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THE STATE OF TREE AND SHRUB VEGETATION
IN THE YEREVAN SECTION OF THE HRAZDAN GORGE
AND POSSIBILITIES FOR ITS IMPROVEMENT

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The study of tree and shrub vegetation in the Yerevan section of the Hrazdan Gorge, covering an area of 276.8 *ha*, revealed the distribution patterns of native and introduced species, a critically low level of natural regeneration, widespread occurrence of pests and plant diseases, and the adverse effects of anthropogenic factors. During the research, a population of *Alcea sophiae*, a species listed as endangered in the Armenian Plants Red Book, was identified. The study proposes a comprehensive set of measures, including the control of invasive species, restoration of areals of native species, establishment of monitoring programs, and long-term ecosystem preservation to ensure biodiversity stability.

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Introduction. The Yerevan section of Hrazdan Gorge is a critical component of Yerevan's urban ecosystem, stretching 17.26 *km* and covering 276.8 *ha*. This area is characterized by xerophytic vegetation, remnant riparian forests, and highly dissected terrain influenced by the Caucasian, Turanian, and Armeno-Iranian botanical provinces. The biodiversity of the gorge plays a vital role in maintaining urban environmental sustainability. However, in recent decades, it has faced numerous threats, including the spread of invasive species and anthropogenic impacts. Local factors of landscape setting, history, and other sources of disturbance constrain ecosystem responses [1] to invasions. This study aims to assess the overall condition of tree and shrub vegetation, identify existing challenges, and propose scientifically grounded solutions for ecological restoration and biodiversity conservation. The research focuses on analyzing species composition, natural regeneration levels, and the impact of anthropogenic factors to contribute to the development of Yerevan's urban greening policies.

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Materials and Methods. The study was conducted using a transect-based methodology, dividing the area into four sections. Detailed botanical observations were performed in each section, including species composition recording, quantitative and qualitative analysis of vegetation, and assessment of environmental conditions. The delineation of transects was based on habitat characteristics such as riparian forests, open arid slopes, and disturbed areas. Plant identification relied on various sources [2, 3]. Data collection occurred throughout 2024, encompassing extensive field surveys and satellite imagery analysis. The presence of pests and diseases was evaluated through visual inspections and sampling. Comparative analytical methods were applied to assess the prevalence of invasive species [4].

The study was conducted in the Yerevan section of the Hrazdan Gorge during 2024 using route survey and transect-based research methods combined with survey-based inventory techniques. The aim of the study was to assess the species composition of tree and shrub vegetation, its spatial distribution, the level of natural regeneration, the health condition of plants, as well as the impact of anthropogenic and invasive factors on the ecosystems.

The study area was divided into four main sections according to relief, vegetation cover, and ecological characteristics. The survey routes were designed to include the most representative and ecologically contrasting habitats of the gorge, including riparian forests, xerophytic slopes, disturbed areas, and sites exposed to anthropogenic influence. Observation points were established along each route, where field botanical and ecological investigations were carried out.

Linear and belt transect methods were applied for vegetation assessment. Linear transects were used to record species occurring directly along the transect line, while belt transects enabled the investigation of vegetation within a defined width, allowing the assessment of vegetation structure, species richness, and plant cover. In certain locations, the quadrat method was also applied to quantitatively evaluate vegetation cover and determine species occurrence frequency.

Plant identification was carried out using floristic and taxonomic references of Armenia, as well as data from the Red Book of Plants of the Republic of Armenia. The inventory of green plantations was conducted using survey-based methods. For each recorded plant, data were collected on species identity, biological condition, and health condition.

During the fieldwork, GIS technologies were applied to determine the boundaries of the study sites and to develop schematic maps of vegetation spatial distribution. In addition, satellite imagery analysis was conducted to assess territorial changes and anthropogenic impacts. Special attention was paid to the distribution of invasive species, the processes of natural regeneration, and the conservation status of rare species. The collected data were subjected to comparative and analytical processing in order to evaluate the overall condition of the ecosystem and its restoration potential.

Results and Discussion. The Yerevan section of Hrazdan Gorge is situated at elevations ranging from 903 to 1204 *m* above sea level and is characterized by diverse botanical and landscape features. The area includes forested sections (74.5 *ha*), open arid zones (155.5 *ha*), water surfaces (22.3 *ha*), and areas occupied

by buildings and construction sites (24.5 ha). Riparian vegetation, including floodplain forests, is prevalent along the riverbed, dominated by representatives of the Oleaceae (*Populus* spp.), Salicaceae (*Salix* spp., *Populus* spp.), and Fagaceae (*Quercus* spp.) families. Open areas feature xerophytic grasslands. However, arid conditions have significantly increased the ecosystem's vulnerability [5].

