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THE IMPACT OF CLIMATIC FACTORS ON DENUDATION PROCESSES IN THE TALYSH MOUNTAINS

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Abstract

The aim of the study is to quantitatively assess the influence of climatic conditions on the intensity of denudation processes in the Talysh Mountains and to establish a scientific basis for managing these processes. The research is based on field observations conducted during 2023–2025 and on official climatic data obtained from the Azerbaijan National Hydrometeorological Service. Observations were carried out at 24 stationary sites, where soil erosion, slope processes, and the condition of vegetation cover were regularly recorded. The relationships between climatic parameters such as precipitation, temperature, humidity, and freeze–thaw cycles and denudation intensity were evaluated using Pearson correlation and linear regression analyses. The results show that there is a strong positive correlation between annual precipitation and denudation ($r = 0.82$; $p < 0.001$; $n = 24$). An increase of 100 mm in precipitation raises the denudation rate by an average of 8–12%. A strong positive correlation ($r = 0.71$; $p < 0.001$) was also identified between the number of freeze–thaw cycles and denudation, indicating the high intensity of physical weathering in the upper mountain belts. In contrast, a strong negative correlation ($r = -0.78$; $p < 0.001$; $n = 24$) was found between forest cover density and denudation. While the erosion rate in forested areas ranges from 5–12 t/ha/year, in deforested slopes this indicator reaches 25–50 t/ha/year. The multiple regression model ($R^2 = 0.76$; $F = 15,05$; $p < 0.001$) indicates that it can serve as a reliable tool for predicting denudation processes. The novelty of the study lies in the first quantitative assessment of denudation processes in the Talysh Mountains using modern statistical methods, the modeling of climate–vegetation interactions, and the development of a regression equation for predicting erosion risk. The results can serve as a scientific basis for planning soil conservation measures, protecting forest ecosystems, and developing climate change adaptation strategies in the region.
Keywords: denudation, climatic factors, correlation analysis, regression model, Talysh mountains

Introduction

Mountainous areas are among the most dynamic parts of the Earth's surface in terms of morphogenetic activity. The complexity of relief, climatic variability, and lithological composition are the main factors determining the intensity and character of denudation processes [11]. Denudation—the weathering of rocks, transportation of material, and downslope movement—plays a key role in landscape transformation and in the modification of landforms.

Modern geomorphological studies show that landscape development is controlled by the combined influence of tectonic uplift, climate change, and rock properties [12]. The Talysh Mountains, located in the southeastern part of Azerbaijan, represent a distinctive mountainous region characterized by a humid subtropical climate and rich biological diversity. The climatic characteristics of the region-high annual precipitation (up to 1400–1600 mm in coastal zones), high atmospheric humidity, and pronounced seasonal temperature variations-directly influence the intensity of erosion processes [1].

Denudation processes in the Talysh Mountains were first quantitatively investigated by Moumeni et al. [13]. Using cosmogenic ^{10}Be isotope analysis, the authors determined that erosion rates on the humid eastern slopes reach 100–400 meters per million years, whereas in the inner arid parts of the region these values are significantly lower.

The role of vegetation cover is particularly important. Studies conducted by Hajiyev and Musayev have shown that the reduction of forest cover in the Talysh Mountains significantly accelerates erosion processes [8, 14]. Forest vegetation performs an important protective function by mechanically stabilizing soils and reducing the erosive impact of rainfall.

The climatic characteristics of the Talysh Mountains distinguish them from other mountainous regions. Shikhlinski and Huseynov note that precipitation decreases with altitude—at elevations above 2000 m, annual precipitation drops to 250–300 mm [9, 16]. The region also records the highest daily precipitation maximum in the country, with values reaching 334 mm in Bilesar.

The temperature regime also has a significant influence on denudation. Research conducted by Safarov shows that in the upper mountain belt (1800–2400 m), the daily temperature amplitude may reach 15–20°C, intensifying freeze–thaw cycles and accelerating physical weathering [15].

The hypothesis of the study is that the intensity of denudation processes in the Talysh Mountains is controlled by the interaction between climatic parameters (precipitation and temperature) and vegetation cover density. The aim of the study is to quantitatively evaluate these relationships and to develop erosion risk models for the region.

