Urban Nature and Human Design: Renewing the Great Tradition

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"Once we can accept that the city is as natural as the farm and as susceptible of conservation and improvement, we work free of those false dichotomies of city and country, artificial and natural, man versus other living things."
Kevin Lynch (1981)

Abstract

The city is part of nature; a fact that has profound implications for how cities are designed, built, and managed. For centuries, city designers have exploited nature to promote human purposes. The roots of this tradition are as diverse as the many ways in which nature contributes to human health, safety, and welfare. An overview of that tradition is outlined here, along with an assessment of existing knowledge and prospects for city design.

Introduction

Nature pervades the city, forging bonds between the city and the air, earth, water, and life within and around it. Urban nature consists of air, the materials suspended within it, and the light and heat transmitted through it. It is the landforms upon which the city rests and the minerals embedded in the earth beneath it; the water in rivers and reservoirs, pipes and soil; and the organisms that live within the urban habitat. But urban nature is more than a collection of individual features like wind, hills, rivers, and trees. It is the consequence of a complex interaction between the multiple purposes and activities of human beings and the natural processes that govern the movement of air, the erosion of the earth, the hydrologic cycle, and the birth and death of living organisms.

The city is part of nature. Recognition of that basic fact has powerful implications for how the city is designed, built, and maintained, and for the health, safety, and welfare of every resident. For the past century, however, consideration of nature has been viewed as pertinent mainly to the design of parks and new suburbs. But cultivation of nature is as relevant to planning transportation and sewage systems as it is to planning open space; as applicable to downtown reconstructon as to land development at the city's edge; as germane to comprehensive planning as to project design. There is an historic tradition for such a field, a foundation of knowledge to support it, and projects that illustrate the beneficial application of that knowledge. This paper represents an initial effort to elucidate this tradition and is part of a larger project to trace its roots and sketch a theoretical framework.

In themselves, the forces of nature are neither benign nor hostile. Acknowledged and harnessed, they represent a powerful resource for shaping a hospitable urban habitat. Ignored or subverted, they magnify problems that have plagued cities for centuries: poisoned air and water; more frequent or more destructive natural hazards; depleted or inaccessible resources; increased energy demands and high construction and maintenance costs; and now, in many cities across the globe, a boring sameness.

Unfortunately, especially in this century, planners and designers have mostly neglected and rarely exploited natural forces within cities. The belief that the city is apart from, and even antithetical to, nature has dominated the way in which the city is perceived and continues to affect how it is built. Issues such as energy conservation, waste disposal, flood control, and water supply are treated as isolated problems, rather than as related phenomena arising from common human activities, exacerbated by a disregard for the processes of nature. Urban environmental planning has most often been a reaction to these specific problems, rather than a considered proposal for managing the relationships among them, or for seizing opportunities to solve several problems with a single solution. Solutions to narrowly defined problems are costly and inefficient and frequently precipitate other, unanticipated problems. The focus on specific problems in isolation from their broader context has characterized the environmental planning literature (Galloway and Huelster 1971) and has dominated the curriculum (Deknatal 1984). This fragmented approach undermines the exploration of potential multi-purpose solutions.

More is known about urban nature today than ever before. Over the past three decades, natural scientists have amassed an impressive body of knowledge about nature in the city. Yet little of this information has been applied directly to molding the form of the city — the shape of its buildings and parks, the course of its roads, and the pattern of the whole. A small fraction of that knowledge has been employed in establishing regulations to improve environmental quality; but these have commonly been perceived as restrictive and punitive, rather than as posing opportunities for new urban forms. Regulations and their enforcement have also proven vulnerable to shifts in public policy, at the mercy of the political concerns of the moment, whereas the physical form of the city endures through generation after generation of politicians. Regulations controlling the emission of air pollutants may be altered or unenforced, for example, but urban form designed to disperse those pollutants will continue to do so regardless of changes in policy.

A few cities, however, have exploited nature ingeniously to shape an urban habitat that is safe, healthy, economical to build and maintain, beautiful, and memorable. Although such cities are not common today, they are part of an abiding tradition in city design. An overview of that tradition is outlined here, along with an assessment of existing knowledge and prospects for city design.

Nature, Human Purpose, and City Design: The Tradition[1]

For centuries city designers have exploited nature to promote human purposes. The roots of this tradition are as diverse as the many ways in which nature contributes to environmental quality. For example, concern for health, motivated Hippocrates' observations on "airs, waters, and places" in the 5th century B.C., John Evelyn's proposals for dissipating "the Inconvenience of the Aer and Smoake of London" in the 17th century, and the sanitary reform movement in the 19th century. The desire to protect the city from hazards, both human and natural, provoked Aristotle's advice for exploiting defensible topography and securing a reliable water supply, and underlies the current interest in hazard planning. Authors through the ages have described the delights of urban groves and gardens, and contemporary social scientists have attempted to measure the pleasure that urban residents derive from plants and parks.

Nature has not meant the same thing to all people in all ages. Yet similar questions have been posed repeatedly: Does nature influence human development, or is man the sole architect of the environment in which he lives? Should man seek to coexist with nature or to dominate nature? Does man exist within nature or apart from it? Answers to these questions have profound consequences for how cities are perceived, designed, and built. To the ancient Greeks, for example, air, water, and fire were powerful elements that could determine the development and character of human cultures. The form of Greek cities was often adapted to the climate, topography, and natural hazards of their locale.

In contrast is the modern view of man as dominant and nature as fragile. This concept has spawned varied reactions; two views — the arcadian and the imperialist — represent the extremes.[2] The arcadians would protect nature, whose "harmony" they perceive as threatened by human actions.[3] The imperialists, on the other hand, would consolidate man's dominion over nature "to multiply and subdue the earth." To both arcadians and imperialists, the city has obliterated nature. Neither attitude has served the city well. Those city designers of the past century who have made important contributions to the field of urban nature and human design — Olmsted, Geddes, Mumford, McHarg, and Lynch, among them — have trod a middle ground between the arcadians and the imperialists. In so doing, they have sought to forge a consonance between natural processes and human purpose.