The study documented a significant presence of invasive species, posing a serious threat to the stability of the local ecosystem [6]. These species, characterized by rapid growth and high reproductive capacity, suppress native plants, disrupting biodiversity. Among the most prevalent is *Acer negundo*, found almost ubiquitously and exhibiting high natural regeneration rates. Introduced to Armenia for landscaping purposes, this species is now expanding its range, threatening native trees. *Ailanthus altissima* is another highly invasive species (Fig. 1), forming homogeneous stands and actively infiltrating natural ecosystems. It suppresses the reproduction of adjacent plants, contributing to the loss of local vegetation. *Robinia pseudoacacia* and *Gleditsia triacanthos* have more limited distributions, but remain potentially hazardous due to their vegetative propagation capabilities. Expansive herbaceous species, such as *Artemisia vulgaris*, *Onopordum acanthium*, and *Clematis orientalis*, further indicate the vulnerability and declining stability of the natural environment.

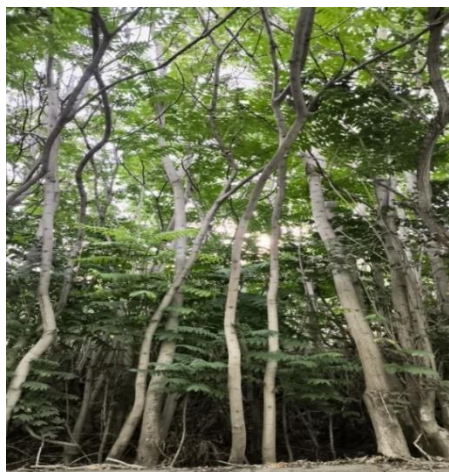


Fig. 1. *Ailanthus altissima* in Yerevan section of Hrazdan Gorge.

During the study, one species listed in the Armenian Red Book, *Alcea sophiae*, was identified as endangered (EN B1ab(iii)+2ab(iii)). This perennial herb, reaching up to one meter in height, occurs naturally in the Yerevan and Shirak floristic regions. Its population is highly limited due to anthropogenic impacts and habitat degradation. The conservation of *Alcea sophiae* (Fig. 2) requires specific measures, including monitoring of its range [7], and protection of natural habitats. Its presence underscores the importance of Hrazdan Gorge as a critical area for conserving endangered plants.

The tree and shrub vegetation of Hrazdan Gorge suffers from widespread pests and diseases, particularly affecting representatives of the Fagaceae, Salicaceae, and Aceraceae families. Signs of leaf-eating insects and fungal infections were observed

on *Quercus* and *Salix* species, reducing tree vitality. These phenomena are driven by ecosystem disturbances, including declining biodiversity and limited natural regeneration. The spread of harmful organisms exacerbates vegetation vulnerability [7], and the absence of control measures may lead to further loss of native species.



Fig. 2. *Alcea sophiae* in its natural habitat.

Natural regeneration of tree and shrub vegetation in Hrazdan Gorge is critically low due to poor soil quality, insufficient moisture, suppression by invasive species, and anthropogenic impacts. While juvenile *Morus*, *Quercus*, *Fagus*, and *Acer* individuals were observed in some areas, their viability remains low due to unfavorable environmental conditions. The spread of invasive species, particularly *Ailanthus altissima* and *Acer negundo*, significantly restricts native tree regeneration, disrupting the ecosystem's natural recovery processes. This situation highlights the need for measures to promote natural regeneration.

The presence of coniferous plants in Hrazdan Gorge is extremely limited, reducing the area's sanitary and aesthetic value. Only *Thuja orientalis* and *Ephedra procera* were recorded, primarily on arid, rocky slopes. The scarcity of conifers negatively impacts air purification efficiency, as these plants are known for their high phytocidal properties. The dominance of angiosperms underscores the need to introduce coniferous species to enhance the area's ecological functions.



Fig. 3. Proportion of angiosperms and gymnosperms in the Yerevan section of Hrazdan Gorge.

