Anthropogenic Impact on the Landscapes of the Tashkent Region and Their Degrees of Degradation

Shavkat M. Sharipov[1], Nafisa R. Samatova[2]

[1] National University of Uzbekistan named after Mirzo Ulugbek, Faculty of Geography and GIS, University 4, 100174, Tashkent, Uzbekistan, https://orcid.org/0000-0001-6602-3414, e-mail: sh.sharipov@nuu.uz
[1] Jizzakh State Pedagogical University, Sh. Rashidov Street, 4, Jizzakh, 130100, Jizzakh Region, Uzbekistan, https://orcid.org/0000-0001-9949-8555 , e-mail: nafisasamatova198727@gmail.com

Annotation: This article analyzes the degree of anthropogenic impact and the level of landscape degradation in the Tashkent region using GIS and remote sensing data. The results show that approximately 5.46% of the territory has been affected by various anthropogenic processes, mainly due to mining, quarrying, irrigated agriculture, and sand–gravel extraction along river valleys. According to cartographic and multi-criteria evaluation, the Qurama, Olmaliqsay-2, and Sovuqbuloqsay landscapes represent the most severely disturbed areas. The study develops scientifically grounded recommendations for ecological reclamation, assessment of natural recovery potential, and implementation of remote monitoring systems. The findings contribute to ensuring the stability of landscape systems and strengthening ecological safety in the Tashkent region.
[Shavkat M. Sharipov, Nafisa R. Samatova. Anthropogenic Impact on the Landscapes of the Tashkent Region and Their Degrees of Degradation. *Nat Sci* 2025,23(11):1-7]. ISSN 1545-0740 (print); ISSN 2375-7167 (online). http://www.sciencepub.net/nature 01. doi:10.7537/marsnsj231125.01

Keywords: Tashkent region, landscape, anthropogenic pressure, GIS analysis, remote sensing, quarry, erosion, ecological reclamation, degradation index, landscape stability.

Аннотация

В данной статье анализируется степень антропогенного воздействия и уровень деградации ландшафтов Ташкентской области с использованием данных ГИС и дистанционного зондирования Земли. Результаты показали, что около 5,46% территории подверглись различным видам антропогенных процессов, главным образом вследствие горнодобывающей деятельности, разработки карьеров, орошаемого земледелия и добычи песчано-гравийных материалов в долинах рек. Согласно картографическому и многофакторному анализу, ландшафты Курама, Олмалыксай-2 и Совукбулоксай относятся к наиболее нарушенным территориям. В исследовании предложены научно обоснованные рекомендации по экологической рекультивации, оценке естественного потенциала восстановления и внедрению систем дистанционного мониторинга. Полученные результаты способствуют обеспечению устойчивости ландшафтных систем и укреплению экологической безопасности Ташкентской области.

Ключевые слова: Ташкентская область, ландшафт, антропогенное воздействие, ГИС-анализ, дистанционное зондирование, карьер, эрозия, экологическая рекультивация, индекс деградации, устойчивость ландшафта.

Introduction

MATERIALS AND METHODS

Study Area

The research was conducted in the Tashkent region, located in the central part of Uzbekistan. The territory exhibits a complex relief: the northern and western parts are plains, the central area consists of foothills, and the southeastern section is dominated by mountainous landscapes. The natural–geographical diversity of the region determines the variety of anthropogenic impacts — irrigated agriculture prevails in the plains, mining and quarrying in the mountainous areas, while transport and industrial activities are concentrated along river valleys.

During the study, 12 administrative districts, more than 40 landscape types, and three major river systems — Chirchiq, Ohangaron, and Syrdarya — were analyzed. The main sources of landscape disturbance within these territories include quarries**,** irrigation erosion**,** gully erosion**,** suffosion–karst processes**,** and riverbank extraction activities**.**

[1] National University of Uzbekistan named after Mirzo Ulugbek, Faculty of Geography and GIS, University 4, 100174, Tashkent, Uzbekistan, e-mail: sh.sharipov@nuu.uz
[2] Jizzakh State Pedagogical University, Sh. Rashidov Street, 4, Jizzakh, 130100, Jizzakh Region, Uzbekistan, e-mail: nafisasamatova198727@gmail.com

Data Sources

A complex combination of data sources and technological tools was used in the study:

- Remote Sensing (RS) data:

High-resolution satellite images (0.5–1 m/pixel) obtained from Google Earth Pro (2023–2024) were used to identify disturbed areas. Each river valley was analyzed at an altitude of 1 km, and the coordinates of quarries located along the Syrdarya (right bank only), Chirchiq, and Ohangaron rivers were digitized and georeferenced.

