Rain garden

From Wikipedia, the free encyclopedia

A **rain garden** is a planted depression or a hole that allows rainwater runoff from impervious urban areas, like roofs, driveways, walkways, parking lots, and compacted lawn areas, the opportunity to be absorbed. This reduces rain runoff by allowing stormwater to soak into the ground (as opposed to flowing into storm drains and surface waters which causes erosion, water pollution, flooding, and diminished groundwater).[1] They should be designed for specific soils and climates.[2] The purpose of a rain garden is to improve water quality in nearby bodies of water and to ensure that rainwater becomes available for plants as groundwater rather than being sent through stormwater drains straight out to sea. Rain gardens can cut down on the amount of pollution reaching creeks and streams by up to 30%.[3]

Business parking lot that drains to a rain garden. The curb retains the asphalt pavement, yet lets water flow off the edges.

Native and adapted plants are recommended for rain gardens because they are more tolerant of one's local climate, soil, and water conditions; have deep and variable root systems for enhanced water infiltration and drought tolerance; habitat value and diversity for local ecological communities; and overall sustainability once established. There can be trade-offs associated with using native plants, including lack of availability for some species, late spring emergence, short blooming season, and relatively slow establishment. The plants — a selection of wetland edge vegetation, such as wildflowers, sedges, rushes, ferns, shrubs and small trees — take up excess water flowing into the rain garden. Water filters through soil layers before entering the groundwater system. Root systems enhance infiltration, maintain or even augment soil permeability, provide moisture redistribution, and sustain diverse microbial populations involved in biofiltration.[4] Also, through the process of transpiration, rain garden plants return water vapor to the atmosphere.[5] A more wide-ranging definition covers all the possible elements that can be used to capture, channel, divert, and make the most of the natural rain and snow that falls on a property. The whole garden can become a rain garden, and each component of the whole can become a small-scale rain garden in itself.

Contents

Restoring the water cycle and mitigating urbanization

In developed areas, natural depressions where storm water would pool, are filled in. The surface of the ground is often leveled or paved. Storm water is directed into storm drains which often may cause overflows of combined sewer systems or poisoning, erosion or flooding of waterways receiving the storm water runoff.[6][7][8] Redirected storm water is often warmer than the groundwater normally feeding a stream, and has been linked to upset in some aquatic ecosystems primarily through the reduction of dissolved oxygen (DO). Storm water runoff is also a source of a wide variety of pollutants washed off hard or compacted surfaces during rain events. These pollutants include volatile organic compounds, pesticides, herbicides, hydrocarbons and trace metals[9] Rain gardens are designed to capture the initial flow of storm water and reduce the accumulation of toxins flowing directly into natural waterways through ground filtration. They also reduce energy consumption. For example, “the cumulative storage capacity of these rain gardens exceeds a conventional stormwater’s system’s by 10 times.”[10] The National Science Foundation, the United States Environmental Protection Agency, and a number of research institutions are presently studying the impact of augmenting rain gardens with materials capable of capture or chemical reduction of the pollutants to benign compounds.

Rain garden, SUNY College of Environmental Science and Forestry, Syracuse, New York

Rain gardens are often located near a building’s roof drainpipe (with or without rainwater tanks). Most rain gardens are designed to be an endpoint of drainage with a capacity to percolate all incoming water through a series of soil or gravel layers beneath the surface plantings. A French drain may be used to direct a portion of the rainwater to an overflow location for heavier rain events. By reducing peak stormwater discharge, rain gardens extend hydraulic lag time and somewhat mimic the natural water cycle displaced by urban development and allow for groundwater recharge. While rain gardens always allow for restored groundwater recharge, and reduced stormwater volumes, they may also increase pollution unless remediation materials are included in the design of the filtration layers .[11]

The primary challenge of rain garden design centers on calculating the types of pollutants and the acceptable loads of pollutants the rain garden's filtration system can handle during storm-water events. This challenge is specifically acute when a rain event occurs after a longer dry period. The initial storm water is often highly contaminated with the accumulated pollutants from dry periods. Rain garden designers have previously focused on finding robust native plants and encouraging adequate biofiltration, but recently have begun augmenting filtration layers with media specifically suited to chemically reduce redox of incoming pollutant streams.