More than two thousand years ago, Hippocrates described the effects of "airs, waters, and places" upon human society, including the health of both individuals and the community at large. He contrasted the ill health plaguing cities that occupy damp, marshy ground or windy slopes with the benefits enjoyed by cities located to exploit sun and breezes (Hippocrates, ca. 5th century B.C.).[4] Subsequent writers suggested how cities might be sited and designed to avoid such problems. The Roman architect Vitruvius, for example, specified how the layout of streets and the orientation and arrangement of buildings should respond to seasonal patterns of sun and wind (Vitruvius, ca. 1st century B.C.).

In the 15th century, the Italian architect Alberti distilled the knowledge of ancient Greeks and Romans on the subject and added observations of his own. Alberti advocated that the siting of cities and the design of streets, squares, and buildings within them should be adapted to the character of their environment so that cities might promote health, safety, convenience, dignity, and pleasure (Alberti 1485). To Alberti, the forces of nature were powerful and deserved respect:

> . . .we ought never to undertake any Thing that is not exactly agreeable to Nature. . .for Nature, if you force or wrest her out of her Way, whatever Strength you may do it with, will yet in the End overcome and break thro' all Opposition and Hindrance; and the most obstinate Violence. . .will at last be forced to yield to her daily and continual Perseverence assisted by Length of Time. (Alberti 1485)

Alberti underscored this warning by cataloguing the disasters incurred by cities that had disregarded the power of nature. He also discussed landscape management techniques, including drainage, embankment, and channel improvements and forest plantation. Alberti was one of the last architects to take such a broad view. In later centuries, this tradition was continued mainly by landscape architects and engineers.[5]

When Francis Bacon stated that "nature is only to be commanded by obeying her," he represented an important change in attitude (Bacon 1620). Implicit in Bacon's statement is the conviction that nature can be understood, and through that understanding, cultivated and controlled for human benefit. John Evelyn's proposed plan to solve the air pollution of 17th century London evidenced a similar confidence. Evelyn based his plan on an understanding of the source of London's pollution and the climatic forces that acted to concentrate or disperse it. The plan is remarkable for its comprehensive scope. His recommendations, outlined in *Fumigium: Or the Inconvenience of the Aer and Smoake of London Dissipated* (1661), included the prohibition of high-sulfur coal, the relocation of polluting land uses like tanneries from central London to outlying areas downwind of the city, and the plantation of entire blocks with trees and flowers to sweeten the air. Evelyn was also the author of *Sylva* (1664), a work on trees and their cultivation. Later, when Louden,[6] Paxton, and Olmsted applied their experience in landscape gardening and "scientific agriculture" to the environmental problems of the 19th century city, they followed Evelyn's precedent.

By the nineteenth century, rapid urban and industrial growth produced alarming changes in both city and countryside. Many observers perceived these changes as evidence that human impact on nature was out of control, especially in large, industrial cities. George Perkins Marsh summed up that mood of disquiet in 1864:

> . . . Man is everywhere a disturbing agent. Wherever he plants his foot, the harmonies of nature are turned to discords . . . the earth is fast becoming an unfit home for its noblest inhabitant, and another era of equal human crime and human improvidence . . . would reduce it to such a condition of impoverished productiveness, of shattered surface, of climatic excess, as to threaten the deprivation, barbarism, and perhaps even extinction of the species (Marsh 1864).

With the publication of *Man and Nature*, a book influential in its own time and since, Marsh became the "fountainhead of the conservation movement" (Mumford 1931). But Marsh did more than sound a warning. He proposed that man's economy be designed to work in concert with nature's: "in reclaiming and reoccupying lands laid waste by human improvidence or malice . . . the task . . . is to become a co-worker with nature in the reconstruction of the damaged fabric" (Marsh 1864).

This was an approach embraced by Marsh's contemporary, Frederick Law Olmsted. Olmsted designed parks, parkways, and residential neighborhoods as part of a broader program to promote the health and welfare of urban citizens by improving the quality of their environment. To achieve these ends, he often harnessed nature's processes in "reclaiming lands laid waste by human improvidence." For example, Olmsted's design for Boston's Back Bay transformed "the filthiest marsh and mud flats to be found anywhere in Massachusetts . . . a body of water so foul that even clams and eels cannot live in it"[7] into a constructed salt marsh — an attractive landscape that accepted the daily and seasonal flux of tides and floods. Olmsted argued that the employment of a "natural" water body, rather than a masonry flood storage basin, would be more effective and attractive; an amenity rather than an eyesore. His primary objective here was to improve water quality and prevent floods; enhancement of adjacent land values and provision for recreation and transportation were important, but secondary, objectives.[8] Despite the scope of Olmsted's vision, however, he still perceived the city itself as artificial, and the urban park and parkway as oases of nature in an otherwise bleak environment.

Olmsted and the sanitary engineers with whom he collaborated were part of a movement for preventative sanitation provoked by environmental health problems.[9] This sanitary reform movement had a fundamental influence on the shape of American cities, and city design was essential to their programs:

> A city, most sanitarians would have agreed, should be arranged as an airy, verdant setting, free from the excessive crowding and physical congestion then common in major urban centers. Its site should be dry and readily drained of storm water. Parks and trees should be abundant enough to refresh the air. There should be ample opportunities for outdoor exercise. A pure water supply should be available as well as a water-carriage sewer system. Nuisance trades, such as slaughter-houses, should not operate within built-up districts. Sunless, ill-ventilated tenements, dark, moist, cellar dwellings, and backyard privies and cesspools should be avoided (Peterson 1979).

