Raingarden

A raingarden, also known as a bioretention basin or a vegetated basin, is a type of garden which is generally formed on a natural slope and looks like a sunken garden bed. It has native shrubs, perennials, and flowers planted in small depressions. It is designed in a way that enables it to hold and soak rainwater runoff from driveways, lawns, patios, sidewalks, parking lots, streets, and roofs. The rainwater runoff is channelled to the basin of raingarden where it stays until it slowly seeps into the soil. As compared to conventional gardens, a raingarden soaks 30 per cent more water into the ground. It also effectively removes 90 per cent of chemicals and nutrients and 80 per cent of sediments from rainwater runoff (Groundwater Foundation, 2022).

Structural parts of a raingarden

Generally, a raingarden must have an inlet, slope, base, sand bed, planting soil layer, buffer, organic matter, berm, and overflow. See figure 1 for a visual representation and table 1 for a description.

Figure 1: Structural parts of a raingarden
<table>
<thead>
<tr>
<th>Structural parts of raingarden</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet</td>
<td>The point from where water enters the soil is called an inlet. Usually, stones are placed here to avoid soil erosion by slowing down the water flow.</td>
</tr>
<tr>
<td>Slope</td>
<td>The slope (50 – 70°) is an inclination that connects the buffer with the base. It has such species of plants which can tolerate both dry and wet environment. It acts as a holding area of water prior to treatment and infiltration.</td>
</tr>
<tr>
<td>Base</td>
<td>The base is the deepest, flat, visible area of raingarden where water-tolerant plants are planted. The base is a levelled area to ensure maximum filtration of water. It can drain itself within 24 hours to avoid mosquito breeding due to stagnant water.</td>
</tr>
<tr>
<td>Sand bed</td>
<td>In case of poor drainage of soil, sand beds are preferred with comparatively coarse sand particles to ensure appropriate infiltration of water. The sand must be precisely selected otherwise it could impede the drainage.</td>
</tr>
<tr>
<td>Planting soil layer</td>
<td>This is the usual native soil layer that provides a ground to grow plants near raingardens. The soil must be tested to ensure adequate nutrients and required pH.</td>
</tr>
<tr>
<td>Buffer</td>
<td>It is an outer edge of raingarden with drought-tolerant plants. It absorbs the pollutants, filters the sediments, and slows down the runoff.</td>
</tr>
<tr>
<td>Organic matter</td>
<td>Under the base, organic matter, such as compost and shredded wood mulch(^1), is used to provide ground for microorganisms that deplete pollutants.</td>
</tr>
<tr>
<td>Berm</td>
<td>It is a constructed mound, both vegetated and mulched, on the bank of a raingarden to control and slow down runoff and retain it within the raingarden.</td>
</tr>
<tr>
<td>Outlet/Overflow</td>
<td>It is the point of exit of the raingarden from where the excess runoff leaves the raingarden during extreme rain events.</td>
</tr>
<tr>
<td>Plants</td>
<td>Different native plant species with varied drought tolerance are planted all over the space with wet tolerant species at base and drought tolerant species on slopes.</td>
</tr>
</tbody>
</table>

\(^1\) Mulch refers to a layer of material (wood chips, leaves, grass clippings, straw, gravel, and plastic) that is spread over the surface of soil to protect it and provide various benefits such as improving soil health, conserving water, and supporting healthy plant growth.
Types of raingardens

There are two primary categories of raingardens: those with underdrainage systems and those that are self-contained. The main purposes of both types of raingardens are to enhance the quality of stormwater, decrease the amount of runoff, and aid the filtration of purified water.

Underdrain raingarden

Underdrain systems receive and clean all stormwater biologically. The excess ponded water is then directed to a conventional drainage system through an installed pipe at the base of raingarden. The underdrain raingardens typically drain within two hours of a storm event.

Self-contained raingarden

Self-contained systems hold the rainwater for longer durations as they infiltrate all the stormwater in the lower areas of the garden. Very porous planting materials are added with soil in more depths (4”- 3”) to allow quicker drainage of water as compared to shallow gardens. For the self-contained system to function properly, it is necessary to have uncontaminated soil and enough space (about four feet) from the average high-water-table of the season.
Raingardens are always installed near the house to catch runoff from the roof. It can also be established up-slope of a spot in a lawn where the rainwater collects due to depression. Otherwise, an underground piping can be installed, or a constructed channel or swale can be used. Usually, rooftops, paved surfaces, slopes, and compacted soils are considered the largest source of runoff. To choose the location wisely, following are a few recommendations (Groundwater Foundation, 2022).