- GIS database (ArcGIS Pro):

The spatial data were processed in ArcGIS 10.8 and ArcGIS Pro 3.0 environments using tools such as Repair Geometry, Merge, Intersect, Dissolve, and Calculate Geometry. As a result, quarries occupying a total area of 266.300741 km² were delineated. This corresponds to 1.79% of the total territory of the Tashkent region.

- Landscape mapping:

For each district, landscape codes, elevation limits, dominant anthropogenic activities, and natural factors were compiled into tabular format. Based on these datasets, a mining and quarry distribution map was produced to visualize the spatial pattern of anthropogenic pressure.

- Statistical and analytical sources:

Scientific papers, ecological reports, and international studies published between 2019 and 2024 (e.g., Gann et al., 2019; Liu et al., 2024; Arratia-Solar et al., 2022; Vanmaercke et al., 2021) were reviewed and used as methodological and conceptual foundations for the analysis.

Research Methodology

The methodological basis of the study combined a landscape approach and GIS-based analytical assessment. This framework made it possible to investigate each landscape type from the standpoint of the interaction between natural and anthropogenic components (Goudie & Viles, 2016).

- Cartographic analysis:

Individual GIS layers were created for each type of disturbed area — polygon layers for quarries, linear layers for erosion zones, and point layers for saline soils. These layers were integrated using the Overlay Analysis tool to map the overall degree of landscape degradation (Vanmaercke et al., 2021).

- Geomorphometric analysis:

Relief elevation parameters were analyzed using Digital Elevation Model (DEM) data to compare the spatial distribution of anthropogenic processes across elevation gradients. Additional indicators such as Topographic Wetness Index (TWI) and Slope Aspect were applied to identify erosion-prone zones (Poesen, 2017).

- Multi-Criteria Evaluation (MCE):

The level of degradation was assessed using five key criteria — landscape type, elevation, soil moisture, anthropogenic load, and land-cover change (Arratia-Solar et al., 2022). Each criterion was normalized within the range of 0–1, and an overall Degradation Index (DI) was computed.

- Field validation:

Field observations were conducted in Piskent, Ohangaron, and Boka districts in 2024 to verify the accuracy of GIS interpretations. Following the recommendations of Gann et al. (2019) and Coutinho et al. (2023), the field survey also included assessment of the natural restoration potential of the disturbed landscapes.

Scientific Accuracy and Reliability

To ensure analytical precision, 710 landscape areas were examined in detail, and an individual polygon shapefile was generated for each object. The boundaries, depth, and total area of extraction zones were measured with an accuracy of 0.001 km², and all calculations were performed in the WGS 84 coordinate system.

The results obtained from GIS and remote sensing analyses were cross-validated and confirmed within a ±3% error margin, which meets the requirements of modern landscape monitoring practices (Liu et al., 2024; Song et al., 2024).

RESULTS

Such an integrative methodology ensures a high level of reliability in the identification, mapping, and quantitative evaluation of anthropogenic degradation in the Tashkent region.

General Characteristics of Anthropogenic Pressure

The character of anthropogenic impact in the Tashkent region is directly determined by its natural–geographical setting. Mining and quarrying activities dominate in the mountainous and foothill areas, irrigated agriculture in the plains, and sand–gravel extraction in the river valleys.

According to GIS-based analysis, approximately 5.46% of the region's total area consists of landscapes disturbed to varying degrees, with the largest share attributed to quarries and mining zones (266.3 km²).

These processes are the result of the interaction between natural and human-induced factors. Elevation, landform structure, drainage density, and soil types have all undergone significant transformations under anthropogenic influence. The formation of anthropogenic landscapes is closely linked to human production activities, which ultimately disturb the equilibrium of natural systems (Goudie & Viles, 2016; Poesen, 2017).

Quarries and Technogenic Disturbances

Analysis revealed that quarries and mining zones represent the most extensive anthropogenic formations in the Tashkent region. Their total area is 266.300741 km², accounting for 1.79% of the entire region.