Rain gardens are beneficial for many reasons: improve water quality by filtering runoff, provide localized flood control, are aesthetically pleasing, and provide interesting planting opportunities. They also encourage wildlife and biodiversity, tie together buildings and their surrounding environments in attractive and environmentally advantageous ways, and provide significant partial solutions to important environmental problems that affect us all.

A rain garden provides a way to use and optimize any rain that falls, reducing or avoiding the need for irrigation. They allow a household or building to deal with excessive rainwater runoff without burdening the public storm water systems. Rain gardens differ from retention basins, in that the water will infiltrate the ground within a day or two. This creates the advantage that the rain garden does not allow mosquitoes to breed. Compost, rather than soil, has better effects on filtering groundwater and rainwater. Compact lawn soil /cannot harbor groundwater nearly as well, because the water simply flows off.

History

The first rain gardens were created to mimic the natural water retention areas that occurred naturally before development of an area. The rain gardens for residential use were developed in 1990 in Prince George's County, Maryland, when Dick Brinker, a developer building a new housing subdivision had the idea to replace the traditional best management practices (BMP) pond with a bioretention area. He approached Larry Coffman, the county's Associate Director for Programs and Planning in the Department of Environmental Resources, with the idea.[12] The result was the extensive use of rain gardens in Somerset, a residential subdivision which has a 300–400 sq ft (28–37 m^2) rain garden on each house's property.[13] This system proved to be highly cost-effective. Instead of a system of curbs, sidewalks, and gutters, which would have cost nearly $400,000, the planted drainage swales cost $100,000 to install.[12] This was also much more cost effective than building BMP ponds that could handle 2-, 10-, and 100-year storm events.[12] Flow monitoring done in later years showed that the rain gardens have resulted in a 75–80% reduction in stormwater runoff during a regular rainfall event.[13]

This is also referred to as Water Sensitive Urban Design (WSUD) in Australia, Sustainable Urban Drainage Systems or SUDS in the United Kingdom, and low impact development (LID) in the United States, and is cited by the U.S. Environmental Protection Agency (EPA).[14]

Some *de facto* rain gardens predate their recognition by professionals as a significant LID tool. Any shallow garden depression implemented to capture and retain rain water within the garden so as to drain adjacent land without running off a property is at conception a rain garden — particularly if vegetation is maintained with recognition of its role in this function. Vegetated roadside swales, now promoted as "bioswales", remain the conventional drainage system in many parts of the world from long before extensive networks of concrete sewers became the conventional engineering practice in the industrialized world.

What is new about such technology is the emerging rigor of increasingly quantitative understanding of how such tools may make sustainable development possible. This is as true for wealthy developed communities retrofitting bioretention into built stormwater management systems, as for developing communities seeking a faster and more sustainable development path.

Characteristics

A rain garden requires an area where water can collect and infiltrate, and plants to maintain infiltration rates, diverse microbe communities, and water holding capacity. Transpiration by growing plants accelerates soil drying between storms. This includes any plant extending roots to the garden area.

Simply adjusting the landscape so that downspouts and paved surfaces drain into existing gardens may be all that is needed because the soil has been well loosened and plants are well established. However, many plants do not tolerate saturated roots for long and often more water runs off one's roof than people realize. Often the required location and storage capacity of the garden area must be determined first. Rain garden plants are then

selected to match the situation, not the other way around.


A home rain garden recently planted

Soil and drainage

When an area's soils are not permeable enough to allow water to drain and filter properly, the soil should be replaced and an underdrain installed. This bioretention mixture should typically contain 60% sand, 20% compost, and 20% topsoil, and there is a current trend to replace compost with biochar. Existing soil must be removed and replaced. Do not combine the sandy soil (bioretention) mixture with a surrounding soil that does not have high sand content. Otherwise, the clay particles will settle in between the sand particles and form a concrete-like substance, as demonstrated in a 1983 study.[15] Deep plant roots also create additional channels for storm water to filter into the ground. Microbial populations feed off plant root secretions and break down carbon (such as in mulch or desiccated plant roots) to aggregate soil particles which increases infiltration rates. A five-year study by the U.S. Geological Survey indicates that rain gardens in urban clay soils can be effective without the use of underdrains or replacement of native soils with the bioretention mix. Pre-installation infiltration rates should be at least .25 in/hour, however. Type D soils will require an underdrain paired with the sandy soil mix in order to drain properly.[16]