Materials and methods

The study was conducted in the southeastern sector of the Talysh Mountains within the territory of the Republic of Azerbaijan. The research area covers the Lankaran–Astara physical-geographical region—from the Caspian Sea coastal zone to the watershed zones of the mountain system reaching an elevation of 2493 m at Mount Komurgoy. The general geographical characteristics of the study area are based on the descriptions provided by Budagov and Geography of the Republic of Azerbaijan [3, 7].

Climate data for 2023–2025 were obtained from eight meteorological stations of the Azerbaijan National Hydrometeorological Service [2]. The stations were selected based on the following criteria: representation of different elevation belts (0–2400 m), continuity of observation data (minimum 30 years), location on different slope aspects, and coverage of major river basins (Lankaran River, Astara River, Tengeru River, and Vilesh River). The selected stations include Lankaran (−12 m), Astara (−21 m), Bilesar (600 m), Lerik (1100 m), Yardimli (750 m), Masalli (20 m), Goytepe (150 m), and Penser (1200 m).

Soil and erosion data were obtained from field investigations conducted by the author during 2023–2025. The methodology of the field studies was based on the program "Monitoring of Erosion Processes in Mountainous Areas" developed by Hajiyev [8].

In total, 24 observation sites were selected. At each site, three repeated measurements were conducted. The sites cover areas with different slope gradients (5–30°), aspects, and vegetation cover densities. A stratified random sampling method was used in selecting the sites . The distribution by slope gradient is as follows: 5–10° (6 sites, agricultural land and sparse forest), 10–15° (6 sites, forest and shrubland), 15–20° (6 sites, dense forest and subalpine zone), and 20–30° (6 sites, subalpine and rocky areas).

Forest cover data were obtained from three sources: analysis of Landsat 8 satellite images for 2023–2025, measurements from geobotanical profiles conducted during the author's field research, and comparative data from previous studies by Musayev and Hajiyev , which were used to assess long-term trends in forest cover change [17].

Satellite image processing was carried out using ArcGIS 10.8 software. The NDVI (Normalized Difference Vegetation Index) was calculated using the formula:

$$NDVI = \frac{(NIR-RED)}{(NIR+RED)} \qquad (1)$$

Forest cover density was determined using an equation calibrated with field measurements based on NDVI values:

$$F = 1.2 \times NDVI \times 100 \ (R^2 = 0.84;\ n = 24;\ p < 0.001) \quad (2)$$

Measurement of denudation rates was carried out using three methods:

Erosion stakes method – At each observation site (50×50 m), 10 metal stakes (50 cm long, 8 mm diameter) were installed. Stakes were inserted 30 cm into the soil, leaving 20 cm above the surface.

The height of the stakes relative to the soil surface was measured twice a year (April and October) with a caliper, with an accuracy of 0.5 mm.

Cesium-137 (^{137}Cs) isotope method – Soil samples were collected at five sites (1–2 sites from each slope gradient group) from depth intervals of 0–5, 5–10, 10–20, and 20–30 cm. Analyses were conducted at the Institute of Radiation Problems of ANAS using a germanium detector gamma spectrometer (Canberra, model BE5030). Soil loss was calculated using the formula:

$$E = \frac{(\mathrm{Aref} - \mathrm{Asamp})}{(\mathrm{C} \times \mathrm{t})} \qquad (3)$$

Gully erosion measurement – At 10 gullies, width, depth, and length were measured once a year (October) at 10 m intervals. Gully volume was calculated as:

$$V = L \times \frac{(\mathrm{W}_1 + \mathrm{W}_2)}{2} \times \frac{(\mathrm{D}_1 + \mathrm{D}_2)}{2} \ (4)$$

Denudation rate (t/ha/year) was calculated using:

$$D = \frac{(\Delta \mathrm{h} \times \rho \times 10000)}{t} \ (5)$$

Where Δh is the change in soil level (m), ρ is the soil bulk density (1.2–1.4 t/m³), and t is the observation period (years).

Precipitation measurement – Daily rainfall (mm) was recorded at meteorological stations using standard rain gauges, and rainfall intensity (mm/min) during heavy rain was measured with automatic pluviographs. Extreme rainfall events were considered when daily precipitation exceeded 50 mm/day [9].

Temperature measurement – Daily maximum and minimum temperatures were recorded using mercury thermometers and automatic sensors. Daily temperature amplitude was calculated as $\Delta T = T_{max} - T_{min}$. Freeze–thaw cycles were determined based on temperatures around 0°C: days with daytime temperatures above +2°C and nighttime temperatures below −2°C were considered as freeze–thaw days.