The Yerevan section of Hrazdan Gorge is significantly affected by anthropogenic factors, including the accumulation of household and construction

waste, uncontrolled sewage discharge, vegetation damage, and unregulated construction. The study revealed that many buildings in the area lack connection to centralized sewage systems, resulting in wastewater being discharged directly into the river or adjacent areas, creating unsanitary conditions. Waste accumulation (Fig. 4), including plastic, metal, and organic debris, disrupts the natural landscape and threatens plant growth. Informal pathways and recreational areas exert additional pressure on vegetation, degrading soil structure. These factors highlight challenges in area management and conservation.



Fig. 4. Household waste accumulation in Hrazdan Gorge.

The tree and shrub vegetation of the Yerevan section of Hrazdan Gorge is in a vulnerable state due to the spread of invasive species, limited natural regeneration, and adverse anthropogenic impacts [8]. The low level of natural regeneration, driven by unfavorable environmental conditions, restricts the recovery potential of native species. The scarcity of coniferous plants reduces the area's air purification capacity, which is particularly critical in an urban context. Anthropogenic impacts, including waste accumulation and sewage discharge, disrupt the natural landscape and create unsanitary conditions.

Restoring the Hrazdan Gorge ecosystem requires comprehensive measures focused on controlling invasive species, protecting native plants, and mitigating anthropogenic impacts. Combating invasive species, particularly *Ailanthus altissima* and *Acer negundo*, should involve mechanical removal and, where necessary, chemical treatment to prevent further spread. Regular monitoring will help control their range expansion [8]. Promoting the regeneration of native tree species, such as *Morus*, *Fagus*, and *Quercus*, requires establishing protected areas to ensure juvenile plant viability. Improving soil quality and regulating moisture levels can support natural recovery. Introducing coniferous species, such as *Thuja orientalis* and *Pinus sylvestris*, will enhance the area's sanitary efficiency and air purification capacity. Conserving the *Alcea sophiae* population necessitates regular monitoring and habitat protection to mitigate anthropogenic impacts. Reducing anthropogenic impacts requires organizing waste cleanup operations, regulating sewage discharge, and implementing public awareness programs to promote environmental stewardship.

Comprehensive measures, including invasive species control, native species restoration, conifer introduction, and anthropogenic impact reduction, can restore ecosystem stability and enhance the area's ecological value. The findings of this study can serve as a foundation for developing Yerevan's urban greening policies and refining environmental management strategies [9]. They may also be useful in developing a national program on invasive plants in Armenia, which should include a monitoring and response system [10].

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Հրազդանի կիրճի երևանյան հատվածի ծառաթփային բուսականության ուսումնասիրությունը, որը ընդգրկում է 276.8 հա տարածք, բացահայտել է

արորիզեն և ներմուծված տեսակների բաշխվածությունը, բնական վերարտադրության խիստ ցածր մակարդակը, վնասատուների և հիվանդությունների տարածվածությունը, ինչպես նաև մարդածին գործոնների բացասական ազդեցությունը: Հետազոտության ընթացքում հայտնաբերվել է Հայաստանի Հանրապետության Բույսերի Կարմիր գրքում գրանցված վտանգված տեսակ՝ Տուղտավարդ Սոփիայի (*Alcea sophiae*): Ուսումնասիրության արդյունքում առաջարկվում է համալիր միջոցառումների իրականացում, որոնք ներառում են ինվազիվ տեսակների դեմ պայքար, արորիզեն տեսակների տարածման արեալների վերականգնում, մոնիթորինգի կազմակերպում և էկոհամակարգի երկարաժամկետ պահպանություն՝ ապահովելու կենսաբազմազանության կայունությունը:

А. З. АЛАВЕРДЯН, З. Т. ТАРХАНЫ

СОСТОЯНИЕ ДРЕВЕСНО-КУСТАРНИКОВОЙ РАСТИТЕЛЬНОСТИ НА ЕРЕВАНСКОМ УЧАСТКЕ РАЗДАНСКОГО УЩЕЛЬЯ И ВОЗМОЖНОСТИ ЕГО УЛУЧШЕНИЯ

Резюме

Исследование древесно-кустарниковой растительности ереванского участка ущелья реки Раздан, охватывающего территорию в 276,8 га, выявило особенности распределения местных и интродуцированных видов, крайне низкий уровень естественного возобновления, широкое распространение вредителей и болезней растений, а также негативное влияние антропогенных факторов. В ходе работы была обнаружена популяция занесенного в “Красную книгу растений Армении” вида *Alcea sophiae*, находящегося под угрозой исчезновения. Исследование предлагает комплекс мер, включающий борьбу с инвазивными видами, восстановление ареалов местных видов, организацию мониторинга и долгосрочное сохранение экосистемы, для поддержания биоразнообразия.