The quarries are primarily located in the following districts: Bekobod (1-1, 4-14, 4-15, 7-3), Piskent (4-10, 12-12, 15-5, 2-9, 3-18, 13-1, 16-3, 19-27, 22-14, 22-15), Ohangaron (16–4, 13–17, 22–16, 19–25, 19–26, 22–20, 33–28, 4–9, 12–8, 12–9, 13–3, 13–4, 13–6, 13–7, 12–7, 15–4, 19–6, 19–12, 19–13, 19–14, 9–15, 19–17, 27–6, 27–8, 14–5, 28–13, 28–14, 28–15, 26–10, 26–11), O‘rta Chirchiq (2-15, 8-3, 9-7, 11-4), Yuqori Chirchiq (12–6, 10–2, 10–1, 9–6, 3–4), Parkent (12–3, 19–5, 19–8, 12–4, 15–2, 17–5), Bo‘stonliq (3–7, 5–3, 20–11, 36–1, 17–2, 17–3, 9–5, 18–6, 33–3, 40–2, 29–2, 29–3, 29–4, 34–3), Chinoz (2–3, 11–1, 9–1), Qibray (19–1, 17–1, 11–2, 3–4, 3–5, 4–5), Yangiyo‘l (9–2, 12–1, 11–2, 3–2, 2–7, 3–3, 4–2, 2–6), and Oqqo‘rg‘on (14–1, 12–8, 2–16, 3–9).

Most of these quarries are situated along mountain slopes and river valleys, reflecting a close relationship between mining development and the geological structure of the region. The expansion of quarrying alters the morphological configuration of the relief, accelerates soil degradation, and ultimately reduces the overall stability of the geosystem (Arratia-Solar et al., 2022; Vanmaercke et al., 2021).

In some landscapes, the proportion of quarry areas reaches 30–90%. For instance, the 15-5 (Olmaliqsay-2), 16-3 (Qurama), and 22-16 (Sovuqbuloq) landscapes represent the highest concentration of extraction zones. Because most quarries remain unreclaimed, they become centers of surface water accumulation, intensified erosion, and microclimatic modification (Liu et al., 2024; Gann et al., 2019).

