Potentials and Systems in Sustainable Landscape Design

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Based on a presentation by Ilse Frank

Figure 1: Five-acre retention pond and native prairie grasses filter and slowly release storm water run-off from adjacent residential development at Mueller Austin, serving an ecological function as well as an aesthetic amenity.

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Sustainable Landscape Design

Landscape architecture will play an important role in structuring the cities of tomorrow by allowing landscape strategies to speak more closely to shifting cultural paradigms. A designed landscape has the ability to illuminate the interactions between a culture’s view of its societal structure and its natural systems. Landscape architecture employs many of the same design techniques as architecture, but is unique in how it deals with time as a function of design (Figure 2), its materials palette, and how form is made. Today, landscape architecture plays a leading role in sustainable design because of its ability to address ecological concerns associated with urban growth and the built environment. Sustainable approaches to landscape strive to create places of value and meaning while also respecting and acknowledging the important functions that nature performs. Sustainable landscape design combines aesthetic and psychological advantages while tapping into the enormous ecological and functional potential of living systems.

Shaping (the role of) water

Water is a powerful element which has the ability to shape the organization of a site. Attitudes toward water as a site element have changed over the course of the 20th century. Water is no longer moved across a site as quickly as possible using heavy urban infrastructure. Today, we are more likely to take advantage of the potential for reusing water onsite for irrigation and gray water systems, for providing habitat, and for slowing storm water flows and allowing infiltration to groundwater systems—all of which can inspire new forms for integrating water into the built environment. Water can be utilized in remarkable variety of ways—as a physical boundary, an ecological habitat, or even a waste filtration system. A large-scale example of an outmoded approach is the Rio Bravo/Rio Grande, which once meandered between the cities of El Paso, Texas and Ciudad Juarez, Mexico. This body of water was rechanneled and defined with concrete banks to create a more clearly delineated geo-political boundary between the two countries. While this intervention has maximized the river’s potent physical and visual ability to demarcate distinct spaces, it has also divorced the river from its unique capacity to engage a landscape through the ephemeral ebb and flow of erosion and deposition, and has removed the habitat potential of a large swath of land. Water is a critical resource for cities in the 21st century, but we can no longer rely on concrete and heavy-handed engineering to shape its flow. These techniques cause critical problems for groundwater recharge, soil erosion, and maintaining native landscapes. We must integrate water into our site design, rather than pushing it aside, to generate new forms for living in the 21st century.
II-Strategies   Site

Water may act as a defining site feature through various “edge conditions” where a transition occurs between water and land. Soil erosion is an important concern when considering the interaction of water and land, and various strategies can be used to address this issue. The grade or slope of the land may be manipulated to protect the edge, and subtle variations can be designed with this goal in mind. Edge conditions have various options to consider in their design—whether to allow or discourage human engagement with a water body, to develop certain habitats, or to direct the flow of water. In Brooklyn Bridge Park, which extends along the East River in Brooklyn, New York, some edges were treated in a rough and naturalized manner, with grass and soil ending in a buffer of large irregular rocks toward the water. Since public use was also a primary component of this program, some other points received a different treatment, with large stone slabs terracing down to provide seating in close proximity to the river. This condition permits the use of the water’s edge and encourages occupants to be in close interaction with nature in an urban context where that is especially rare and valuable.

Another type of edge condition is a riparian buffer, which is the strip of land adjacent to a stream where the vegetation is closely influenced by the presence of water. A buffer at the edge of a creek or river can protect against soil erosion, provide habitat and food for native species, mitigate non-point source pollution, and slow stormwater surges. Depending on their width, buffers can serve multiple functions, with increasing possibilities where greater width is available for the buffer area. A narrow buffer can protect against erosion and supply an important source in the food web, while larger buffers can serve additional functions such as providing habitat, flood control, and sediment control, etc. Buffers can also play an important role in managing non-point source pollution, such as street run-off (Figures 2 and 4), by providing an area of natural filtration and helping to break down some of the harmful substances in the run-off before the water drains into a stream.

Consequences of the built environment

Rapid sheet flow across impermeable surfaces during a storm event and accumulation of sediments and pollution from roadways in the storm surge are the two largest problems affecting the built environment’s impact upon water quality. Water flows more quickly across impermeable surfaces such as buildings and paved areas, than it does across impermeable surfaces that allow water to infiltrate. The most critical volume of water in a storm event, with regard to water quality, is the “first flush,” which contains the majority of the pollutants and sediments which are washed across impermeable areas. As the water runs over these surfaces, it collects impurities and toxic elements left by pollution from cars or other sources.

