# Dredging Effects on Plant Species Diversity of River Sides (Case Study: Shahrchay River, Urmia)

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Received: 2025-05-10 Accepted: 2025-07-23


## Abstract

Dredging refers to the process of removing material from the bottom of a river, lake, or other aquatic environments to eliminate excess sediment, expand the riverbed, or provide drainage in adjacent lands. The Shahr Chay River flows through the middle of Urmia city and discharges into Lake Urmia. The Shahr Chay is recognized as one of the most scenic locations in Urmia city, attracting thousands of urban tourists each day. This study aims to investigate the effect of dredging on the diversity of vegetation in a regular section of Shahrchay Urmia. Plant species were collected along the Shahr Chay River Coastal Park route, approximately 2.692 km from Kashani Bridge to Shahidan Gomnam Street Bridge. A total of 25 plant species were collected, belonging to 12 families of flowering plants. Dredging results in the loss or deep burial of seeds within the soil. Prior to dredging, 25 plant species were identified, but this number fell into 12 species following the dredging process. The Shannon-Weiner species diversity index for the pre- and post-dredging stages was 1.72 ± 0.296 and 0.93 ± 0.224, respectively. These figures suggest a decline in plant species diversity due to dredging activities. After dredging, *Persicaria maculasa* Gray, an annual weed, was observed as the dominant species at the majority of sampling locations. In recent decades, advances in technology and more selective dredging methods have enabled the extraction of the required sediments while minimizing dispersal and mitigating environmental impacts, such as of the reduction of plant diversity. Adaptive management is increasingly advocated as the most appropriate method for reconciling economic priorities with environmental concerns in dredging operations. This approach encompassesgoal setting, monitoring ecosystem effects, evaluating data, and modifying practices to adapt to evolving conditions.


**Keywords**: Dredging, Plant diversity, Plant species, Shahr Chay River, Uramia

## Introduction

Dredging is the extraction or movement of soil or rock from the seabed, river, ports, etc. Dredging activities are usually carried out in two ways: construction dredging, which is carried out for the first time, and maintenance

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Doi: 10.48308/pae.2026.242270.1128

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dredging, which is carried out in two periodic and regular forms. Dredging has objectives that briefly include deepening rivers or lakes or port basins, filling hollows underwater or on land, and replacing poor-quality with good-quality materials. For example, in buildings and structures for foundations and restoration with suitable materials, and most importantly for environmental development, extracting clean materials and placing pollutants on contaminated materials as a covering layer is used (Planning and Budget Organization, 1402).

Shahrchay is a river with a northeast-southwest extension that, after passing through the middle of the city of Urmia, which is now a green space on both sides, and irrigating the fields and gardens of the city, finally enters Lake Urmia. Other names are Barda-Rood, Shahrchay, Barda, Bakshlochay, and Urmia-Rood and Sang-Sorkh. This river originates from Mount Kan-Kaboutar at an altitude of 3271 meters in the mountains of West Azerbaijan Province, and a range of Turkish border mountains is also added to it. After digging a valley for itself in the aforementioned heights, it enters Barda-Sur and passes through it, after receiving a few streams along its route and irrigating the lands along its route, it reaches the village of Band near the city of Urmia (Fig. 1). Here, part of it is branched off to provide drinking water to Urmia city, the rest, after irrigating gardens and agricultural lands, passes near Urmia city and is appropriately called Shahr-e-Chay (Rood-e-Shahr) and then enters Lake Urmia in the south at a place called Mughe-e-Hesar (Khamachi, 1989).

Conventional river engineering operations have a significant impact on river ecosystems. Dredging generally reduces the physical heterogeneity of the riverbed and banks and of the habitats. This study aims to expand and improve current knowledge about the impact of dredging on the vegetation cover and diversity in a green space section of an urban river (Shahr-e-Chay, Urmia).