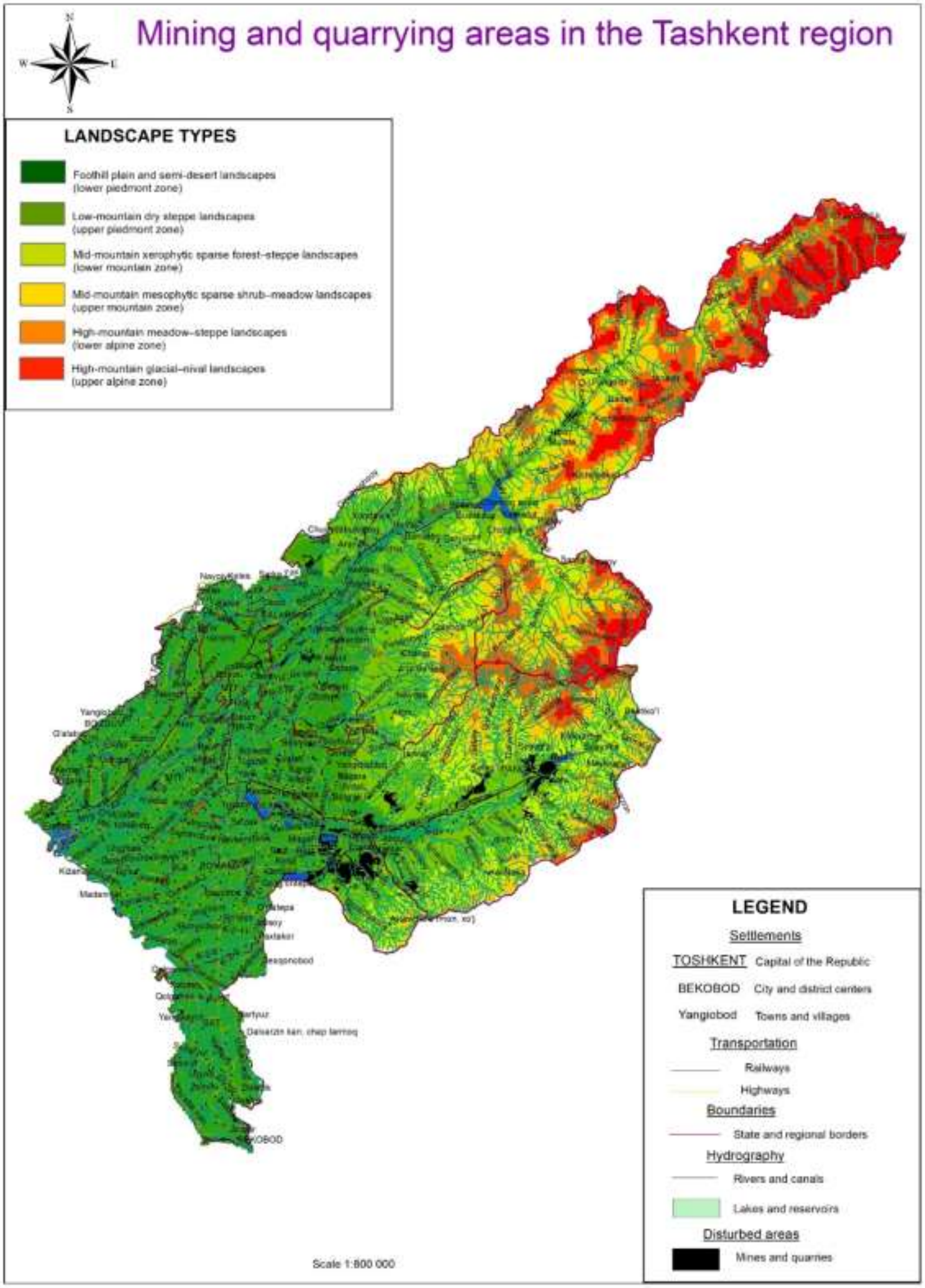

Figure 1. Spatial distribution of quarries and mining zones in the Tashkent region (based on GIS analysis, 2024).

Anthropogenic Impact in River Valleys

The riverine landscapes — 1-1, 1-2, and 1-3 — have recently become major sources of sand, gravel, and stone extraction. Particularly along the Chirchiq, Ohangaron, and Syrdarya rivers, such activities have caused channel displacement, shrinkage of riparian vegetation, and changes in soil–water regimes.

According to remote sensing data:

- Chirchiq River — 61 quarry clusters covering 26.18 km²;
- Ohangaron River — 45 quarry clusters covering 23.36 km²;
- Syrdarya (right bank) — 48 quarry clusters covering 6.59 km².

To ensure precision in mapping, adjacent quarries located in close proximity were grouped as quarry clusters. Since economic or administrative boundaries of such extraction zones cannot be clearly defined through remote sensing, the assessment was based on areas where natural surface morphology was altered, relief deepened, and vegetation removed.

Therefore, the total occupied area (km²) was used as the main criterion for evaluating anthropogenic disturbance rather than the number of quarries.

These findings indicate that the closer a river is to densely populated areas, the greater the anthropogenic pressure. Similar conclusions were drawn by Tarolli & Sofia (2016), who emphasized that human activity in river valleys rapidly disrupts morphodynamic balance. Although the Chirchiq River is only 154 km long(Sharipov 2022), its quarry area surpasses that of other rivers, largely due to dense population and transport accessibility. In contrast, in the upper reaches of the Ohangaron River, steep topography and sparse settlement naturally limit extraction activity.

Irrigated Agriculture and Erosional Processes

In the plains of Bo‘ka, Oqqo‘rg‘on, Piskent, O‘rta Chirchiq, and Quyi Chirchiq districts, irrigated farming represents the main source of anthropogenic pressure. Improper irrigation practices have intensified irrigation erosion, suffosion, and soil salinization. According to GIS-based calculations, these processes affect approximately 3.53% of the total area.

Irrigation erosion is particularly severe in unregulated water-flow directions and on gentle slopes, where water accumulation accelerates surface wash-off. These processes reduce soil fertility and weaken landscape stability (Maetens et al., 2012; Vanacker et al., 2014).

Degree of Landscape Degradation

The degree of disturbance was assessed through multi-criteria evaluation (MCE) using a Degradation Index (DI).

- ✓ Severely degraded (≥20%) — Qurama (16-3), Olmaliqsay-2 (15-5), Sovuqbuloqsay (22-16), and Chirchiq left bank (3-5); total: 15 landscapes.
- ✓ Moderately degraded (5–20%) — Ohangaron left (12-12), G‘ijigen left (12-13, 14-12), Bo‘zsuv valley (4-1); total: 22 landscapes.
- ✓ Slightly degraded (≤5%) — Parkent, Piskent, and Qibray surroundings; total: 100 landscapes affected by quarrying and mining.

