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A More Protective Urban Landscape

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As the world warms and becomes more populous and urban, more is expected from cityscapes.

Beyond aesthetics, urban ecosystems must provide benefits to residents such as shading against urban heat islands, improving air quality, abating floods, and securing local food sources. Other important objectives include accommodating wildlife, purifying runoff, and sequestering carbon to help prevent global warming. Virtually every urban environment, no matter how densely populated, can be optimized in terms of the ecological services it can provide. This becomes ever more important as cities expand, often at the expense of natural habitats that provide these essential services.

When landscapes are designed and installed as part of "high-performance infrastructure," as architect Hillary Brown, executive director of New York City–based New Civic Works, calls it, urban ecosystems need to be established that will grow ever more functional over time and that will hold up to any disturbances that might be encountered. Many cities are threatened by earthquakes, tsunamis, ice storms, and various types of flooding and violent weather, which are predicted to increase as a consequence of climate change. Perhaps no combination of urban infrastructure and landscape can protect itself and its citizens from the most catastrophic scenarios, but much can be done to improve the resistance and resilience of urban ecosystems to a broad range of disturbances that, over time, are inevitable. The key is to plant a system that will protect the environment and provide as much stability as possible.

For example, the misery experienced by post–Katrina New Orleans was exacerbated by pervasive failures in the urban ecosystem. The widespread dropping of the urban forest could almost be seen as a "betrayal," with supposedly protective trees chopping roofs, downing power lines, and blocking streets. Many of the trees that should have served as protective sentinels against the wind instead fell because they were the wrong species, or were improperly installed, or were poorly maintained. Due to pervasive and lingering floodwaters, many of the trees that did not fall, especially magnolias, died from root suffocation or salt absorption.

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However, it is important to point out that the calamity began before Katrina hit. It began with a massive failure of the external ecosystem, which had deteriorated because of shortsighted developmental activities. The multiple layers of defense in Louisiana's wetlands—from the distant cheniers (oak-dappled coastal islands) to the bald cypress swamps to the vast inland marshes—had suffered chronic degradation due to river channelization, oil development, and various navigational naiveties. The failure of the natural ecosystem around New Orleans is worth noting because when functional urban ecosystems are designed, the encompassing natural ecology needs to be carefully examined for successful (and failing) soil/plant systems to emulate (and avoid); and to establish peripheral link-

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ages—for instance, wildlife corridors and continuous riparian strands—that will weave the cityscape into nature.

Because of the weakened coastal fringe and substandard levees, flooding became catastrophical. The water, once past the levees, filled the urban bowl to sea level and lingered for weeks until the levees could be patched and the bowl drained to a safe level. Last year's levee failures made the national news, but in fact flooding is the city's bane, not just when the levees fail, but each time rainfall outpaces the pumping system. In this regard, the Crescent City suffers the same stormwater backups faced by any city, but the problem is exacerbated by the need to pump water uphill to Lake Pontchartrain. Millions of liters of stormwater are pumped each year, requiring fossil fuel and carrying pollution. If any city in America has an incentive to capture and use stormwater, it is the Big Easy. The improved accommodation of stormwater can avert flooding and its often long-term damage.

Much can be done—especially under duress—to enhance the performance of the urban forest. By understanding which trees are most reliable in tolerating catastrophe, landscape experts can select trees that best withstand disaster. To do that, they observe the "performance" of trees in nature. Life sciences writer Janine M. Benyus, author of *Biomimicry: Innovation Inspired by Nature*, describes oaks during a storm bowing their trunks and bending major branches to adjust to 100-knot winds. The leaves, she observed, were coiled into tubes to ease the wind's passage until they were released explosively in peak gusts to spare the branch. Legendary southern arborist Bob Thibodaux observed the remarkable impacts of bald cypress forests on advancing hurricanes. Storm surges raging high through marshes were substantially dampened by the cypress forests and their interlocking roots. The tapered trunks bowed their upper halves almost flat and, in an elevated mat, seemed to deny the cyclonic vacuum access to its watery fuel. Swamp-dwelling Cajuns speak of the forest "taming" the storm; today, we speak of its capacity to "deenergize" storms.

The remarkable capacity of oak, bald cypress, and other stately species, such as magnolia and sycamore, to protect against the wind, and to provide other benefits such as shading, is underappreciated in landscape design. Trees can be planted to provide shelter and shade by anticipating wind paths and solar angles, but this will be for naught—or possibly even counterproductive—if deep rooting and proper development are not encouraged. Trees should be transplanted into excavations that are twice the width of the root ball, and that are underlain by soil that has been loosened to encourage root penetration. Every sentinel tree should be mulched deeply to the drip-line, and should be remulched and structurally pruned on a regular basis. The importance of proper mulch cannot be overemphasized: mulch excludes turf and, thereby, allows water to penetrate deeply, where roots will follow to make a stronger anchor. Partially composted, recycled wood chips are ideal for this purpose because they decompose quickly, continuously infusing organic matter into the soil, promoting healthy roots by aerating the soil, enhancing tillage, and feeding root symbionts (microbial species that nourish roots). Mulch is always important, but, when planting in confined space, it is the best defense against sidewalk buckling or foundation damage.

