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**USE OF TREATED DOMESTIC WASTEWATER FOR IRRIGATION OF
ORNAMENTAL TREES****Khakimova Zarina Ziyodilloevna**

Associate Professor, Department of Transport Engineering,
Bukhara State Technical University, DSc in Agricultural Sciences

zarina_khakimova90@mail.ru

Fazliyev Jamoliddin Sharofiddinovich

Associate Professor, Department of Transport Engineering,
Bukhara State Technical University, PhD in Technical Sciences

jamolliddinfazliyev@gmail.com

Khalilov Jakhongir Mansur oglu

Associate Professor, Department of Transport Engineering,
Bukhara State Technical University, PhD in Technical Sciences

xalilov.jahongir93@mail.ru

Abstract. The use of treated household wastewater is a significant factor in water resource conservation, ensuring ecological sustainability, and promoting the development of "green economy" in urban infrastructure. The use of treated wastewater for irrigating green areas has been widely implemented in countries such as Israel, Spain, the United Arab Emirates, and the USA. In the USA, Israel, Latin America, Australia, the Mediterranean, Arab countries, North Africa, and India, irrigating green spaces with treated wastewater is common practice. In several countries (Israel, Jordan, Peru, Saudi Arabia), the use of wastewater for irrigation is part of state policy. In Israel, by the year 2000, several hundred reservoirs and storage facilities were established for collecting, neutralizing, and reusing treated wastewater, with a total volume of 300 million cubic meters.

Keywords: household wastewater, irrigated lands, biological pond, ornamental trees, salinization, water resources, treatment methods, irrigation.

**ИСПОЛЬЗОВАНИЕ ОЧИЩЕННЫХ СТОЧНЫХ ВОД ДЛЯ ОРОШЕНИЯ
ДЕКОРАТИВНЫХ ДЕРЕВЬЕВ**

Аннотация. Использование очищенных сточных вод является важным фактором для сохранения водных ресурсов, обеспечения экологической устойчивости и развития

"зеленой экономики" в городской инфраструктуре. Применение очищенных сточных вод для орошения зеленых территорий широко распространено в таких странах, как Израиль, Испания, Объединенные Арабские Эмираты и США. В США, Израиле, странах Латинской Америки, Австралии, Средиземноморья, арабских странах, Северной Африке и Индии использование очищенных сточных вод для орошения зеленых территорий является обычной практикой. В ряде стран (Израиль, Иордания, Перу, Саудовская Аравия) политика государства включает в себя использование сточных вод для орошения. В Израиле, начиная с 2000 года, было создано несколько сотен резервуаров и водохранилищ для сбора, нейтрализации и повторного использования сточных вод, объем которых составил 300 миллионов кубометров.

Ключевые слова: бытовые сточные воды, орошаемые земли, биологический резервуар, декоративные деревья, засоление, водные ресурсы, методы очистки, орошение.

Introduction. The growing demand for water resources, particularly the need to maintain green areas in both rural and urban settings, is increasingly emphasized as a pressing issue. The use of treated domestic wastewater is considered one of the most water-efficient and environmentally sustainable practices. However, when such water is used for irrigation, it is essential to carefully monitor factors affecting tree physiology and soil conditions. In urban areas of our republic, the use of large volumes of potable water for irrigating green spaces leads to numerous ecological and economic challenges [10]. Therefore, the utilization of treated domestic wastewater for landscaping and irrigation of ornamental trees is regarded as one of the urgent tasks.

The Decree of the President of the Republic of Uzbekistan No. PF-158 dated September 11, 2023, "On the Strategy 'Uzbekistan – 2030'," as well as Decree No. PF-6074 dated September 25, 2020, "On measures to further improve drinking water supply and wastewater systems and increase the efficiency of investment projects in the sector," encourage the targeted use of domestic wastewater generated in certain regions.

Globally, countries such as Israel, Spain, the United Arab Emirates, and the United States have widely implemented the reuse of treated wastewater for green areas. Irrigation of green spaces with treated wastewater is also common in the United States, Israel, Latin America, Australia, Mediterranean and Arab countries, North Africa, and India. In several countries (Israel, Jordan, Peru, and Saudi Arabia), wastewater reuse for irrigation is part of state policy. Israel, for instance, has established extensive systems for collecting, treating, and reusing

wastewater. By 2000, approximately 300 million m³ of treated wastewater was being reused, supported by hundreds of ponds and storage reservoirs [5].