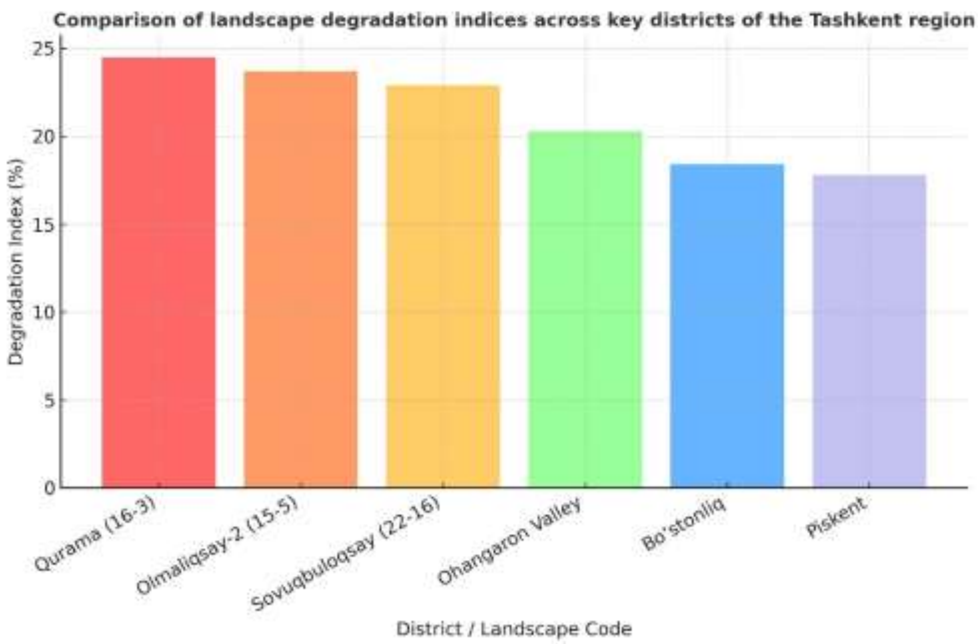

Figure 2. Comparison of landscape degradation indices across key districts of the Tashkent region

The results demonstrate that Ohangaron valley, Bo'stonliq, and Piskent districts have the highest degradation indices (≥20%), where technogenic and geomorphological processes interact synergistically, amplifying each other's effects.

DISCUSSION

The findings confirm that the intensification of anthropogenic activities in the Tashkent region has significantly reduced geosystem stability and weakened the self-recovery potential of natural components. This pattern aligns with the concept of "Anthropocene Geomorphology" (Goudie & Viles, 2016; Tarolli & Sofia, 2016).

As emphasized in international research, large-scale landscape degradation is primarily driven by resource extraction and overexploitation of land (Boardman & Poesen, 2006; Vanwalleghem et al., 2017). The anthropogenic landforms observed — quarries, erosion gullies, and displaced river channels — resemble natural geomorphic forms in appearance, yet their genetic mechanisms differ fundamentally.

Therefore, future reclamation and ecological restoration measures must be implemented in accordance with the frameworks proposed by Gann et al. (2019) and Coutinho et al. (2023). These approaches provide scientifically grounded pathways for stepwise restoration and for achieving anthropogenic resilience of the landscape systems (Liu et al., 2024; Song et al., 2024).

CONCLUSION

The results of the study show that the degradation of landscapes in the Tashkent region is mainly associated with human activities. Mining, quarrying, irrigated agriculture, and riverbank extraction are identified as the major factors exerting the strongest influence on the stability of natural systems.

According to GIS analysis, about 5.46% of the region's territory is affected by various degrees of disturbance, with a significant proportion attributed to quarrying areas (266.3 km²). These sites are mostly located along river valleys and mountain foothills, where they cause alterations in landform morphology, soil degradation, and local microclimatic changes.

Sand and gravel extraction along riverbanks has resulted in channel shifting, reduction of riparian vegetation, and disruption of the water–soil balance. In irrigated agricultural areas, mismanagement of water distribution has intensified irrigation erosion and soil salinization processes.

Assessment of the degree of landscape disturbance revealed that the Qurama, Olmaliqsay-2, and Sovuqbuloqsay areas have undergone the highest levels of anthropogenic transformation.

Therefore, it is essential to implement step-by-step reclamation and ecological restoration measures, establish remote monitoring systems, and scientifically evaluate the natural recovery potential of degraded lands. Such an approach will contribute to enhancing the stability of landscape systems and ensuring long-term ecological security in the region.