The introduction of public water and sewer systems and projects such as The Fens and The Riverway in Boston produced dramatic improvement in urban public health by the end of the century. During four decades of practice, Olmsted forged new functions for urban open space that embraced concerns for health and safety, as well as beautification. Today, a century later, many prized urban amenities are the result of those efforts. Yet their broad, original purpose and the ways in which nature was exploited in their design are often forgotten. Within the field of urban nature and human design, modern practitioners have rarely advanced the impressive accomplishments of landscape architects like Olmsted and their colleagues in engineering who, together, founded the American city planning movement at the turn of the century.[10]

Soon after the turn of the century, most city designers who wished to integrate nature and city turned to new towns and suburbs; only a few remained dedicated to the reconstruction of existing city centers. Two British planners, Ebenezer Howard and Patrick Geddes, represent these divergent approaches. Ebenezer Howard rejected the old city and proposed new "garden cities," where the advantages of town and country might be combined; where industry and commerce could be integrated with homes, gardens, and farms (Howard 1902). The garden city and the new towns and "greenbelt" suburbs it inspired had as their goal the integration of nature and human settlement; but most merely incorporated the trappings of nature, like trees, lawns, and lakes, and were built with as little regard for the processes of nature as were the old cities. With few exceptions, they have utilized the same techniques of land development and building. As they have grown older and as urbanization has spread around them, they have come to exhibit many of the same environmental problems as older cities.

Patrick Geddes argued for the realization of the ideal city latent in every town. "Here or nowhere is our utopia," was his response to proponents of the new garden city movement (Geddes 1915). From his perspective as a biologist and geographer, Geddes viewed the city and its surrounding countryside as an organic whole. He advocated that city design be based upon an understanding of the natural and social history of each city and region and the needs of its current residents. To attain such an understanding, Geddes undertook "regional surveys" and displayed the results in exhibits and reports. These formed the basis for proposals that were "consistent with the unique individuality of the particular city" (Goist 1974). Geddes' regional approach has had an enduring influence upon city design through the work of Lewis Mumford.

Mumford, like his entor Geddes, advocates that solutions to the problems facing both city and countryside depend upon perceiving both as part of a region: "Once a more organic understanding is achieved of the complex interrelations of the city and its region, the urban and the rural aspects of environment, the small-scale unit and the large-scale unit, a new sense of form will spread through both architecture and city design" (Mumford 1968). To Mumford this new urban form "must include the form-shaping contributions of nature, of river, bay, hill, forest, vegetation, climate, as well as those of human history and culture, with the complex interplay of groups, corporations, organizations, institutions, personalities" (1968). Yet Mumford's attitude to the central city is problematic. Although he speaks of integrating nature and city and the need not to "widen the retreat from the city, but to return to the original core, with a new method of containing and distributing its great numbers" (1961), nevertheless much of his work has been in support of the new town movement.

Mumford's recommendations for integrating urban nature and human purpose to produce a new city form remain very general. The importance of his contribution lies not in specific prescriptions, but in his analysis of the shortcomings of city design as it has been practiced in this century — shortcomings that include the neglect of nature. Mumford has also influenced important theorists and practitioners, among them Ian McHarg and Kevin Lynch. McHarg and Lynch share the conviction that the city must be viewed in its regional context and that urban form is an expression of the natural and cultural history of a region. To both, nature has a social value to be cultivated and incorporated into city design. From that common ground, they diverge.

An emphasis on natural processes is central to McHarg's approach: "Let us accept the proposition that nature is process, that it is interacting, that it responds to laws, representing values and opportunities for human use with certain limitations and even prohibitions" (McHarg 1969). McHarg's emphasis upon processes rather than upon features like floodplains or fault lines yields a holistic appreciation for nature and fosters designs that transcend narrow temporal and spatial limits.[11] McHarg employs a checklist of natural factors — to be addressed regardless of location, scale, or land use — which is comprehensive and ordinal: climate, geology, hydrology, soils, vegetation, and wildlife. Like Mumford, McHarg's attitude to the city is ambivalent; his greatest success has been with designs for newly urbanizing areas. His general approach, however, is equally relevant to the inner city. Balanced with other concerns, the social, economic, and aesthetic implications of nature are as important in the center of the city as they are at its edge.

Lynch's *A Theory of Good City Form* (1981) is a clearly expounded statement of what constitutes environmental quality in cities and how urban form can promote or undermine that quality. This framework incorporates all the varied ways that nature contributes to environmental quality, as well as the contribution of other social and economic factors. Good city form, as defined by Lynch, can be judged by how well it sustains life ("vitality"), by how clearly it is perceived in space and time ("sense"), how well environment and behavior "fit," and by whether these elements are provided in a manner that provides "access," "control," "efficiency," and "justice". The profound significance of urban nature for city design and the quality of human life is evident when viewed through this lens.

Lynch, in particular, stressed the importance of how people perceive the city and explored the role that nature plays in enhancing the identity, legibility, coherence, and immediacy of urban form. City form that exploits distinctive natural features enhances and intensifies a city's sense of place. City form that respects and reflects natural features and the social values they acquire has a coherent and legible structure, one that embodies shared values. City form that increases the visibility of natural processes (the passing of the seasons, the movement of water, the birth and death of living organisms), creates an environment that has both a sense of immediacy and of evolution over time. "The mental sense of connection with nature is a basic human satisfaction, the most profound aspect of sensibility . . .. The movements of sun and tides, the cycles of weeds and insects and men, can also be celebrated along the city pavements" (Lynch 1981).