## Material and methods

The total length of the Shahr Chay River in Urmia is 84 km, starting from the Iranian-Turkish border and flowing into Lake Urmia (Fig. 1). The catchment area of the Shahr Chay River at the dam is 396 km$^2$, and the average annual water flow of this river at the dam after the drinking water branch reaches 168 million cubic meters. The water of the Barda-Rood River is used by about 911 villages and settlements along its route. The Shahr Chay River at the famous dam is one of the tourist attractions of the people of Urmia.

The Shahr Chay River is one of the scenic views of the city of Urmia. Due to the green space around this river, as one of the tourist attractions that receives thousands of urban tourists daily.

The Shahr Chay River is one of the rivers of West Azerbaijan that leads to the catchment area of Lake Urmia and passes through the middle of the city of Urmia, and is considered a special symbol for the metropolis of Urmia. Dredging of the Shahr Chay River was carried out in cooperation with the West Azerbaijan Regional Water Company in November 1401.

Plant species were collected along the Urmia Coastal Park route, approximately

2.692 km from Kashani Bridge to the Bridge on Shahidan Gomnam Street (Fig. 2). Field operations and collection of plant species were carried out over two consecutive years. Once before dredging (1401) and once after dredging during the growing season of 1402. The collected plants were pressed, dried, and transferred to the herbarium of the West Azarbaijan Agricultural and Natural Resources Research and Education Center (WESTA).

Dredging activities on the Shahr Chay River were carried out between 2021 and 2024. In 2021, around 12 kilometers of the Shahr Chay River were dredged, extending from the downstream of the Shahr Chay Dam to the upstream area of the city of Urmia. Approximately 2 kilometers of the river, located downstream of the city were dredged utilizing national funds in 2022. The Dredging process within the city began in November 2024 and was executed in several stages.

Sampling of plant communities was conducted in a random systematic approach. At each site, variation in river conditions, including width, number of branches, depth and slope of walls and natural and man-made obstacles, influenced using of two longitudinal transects (200 m) to characterize the vegetation cover (Fig. 3). Plant communities were determined through