With proper planning and attention, protective canopies of storm-worthy trees—sentinels—can watch over the urban landscape.

There is a wide spectrum of wind-tolerant tree species. As a rule, fast-growing species such as Drake Elm, while providing shade, are wind intolerant and the first to cause problems in a disaster because their fast growth results in less dense wood and less stout root systems. Slower-growing species such as live oak, bald cypress, and magnolia are wind tolerant, with thick trunks, strong branches, and extensive, durable root systems suited to decades of protective duty.

A final strategy for a wind-worthy urban forest is to promote teamwork among the sentinels. The big trees should be planted close enough for their roots to interweave, lacing the urban forest to the soil so thoroughly that it prevails against even the strongest gusts of wind.

Water is obviously essential to plant growth, but can be a nuisance during storms. When runoff backs up, property is damaged and traffic is blocked, forcing engineers to install larger storm sewers or, worse, disruptive networks of unsightly concrete ditches. This action tends to export the trouble to the next city down. Ironically, a few days after

Stormwater can be caught and stored in cisterns, green roofs, bioretention basins, or box gardens (top), avoiding flooding and averting water damage. Rather than directing gutter downspouts straight to storm sewers, they can feed sinuous swales of rocks and water-adapted plants (middle). With widespread landscapes, or with downslopes from large impervious surfaces, swales can be established along the contour to encourage infiltration (above).

stormwater has been so assiduously shed, plants wilt and must be watered—expensively—from the tap.

What if, instead of stormwater being shed, it is caught, stored, and used in cisterns, green roofs, box gardens, and bioretention basins? These features may increase costs, but the expense can be offset when floods and the damage that results are avoided. Such features can be integrated into an initial design, or added on. Individually, they may save their owner only a water bill, but collectively they can alter the water balance of a neighborhood, replacing flooding with retention, averting water damage, and fostering healthier plants.

Permeable pavement also serves to absorb and capture water, as does an abundance of mulch. Besides nourishing trees and encouraging deep roots, organic matter soaks up water prodigiously.

Mulch will play a major role in water-effective landscapes, whereas turf will be less widely used. Grass demands many resources and constant maintenance. It must be mowed, fertilized, and irrigated. While needing regular sprinkling, turfs are quick to become saturated and shed during deluges. During protracted flooding, turf can kill trees when it blocks oxygen and traps salt. Along several avenues in post–Katrina New Orleans, deeply mulched magnolias have re-leafed to their former vigor while those surrounded by grass remain leafless.

A final but key element in water efficiency is that landscape surfaces may be shaped to encourage infiltration. The commercial and residential landscaping process should start with downspouts being disconnected from the gutter system. These dischargers of rainwater, rather than pointing straight to the storm sewer, should feed sinuous swales of rocks and water-adapted plants. Under all but the most extreme circumstances, rainwater will be captured in soil for eventual uptake by plants. The deep infiltration will help trees develop deeper roots, improving their wind-worthiness. Alternatively, drainage swales and retention basins may be richly planted to become "rain gardens" of aquatic species that give beauty, host wildlife, and sequester carbon.

The best swales undulate, escorting water slowly to encourage infiltration. Cobbles, vegetation, or both create turbulence that further impedes the flow. During intense rain, properly designed systems will gradually become saturated, at which point the current becomes laminar and fast moving, finding the sewer and draining from the site, but doing so much later in the deluge than in conventional landscapes. With broad landscapes, or downslopes from large impervious surfaces, swales also can be established along the contour to encourage infiltration until they overflow and the water runs to the sewer.

All of these elements—sentinel trees, deep organic mulches, and water-wise morphology—are important to the environmental performance and disaster worthiness of an urban ecosystem. But the most important ingredient, that which is provided by the designer, is integration. Urban and neighborhood landscapes should be as integrated as possible, both within themselves and within their surrounding infrastructures.

For instance, placing sentinel trees near swales will enhance their wind tolerance by encouraging the roots to follow the deeply infiltrating water. Trees should also be placed to protect against solar heating, north-wind chill, and gale-force damage, while the swales must be keyed to downspouts and impervious surfaces, an example that epitomizes the circularity of the design process.

A source of inspiration for designers is permaculture, devised by Bill Mollison and David Holmgren, which strives to create human systems of plants and structures that are as ecologically diverse and resilient as natural ecosystems. Permaculture integrates the best of organic growth, civil engineering, and architecture into an endless array of design possibilities, all of which form systems that develop over time, striving toward the highest state of multifunctionality.

Landscape architects can no longer design without striving for the broadest possible functionality, synergistically addressing such objectives as stormworthiness, water-use efficiency, wildlife accommodation, and more. Neither can they design solely for conditions of climatic or geologic tranquility. The challenge is to design urban landscapes that beautify, perform, improve, and endure. UL

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