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«PLANT SELECTION STRATEGIES FOR RAIN GARDENS IN REGIONS WITH ARID CLIMATE»

Firuza Timurovna Abdullaeva
Lecturer, Faculty of Architecture,
Samarkand State University of Architecture and Construction
named after Mirzo Ulugbek

Abstract: Amid the growing climate crisis and increasing frequency of droughts, the issue of effective urban greening is becoming especially urgent. Rain gardens offer a promising solution for sustainable stormwater management and environmentally friendly landscaping, particularly in arid regions. This paper focuses on the criteria for selecting resilient plant species for rain gardens under conditions of limited water availability. It examines the climatic and soil factors affecting plant viability, as well as the role of phytoremediating species in purifying surface runoff. Special attention is given to plants capable of withstanding both temporary flooding and prolonged drought—an essential feature for their application in rain gardens. The study provides recommendations for assembling a plant palette based on ecological adaptability, pollutant accumulation capacity, and support of biodiversity. The findings may serve as a practical foundation for designing sustainable landscapes in arid and semi-arid environments.
The aim of this study is to explore the criteria for selecting drought-resistant plants suitable for rain gardens in arid climates and to analyze existing plant species that meet these requirements. Key considerations in plant selection include not only drought tolerance but also adaptability to local ecosystems.

Keywords: rain gardens, arid climate, resilient plants, phytoremediation, biodiversity, sustainable development, stormwater runoff.

Introduction

Rain gardens, serving as compact water retention and filtration systems, provide both efficient and aesthetically appealing solutions for mitigating polluted runoff, thereby contributing to the improvement of water quality in rivers, lakes, and oceans. Interestingly, rain gardens tend to be more resilient to drought than traditional gardens. Native plants are recommended based upon their relationship with local climate, ground, and humidity conditions without the use of any fertilizers [1]. Carefully selected plant species and their capacity for water retention are capable of thriving during periods of drought as well as during heavy rainfall. This adaptability makes them especially suitable for regions with variable precipitation patterns, such as those found in the southern climates. As innovative components of sustainable stormwater management systems, rain gardens offer significant benefits by alleviating pressure on urban drainage infrastructure and enhancing the ecological balance of urban environments. Through the natural filtration of polluted runoff via the soil-plant matrix, rain gardens represent a nature-based solution that supports environmental health and urban sustainability [2]. Various types of rain gardens can be created depending on location characteristics such as geo-hydrology, as well as local conditions and needs. Furthermore, each of them might be equipped with specific technical solutions to improve the rain garden's function – for example, an oil separator or setter can be included to absorb the initial, most polluted runoff. During winter, the large amount of sodium chloride usually used to grit the roads may pose the greatest threat to biodiversity and plants [3].

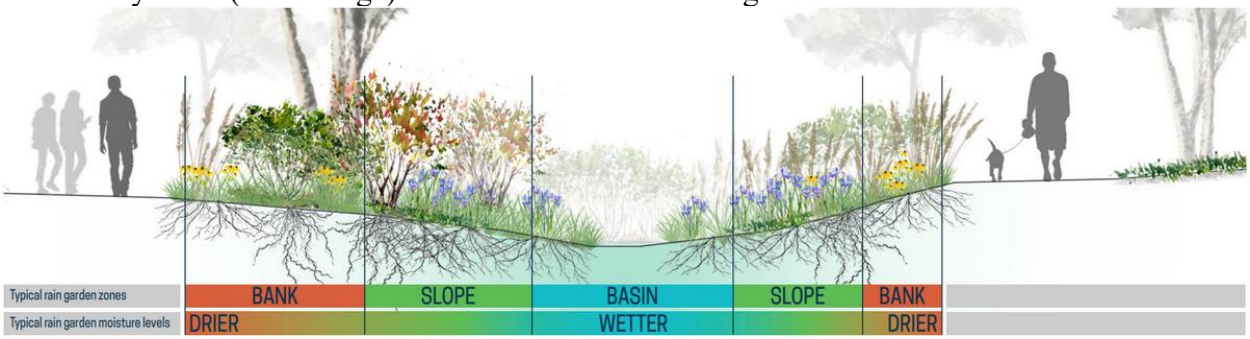
Methodology for selecting hardy plants for rain gardens.

A rain garden can be designed as both an infiltration solution for storm water, and a waterproof solution that mainly performs a retention function. In both cases, the total outflow is minimized by evapotranspiration [4].