Although Lynch's dimensions of environmental quality integrate the value of nature with other social and economic concerns, they fragment natural features and systems into categories that relate more to human needs than to the modes in which nature operates.[12] Exclusive reliance on such a framework obscures potential connections among features and activities and militates against city design that serves multiple environmental functions. The results of such an approach are already evident in the planning profession's focus on special areas like energy conservation and hazard planning to the exclusion of other, related issues.[13]

If urban nature is to be wholly integrated into city design and its value fully realized, a new framework is needed: one that recognizes both the integrity and interconnectedness of the natural world and the importance of all human concerns, one that relates to all elements of urban form at all scales. Scientific knowledge exists to inform such a framework, and there are models that demonstrate the benefits such an approach would yield.

Nature and the City: An Overview of the Literature

Cities do not obliterate nature, they transform it, producing a characteristically urban natural environment. All cities, by virtue of density of people and buildings and the combustion of fuel, the excavation and filling of land, the pavement of ground surface, importation of water and disposal of wastes, and the introduction of new plant and animal communities, alter the character of their original environments in similar ways. These interactions between human activities and the natural environment produce an ecosystem very different from the one that existed prior to the city. It is a system sustained by massive importation of energy and materials, a system in which human cultural processes have created a place quite different from undisturbed nature, yet united to it through the common flow of natural processes. These changes are generated not only by human activities, but also by the form of the urban fabric in which they take place. Changes in the form of the city can therefore modify many of the attributes of urban nature.

A growing literature has traced the interactions between natural processes, human purpose, and urban form. Fueled by the environmental movement and the energy crises of the 1970s, this literature on urban nature has matured in the past two decades. While the bulk of the literature deals with the description and measurement of specific natural phenomena, there is a body of work that applies that knowledge to city design. Although the literature within individual scientific disciplines is rich, cross-disciplinary studies and investigations by city designers are comparatively rare. The following paragraphs provide a brief overview of the applied literature.[14] This overview is organized by the various compartments of the physical and biological environment — air, land, water, life, and ecosystems — since this framework most closely reflects the disciplines concerned with urban nature, the natural processes involved, and the interrelationships among issues.

Urban Air

There are excellent reviews of the scientific literature on climate and air quality, including its implications for city design (Chandler 1976; Landsberg 1981), and of more specialized subjects such as air quality and urban form (Rydell and Schwartz 1968; Spirn and Batchelor 1985). These and other studies demonstrate how urban form can promote or undermine air quality, comfort, and energy conservation through its influence on air circulation and the urban heat island. Intense pedestrian-level winds, pockets of stagnant air where pollutants concentrate, and ventilating breezes, for example, can all be initiated, eliminated, or ameliorated by altering urban form. These phenomena have been observed and compared in wind tunnel tests of single buildings and building complexes, (Gandemer and Guyot 1976; Durgin and Chock 1982), of street canyons (Cermak 1975; Wedding et al. 1977), and even of entire downtown areas (Spirn 1984a; and Spirn 1984b). It is also possible to moderate or intensify the urban heat island effect at the microscale (Landsberg 1968; Hutchinson et al. 1982) and at neighborhood and city-wide scales (Landsberg 1981).

Urban Land

There are comprehensive texts on urban geology and city design (Legget 1973; Leveson 1980) and on specific problem areas like geological hazards (Bolt et al. 1975; Schuster and Krizek 1978). The U.S. government has published many case studies that demonstrate the application of geological information to city planning (Nichols and Campbell 1969; Robinson and Spieker 1978). To date, however, attention has been focused mainly on the prevention of geological hazards and the reduction of losses incurred from them. Other important issues have received less attention: how to rebuild cities following a future disaster, for example, or how to design cities that conserve and exploit mineral resources. The absence of a plan for reconstruction after a disaster has resulted, time and time again, in the repetition of past mistakes despite widespread public support for "doing it right" (Bolt et al. 1975). Existing projects demonstrate the advantages of sequential use of mineral deposits, including coordination of extraction with site preparation for anticipated future land uses (Bates 1978; Stauffer 1978).

Urban soil is an important mineral and biological resource that has received little attention. The first urban soil survey in the United States was published in 1976, and there have been few since (U.S. Soil Conservation Service 1976). A small, but growing literature documents the characteristics of urban soils and how they might be managed to support the city's landscape and help assimilate the city's wastes (Patterson 1975; Craul 1982).

Urban Water

Water is by far the city's largest import and export (Wolman 1965); in coming years the management of water resources will pose the city's greatest challenge. There are excellent sources on urban storm drainage and flood control (Dunne and Leopold 1978; Sheaffer et al. 1982; Whipple et al., 1983) and reviews of conventional and innovative sewage and water treatment methods (Barnes et al. 1981; Bastian 1981). There are projects that demonstrate the aesthetic and economic benefits of using naturally-occurring or constructed wetlands, ponds, and flood plains to prevent floods, treat waste water, protect water quality, and manage water supply resources (Poertner 1973; Wright and Taggart 1976; Notardonato and Doyle 1979; Bastian and Benforado 1983). To date, however, there is no text that incorporates storm drainage and flood control, water supply, water quality, and wastewater treatment as they relate to city design. Given the importance of water for the city and the close interrelationships among these issues, this gap in the literature is a serious one.

Urban Life

There is no single source that adequately surveys the city's many plant communities and the functions they serve. Plants, especially trees, can transform the appearance of a city, but the benefits they provide extend far beyond beautification. At the local scale, vegetation modifies microclimate (Hutchinson 1982), captures particulate air pollutants (Smith and Staskawicz 1977), prevents erosion, and provides wildlife habitat (Gill and Bonnett 1973). At the city-wide scale, the cumulative effect of trees can moderate the intensity and extent of the urban heat island and can mitigate pedestrian-level wind problems (Spirn 1984b). Urban forests can be designed and managed for timber production as well as for aesthetics and recreation (Osband 1984); wetland and floodplain plant communities can be managed to improve the quality of surface waters, conserve groundwater resources, and prevent flooding (Spirn 1984a). Urban vegetation can even affect the psychological health of city residents (Lewis 1979; Francis et al. 1984) and their attitudes to the environment in which they live (Rapoport 1977).

