that in the winter pastures of the Yevlakh District, the *Suaeda*-dominated desert vegetation has the characteristic of low productivity, particularly the *Suaedeta-Halostachysetum* and *Artemisieta-Suaedetum* communities; it includes important ephemeral forage species, such as *Suaeda dendroides*, *Artemisia lerchiana*, and *Lolium rigidum*. Accordingly, the implementation of efficient utilization measures in the low-productivity and low-nutritive-value *Artemisieta-Suaedetum* community was advisable.

The relevant studies revealed that the desert vegetation in the Yevlakh District has undergone degradation due to intensive zoogenic (livestock grazing) and anthropogenic impacts, as well as overgrazing and unsystematic grazing by flocks. The prevention of such negative processes enabled the study to recommend the implementation of fundamental reclamation and efficient usage measures as a priority. Desert and semi-desert phytocenoses of the Mil and Shirvan plains were highly susceptible to degradation from overgrazing and human activities, which eventually reduced the productivity and forage quality (Mammadova *et al.*, 2017; Mammadova, 2025; Asadova, 2026).

The comparison of productivity values showed substantial differences among the three *Suaeda*-dominated formations. The highest dry biomass production was evident in the *Suaedeta-Halostachysetum* formation (1.21 t ha⁻¹), followed by *Suaedeta-Salsolietum* (0.94 t ha⁻¹), while the lowest productivity resulted in *Artemisieta-Suaedetum* (0.68 t ha⁻¹). This represents a 44% reduction in biomass production between the most productive and least productive formations, indicating the influence of soil salinity and vegetation structure on forage yield.

CONCLUSIONS

The results suggest the Suaedeta desert vegetation of the winter pastures in the Yevlakh Region of the Shirvan Plain, Azerbaijan, was compositionally rich in valuable forage species, primarily cereal grasses, and especially legumes and forbs. Although the desert plant communities had the dominance of the *Suaeda* genus species, formed across the diverse relief types, their forage-rich species composition allows their effective use as winter pastures. The improvement of the sustainable use of these winter pastures enabled the advice to apply rotational grazing systems, partial or deferred grazing. Moreover, recommendations arise to regulate pasture carrying capacity, eradicate harmful and toxic plants, and restore the vegetation through agrotechnical measures, including the application of organic and mineral fertilizers to improved lands.

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