Method. Most domestic wastewater originates from household activities and is treated through a series of systematic stages:

1. **Mechanical treatment** – removal of large impurities through filtration, and separation of sludge and sand.
2. **Biological treatment** – decomposition of organic matter using microorganisms.
3. **Advanced treatment (ultraviolet, chlorination, filtration)** – elimination of pathogenic microorganisms.

Through these processes, wastewater is treated to meet sanitary standards and becomes safe for irrigation purposes. Treatment procedures are carried out in accordance with national standards (Uz DST) [2,3].

Results. Domestic wastewater contains various components such as nitrites, nitrates, phosphorus, BOD, potassium, magnesium, sulfates, chlorides, iron, and other elements. These minerals serve as nutrients essential for soil fertility and plant growth. Treated wastewater has been effectively used for irrigating urban parks and squares, roadside ornamental trees, areas with low rainfall, green zones around industrial enterprises, and the courtyards of universities and schools. The use of domestic wastewater for growing ornamental plants not only conserves water resources but also provides multiple additional benefits [9;10].

Advantages of using treated wastewater for irrigation include:

1. **Water conservation** – Green areas, parks, and roadside trees require significant amounts of water; using treated wastewater reduces pressure on drinking water supplies.
2. **Environmental sustainability:**
 - reduces water scarcity,
 - decreases the discharge of wastewater into the environment,
 - helps maintain ecological balance.
3. **Nutrient utilization** – The presence of small amounts of nitrogen, phosphorus, and organic matter in treated water acts as a supplementary fertilizer for ornamental trees [1,3].

The amount of nutrients supplied depends on the volume of water applied after planting each seedling. However, alongside its advantages, the use of domestic wastewater also has certain drawbacks:

- **Health risks:** Domestic wastewater may contain microbes, viruses, bacteria, and other harmful pathogens. Without proper treatment and disinfection, its use for irrigation can pose health risks.

- **Soil contamination:** Inadequately treated wastewater may introduce chemicals and heavy metals into the soil, reducing its quality and negatively affecting plant growth over time.

- **Environmental impact:** If treatment systems are inefficient, harmful substances may enter soil and water bodies, damaging ecosystems.

- **Energy and cost requirements:** Wastewater treatment requires significant energy and investment in technology, along with continuous monitoring.

- **Unpleasant odor and appearance:** Untreated wastewater can produce undesirable odors and visual pollution, especially in residential areas [1,2,3].

The water requirements of ornamental trees depend on multiple factors, including climatic conditions, soil type and its moisture retention capacity, tree age, size (canopy diameter or trunk thickness), root system development, and seasonal variations. In Uzbekistan and Central Asia, long, hot, and arid summers significantly increase water demand. During June–August, evapotranspiration intensifies, making proper irrigation scheduling critical.

Not all ornamental trees require the same amount of water. Some species are naturally drought-resistant and use water more efficiently. For example, juniper, pine, and acacia can grow well with relatively low water input due to their leaf structure (needle-like or small leaves), thick bark, and deep root systems. These species are particularly suitable for urban greening in water-scarce regions. In contrast, broad-leaved, fast-growing, or large-canopy trees such as plane tree, poplar, oak, and chestnut require more water. Without sufficient irrigation during hot summers, their growth rate declines, and leaves may yellow or fall prematurely [7].

Key factors affecting water demand:

1. **Climate** – High temperatures, dry air, and wind increase evapotranspiration (ET), leading to higher water loss.
2. **Soil type** – Sandy soils drain quickly and require more frequent irrigation, while clay or loamy soils retain moisture longer.
3. **Tree age** – Young seedlings require frequent but smaller amounts of water, whereas mature trees need less frequent but larger volumes.
4. **Canopy size and trunk diameter** – Larger canopies increase leaf area and transpiration rates.

5. **Season** – Water demand is moderate in spring, peaks in summer, decreases in autumn, and is minimal in winter (except for evergreen species).