Sometimes a drywell with a series of gravel layers near the lowest spot in the rain garden will help facilitate percolation. However, a drywell placed at the lowest spot can become clogged with silt prematurely turning the garden into an infiltration basin defeating its purpose. Depression-focused recharge of polluted water into wells poses a serious threat and should be avoided. Similarly plans to install a rain garden near a septic system should be reviewed by a qualified engineer. The more polluted the water, the longer it must be retained in the soil for purification. This is often achieved by installing several smaller rain garden basins with soil deeper than the seasonal high water table. In some cases lined bioretention cells with subsurface drainage are used to retain smaller amounts of water and filter larger amounts without letting water percolate as quickly.

Rain gardens are at times confused with bioswales. Swales slope to a destination, while rain gardens do not; however, a bioswale may end with a rain garden. Drainage ditches may be handled like bioswales and even include rain gardens in series, saving time and money on maintenance. Part of a garden that nearly always has standing water is a water garden, wetland, or pond, and not a rain garden. Using the proper terminology ensures that the proper methods are used to achieve the desired results.

Plant selection

Plants selected for use in a rain garden should tolerate both saturated and dry soil. Using native plants is generally encouraged. This way the rain garden may contribute to urban habitats for native butterflies, birds, and beneficial insects.

Well planned plantings require minimal maintenance to survive, and are compatible with adjacent land use. Trees under power lines, or that up-heave sidewalks when soils become moist, or whose roots seek out and clog drainage tiles can cause expensive damage.

Trees generally contribute most when located close enough to tap moisture in the rain garden depression, yet do not excessively shade the garden. That said, shading open surface waters can reduce excessive heating of habitat. Plants tolerate inundation by warm water for less time because heat drives out dissolved oxygen, thus a plant tolerant of early spring flooding may not survive summer inundation.

Another plant that works particularly well is bamboo. It has been tested, and it can clean water 27.6% better than domestic plants like grass or clovers. Rice, although it is hard to grow and maintain, works even better.

Rain garden projects

Australia

- Healthy Waterways Raingardens Program promotes a simple and effective form of stormwater treatment, and aims to raise peoples' awareness about how good stormwater management contributes to healthy waterways. The program encourages people to build rain gardens at home, and has achieved its target is to see 10,000 rain gardens built across Melbourne by 2013.[17]
- Melbourne Water's database of Water Sensitive Urban Design projects, including 57 case studies relating to rain gardens/bioretention systems. Melbourne Water is the Victorian State Government agency responsible for managing Melbourne's water supply catchments.[18]
- Water By Design is a capacity building program that supports the uptake of Water Sensitive Urban Design, including rain gardens, in South East Queensland. It was established by the South East Queensland Healthy Waterways Partnership in 2005, as an integral component of the SEQ Healthy Waterways Strategy.[19]

United Kingdom

- The Wildfowl and Wetlands Trust's London Wetland Centre includes a rain garden designed by Nigel Dunnett.[20]
- Islington London Borough Council commissioned sustainable drainage consultants Robert Bray Associates to design a pilot rain garden in the Ashby Grove development which was completed in 2011. This raingarden is fed from a typical modest domestic roof catchment area of 30m² and is designed to demonstrate how simple and cost effective domestic rain gardens are to install. Monitoring apparatus was built into the design to allow Middlesex University to monitor water volumes, water quality and soil moisture content. The rain garden basin is 300mm deep and has a storage capacity of 2.17m³ which is just over the volume required to store runoff from the roof catchment in a 1 in 100 storm plus 30% allowance for climate change.[21][22]
- The Day Brook Rain Garden Project has introduced a number of rain gardens into an existing residential street in Sherwood, Nottingham[23]