• Raingardens must be at a ten feet distance from nearby houses to avoid water seepage.

• It’s important to avoid developing raingardens near or on top of septic drains, as these areas have inadequate drainage already.

• Raingardens thrive in areas with plenty of sunlight or partial sunlight, although they can still be successful in shaded locations.

• The raingarden must be integrated with the present landscape according to the preference.
• The raingarden must be installed away from large trees. This will avoid damage to the excavation process of the garden because of the expanding roots of the tree. Moreover, at times, large trees may not be able to tolerate the extra moisture held by the raingardens.

• Get a complete guideline about the underground service lines and utilities.

• Water can be directed from downspouts to the raingarden by using flexible plastic pipe, while considering the garden size calculation and additional water flow.

Soil and drainage

Raingardens need well-drained and sandy soils but can be installed on clayey soil too. However, it can become waterlogged very quickly. The soil must be capable to absorb the roof and driveway runoff. If it is too sandy, it must be amended with compost to ensure good plantation and in case of too clayey soil, it might need to be replaced to avoid drainage issues. It is suggested to use a soil mixture containing 50-60 per cent sand, 20-30 per cent topsoil, and 20-30 per cent compost without any clay. However, if the designated site remains waterlogged even after a few days of rainfall, exhibits wetland soil characteristics such as grey soil with ribbons or brown areas within a foot of the surface, or water poured in a test hole remains stagnant after a couple of days, then it’s better to look for an alternative location for the raingarden. Alternatively, the site can be used as a wetland garden in the backyard (Cahill, 2018).
Size

Raingardens can be of varied sizes from small to large depending upon the site drainage area. A well-shaped raingarden might be 10 ft x 7.5 ft. However, it can be of any shape as per choice. In the case of silty soils, the raingarden’s size can be expanded by approximately 50 per cent, while for clayey soils, the size can be doubled. This enlargement compensates for the reduced treatment capability of these soils in comparison to sandy soils. A useful guideline is that the raingarden’s length should be approximately twice its width, perpendicular to the slope (Cahill, 2018).

Installation

After designating the location for a raingarden, the shape layout is decided. Typically, the designated zone is marked using non-hazardous field paint. However, alternative approaches, such as placing a hose along the perimeter of the garden and then digging alongside it, could also be used. Alternatively, a general rectangular shaped garden can be simply used.

In case of fairly levelled yard, a bowl with proper depth (6 inches and more in case of mulch) can be dug. In case of sloped yard, a small berm (mound) will be constructed at the downslope to prevent soil washing during and after storm. The removed soil from upslope can be used on the downslope side for this purpose. To keep the storage area in the garden organized, it’s important to ensure that the ground at the base of the garden is evened out. However, the edges of the garden are sloped but not too steep as steep slopes erode easily. To stabilize the soils, mulch or ground covers are applied.
In case of lawns, the turf must be removed beforehand which can be used in another area of lawn or can be composted. If the soil has good drainage, basic soil preparation may be enough. Adding compost can enhance soil quality in garden beds. However, if the soil is composed of clay, replacing it is the only solution.

To prevent waterlogging in a raingarden, you can add a layer of gravel at the bottom of the garden bed or install tiles or an underdrain that diverts water to another area. The aim is to create a vibrant soil environment with plants, roots, and mulch, not a waterlogged swamp. Ensuring that the surface of a raingarden is appropriately sloped is crucial for distributing rainwater evenly across a wide, flat space and allowing it to seep into the ground. This may necessitate removing a significant amount of soil. Once the depression area is prepared and the soil is sufficiently loose, vegetation can be planted. Following the raingarden’s preparation, it can be covered with mulch, and planting can occur through the mulch. Alternatively, planting can be done right away, and then mulch can be added. The raingarden will become established more quickly if the plants are planted as soon as possible (Cahill, 2018).