Slope gradient – Calculated from a 30 m resolution Digital Elevation Model (ALOS PALSAR, 2023) in ArcGIS 10.8 using the "Slope" function. Field verification was done with a clinometer (Suunto PM-5) at five directions per site, and the average value was taken.

Statistical analyses were performed using SPSS 26.0 [IBM Corp. 2019]:

Normality test – Data normality was checked using the Kolmogorov–Smirnov test ($p > 0.05$). Log-transformation was applied for non-normally distributed variables.

Correlation analysis – Pearson correlation coefficient (r) was used to assess the strength and direction of linear relationships. Significance was considered at $p < 0.05$. The interpretation of correlation coefficients followed Cheddock [5].

Regression analysis – A multiple linear regression model was constructed:

$$D = \beta_0 + \beta_1 P + \beta_2 T + \beta_3 F + \beta_4 S + \varepsilon \ (6)$$

D – denudation rate, P – annual precipitation, T – mean annual temperature, F – forest cover density, S – slope gradient. Model explanatory power was evaluated using R^2 and F-test; regression coefficients' significance was tested with the t-test ($p < 0.05$). Multicollinearity was checked using VIF, with VIF < 5 accepted.

Spatial analysis – To evaluate the spatial distribution of erosion risk, an erosion risk map was created in ArcGIS 10.8 using the Weighted Overlay method. Weight coefficients used: precipitation – 40%, slope gradient – 30%, forest cover – 20%, lithology – 10% .

Results and discussion

Denudation processes in the Talysh Mountains primarily manifest as slope erosion, surface wash, gully erosion, and landslides. Measurements conducted at 24 observation sites during 2023–2025 showed that relative denudation rates varied between 15–22%. In absolute terms, soil loss ranged from 5–50 t/ha/year.

Table 1. Dynamics of precipitation and erosion indicators by year

Year	Number of observation sites (n)	Mean annual precipitation (mm)	Erosion rate (%)	Soil loss (t/ha/year)
2023	24	1100 ± 100	15–20	7–45
2024	24	1025 ± 75	18–22	10–50
2025	24	1065 ± 85	17–21	9–48

Although precipitation was high in 2023 (1100 mm), erosion rates remained relatively low (15–20%) due to a more even distribution of rainfall throughout the year and the absence of intense heavy rain events. In 2024, despite lower total precipitation (1025 mm), erosion rates increased to 18–22%, which was linked to three intense summer storms (July–August) with rainfall intensity >2 mm/min. These observations indicate that denudation processes are influenced not only by the total amount of precipitation but also by its intensity and temporal distribution.

Table 2. Dynamics of temperature indicators by year

Year	Number of observation sites (n)	Daytime temp. (°C)	Nighttime temp. (°C)	Daily amplitude (°C)	Freeze–thaw cycles (number/year)	Denudation rate (%)
2023	24	19–21	8–11	10–13	16–20	15–20
2024	24	18–20	7–10	10–13	22–26	18–22
2025	24	18–21	8–11	9–13	18–22	17–21

In 2024, relatively lower nighttime temperatures (7–10°C) increased the daily temperature amplitude, resulting in 22–26 freeze–thaw cycles per year. This was accompanied by a rise in denudation rates to 18–22%. In the upper mountain belt (1800–2400 m) during winter, daytime temperatures range from +2 to +5°C, while nighttime temperatures drop to −8 to −12°C. Such conditions intensify freeze–thaw cycles and accelerate physical weathering.

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Table 3. Dynamics of forest cover and its effect on erosion

Year	Number of observation sites (n)	Forest cover (%)	Annual decrease (%)	Erosion in forested areas (t/ha/year)	Erosion in deforested areas (t/ha/year)
2023	24	25.4	0.6	6–9	28–45
2024	24	24.2	1.2	8–12	35–50
2025	24	23.4	0.8	7–10	30–48

Forest cover in the Talysh Mountains decreases at an average rate of 0.8% per year, primarily due to deforestation, grazing, and agricultural expansion. Each 1% loss of forest cover is associated with an approximate 2–3% increase in erosion rates. In forested areas, the average erosion rate ranges from 5–12 t/ha/year, while in deforested areas it reaches 25–50 t/ha/year. On steep slopes (gradient >15°), complete removal of forest can increase erosion rates by 5–6 times, highlighting the critical role of vegetation in slope stabilization and soil protection.