Phytoremediation, the process by which plants remove pollutants, enhances the quality of discharged water. A rain garden can be designed either as an infiltration system to manage stormwater or as a sealed structure primarily focused on retaining water. Some important metals, such as Ni, Se, Zn, and Fe can be recovered from the phytoremediation process of phytomining and biofortification. The recovery of metals from metal contaminated sites, using high biomass producing plants is known as phytomining [5]. However, a major drawback of hyperaccumulator plants is their slow growth and low biomass, which makes them unsuitable for use in phytoremediation of large areas. Therefore, special attention is paid to studying the ability of cultivated and wild plant species to accumulate heavy metals [6]. Phytoremediation is an emerging technology that uses plants to clean up pollutants (metals and organics) from the environment. Within this field of phytoremediation, the utilization of plants to transport and concentrate metals from the soil into the harvestable parts of roots and above-ground shoots is usually called phytoextraction. Most traditional remediation methods do not provide acceptable solutions for the removal of metals from soils. By contrast, phytoextraction of metals is a cost-effective approach that uses metal-accumulating plants to clean up these soils. Subsequently, the harvestable parts, rich in accumulated metals, can be easily and safely processed by drying, ashing or composting. Some extracted metals can also be reclaimed from the ash, generating recycling revenues. Phytoextraction appears a very promising technology for the removal of metal pollutants from the environment and may be, at present, approaching commercialization [7].

Rain gardens typically have three zones based on water saturation (Pic. №1)*:*

- Wet Zone (Center): Can handle standing water for extended periods.
- Mesic Zone (Middle): Prefers moist, well-drained soil.
- Dry Zone (Outer Edge): Tolerates occasional drought conditions.



Picture №1

Wet Zone Plants (Standing Water Tolerance)

Plant life in the wet zone must endure long periods of saturation and even standing water. These plants generally possess deep, fibrous root systems that allow for the absorption of water and discourage erosion. These plants are especially beneficial to those parts of the Pacific Northwest that get a lot of rain and also have poor drainage, i.e., coastal regions and lowlands.

Blue Flag Iris (Iris versicolor)	Thrives in wet soil, provides stunning blue-purple flowers, and attracts pollinators.	
Swamp Milkweed (Asclepias incarnata)	Ideal for supporting monarch butterflies while tolerating saturated soils.	
Cardinal Flower (Lobelia cardinalis)	Produces striking red blooms that draw hummingbirds to the garden.	

Mesic Zone Plants (Moderately Moist Areas)

Mesic zone plants are well suited to regions of seasonal fluctuation in moisture because they tolerate both wet and fairly dry conditions. They are good choices for territories, where seasonal rain can be intense but summers are comparatively dry. The plants stabilize the transition between the wet and dry zones, so the rain garden will be working year-round to manage runoff.

Tamarix ramosissima	Notable for its bright red winter stems, stabilizing soil and providing shelter for wildlife.	

Sweet Pepperbush (Clethra alnifolia)	Offers fragrant white flowers that attract bees and butterflies.	
Culver's Root (Veronicastrum virginicum)	Produces tall spikes of white flowers, making it a great choice for rain gardens.	

Dry Zone Plants (Drought Tolerance)

Mesic zone plants are best adapted to seasonal fluctuations in moisture areas because they can tolerate both wet and fairly dry situations. They would be suitable in areas, where summers are fairly dry but rainfall during seasons is heavy. The vegetation stabilizes the wet-dry interface so that the rain garden will be in operation throughout the year to address runoff [8].

Black-Eyed Susan (Rudbeckia hirta)	Provides bright yellow flowers and thrives in drier conditions.	

Goldenrod (Solidago rugosa)	Late-season bloomer supporting pollinators into autumn.	
Butterfly Weed (Asclepias tuberosa)	Host plant for monarchs with vibrant orange flowers.	

The role of resilient plants in maintaining biological diversity.

A rain garden well-planned rewards with fruits, seeds, and nectar and is a valuable source of food at all times. Migratory birds will have shelter, food, and refuge, completing this unique habitat. Landscaping wildlife brings back desperately lost habitat. The native plants that make up the signature rain gardens to draw butterflies, frogs, turtles, toads, and birds that depend upon them for water, shelter, and food. Rain transient flooding will bring a multitude of birds, mammals, and insects-- especially dragonflies. The mud and moisture are vital to the male butterflies shown puddling above since it's a cooling surface for cold-blooded amphibians and reptiles on the warmest days of the year [9].

Conclusion

In the face of increasing urbanization and climate-induced water scarcity, rain gardens emerge as a viable and sustainable strategy for managing stormwater while enhancing ecological value. This study examined plant selection strategies tailored to arid and semi-arid climates, emphasizing the importance of using species that are not only drought-tolerant but also capable of withstanding periodic flooding. Special focus was given to plants with phytoremediation properties, which contribute to the purification of urban runoff. By categorizing plants into wet, mesic, and dry zones, landscape designers can create resilient green infrastructure that functions effectively throughout the year. Integrating native and climate-adapted species not only supports biodiversity but also promotes long-term sustainability in water management. The insights and recommendations presented in this paper offer a practical framework for the development of rain gardens in environmentally stressed urban areas.

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