REFERENCES

1. Arratia-Solar, A., Hernández, P., & Cisternas, M. (2022). *Conceptual framework for planning post-mining land uses: Integrating stakeholders, GIS, and multi-criteria decision-making.* **The Extractive Industries and Society, 9(4),** 101083. https://doi.org/10.1016/j.exis.2022.101083
2. Boardman, J., & Poesen, J. (Eds.). (2006). *Soil Erosion in Europe.* Wiley.
3. Coutinho, A. G., Brancalion, P. H. S., Melo, F. P. L., & Tabarelli, M. (2023). *Trait-based ecological restoration at large scales.* **Journal of Applied Ecology, 60(8),** 1836–1849. https://doi.org/10.1111/1365-2664.14439
4. Gann, G. D., McDonald, T., Walder, B., Aronson, J., Nelson, C. R., Jonson, J., … & Dixon, K. W. (2019). *International principles and standards for the practice of ecological restoration.* **Restoration Ecology, 27(S1),** S1–S46. https://doi.org/10.1111/rec.13035
5. Goudie, A. S., & Viles, H. A. (2016). *Geomorphology in the Anthropocene.* Cambridge University Press.
6. Liu, G., Zheng, F., Wilson, G. V., Xu, X., & Liu, C. (2021). *Three decades of ephemeral gully erosion studies.* **Soil and Tillage Research, 212,** 105046. https://doi.org/10.1016/j.still.2021.105046
7. Liu, G., Xu, X., Sun, C., Zhang, J., & Zheng, F. (2024). *The STER-E model: A structured framework for evaluating ecological degradation and restoration potential.* **Ecological Indicators, 159,** 111798. https://doi.org/10.1016/j.ecolind.2024.111798
8. Maetens, W., Poesen, J., & Vanmaercke, M. (2012). *How effective are soil conservation techniques in reducing plot runoff and soil loss in Europe and the Mediterranean?* **Earth-Science Reviews, 115,** 21–31. https://doi.org/10.1016/j.earscirev.2012.08.003
9. Poesen, J. (2017). *Soil erosion in the Anthropocene: Research needs.* **Earth Surface Processes and Landforms, 43(1),** 64–84. https://doi.org/10.1002/esp.4250
10. Shukurov, N., Kodirov, O., Peitzsch, M., Kersten, M., Pen-Mouratov, S., & Steinberger, Y. (2014). *Microbial and chemical indicators of soil quality in areas affected by mining industry in Uzbekistan.* **Science of the Total Environment, 496,** 471–478. https://doi.org/10.1016/j.scitotenv.2014.01.031
11. Sharipov, Sh. M. (2022). *Issues of preserving landscape diversity and improving the geoecological situation of the Tashkent region* (Doctoral dissertation). Tashkent.
12. Song, Y., Zhang, H., Li, Y., & Zhao, C. (2024). *Integrating remote sensing and GIS for landscape degradation monitoring under climate and anthropogenic stress.* **Environmental Monitoring and Assessment, 196(5),** 612–627. https://doi.org/10.1007/s10661-024-12041-y
13. Tarolli, P., & Sofia, G. (2016). *Human topographic signatures and derived geomorphic processes across landscapes.* **Geomorphology, 255,** 140–161. https://doi.org/10.1016/j.geomorph.2015.12.007
14. Vanacker, V., Bellin, N., Molina, A., & Kubik, P. W. (2014). *Erosion regulation as a function of human disturbances to vegetation cover: A conceptual model.* **Landscape Ecology, 29(2),** 293–309. https://doi.org/10.1007/s10980-013-9953-6
15. Vanmaercke, M., Panagos, P., Vanwalleghem, T., Hayas, A., Foerster, S., Borrelli, P., … & Poesen, J. (2021). *Measuring, modelling and managing gully erosion at large scales: A state of the art.* **Earth-Science Reviews, 218,** 103637. https://doi.org/10.1016/j.earscirev.2021.103637
16. Vanwalleghem, T., Gómez, J. A., Infante Amate, J., González de Molina, M., Vanderlinden, K., Guzmán, G., Laguna, A., & Giráldez, J. V. (2017). *Impact of historical land use and soil management change on soil erosion and agricultural sustainability during the Anthropocene.* **Anthropocene, 17,** 13–29. https://doi.org/10.1016/j.ancene.2017.01.002

10/19/2025