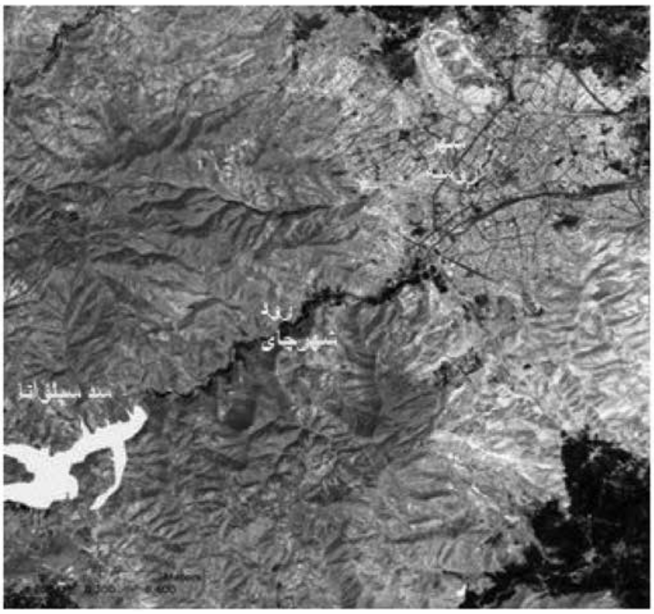

**Fig. 1.** Satellite and general image of the Shahrchay River and the city of Urmia


**Fig. 2.** Aerial image of the sampling site of the Shahr Chay River in Urmia

surveying conducted along the transects and based on changes in the vegetative form of the dominant species, which could be distinguished as separate patches from each other. Plots were established at a distance of 20 m from each other along the transects to sample plant species and determine plant density and diversity (Feoli and Gerdol, 1982). The appropriate sampling plot area was determined using the minimum area change method, and the number of plots was determined statistically based on the vegetation cover. The plot size was determined as 2×2 or 3×3, depending on the characteristics of the vegetation cover. For accurate identification of species, herbarium specimens were prepared from selected plants and transferred to the herbarium of the West Azerbaijan Agricultural and Natural Resources Research and Education Center. To prepare herbarium specimens from various plant species, we first harvested the plants completely, numbered them, and stored them in a plastic bag. Subsequently, at the earliest opportunity, the specimens were pressed until they were completely dried. Plant specimens were identified using botanical references, including Flora Iranica (Rechinger, 1963-2015), Flora Iran (Assadi et al., 1988-2021), and they were registered in the herbarium collection after the herbarium code was applied. The geographical distribution of the species was determined based on the plant geography classifications of the northern hemisphere (Eig, 1931-1932; Zohary, 1950) and by referencing species distribution studies found in Flora Iranica Rechinger (1963-2015), Flora Iran Assadi et al. (1988-2021). Finally, the samples were compared with previously collected herbarium specimens located in the herbarium of the West Azerbaijan Agricultural and Natural Resources Research and Education Center (WESTA). Figure 4 illustrates *Epilobium hirsotum* and *Lythrum salicaria* that have been identified according to references.

This study encompassed pre-dredging (2022) and post-dredging (2024) surveys. The analysis of vegetation focused on species composition, origin of species, life forms, distribution of plant life strategies, and

**Fig. 3.** *Persicaria maculasa* habitat

selected ecological factors. The Shannon-Wiener biodiversity index (H) (Shannon, 1948) was calculated and recorded both before and after dredging.

**Results and discussion**

The biodiversity of species and overall biodiversity, quantified by the Shannon-Wiener index (H), was greater in the study area prior to the river dredging. However, following the dredging process, there was a decline in the number of species present in the river channel, as dredging of the riverbed and the leveling of the banks considerably reduced habitat diversity.

In this study, a total of 25 plant species belonging to 12 different flowering plant families were collected and documented (Table 1).

The vegetative form of plants collected from the banks of the Shahr Chay River is shown in Figure 5. As can be seen, hemicryptophyte plants (He), comprising 17 species, represent the predominant biological form. Following them, annual plants or therophytes (T) with 5 species rank second. Lastly, geophytes (Geo) with one species are placed in the third.

In this study, plant species exhibited low dominance prior to dredging. Species belonging to the Poaceae family were identified as the dominant species, with a dominance range of 50-60%. While following dredging, a significant dominance (more than 85% in the majority of plots) of Spotted Lady's Thumb (*Persicaria maculasa* Gray) was observed.

Flowers and plants play a crucial role in riverbanks and aquatic environments, with one of their primary functions being the prevention of soil erosion. In fact, employing biological strategies through the establishment of plant life serves as an effective means to mitigate soil erosion. Riverbank erosion represents a type of water erosion, and its negative effects encompass


a b

**Fig. 4.** Image of *Epilobium hirsotum* (a) and *Lythrum salicaria* (b)

**Table 1.** Plant species recorded along the banks of the Shahrchay River in Urmia prior to and following dredging

| Plant species | Family | Phytogeographic region | Biological form | Pre-dredging species | Post-dredging species |
|---|---|---|---|---|---|
| *Artemisia* sp. | | Ir-Tur | He | - | + |
| *Cirsium arvense* (L.) Scop. | Asteraceae | Ir-Tur | He | + | + |
| *Artemisia vulgaris* L. | | Eu-Sib ، Ir-Tur | He | + | - |
| *Xanthium strumarium* L. | | Cos | T | - | + |
| *Sysamberium officinalle* | Brassicaceae | Ir-Tur | T | + | - |
| *Descurainia Sophia* (L.) Sehur. | | Med | T | + | - |
| *Convolvulus arvensis* L. | Convolvullaceae | Eu-Sib ، Ir-Tur | He | + | - |
| *Euphorbia* sp. | Euphorbiaceae | Ir-Tur | He | + | + |
| *Medicago sativa* L. | | Ir-Tur | He | + | - |
| *Melilotus officinalis* (L.) Lam. | Fabaceae | Ir-Tur, Med | He | + | - |
| *Trifolium sativum* (Schreb.) Crome ex Boenn. | | Ir-Tur | He | - | + |
| *Lythrum salicaria* L. | Lythraceae | Poly region | He | + | - |
| *Epilobium hirsotum* L. | Onagraceae | Poly region | Geo | + | - |
| *Plantago lanceolata* L. | Plantaginaceae | Poly region | He | + | - |
| *Dactylis glomerata* L. | | Ir-Tur Eu-Sib | He | + | - |
| *Phragmittes australis* (Cav.) Trin. ex Steud. | | Cos | He | + | + |
| *Polygon viridis* (Gouan) Breistr. | Poaceae | Sah-sen, Eu-Sib Ir-Tur | T | - | + |
| *Phalaris arundinacea* L. | | Ir-Tur | T | - | + |
| *Poa bulbosa* L. | | Poly region | He | + | - |
| *Calamagrostis epigejos* (L.) Roth. | | Ir-Tur | He | - | + |
| *Persicaria maculasa* Gray | Polygonaceae | Ir-Tur | T | + | - |
| *Rumex acetosa* L. | | Ir-Tur | He | + | - |
| *Sanguisorba minor* Scop. | Rosaceae | Ir-Tur | He | + | - |
| *Verbascum* sp. | Scrophulariaceae | Ir-Tur | He | + | - |
| | 12 Families | | | 18 species | 9 species |