**Plantation**

Plants are utilized to enhance the visual appeal of a raingarden and its surrounding areas. The overall design of the house’s landscape, including factors such as plant height, bloom time, colour, and texture, must be considered. To achieve a long flowering season, plants with varying bloom times are utilized. The garden’s depth and dimension are created by incorporating plants of different heights, shapes, and textures. If the raingarden is large enough, small plants or a few flowering shrubs may be included.
It’s important to note that plants in a raingarden must be able to tolerate varying levels of soil wetness since the garden will have different wetness zones. Plants that are more water-tolerant can thrive in the deepest part of the garden, while more typical landscape plants can be utilized in the shallower areas and along the edges. Drought-tolerant plants may be planted on the perimeter. Many native plants are suitable for raingardens and are typically adapted to local growing conditions. Introduced ornamentals may also be used if they don’t have invasive characteristics or pose a pest problem.

To create a more striking display of colour, plants can be arranged in random clusters consisting of three (03) to seven (07) plants. However, repetition should be employed within these individual groupings to ensure that there is a sense of unity in the planting. This will result in a more traditional and formal appearance. Additionally, it is recommended to apply mulch that is two (02) inches thick while being careful not to cover the crowns of the plants. Using hardwood mulch is ideal as it is less likely to be washed away by water (Cahill, 2018).

Figure 2: Landscaping of raingarden
Maintenance of raingardens

For healthy functioning of the raingarden, regular maintenance is mandatory. Following are some measures that can be adopted to maintain raingardens (Cahill, 2018):

• To prevent the growth of weeds and maintain soil moisture for efficient stormwater infiltration, it is recommended to apply mulch once a year. Soil surfaces that are not mulched may become compacted, creating a hardpan that hinders water infiltration. When applying new mulch, it is advisable to remove the old mulch first. Alternatively, the old mulch can be loosened with a rake and topped with new mulch. It is important to note that the depth of the mulch should not exceed three (03) inches.

• During the establishment of the garden, it is important to remove weeds regularly, as newly planted species may struggle to compete with them. As the plants become more established, there will be less need for weeding.

• To promote healthy growth, the plants in the raingarden should be watered regularly during the establishment period. Once established, the plants should be watered during extended periods of drought. It is recommended to water deeply once or twice a week, rather than frequent shallow watering.

• It is important to maintain the cleanliness and health of the garden by periodically removing dead vegetation and any debris that may have accumulated. Over time, replanting may be necessary. If a plant is not thriving in its current location within the garden, it may need to be relocated to a drier or wetter area depending on its specific moisture requirements.
Advantages and disadvantages of raingardens

**ADVANTAGES**

- Simple to add on to existing structures.

- Require little space.

- Enhance the aesthetic appeal of open areas.

- Can be designed to blend with other landscaping elements.

- Have the potential to slow down runoff and lower volume.

- Adaptable layout to complement the surrounding environment.

- Can be installed on impermeable surfaces with proper planning.

**DISADVANTAGES**

- Drainage issue due to clogging of raingarden outlets.

- Rainwater runoff accumulation in the basin, which can lead to backups and flooding.

- Increased erosion rates due to improperly designed basin.
WWF-Pakistan is working on an AusAid funded project titled the Australia-Pakistan Water Security Initiative (APWASI) which aims to improve water resource management and introduce the Water Sensitive Cities (WSC) approach in Pakistan. Two communities, Farash Town, Islamabad and James Town, Rawalpindi have been chosen for this project, both of which lack public water supply and accommodate middle and low-income inhabitants. The objective of APWASI is to improve safe water and sanitation access to disadvantaged communities, build capacity of stakeholders in water conservation and management, and ensure community resilience to climate change and other water-related issues through a mix of nature-based solutions and locally suitable interventions. Groundwater quality and availability are major issues in both selected sites. Several interventions are proposed to alleviate the issue and are being demonstrated under APWASI. One of them is the establishment of raingardens. Till now, four raingardens have been established, two at each demonstration site. Please refer to Figures 3 and 4, which show the situation before and after the establishment of the raingardens.
Figure 3: Images of open space before and after the establishment of a raingarden at James Town, Rawalpindi.

Figure 4: Images of open space before and after the establishment of a raingarden at Farash Town, Islamabad.
Conclusion

Given the increasing water stress in urban areas throughout Pakistan, it is crucial to adopt water sensitive approaches that can help conserve and replenish freshwater resources. One such approach is the implementation of raingardens, which can play a significant role in replenishing groundwater by temporarily holding and soaking in rainwater runoff from rooftops, driveways, patios, or lawns. This approach is particularly valuable in water-scarce regions. This knowledge series issue highlights the joint initiative between WWF-Pakistan and Australian Aid to demonstrate the establishment of raingardens in Pakistan.
References

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