<i>Numbers</i>	Tree species	Water demand (mm/week)	Estimated water requirement (liters/tree/day, for 10–15 m canopy diameter)	Notes (Uzbekistan conditions)
1	Platanus orientalis	30–50 mm/week	100–300 L/day	High demand; rapid water uptake in hot conditions
2	Ulmus	25–45 mm/week	80–250 L/day	Moderate to high demand; requires well-drained soils
3	Robinia pseudoacacia	15–30 mm/week	50–150 L/day	Water-efficient; drought-tolerant
4	Pinus / Juniperus	10–25 mm/week	30–100 L/day	Highly water-efficient; grows well in arid areas
5	Quercus robur	20–35 mm/week	60–180 L/day	Moderate demand; deep root system
6	Populus	40–70 mm/week	200–500+ L/day	Very high demand; thrives near water sources

The following indicators represent average summer water requirements for mature ornamental trees, based on international and regional studies, including U.S. experience and Central Asian conditions:

- 1 - **Small-sized trees** (canopy diameter 3–5 m): 30–60 liters/tree/day
- 2 - **Medium-sized trees** (canopy diameter 5–8 m): 60–120 liters/tree/day
- 3 - **Large-sized trees** (canopy diameter >8 m): 120–250 liters/tree/day

Alternatively, this can be expressed as approximately 25–50 mm of water per week (1 mm = 1 liter/m²). These values are determined based on evapotranspiration (ET) rates. Under extremely hot and windy conditions, these requirements may increase further [6].

Irrigation norms for young seedlings and mature trees differ significantly. The first 1–3 years after planting are considered an “establishment period,” during which the root system is not yet fully developed in depth and spread. As a result, young trees depend more on moisture in the upper soil layers and require more careful and regular irrigation.

1. Young trees typically require 2–3 times more controlled irrigation than mature trees.
2. As a practical guideline, it is recommended to apply 10–20 liters of water per week for every 1–2 cm of trunk diameter.
3. Irrigation should be applied less frequently but deeply (2–3 times per week), rather than shallow and frequent watering.

Deep irrigation (moistening the soil to at least 30–40 cm depth) promotes downward root development. In contrast, shallow and frequent watering leads to surface root formation, making trees more vulnerable to drought stress.

Under hot and arid summer conditions (as in Uzbekistan and Central Asia), young trees should be closely monitored, especially during June–August. If the top 5–7 cm of soil becomes dry, irrigation should be applied.

A practical and simplified formula for determining irrigation volume is:

$$\text{Water requirement} = (\text{Canopy diameter (m)})^2 \times 0.5\text{--}0.8 \times \text{ET}$$

Where:

canopy diameter (m) – width of the tree canopy
0.5–0.8 – crop coefficient depending on species
0.5 for water-efficient species (e.g., conifers)
0.8 for water-demanding broadleaf species
ET (mm) – weekly evapotranspiration rate.

Under Uzbekistan conditions, ET during summer typically ranges from 40–70 mm/week, and may be higher during extremely hot and windy periods.

As a result, a tree may require approximately 200–400 liters/day in summer (depending on weather conditions and species). On a weekly basis, this amount is significantly higher; therefore, irrigation is usually applied deeply 1–2 times per week.

After irrigation, root exposure may occur. In such cases, exposed roots are vulnerable to freezing in winter and waterlogging in summer, which can damage the root system. To prevent

this, it is recommended to use a spherical disk cultivator to cover exposed roots and cultivate inter-row spaces [8].

At the same time, proper use of wastewater—through adequate treatment and reuse—can create additional benefits. When using treated domestic wastewater for irrigating ornamental trees, the following factors must be considered:

- a) Compliance of treated wastewater with sanitary standards and permissible limits of heavy metals;
- b) Mineralization level of the water should not harm trees;
- c) Selection of salt-tolerant tree species (e.g., poplar, acacia, plane tree, juniper, elm, willow, mulberry, cypress).

Conclusion. The use of treated domestic wastewater for irrigating green areas and ornamental trees is an effective approach to conserving water resources, ensuring environmental sustainability, and improving economic efficiency. It enhances soil fertility and improves the meliorative condition of the area. This method contributes to the development of environmentally friendly and sustainable infrastructure. Wastewater irrigation represents a viable solution to water scarcity, particularly in arid regions. With the application of modern scientific approaches and technologies, safe and efficient methods of wastewater reuse can be developed, significantly contributing to sustainable agricultural and landscape development in water-limited areas.

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