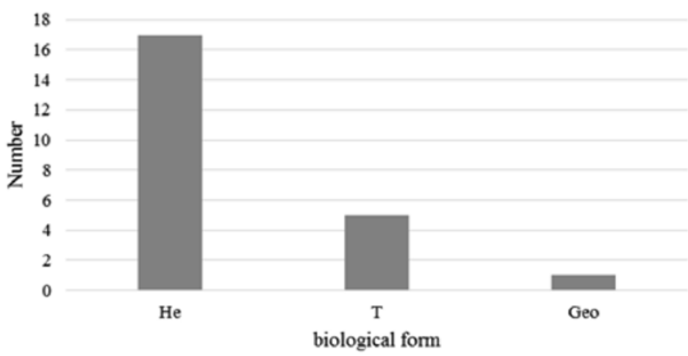


**Fig. 5.** Vegetative forms of plant species along the banks of the Shahr chay River in Urmia

heightened water pollution, degradation of riverbank territories, and issues arising from sediment displacement downstream.

It is noteworthy that the presence of vegetation around rivers prevents flooding. Vegetation or flowers and plants on the banks of rivers or aquatic environments act like a dam at certain times and prevent flooding. In this way, floods cannot damage the surrounding gardens. For this reason, experts emphasize the presence of vegetation diversity on the banks of rivers. Dredging activities can impose adverse environmental consequences, from local effects near the dredging site to wider disturbances. The extent of these impacts depends on a variety of factors, such as currents, tides, and other hydrological conditions, which can cause the consequences to extend beyond the initial dredging area. The extraction and disposal of bottom sediments alter the local physical conditions and ecological dynamics in the affected water bodies. This process uproots benthic organisms such as small invertebrates, shellfish, and benthic fish, while simultaneously destroying the complex biological habitats that have developed over time on the rock formations and substrates targeted for dredging (Azeez, 2024).

In addition to direct mortality of aquatic organisms, dredging indirectly affects local ecology by increasing water turbidity. As sediments are stirred up and particles are thrown into the water, turbidity increases, and sunlight penetration, which is crucial for photosynthesis by aquatic plants and phytoplankton, is decreased. This, in turn, reduces photosynthetic activity and primary productivity, limiting the foundation of the marine food web (Owais, 2023). Recognizing the potential for environmental damage, international and national organizations have in recent decades established licensing restrictions, sampling protocols, disposal guidelines, and standards to regulate dredging activities.

Compliance with these regulations is critical to ensuring responsible and safe dredging, while violations can lead to legal consequences and project delays.