Table 4. Pearson correlation analysis results (n = 24 observation sites)

Parameter	Pearson r	p	Significance
Annual precipitation	0.82	<0.001	Strong positive correlation
Daytime temperature	0.65	<0.01	Positive correlation
Nighttime temperature	0.48	<0.05	Moderate correlation
Freeze–thaw cycles	0.71	<0.001	Strong positive correlation
Forest cover density	-0.78	<0.001	Strong negative correlation
Slope gradient	0.69	<0.001	Positive correlation

The correlation analysis shows a strong positive correlation between precipitation and denudation ($r = 0.82$; $p < 0.001$), indicating that rainfall is the primary driver of erosion in the region. A strong positive correlation with freeze–thaw cycles ($r = 0.71$; $p < 0.001$) confirms the importance of physical weathering processes. The strong negative correlation with forest cover ($r = -0.78$; $p < 0.001$) emphasizes the protective role of forests. Finally, the strong positive correlation with slope gradient ($r = 0.69$; $p < 0.001$) indicates a higher erosion risk on steep slopes.

Multiple linear regression results

Based on the multiple linear regression model, denudation rate is expressed as:

$D = 5.2 + 0.12P + 0.75T – 0.08F + 1.3S$ (7)

• D – denudation rate (t/ha/year)
• P – annual precipitation (per 100 mm increment)
• T – mean annual temperature (°C)
• F – forest cover density (%)
• S – slope gradient (degrees)

Interpretation of the coefficients:

• Precipitation (0.12): Each 100 mm increase in rainfall raises denudation by 0.12 t/ha/year.

• Temperature (0.75): Higher mean annual temperatures increase denudation, highlighting the role of thermal processes and freeze–thaw cycles.

• Forest cover (–0.08): Denser forest reduces denudation, confirming the protective function of vegetation.

• Slope gradient (1.3): Steeper slopes strongly increase denudation rates, emphasizing topography as a key factor.

The model provides a quantitative tool to predict soil loss under different climate, vegetation, and topographic scenarios in the Talysh Mountains.

Table 5. Statistical indicators of the regression model

Indicator	Value
R^2	0.76
F	15,05
p	<0.001
Standard error	4.8 t/ha/year

Substituting the values:

$$F = \frac{R^2/k}{(1-R^2)/(n-k-1)} = \frac{0.76/4}{(1-0.76)/(24-4-1)} = \frac{0,19}{0,01263} \approx 15,05 \quad (8)$$

• k – number of independent variables (4 in our model),
• n – number of observation sites (24)

The model explains 76% of the variability in denudation rates; the remaining 24% may be associated with lithology, tectonic activity, soil physical–chemical properties, and anthropogenic factors.

Comparison of results with regional studies

The results of this study are largely consistent with previous research conducted in the Talysh Mountains. Moumeni et al. using cosmogenic ^{10}Be isotope analysis, reported that erosion rates in the humid eastern slopes of the Talysh Mountains reach 100–400 m over a million-year timescale [11]. Our observations similarly show that areas receiving high precipitation exhibit contemporary erosion rates of 30–50 t/ha/year, which are higher compared to other regions of the Caucasus.

Research by Hajiyev demonstrated that a reduction in forest cover accelerates erosion processes in the Talysh Mountains [8]. Our results confirm a strong negative correlation between forest cover and denudation (r = -0.78), providing a quantitative measure: each 1% decrease in forest cover increases erosion rates by 2–3%.

Safarov [15] indicated that freeze–thaw cycles in the upper mountain zones intensify physical weathering. Our observations support this finding, showing a strong positive correlation (r = 0.71) between the number of freeze–thaw cycles and denudation rates.

Comparison of results with international studies

Table 6. Comparison of Denudation Rates in the Talysh Mountains with International Studies

Region	Source	Denudation Rate (t/ha/year)	Climate Type
Talysh Mountains	This study	5–50	Humid subtropical
Chile Coastal Cordillera	Moumeni et al., 2024	~2.9	Mediterranean
Pyrenees	García-Ruiz et al., 2015	1–10	Temperate
West Africa (Sierra Leone)	Millington et al., 2017	10–40	Humid tropical
Himalayas	Burbank [4]	20–60	Temperate-tropical

The denudation patterns observed in the Talysh Mountains are comparable to those in other humid subtropical and tropical mountainous regions. Studies in the Chilean Coastal Cordillera indicate that erosion rates in humid Mediterranean zones can reach 290 t/km²/year (approximately 2.9 t/ha/year) [12]. In the Talysh Mountains, this rate is higher (up to 50 t/ha/year), likely due to more intense precipitation in the region.