There is a small body of literature on urban wildlife and habitats, including an overview of the field (Gill and Bonnett 1973) and reviews of specific issues, such as pest control and habitat management to attract amenity wildlife (Leedy et al. 1978). Few cities would consider the creation of wildlife habitat as a primary objective. If habitat requirements are considered when planning for other functions, however, amenity wildlife can be increased within the city and many pest problems averted. There are guidelines for such habitat design, both local and regional (Goldstein et al. 1980/81; Godron and Forman 1985)

Urban Ecosystems

Literature on urban ecosystems is scanty, but promising. The potential contribution of ecologists to urban planning and the identification of future research needs has been summarized (Holling and Orians 1971; Cooper and Vlasen 1973). Environmental models, especially in relation to air and water quality, have evolved significantly in the past two decades, and "ecological" approaches to resource and waste management have been explored (Morris 1982; Spirn 1984a). Recent developments in landscape ecology (Godron and Forman 1985; and Forman 1981) yield new insights into spatial patterns in the urban ecosystem.

However imperfect current models are, the view of the city as an ecosystem, composed of many smaller ecosystems, is a useful strategy for city designers. Natural processes link the air, land, and water of the city and the organisms that live within it. The pathways along which energy and materials flow through the urban ecosystem are also the routes along which pollutants disseminate and where energy is stored and expended. Such an approach is as relevant to the design of a building or park as it is to the planning of a neighborhood or region. It permits a more comprehensive assessment of the costs and benefits of alternate actions than is otherwise possible.

Existing knowledge about urban nature would be sufficient to produce profound changes in the form of the city, if only it were applied. Several barriers to applying that knowledge lie within the literature itself: the fact that much material is sequestered in specialized scientific journals, conference proceedings, and technical reports; the bewildering profusion of information, often unintelligible to the lay person and sometimes contradictory; and the relative scarcity of work that assesses and synthesizes existing knowledge. Most interdisciplinary works that attempt to be comprehensive consist of books by multiple authors. While such volumes have made an important contribution, they often lack consistency, treating some subjects in great detail while others are neglected (Detwyler and Marcus 1972; Laurie 1979).[15] Rarely do they make explicit recommendations for city design; and when they do, most treat environmental planning issues at the city-wide scale only. Fortunately, there are existing projects that demonstrate the benefits of this approach.

Urban Nature and City Design: Three Cases[16]

An emphasis upon natural processes, rather than upon the individual features that arise from them, yields a framework for city design that is dynamic rather than static, that highlights the interrelation of issues, actions, and locations, and that facilitates the integration of work at local and regional scales. Multiple benefits may be gained when storm drainage, flood control, sewage treatment, and water supply are seen as related issues that require an integrated solution, as they were in Woodlands, Texas, described below. Long-term, economical solutions are possible when depleted energy and material resources, on the one hand, and waste disposal, resulting in contamination of air, earth, and water, on the other, are perceived as a single problem with several faces. Stuttgart, in the Federal Republic of Germany, has implemented an energy conservation, air quality, and waste disposal program that recognizes these connections.

Woodlands, Texas

Woodlands, a new town now being built on 20,000 acres of pine-oak forest north of Houston will eventually be a city of 150,000 people. Water emerged as a critical factor early in the planning process. Much of Woodlands is very flat, with poorly-drained soil. The construction of a conventional storm drainage system would have entailed extensive clearance of woods and loss of much of the remainder over the long run, due to a lowered water table. It would also have increased the severity and frequency of floods downstream. In addition, since Woodlands lies atop the recharge area for an aquifer that underlies Houston, a conventional storm drainage system would have decreased the water entering the aquifer and thus contributed to ground subsidence under Houston.(Houston has already subsided ten feet in some areas due to oil and water extraction.)

The proposed solution — a "natural" drainage system — comprises ponds, wooded floodplains, and well-drained soils instead of concrete ditches. In this system, the larger floodplain network drains runoff from major storms, while well-drained soils and ponds absorb and store the rainfall from lesser storms in parks, street rights-of-way, and private yards. When compared to the cost of a more traditional system, it was estimated that the natural drainage system would save the developer over $14 million. The retention of the beautiful, wooded setting and the acquisition of a town-wide open space system are additional benefits.

The natural drainage system has structured the design of the new town. Major roads and commercial development are sited on ridgelines and higher elevations, while floodplains and recharge soils are preserved in parks and public rights-of-way. Roads, golf courses, and parks impound stormwater over sandy soils to enhance its absorption. Use of the floodplain and well-drained soils as open space works well from both ecological and social standpoints. Much of the hydrologic system is wooded; it not only soaks up and carries off rainfall, but also assimilates urban runoff and treated wastewater. Where understory is left uncleared, the woods are self-regenerating, requiring no fertilization, no new planting, no pruning, and no raking. The floodplains harbor a spectacular plant community — including large evergreen magnolias, water and willow oaks, and towering pines and a diverse, abundant native wildlife, including white-tailed deer, oppossum, armadillo, and many birds—making the whole town a vast nature reserve. A continuous system of hiking, bicycle, and bridle paths runs within the drainage network, linking all parts of the town.

The quantity and quality of stormwater flowing out of the new town has been monitored since before construction began over a decade ago. Increased runoff is only one third the amount generated by a typical suburban development in Houston, and the quality of that runoff is substantially better. In April 1979, a record storm hit Houston. Nine inches of rain fell within five hours, and no house within Woodlands flooded, though adjacent subdivisions were awash (Juneja and Veltman 1979).