Figure 2: Park as a catalyst for new development patterns for the city of Quito through urban tree production. Parque del Lago Competition Design by Dean Almy, Ilse Frank, and Jason Sowell.
Collecting and slowing this first run-off from a storm event, thus managing pollutants onsite as much as possible, is the most important task that landscape design can undertake with regard to water. Water cannot penetrate impermeable surfaces and thus cannot be filtered and absorbed by plants and soil. In addition, the flow of water is not slowed by the absorption process and therefore places a greater burden on our storm sewer systems. Cities with combined sewer systems are at high risk, since the overflow of combined sewer systems can cause raw sewage to end up in natural waterways. When run-off drains rapidly into bodies of water, it causes higher levels of toxicity, erosion problems, and the possibility of storm surges and flooding conditions. We must design the path of the water, especially the “first flush,” to mitigate the problems of erosion, non-point source pollution, and overburdening our municipal storm sewer systems.

Retention and filtration strategies

Allowing the landscape to filter and absorb water naturally is a key strategy for sustainable landscapes. Some fundamental approaches include bioswales, rain gardens, retention basins, detention basins, and sediment/infiltration basins. In addition to providing ecological benefits, these systems also supply landscape amenities that are of significant value to the users of the site. The addition of functional vegetative elements to a site can provide aesthetic value and the psychological benefits of viewing natural elements, through inviting native species such as birds and insects to be involved in a user’s daily interaction with a space.

Bioswales

Bioswales are shallowly sloped channels filled with vegetation, compost or rocks that have been graded to accept run-off and move it slowly over their surfaces. They are designed to maximize the amount of time the water spends in the swale, allowing contaminants and silt to be captured and slowing the flow of water to larger bodies. They are commonly used around parking lots and roadways, where run-off tends to be highly polluted. As a physical intervention, bioswales can engage seasonal changes through vegetation, make evident the natural processes of vegetation interacting with water, and provide a new edge condition between streets and buildings.

Retention and Detention Basins

Retention basins (Figure 1) serve a similar purpose but hold water in pools, whose water levels fluctuate with the level of rainfall versus the rate of absorption. Retention basins can take on the form of a vegetated pond, similar to a wetland condition, which can engage public space as a respite from the day to day urban built environment. At further extremes, the form of a detention basin can take on a format that engages pools in a series of functions that slow water and filter different sediments—with the potential to alleviate a new development’s reliance on sewage treatment. A second basin condition, the detention basin, acts similarly but does not necessarily always contain water. Its main purpose is to capture water during high levels of rainfall, when any detention basins may already be exceeding their holding capacity, thus slowing its flow and allowing it to absorb slowly into the ground. Detention basins may be heavily vegetated and during drier periods can serve multiple functions as sports fields or open green spaces. Both retention and detention basins provide an opportunity for stormwater to recharge the groundwater onsite, provide irrigation, and to supply an amenity on site, whether functional or aesthetic.

Sediment/infiltration basins

Sediment or infiltration basins also allow water to percolate slowly into the ground and are commonly used in urban conditions as landscape elements. They can take a variety of forms and can make use of vegetation which is able to handle a wide range of moisture in order to survive dry periods as well as times of inundation. A second kind of sediment/infiltration basin (Figure 3) can be contained sub-grade which sends storm water for cleansing through a filtration system composed of varying grades of fines in a contained area. This system can be of particular benefit to more urbanized areas where open space is at a premium, and vegetative water-cleansing techniques are not feasible. Through all of these retention methods, rainwater can be captured and reused with a pumping system for irrigation, thereby greatly reducing overall water consumption.

Rain gardens

Another landscape amenity that also serves a functional need is the rain garden. It is essentially a more specific type of bioswale or sediment/infiltration basin. Rain gardens are planted depressions located in areas where rainwater drains from an impermeable source such as downsputs on buildings or a parking lot. They can be used at points where a shift between pervious and impervious occurs. Rain gardens create an attractive alternative to the typical drain set into a depression in the asphalt below a downsput.
Alternative surface treatments

Pervious concrete paving (Figure 4) and porous asphalt are also options for managing stormwater run-off. This technology provides a smooth, drivable surface that while still allowing water to penetrate through it and be absorbed into the ground. Pervious paving can take many forms, from pre-cast pavers or bricks set in sand, to a concrete mix that preserves pockets of air to allow infiltration. It should be noted that pervious pavement is not suitable for all situations, since it needs to be regularly maintained and vacuumed out so that sediment will not clog the pores of the asphalt. Pervious paving can take many forms, from pre-cast pavers or bricks set in sand, to a concrete mix that preserves pockets of air to allow infiltration. It should be noted that pervious pavement is not suitable for all situations, since it needs to be regularly maintained and vacuumed out so that sediment will not clog the pores of the asphalt. This may also limit its use in colder climates where roads are salted in the winter to prevent snow accumulation.

A second, inexpensive alternative surface treatment is selective mowing of grasses (Figure 5). By planting native grasses and allowing them to grow tall, animal habitat and diversity is restored and a greater amount of carbon sequestration function is restored.

Green roofs and their benefits

Green roofs are perhaps the most iconic system utilized in sustainable landscapes. There are two types of green roofs—extensive and intensive. Extensive green roofs are typically composed of a mat of sedums or grasses with a minimum soil depth of three inches (Figure 7). They are typically self-sustaining, requiring very little maintenance; however in more arid environments, such as Texas, some irrigation may be required to supplement in times of drought. Intensive green roofs (Figure 6) require a greater soil depth and can support larger plants such as trees. They typically require a fairly high level of maintenance and regular irrigation but are commonly designed to also function as public space and withstand those associated live load conditions.