United States of America

- The 12,000 rain garden campaign for Puget Sound is coordinating efforts to build 12,000 rain gardens in the Puget Sound Basin of Western Washington by 2016. The 12,000 rain gardens website provides information and resources for the general public, landscape professionals, municipal staff, and decision makers. By providing access to the best current guidance, easy-to-use materials, and a network of trained "Rain Garden Mentor" Master Gardeners, this campaign seeks to capture and cleanse over 200 Million gallons of polluted runoff each year, and thereby significantly improve Puget Sound's water quality.[24]
- Maplewood, Minnesota has implemented a policy of encouraging residents to install rain gardens. Many neighborhoods had swales added to each property, but installation of a garden at the swale was voluntary. The project was a partnership between the City of Maplewood, University of Minnesota Department of Landscape Architecture, and the Ramsey Washington Metro Watershed District. A focus group was held

with residents and published so that other communities could use it as a resource when planning their own rain garden projects.

- In Seattle, a prototype project, used to develop a plan for the entire city, was constructed in 2003. Called *SEA Street*, for Street Edge Alternatives, it was a drastic facelift of a residential street. The street was changed from a typical linear path to a gentle curve, narrowed, with large rain gardens placed along most of the length of the street. The street has 11% less impervious surface than a regular street. There are 100 evergreen trees and 1100 shrubs along this 3-block stretch of road, and a 2-year study found that the amount of stormwater which leaves the street has been reduced by 99%.[25]
- 10,000 Rain Gardens is a public initiative in the Kansas City, Missouri metro area. Property owners are encouraged to create rain gardens, with an eventual goal of 10,000 individual gardens.
- The West Michigan Environmental Action Council has established Rain Gardens of West Michigan as an outreach water quality program.[26] Also in Michigan, the Southeastern Oakland County Water Authority has published a pamphlet to encourage residents to add a rain garden to their landscapes in order to improve the water quality in the Rouge River watershed.[27] In Washtenaw County, homeowners can volunteer for the Water Resources Commissioner's Rain Garden program, in which volunteers are annually selected for free professional landscape design. The homeowners build the gardens themselves as well as pay for landscaping material. Photos of the gardens as well as design documents and drainage calculations are available online.[28] The Washtenaw County Water Resource Commisioner's office also offers yearly in person and online Master Rain Gardener classes to help guide those interested in the rain garden design, building, and upkeep process.[29]
- The city of Portland, Oregon, has established a Clean River Rewards program, to encourage residents to disconnect downspouts from the city's combined sewer system and create rain gardens. Workshops, discounts on storm water bills, and web resources are offered.[30]
- In Delaware, several rain gardens have been created through the work of the University of Delaware Water Resources Agency, and environmental organizations, such as the Appoquinimink River Association.[31]
- In New Jersey, the Rutgers Cooperative Extension Water Resources Program has already installed over 125 demonstration rain gardens in suburban and urban areas. The Water Resources Program has begun to focus on using rain gardens as green infrastructure in urban areas, such as Camden and Newark to help prevent localized flooding, combined sewer overflows, and to improve water quality. The Water Resources Program has also revised and produced a rain garden manual in collaboration with The Native Plant Society of New Jersey.[32]

See also

- Climate-friendly gardening
- Constructed wetland
- Ecohydrology
- Green roof
- Microclimate
- Runoff footprint
- Urban runoff
- Water-energy nexus

References

1. University of Rhode Island. Healthy Landscapes Program. "Rain Gardens: Enhancing your home landscape and protecting water quality." (http://www.uri.edu/ce/healthylandscapes/raingarden.htm)