The plan for Woodlands thus does more than protect the health and safety of its residents. Well fitted to the hydrologic system that existed prior to its construction, it has a built-in resilience to flood or drought. The town's overall structure is coherent and meaningful; it reflects and reinforces the landforms, waterbodies, and plant communities within it and makes visible the movement of water through it. Since the drainage system must be linked, open space is accessible to every home and business. It is an efficient system, not only in its ability to drain and store stormwater, but also in its conservation of water resources, its assimilation of wastes, and its provision of low maintenance parkland that costs far less to maintain than the conventional suburban landscape of lawns and trees.

Denver

A drainage system like Woodlands' is most easily implemented in a new town, but it is practicable even in the dense cores of existing cities. For example, Denver has also implemented storm drainage and flood control plans that are based upon the hydrologic cycle. These plans tie regional flood planning to the design of specific drainage projects and reconcile the need to drain local streets and plazas with the need to protect downstream areas from increased floods. Denver's Urban Drainage and Flood Control District, formed in 1969, coordinates the adoption and implementation of adequate and consistent floodplain regulations among local governments and undertakes master plans for individual watersheds that straddle municipal boundaries.

Rooftops, plazas, and parking lots in downtown Denver are now as much a part of these regional flood control plans as suburban creeks and the urban floodplain. The city requires new and renovated buildings in the Skyline Urban Renewal District to detain stormwater on site. The alternative, upgrading the existing storm sewer system to accommodate increased runoff, would have been an expensive burden for the city and would have increased flooding in the nearby South Platte River (Poertner 1973). The principle applied here is the same as that employed at Woodlands; developers in Denver have used rooftops, plazas, and parking lots to detain stormwater instead of ponds and soil. These fulfill their function with minimal inconvenience to pedestrians and drain gradually after a rainstorm peaks.

The riverbed, banks, and floodplain of the South Platte River have been redesigned and reshaped, not only to contain floodwaters, but also to permit their overflow into designated areas (Wright and Taggart 1976). The design of riverside amphitheatres, plazas, and sportsfields were based upon flood hydraulics, built to resist flood damage and provide flood storage. But the benefits have extended beyond public safety. The central channel of the river was dredged and refashioned not only to accommodate floodwaters, but also to create a white-water slalom run for boats. The Platte River Greenway, comprising 450 acres in eighteen parks and fifteen miles of riverside trails, is now Denver's largest park. With increased use of the river for walking, bicycling, and boating has come a heightened awareness of the river's water quality and a strong constituency for improving that quality. Many sources of water pollution have been removed from the riverbanks as a consequence: an old dump has been converted to a nature preserve; a highway maintainenace yard piled with salt and sand became a park after those materials were moved to a less vulnerable spot. Citizens have brought pressure upon the city to cease dumping street sweepings and salt-laden snow in the river. Districts bordering the South Platte, among them several of Denver's lowest-income neighborhoods, have gained new parks and riverbanks free from former hazards and nuisances.

Stuttgart

Stuttgart, an industrial city of 630,000 in The Federal Republic of Germany, provides yet another model of city design that exploits natural processes. For the past several decades Stuttgart has attempted to improve air quality and reduce the energy required to heat and cool buildings. Stuttgart lies in a valley and is plagued by persistent inversions two days out of three, a situation that resulted in frequent, unhealthy concentrations of air pollutants before the current program was implemented.

Climatologists in Stuttgart have plotted the patterns of air circulation through and around the city and continue to survey air quality to pinpoint critical areas (Franke 1976; Robel et al. 1978). These studies identified the fresh, cool air that flows through the city down canyons and along the valley bottom on calm, clear nights as a resource which ventilates and cools the city. During frequent calm periods this hill-to-valley air movement provides the only ventilation in downtown Stuttgart. Land use within these fresh air channels is therefore regulated, and many are landscaped. Together, they form a radial open space system that extends from forests at the city's outskirts to parks and pedestrian streets in the downtown. As fresh air flows down into the valley, it is funneled into a linear park several miles long that runs through the heart of the city, bordered by institutions and businesses.

As a citywide system, these open spaces do more than promote air quality and a comfortable local climate. The forested park at the city's edge is managed for timber and for the protection of the city's water resources, including the recharge areas for its many mineral springs. The landscaped terraces and steps that tumble down the fresh air canyons create short-cuts with intermittent views of the city below. The large, downtown park is filled with sitting areas, playgrounds, flower gardens, and cafes.

Stuttgart has also decreased the emission of air pollutants through a program to reduce the energy required to heat and cool buildings. The summer heat load on downtown buildings has been reduced by converting parking lots from asphalt to turf block, and by introducing roof gardens and "wet roofs" with an inch or two of ponded water. In sections of the city where air circulation is poor, the burning of oil and coal is prohibited. Steam, produced by burning garbage in municipal incinerators, is now piped to heat individual homes and businesses in these areas; and the byproducts of cinders and ash are used in constructing roadbeds.

Woodlands, Denver, and Stuttgart illustrate the benefits of applying an understanding of natural processes to city design. All three examples address the prevention of hazards, the conservation of resources, the disposal of wastes, and the protection of critical areas. But the result is more than the sum of the parts. In each case, concern for all these issues is synthesized in a single program that links city-wide planning to the design of local projects. Although the impetus for each lay in concern for a single overriding problem — water in Woodlands, floods in Denver, and air pollution in Stuttgart — in each case the solution incorporated other concerns besides the primary one.

Woodlands, Denver, and Stuttgart are not isolated examples, nor do they represent revolutionary ideas. The germ of Stuttgart lay in ancient Greek city planning, and the principles upon which Woodland's and Denver's drainage systems are based were applied a century earlier by Olmsted. In these examples and the historic tradition to which they belong lies an important direction for future city design.