Like the previously discussed infiltration and drainage systems, green roofs also capture, slow, and filter rainwater. The soil and plants bind heavy metals and can capture up to 95% of the cadmium, copper and lead particulates that fall on them. Besides creating a permeable layer that reduces the flow of rainwater and moderates runoff temperatures that could harm aquatic life, green roofs provide additional insulation to the building’s roof, reducing the energy needed to heat and cool the interior.
spaces. This added mass also serves as an acoustic buffer. When used in cities, green roofs can have a significant impact on reducing the urban heat island effect through absorbing solar radiation and releasing the heat through evapotranspiration, which cools the building and the local air. In addition, the layer of plants protects the roof from UV deterioration, doubling its lifespan. The plants absorb gaseous pollutants through their leaves and filter dust and dirt particles out of the air, thus improving air quality for the building’s occupants. Ten square feet of leaf surface can trap five pounds of dirt from the air every year. Sixteen square feet of uncut grass can provide a one year supply of oxygen for one person. Beyond these numerous environmental advantages, green roofs also provide immense aesthetic value by replacing views of typical black, tar roofs with the beauty, color and texture of plantings.

Green walls

A green wall is a vertical surface which is covered in plant material. There are two fundamental types of green walls - green facades and living walls. Green facades consist of climbing plants which are trained to grow over certain portions of the wall and are rooted either at the bottom of the structure or in intermediary planters. Living walls (also known as biowalls) are made up of modular pregrown panels, similar to those used for green roofs, which can be mental types of green walls - green facades and living walls. Green facades consist of climbing plants which are trained to grow over certain portions of the wall and are rooted either at the bottom of the structure or in intermediary planters. Living walls (also known as biowalls) are made up of modular pregrown panels, similar to those used for green roofs, which can be installed onto a vertical surface in both exterior and interior applications. These wall systems can have benefits similar to those of green roofs, though generally to a lesser degree.

Speculations and potentials

The incorporation of new greenspaces into urban environments can be accomplished through early decision making for allocation of functional open space and the re-use of derelict infrastructure for new purposes (Figure 11) as well as finding new potential in existing urban spaces (Figure 9).

The greater sum of all new green space in a city can have a significant impact upon its future. Balmori Associates undertook an exploration of the potential for green roofs in the dense urban context of New York City. Looking specifically at a particular neighborhood, Long Island City, in Queens, they posed the question – What if every building had a green roof? They discovered that the added green area would be equivalent to the area of Figure 9: 2009 PARK(ing) Day temporary installation, Austin, TX.
Prospect Park, one of the most significant park spaces in Brooklyn. In addition, 55% of the existing impervious cover would be transformed into pervious green space. These changes would lead to significant benefits both at the scale of the neighborhood and at the larger scale of the city in ameliorating the urban heat island effect, cleaning air, and regulating water.

Another more speculative approach to the integration of landscape and building appears in the work of the Austrian artist, Friedensreich Hundertwasser. His whimsical sketches and projects place trees as dominant elements, bursting out of windows and even acting as “tenants” (Figure 10) within buildings. Hundertwasser’s work suggests a significant rethinking of the secondary role we tend to assign to landscape and nature and envisions what such a reevaluation could inspire.

Conclusion
Sustainable landscape design serves an important role in mediating the significant environmental damage caused by common building practices. It aims to create places that can link into ecological systems instead of destroying them. Landscape is also recognized for its profound psychological and aesthetic benefits — helping us to understand our place in the world. The intrinsic value of landscape can be rediscovered and brought to the forefront of design and the built environment. Sustainable landscapes investigate how we reflect ourselves in landscape and how landscape in turn reflects us.

Notes

Figures
Figure 1: Courtesy of Ilse Frank.
Figure 2: Courtesy of Dean Akmy, Ilse Frank, and Jason Sowell.
Figures 3-9: Courtesy of Ilse Frank
Figure 10: http://voluntarysimplicityinaction.blogspot.com/
Figure 11: Courtesy of Ilse Frank

Recommended Reading

Biography
Ilse Frank holds a Bachelor of Architecture from the University of Texas at Austin and a Master of Landscape Architecture and Master of City Planning from the University of Pennsylvania’s School of Design.

At Penn, she was research assistant to Dr. Susan Wachter, Wharton Professor of Real Estate & Finance and co-director of the Penn Institute for Urban Research, focusing on future development patterns and natural resources of the Everglades and Biscayne Bay, in and around Miami-Dade County.

Ms. Frank’s interdisciplinary experience focuses on urban design and landscape architecture. Ms. Frank has practiced in design offices in New York, Philadelphia, and The Netherlands. In practice, Ms. Frank has joined with collaborative teams for winning, international competition entries for urban-scale projects in Spain, South America, and Korea.