Research in the Pyrenees (Spain) highlighted the importance of freeze–thaw processes, showing that the energy associated with freeze–thaw cycles is approximately twice that of rainfall kinetic energy [6]. Similarly, in the upper zones of the Talysh Mountains, freeze–thaw processes are a major driver of mechanical rock breakdown.

In West Africa (Sierra Leone), studies in humid tropical areas demonstrate that mass movement processes, such as landslides, are a significant component of overall denudation in regions with steep relief [10]. In the Talysh Mountains, landslides are also widespread, particularly in the valleys of the Tengervuçay, Lənkərançay, and Astaraçay rivers.

Interpretation of results and mechanisms

Precipitation–erosion relationship – The strong correlation (r = 0.82) indicates that precipitation is the primary driver of erosion in the Talysh Mountains. However, in 2023, despite high rainfall, erosion rates were relatively low, highlighting the importance of rainfall intensity and seasonal distribution. This observation aligns with Huseynov who noted the increasing frequency of extreme precipitation events [9].Temperature–erosion relationship – The strong correlation between freeze–thaw cycles and denudation (r = 0.71) emphasizes the significance of physical weathering, especially in upper mountain zones. The mechanism operates as follows: daytime temperatures rise, melting snow and ice, allowing water to infiltrate rock fractures; nighttime temperatures drop, freezing the water; frozen water expands by 9%, cracking the rocks; repeated cycles lead to mechanical rock breakdown.

Forest cover–erosion relationship – The strong negative correlation (r = -0.78) confirms the protective role of forests. Forests reduce erosion through three main mechanisms: the canopy diminishes the kinetic energy of raindrops, root systems mechanically reinforce the soil, and the litter layer slows surface runoff and enhances infiltration.

Conclusion

The study confirmed that denudation intensity in the Talysh Mountains is controlled by the interaction between climatic parameters and vegetation cover. Based on field measurements at 24 sites (2023–2025), denudation rates range from 5 to 50 t/ha/year, with the highest values (>40 t/ha/year) observed on steep slopes (>20°) with sparse forest cover.

Statistical analysis revealed strong correlations between denudation and its controlling factors: precipitation (r = 0.82; p < 0.001), freeze–thaw cycles (r = 0.71; p < 0.001), forest cover (r = -0.78; p < 0.001), and slope gradient (r = 0.69; p < 0.001). A 100 mm increase in precipitation raises denudation by 8–12%, while each 1% loss of forest cover increases erosion by 2–3%. On steep slopes (>15°), complete deforestation can amplify erosion rates 5–6 times.

The multiple regression model ($R^2 = 0.76$; F = 15.05; p < 0.001) explains 76% of denudation variability through precipitation, temperature, forest cover, and slope gradient. This model provides a quantitative tool for predicting erosion risk under different scenarios.

These results highlight that climate change (increasing extreme rainfall events) and anthropogenic pressure (deforestation) will likely accelerate denudation processes in the region. Forest restoration and regulation of agricultural activities on steep slopes are essential mitigation measures. The findings provide a scientific basis for soil conservation, forest management, and landscape planning in the Talysh Mountains.

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İQLİM AMİLLƏRİNİN TALIŞ DAĞLARINDA DENUDASİYA PROSESLƏRİNƏ TƏSİRİ

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Xülasə

Tədqiqatın məqsədi Talış dağlarında denudasiya proseslərinin intensivliyinə iqlim şəraitinin təsirini kəmiyyətcə qiymətləndirmək və bu proseslərin idarə olunması üçün elmi əsas yaratmaqdır. Tədqiqat 2023–2025-ci illərdə aparılmış çöl müşahidələrinə və Azərbaycan Milli Hidrometeorologiya Xidmətindən əldə olunmuş rəsmi iqlim məlumatlarına əsaslanır. Müşahidələr 24 sabit məntəqədə aparılmış və torpaq eroziyası, yamac prosesləri və bitki örtüyünün vəziyyəti müntəzəm olaraq qeydə alınmışdır. Yağıntı, temperatur, rütubət və donma-ərimə dövrləri kimi iqlim parametrləri ilə denudasiya intensivliyi arasındakı əlaqələr Pearson korrelyasiya və xətti reqressiya analizləri ilə qiymətləndirilmişdir. Nəticələr göstərir ki, illik yağıntı ilə denudasiya arasında güclü müsbət korrelyasiya mövcuddur ($r = 0.82$; $p < 0.001$; $n = 24$). Yağıntının 100 mm artması denudasiya sürətini orta hesabla 8–12% artırır. Donma-ərimə dövrlərinin sayı ilə denudasiya arasında da güclü müsbət korrelyasiya ($r = 0.71$; $p < 0.001$) aşkar edilmiş, bu isə yuxarı dağ qurşaqlarında fiziki aşınmanın yüksək intensivliyini göstərmişdir. Əksinə, meşə örtüyünün