Urban Nature and City Design: Prospects

How to integrate the diverse elements of nature with one another and with other issues facing the city? How to synthesize all this into a coherent structure that provides equitable access to the city's resources and that remains responsive to changing human needs? How to accomplish this in the dense, inner city as well as in new towns and in expanding settlements at the edge of the metropolis?

Answers will vary from city to city depending upon the overriding problems of their natural and socio-economic environments, the institutional framework within which those problems must be addressed, and the legacy of the past, as embodied in the urban fabric and in cultural traditions. Each city should first focus on those problems that are of primary importance and then, in creating solutions to those problems, find ways to accommodate other concerns. Some cities, such as Denver, must contend with recurrent natural disasters; others, such as Stuttgart, are prone to serious, prolonged air pollution episodes. Some cities occupy ground that contains valuable mineral resources; others face growing problems of waste disposal that threaten their water supplies. Many American cities, however, share two major problems: the deterioration of urban infrastructure, including water supply and sewage treatment systems, and the decline of inner city neighborhoods. A comprehensive view of urban nature could contribute to the restoration of both.[17]

The introduction of public water supplies, storm and sanitary sewers, and public park and transportation systems in the 19th century transformed the shape of the American city. When these diverse public improvements were coordinated, they formed a coherent framework within which the growing city evolved. Many of the great urban parks and parkways built during that period, for instance, served not only to beautify the city and to provide recreation space, but also to eliminate environmental hazards and nuisances and facilitate transportation within the city. In many cities that infrastructure is now a century old and must soon be renovated or reconstructed.

In the past few decades there have also been dramatic changes in the demographics of inner cities, shifts often accompanied by a proliferation of abandoned buildings and land and a decline in public services. In some cities vacant land now comprises ten percent of the total land area, and some neighborhoods are more than half vacant. Together, the need for reinvestment in urban infrastructure and the resource of vacant lands represent an opportunity for harnessing nature to reshape the city and, in the process, to address many other urban problems as well.

Most cities, for example, face the prospect of increased water demand and floods, accompanied by depleted water supplies and continued water contamination. Vacant lands, many of which occur in low-lying parts of the urban landscape, afford an opportunity to explore alternative solutions to these problems that might not otherwise be feasible. These include the reduction of flooding and combined sewer overflows during and following rainstorms, the exploration of alternative wastewater treatment methods, the implementation of decentralized treatment systems, and the exploitation of the residual resources in waste that would otherwise pose a disposal problem.

The development of some vacant lands to accomplish such objectives could, if designed to do so, provide recreational and aesthetic amenities, promote investment in inner city neighborhoods, and yield new funding sources for maintaining public parkland. Stormwater detention areas have been landscaped and managed as parks. Woodlands, meadows, and constructed wetlands have been used for treating wastewater, with portions also used as parkland and wildlife habitats (Bastian and Benforado 1983; Spirn 1984a). Sewage sludge poses a major disposal problem for most cities; yet sludge is extremely high in nutrients and forms an ideal soil amendment. Large-scale reclamation of urban vacant lands, whether for housing, for commerce, or for open space, will require enormous quantities of soil. Sewage sludge composted with woodchips is relatively inexpensive and has been used for such purposes in Washington, D.C., and Philadelphia (Patterson 1975; Marrazzo 1981).

The opportunities afforded by vacant land are not limited to issues of water management. In Dayton, Ohio, for example, open land (currently parking lots) surrounding the central business district has been linked to wind problems at the base of tall downtown buildings. Wind tunnel studies have suggested that these wind problems could be mitigated by adding trees or buildings to open lands upwind (Spirn 1984a).

Vacant lands are extraordinarily diverse in their physical character and social context as well as in the constellations that they form collectively. Perceived as part of the city's greater land and open space resource, and viewed together with the social and economic needs of the neighborhoods in which they occur, vacant lands represent an opportunity to integrate nature and city in new ways. In the process they can transform the city and the way people live within it.

The integration of nature and city design is now possible on a scale that was previously unimaginable. Modern science has given us a view of the natural world in which the human organism has an important but not omnipotent role and ecology has yielded a systems framework that elucidates the interactions between humans and their habitats. Information technology provides a tool for storing and correlating a complex array of data in a manner that would have been impossible even a few decades ago. If we are to realize the potential of these advances for city design, however, a means must be found to bring together those from many disciplines now working on urban nature and its implications for city design, to assemble and assess the knowledge they produce, and to stimulate the construction of projects that incorporate that information.

Neither the arcadian nor the imperialist view of nature will serve to advance this field, but rather the middle ground that aspires to a beneficial meshing of the cultural processes of society and the physical and biological processes of the natural world. Such an approach could yield a new form for the city, one that would "have the biological advantages of the suburb, the social advantages of the city, and new aesthetic delights that will do justice to both modes" (Mumford 1961).

Notes

[1]This article focuses on the role of nature in city design in Europe and North America, primarily in the United States and Great Britain. There are important traditions in other parts of the world, especially in East Asia, but their inclusion here is outside the scope of this initial article. The figures discussed here are only a few of those who have applied an understanding of nature to city design; many others have also made important contributions.

[2]The terms "arcadian" and "imperialist" are used by Donald Worster in *Nature's Economy: The Roots of Ecology (1977).* Worster demonstrates that both attitudes have been influential in ecologicathought since the 18th century. The management and conservation of nature for human benefit represents a middle ground between these two poles. The distinction between preservation and conservation has split American environmentalists ever since 1897, when John Muir and Gifford Pinchot clashed bitterly over the management of Yosemite Valley. This split has permitted imperialist view to prevail.