2. Dussaillant et al. [1] (http://cedb.asce.org/cgi/WWWdisplay.cgi?140904) Journal of Hydrologic Engineering
3. Sandy Coyman; Keota Silaphone. "Rain Gardens in Maryland's Coastal Plain" (PDF). p. 2. Retrieved 11 October 2011.
4. B.C. Wolverton, Ph.D., R.C. McDonald-McCaleb (1986). “Biotransformation of Priority Pollutants Using Biofilms and Vascular Plants.” (http://ntrs.nasa.gov/archive/nasa/ssctrs.ssc.nasa.gov/journal_vol_31/journal_vol_31.pdf) Archived (https://web.archive.org/web/20090407052746/http://ntrs.nasa.gov/archive/nasa/ssctrs.ssc.nasa.gov/journal_vol_31/journal_vol_31.pdf) April 7, 2009, at the Wayback Machine. *Journal Of The Mississippi Academy Of Sciences.* Vol. XXXI, pp. 79-89.
5. A. Dussaillant, Ph.D., et al. (2005). "Archived copy". Archived from the original on 2011-06-11. Retrieved 2010-06-09. *Water Science & Technology: Water Supply journal.* Vol. 5, pp. 173-179.
6. Kuichling, E. 1889. “The relation between the rainfall and the discharge of sewers in populous districts.” *Trans. Am. Soc. Civ. Eng.* 20, 1–60.
7. Leopold, L. B. 1968. “Hydrology for urban land planning: A guidebook on the hydrologic effects of urban land use.” (http://pubs.er.usgs.gov/usgspubs/cir/cir554) *Geological Survey Circular* 554. United States Geological Survey.
8. Waananen, A. O. 1969. “Urban effects on water yield” in W. L. Moore and C. W. Morgan (eds), *Effects of Watershed Changes on Streamflow.* University of Texas Press, Austin and London.
9. Novotny, V. and Olem, H. 1994. “Water Quality: Prevention, Identification, and Management of Diffuse Pollution.” Van Nostrand Reinhold, New York.
10. Strassberg, Valerie; Brad Lancaster (June 2011). "Fighting water with water: Behavioral change versus climate change" (PDF). *American Water Works Association*. **103** (6): 59. Retrieved 29 March 2012.
11. Dietz, Michael E.; Clausen, John C. (2005). "A Field Evaluation of Raingarden Flow and Pollutant Treatment". *Water, Air, & Soil Pollution*. **167** (1–4): 123–138. doi:10.1007/s11270-005-8266-8.
12. "Urban Runoff" (PDF). *Nonpoint Source News-Notes*. No. 42. Washington, D.C.: U.S. Environmental Protection Agency (EPA). August 1995. Archived from the original (PDF) on 2012-07-07.
13. *Wisconsin Natural Resources* (magazine). “Rain Gardens Made One Maryland Community Famous.” (http://dnr.wi.gov/wnrmag/html/supps/2003/feb03/run.htm#one) February 2003.
14. "Rain Gardens". *Soak Up the Rain*. EPA. 2016-04-28.
15. http://www.hriresearch.org/Docs/Publications/JEH/JEH_1983/JEH_1983_1_3/JEH%201-3-77-80.pdf
16. Sustainable City Network, Dubuque, IA (2011-02-21)."USGS: Rain Gardens Work Regardless of Soil Conditions." (http://www.sustainablecitynetwork.com/topic_channels/water/article_b65fe518-3de0-11e0-82aa-00127992bc8b.html?utm_source=SCN+InBox+e-Newsletter&utm_campaign=2c869b70df-Newsletter_2-23-11_Tech&utm_medium=email)
17. http://melbournewater.com.au/raingardens
18. http://wsud.melbournewater.com.au/content/case_studies/case_studies.asp
19. http://www.waterbydesign.com.au
20. http://www.wwt.org.uk/visit/london/
21. "Robert Bray Associates Design Statement - Islington Council Public Records" (PDF). Islington Council.
22. "Ashby Grove residential retrofit rain garden, London". Susdrain. Retrieved 2013-12-02.
23. "Nottingham Green Streets – Retrofit Rain Garden Project". Susdrain. Retrieved 2013-08-04.
24. http://www.12000raingardens.org
25. City of Seattle, Washington. Seattle Public Utilities. “Street Edge Alternatives (SEA Streets) Project.” (http://www.seattle.gov/util/environmentconservation/projects/drainagesystem/greenstormwaterinfrastructure/completedgsiprojects/streetedgealternatives/)
26. Rain Gardens of West Michigan, Grand Rapids, MI. “Rain Gardens of West Michigan” (http://www.raingardens.org/)
27. Southeastern Oakland County Water Authority, Royal Oak, MI.
    - “Rain Gardens for the Rouge River: A Citizen’s Guide to Planning, Design, & Maintenance for Small Site Rain Gardens” (http://www.socwa.org/nature/PDF/Rain%20Gardens.pdf) Archived (https://web.archive.org/web/20060510063424/http://www.socwa.org/nature/PDF/Rain%20Gardens.pdf) May 10, 2006, at the Wayback Machine.
28. Washtenaw County, Michigan. “Rain Garden Virtual Tour” (http://www.ewashtenaw.org/raingardens)
29. "Master Rain Gardener Volunteer Program —". *www.ewashtenaw.org*. Retrieved 2016-09-01.
30. Clean River Rewards, Portland, Oregon. “Clean River Rewards.” (http://www.portlandonline.com/BES/index.cfm?c=41976)
31. University of Delaware Cooperative Extension. “Rain Gardens in Delaware.” (http://ag.udel.edu/extension/horticulture/raingarden.)