The Shannon Biodiversity Index for vegetation along Shahr Chay was 1.72 ± 0.296 before dredging and 0.93 ± 0.224 after it. These figures indicate that the diversity of plant species after dredging was reduced compared to before. The primary cause for this reduction is the burial of seeds from numerous species as a result of excavation operations. In this study, the species *Persicaria maculasa* from the Polygonaceae family, which exhibited a limited distribution prior to dredging, was observed as a dominant species after dredging. The findings of this study are consistent with a study conducted by Strobl et al. (2015, which indicated that the introduction of sand to the riverbed led to a more uniform composition of plant species, partly due to which was partly due to the enhanced fertility of the substrate and the potential of the growth of tall riparian plants. Peacock (2024) states that although dredging plays an important role in facilitating trade and managing flood risks, it significantly affects water quality and disrupts the habitats of living organisms. This finding aligns with our study indicating that plant diversity has decreased as a result of dredging. Dawson (1990), in his examination of the impact of dredging and construction on the vegetation of British rivers, found that it had a limiting effect on plant life, which corroborates our findings. Conversly, Donazar Aramendia et al. (2024) investigated the effect of various dredging techniques on the banks of aquatic ecosystems and concluded that this activity did not adversely affect water variables, sediments, and flora and fauna, which is inconsistent with the results of our study.

Pour Rezaei (1402) conducted a study on the plant communities of two rivers located in Khuzestan province. This research identified 36 species belonging to 17 plant families. The Poaceae family was noted to have a significant number of species, similar to our study. However, in our study. the Cyperaceae family exhibited the highest species count in Khuzestan province, as opposed to the Shahr Chay River in Urmia.

The velocity of water flow, the type and thickness of bed sediments, along with variations in river width, are regarded as the key factors influencing plant communities in the studied rivers. Consequently, moisture-dependent communities develop in sandy soils, while waterlogged communities arise in beds characterized by soft and deep sediments with medium to slow flow rates. Additionally, submerged communities are found in beds with soft and deep sediments, extremely slow flows, and in association with waterlogged plants (Pourrezaei, 1402). Jahan Tigh (2016) investigated the correlation between soil characteristics and vegetation cover along the banks of the arid Tershab River in the southwestern region of Zabol. The findings of this study indicated that variations in soil characteristics, despite similar moisture conditions, have led to alterations in the vegetation cover along the riverbanks in question. The study concluded that enhancing vegetation cover along riverbanks in arid regions requires effective management strategies that consider the potential and attributes of the soil present on those banks. Gholami and Khaleghi (2013) investigated the effect of vegetation cover on the erosion of the bank of the Haraz River in Mazandaran Province. The results showed that the introduction of vegetation cover along the river banks resulted in modifications to water velocity, water depth, and shear stress strength, all of which should ultimately influence the rate of bank erosion.

In recent decades, advancements in technologies and more precise dredging methods have enabled the extraction of necessary sediments while minimizing dispersion and mitigating environmental impacts.

## Conclusion

Nowadays, the presence of various plant species within urban green areas is essential and enhances biodiversity, which includes the variety of pollinating insects and birds found in urban settings. This biodiversity significantly contributes to human health and alleviates stress. With appropriate river maintenance, vegetation can be swiftly restored following; dredging, this process may result in the loss of some plant species and groups. Considering that the section of the Shahr Chay River studied in this research serves as a coastal park for public recreation and walking. By implementing effective management and technical strategies during dredging, it is feasible to reap the benefits of dredging while maintaining the diversity of natural plant species along its banks, thereby enhancing its aesthetic appeal and positively impacting urban life.

Incorporating environmental considerations into dredging activities can be achieved through several key strategies. This includes conducting regular technical studies to evaluate the effects of dredging on biological resources, environmental stressors, and specific life stages. These studies should prioritize the integration of local and regional data while identifying gaps in scientific information for future research. Furthermore, it is crucial to bridge the gap between dredging engineering projects and the conservation of biological resources. facilitating mutual learning opportunities for resource managers and operators. This collaboration aids both parties in comprehending each other's challenges and requirements. This approach entails an interactive cycle of goal setting, monitoring ecosystem impacts, valuating data, and modifying practices to adapt to evolving conditions. While adopting adaptive management may require more initial effort in developing monitoring programs and impact thresholds, it ultimately results in policies and procedures that balance economic and environmental demands.

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