[3]Implicit in the arcadian view is a romanticization of nature and a nostalgia for a simpler, pastoral life. This nostalgia, however, may be for a way of life that never existed, or one that has been enjoyed only by a privileged few. See Raymond Williams, *The Country and the City* (New York: Oxford University Press, 1973), and Leo Marx, *The Machine in the Garden* (New York: Oxford University Press, 1964), for a discussion of the pastoral image in literature and society.

[4]The writings attributed to Hippocrates were probably not written by a single individual, but they do provide a summary of medical thought in the late 5th century, B.C. See Clarence J. Glacken, *Traces on the Rhodian Shore* (Berkeley: University of California Press, 1967).

[5]Most architects since Alberti have been concerned exclusively with the aesthetic or sociological aspects of city design and have shown little interest in nature, except for its decorative qualities. There is, however, a long-standing tradition that has addressed the relationship between architecture and climate, particularly sun and wind (Unwin 1911; Atkinson 1912; Rey 1915; Aronin 1953; Olgyay 1963; Knowles 1981).

[6]See J.C. Loudon (1829) "Hints for Breathing Places. . ." *Gardener's Magazine* V:686-90 and M. Simo (1981) "John C. Loudon's London: On Planning and Design for the Garden Metropolis." *Garden History* 9: 184-201. Loudon presented a plan for greater London, including green "belts" and "wedges" in 1829.

[7]E.W. Howe. (1881). "The Back Bay Park, Boston." Speech read before the Boston Society of Civil Engineers in March 1881. Washington, D.C.: Library of Congress, Olmsted Papers.

[8]This was the first time, to this author's knowledge, that anyone had deliberately created a salt marsh (as opposed to a lake or pond) for such a purpose. Olmsted discussed both his rationale and the difficulties he encountered in a speech to the Boston Society of Architects on April 2, 1886. See Olmsted Papers, Washington, D.C.: Library of Congress.

[9]Olmsted had studied civil engineering himself and was a close friend of George E. Waring, Jr., a pioneering sanitary engineer. His frequent collaboration with Waring and other sanitary engineers produced innovative designs for drainage and transportation systems in parks, parkways, and entire cities. See Schultz and McShane 1978.

[10]The National Conference on City Planning, inaugurated in 1909, created the American City Planning Institute in 1917 "to study the science and advance the art of city planning." All 75 members of the ACPI were originally trained in other fields; most presidents through 1942, as well as more than half the original members, were trained as landscape architects or engineers. See John L. Hancock, "Planners in the Changing American City, 1900-1940," *AIP Journal* 33:290-304.

[11]See, for example, his work on Woodlands New Community (described in this article) in which the water supply, flooding, and subsidence of Houston, over twenty miles away, were seen as related to the new town project and a solution proposed that addressed both local and regional problems. The author served as project director on two phases of this project.

[12]Lynch himself does not make an explicit connection between nature and his dimensions of environmental quality, except as represented by individual natural factors. McHarg, in his own professional work and that of his associates, has increasingly incorporated social and economic concerns but in a different manner than Lynch. Narendra Juneja, a partner of McHarg's, was explicit in the assignment of social values to natural processes, distinguishing between their value to society as a whole, to specific interest groups, and to individuals. See, for example, *Medford: Performance Requirements for the Maintenance of Social Values Represented by the Natural Environment of Medford Township, New Jersey* (Philadelphia: Center for Ecological Research in Planning and Design, University of Pennsylvania, 1974) and *Environmental Resources of the Toronto Central Waterfront (Philadelphia: Wallace McHarg Roberts and Todd, 1976).* Many of the social values defined by Juneja in these reports are comparable to those utilized by Lynch, and the emphasis on peformance requirements rather than environmental determinants represents a shift from McHarg's earlier writings.

[13]Specialization may be desirable and even necessary, but when planning students' sole exposure to environmental factors consists of a single specialized course in water resources, energy conservation, or waste management, those students may never gain an appreciation for the urban natural environment as a whole. See Charles Y. Deknatal, "Choices of Orientation in Teaching Environmental Planning," *Journal of Planning Education and Research* 1984 (3):118-125, for a review of environmental planning curriculum. Such an approach may also lead to artificial distinctions between subject areas, obscuring the connections between them. The conservation of energy and mineral resources and environmental pollution, for example, are closely related problems which demand integrated solutions.

[14]Space does not permit a comprehensive review of this literature and the promise it holds for city design. A more extensive review and bibliography is provided by the author in *The Granite Garden: Urban Nature and Human Design* (New York: Basic Books, 1984).

[15]Recently the profession of forestry has provided a forum for researchers and practitioners with an interest in urban nature (U.S. Forest Service 1977; Hopkins 1980), and has coined the term "urban forestry" to describe the field. Although "urban forestry" aptly captures the applied nature of the field, nevertheless, it reflects neither its breadth nor its applicability to non-forest biomes.

[16]The case studies of Woodlands, Denver, and Stuttgart, as well as the introducton to this article have been adapted from my book, *The Granite Garden: Urban Nature and Human Design* (Basic Books, 1984).

[17]The author has explored this subject in greater detail, using the example of Boston, in "Reclaiming Common Ground: The Future Shape of Boston," a paper sponsored by the American Institute of Architects and McGraw-Hill Publications, delivered to the Boston Society of Architects on April 30, 1985.

[18]The author is currently concluding a study of the open space potential of vacant urban lands, funded by a grant from the National Endowment for the Arts. This study defines potential open space uses broadly, including not only recreation, but also functions related to agriculture, forestry, air quality and climate, the conservation of mineral and water resources, flood control, and storm drainage, among others. The objective of the study is to enable city planners and neighborhood groups alike to evaluate the open space potential of vacant land and to weigh the benefits of open space uses with other uses, such as housing.

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