sıxlığı ilə denudasiya arasında güclü mənfi korrelyasiya ($r = -0.78$; $p < 0.001$; $n = 24$) müşahidə edilmişdir. Meşəli ərazilərdə eroziya sürəti 5–12 t/ha/il aralığında dəyişirsə, meşəsiz yamaclarda bu göstərici 25–50 t/ha/il-ə çatır. Çoxsaylı reqressiya modeli ($R^2 = 0.76$; $F = 15{,}05$; $p < 0.001$) denudasiya proseslərini proqnozlaşdırmaq üçün etibarlı alət kimi xidmət edə bilər. Tədqiqatın yeniliyi Talış dağlarında denudasiya proseslərinin ilk dəfə kəmiyyətcə qiymətləndirilməsi, iqlim–bitki örtüyü qarşılıqlı təsirlərinin modelləşdirilməsi və eroziya riskini proqnozlaşdırmaq üçün reqressiya tənliyinin işlənməsidir. Nəticələr regionda torpağın mühafizəsi tədbirlərinin planlaşdırılması, meşə ekosistemlərinin qorunması və iqlim dəyişmələrinə adaptasiya strategiyalarının hazırlanması üçün elmi əsas rolunu oynaya bilər.
Açar sözlər: denudasiya, iqlim amilləri, korrelyasiya analizi, reqressiya modeli, Talış dağları

ВЛИЯНИЕ КЛИМАТИЧЕСКИХ ФАКТОРОВ НА ДЕНУДАЦИОННЫЕ ПРОЦЕССЫ В ТАЛЫШСКИХ ГОРАХ

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Резюме

Цель исследования заключается в количественной оценке влияния климатических условий на интенсивность денудационных процессов в Талышских горах и в создании научной основы для их управления. Исследование основано на полевых наблюдениях, проведённых в 2023–2025 годах, а также на официальных климатических данных, полученных от Государственной службы гидрометеорологии Азербайджана. Наблюдения проводились на 24 стационарных участках, где регулярно фиксировалась эрозия почвы, процессы на склонах и состояние растительного покрова. Взаимосвязь между климатическими параметрами, такими как осадки, температура, влажность и циклы замерзания–оттаивания, и интенсивностью денудации оценивалась с помощью анализа корреляции Пирсона и линейной регрессии. Результаты показывают, что существует сильная положительная корреляция между годовым количеством осадков и денудацией ($r = 0{,}82$; $p < 0{,}001$; $n = 24$). Увеличение осадков на 100 мм повышает скорость денудации в среднем на 8–12 %. Также выявлена сильная положительная корреляция ($r = 0{,}71$; $p < 0{,}001$) между числом циклов замерзания–оттаивания и денудацией, что указывает на высокую интенсивность физического выветривания в верхних горных поясах. Напротив, между плотностью лесного покрова и денудацией обнаружена сильная отрицательная корреляция ($r = -0{,}78$; $p < 0{,}001$; $n = 24$). В лесных районах скорость эрозии составляет 5–12 т/га/год, тогда как на вырубленных склонах этот показатель достигает 25–50 т/га/год. Множественная регрессионная модель ($R^2 = 0{,}76$; $F = 15{,}05$; $p < 0{,}001$) может служить надёжным инструментом для прогнозирования денудационных процессов. Новизна исследования заключается в первой количественной оценке денудации в Талышских горах с использованием современных статистических методов, моделировании взаимодействия климата и растительности, а также в разработке регрессионного уравнения для прогнозирования риска эрозии. Результаты могут служить научной основой для планирования мер по сохранению почвы, защиты лесных экосистем и разработки стратегий адаптации к изменениям климата в регионе.
Ключевые слова: денудация, климатические факторы, анализ корреляции, регрессионная модель, Талышские горы

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