32. http://water.rutgers.edu/Rain_Gardens/RGWebsite /demoraingardens.html

Further reading

- Dunnett, Nigel and Andy Clayden. *Rain Gardens: Sustainable Rainwater Management for the Garden and Designed Landscape*. Timber Press: Portland, 2007. ISBN 978-0-88192-826-6
- Liu, Jia, David J. Sample, Cameron Bell and Yuntao Guan. 2014. "Review and Research Needs of Bioretention Used for the Treatment of Urban Stormwater" (http://www.mdpi.com/2073-4441/6/4/1069/htm). Water, 6 (4): 1069–1099. "doi:10.3390/w6041069" (http://dx.doi.org/10.3390%2Fw6041069)
- Prince George's County. 1993. *Design Manual for Use of Bioretention in Stormwater Management.* Prince George's County, MD Department of Environmental Protection. Watershed Protection Branch, Landover, MD.
- Bioretention Manual (Report). Landover, MD: Prince George's County, Department of Environmental Resources. 2002. Archived from the original on 2009-04-22.
- Clar, Michael L.; Barfield, Billy J.; O'Connor, Thomas P. (September 2004). Stormwater Best Management Practice Design Guide, Volume 2: Vegetative Biofilters (Report). Edison, NJ: EPA. EPA 600/R-04/121A.
- Kraus, Helen, and Anne Spafford. *Rain Gardening in the South: Ecologically Designed Gardens for Drought, Deluge & Everything in Between.* Eno Publishers: Hillsborough, NC, 2009. ISBN 978-0-9820771-0-8
- Bray, B., Gedge, D., Grant, G., Leuthvilay, L. *UK Rain Garden Guide*. Published by RESET Development, London, 2012

External links

- Rain garden case study (https://web.archive.org/web/20071205203223/http://www.landandwater.com:80/features/vol48no5/vol48no5_2.php), Burnsville, MN (USA). 2004. *Land & Water:* 48(5).
- Water at the Grass Roots (https://web.archive.org/web/20060326171040/http://www.flcities.com/membership/library_water_grassroots.asp) A brief introduction to Low Impact Development and rain gardens
- Details for construction of rain garden with a long plant list from Brooklyn Botanical Garden (http://www.bbg.org/gar2/topics/design/2004sp_raingardens1.html)
- Rain Garden Network - Local Solutions to Local Stormwater Issues (http://www.raingardennetwork.com/) — Chicago, Illinois, United States
- Stormwater Tender project (http://www.urbanstreams.unimelb.edu.au/) — Little Stringybark Creek, Victoria, Australia
- Rain Garden Design Templates for the Chesapeake Bay Watershed (http://www.lowimpactdevelopment.org/raingarden_design/)
- Wisconsin Department of Natural Resources — Rain Gardens (http://www.dnr.state.wi.us/runoff/rg/)
- Healthy Waterways Raingardens Program — Melbourne, Victoria, Australia (http://www.melbournewater.com.au/raingardens/)
- UK Rain Garden Guide (http://raingardens.info/)

Wikimedia Commons has media related to ***Rainwater harvesting***.

Categories: Sustainable gardening | Environmental engineering | Waste management concepts | Sustainable design | Types of garden | Water pollution | Hydrology and urban planning | Waste treatment technology | Landscape architecture | Water conservation | Stormwater management