AN ECOLOGY OF URBAN FORM: THE IMPERATIVE OF THE BIOREGION

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1 ABSTRACT

Landscape architecture has two areas significant to focus on sustainability, and urbanization, and global cities: landscape planning, i.e., bioregional planning (bioregionalism) and urban design. Compared with urban planning and architecture, landscape architecture's status regarding bioregionalism and urban design has diminished. Bioregionalism are and urban design are reconsidered vis-à-vis sustainable urban form, globalization, and landscape architecture's potential role. andscape architecture's contribution to bioregionalism was established in Olmsted's Yosemite Valley plan and more recently the 1960s environmental movement exemplified by luminaries in the profession, e.g., McHarg, Lyle, Steinitz. Characterizing landscape architecture's "generalist" underpinnings, embracing works of Powell, Marsh, Pinchot as well as those of Mumford, Lynch, Berry, Wilson, and Relph is also significant. Landscape architecture's bona fides in urban design date to urban planning being largely conducted by landscape architects in the 19th century including Nolen, Peets, Manning, Kessler, the Olmsteds, and Wright. Landscape architecture's practice of regional planning and urban design has diminished for two reasons. First, planning regionally is difficult to implement, although this is changing. Second, New Urbanism and Smart Growth have displaced landscape architecture. Nevertheless, landscape architecture is poised for leadership in a number of areas – to realize an "ecological tapestry of urban form" in a global era. Sustainable practices of the land-water nexus while addressing carbon emissions are essential. Ecology's natural systems model within bioregions dictates broadly defining urban form. Interrelationships within watersheds are paramount, e.g., regarding carbon and hydrological cycles as complex bounded systems, conservation of areas of ecological value, multinuclear and multimodal settlement, and urban agriculture.

1.1 Keywords

Regionalism, Globalization, Urban Design, Urban Form

2 INTRODUCTION

Large scale landscape planning of a regional nature dates to the earliest practices of landscape architecture in the United States. Seminal in this regard is the commission headed by Frederick Law Olmsted established by Congress that resulted in the Yosemite Valley landscape management plan.

Drawing from Congress' 1864 enactment, the following statement identifies regional considerations for a major portion of a watershed.

> *"Cleft" or "Gorge" in the Granite Peak of the Sierra Nevada Mountains, situated in the county of Mariposa . . . and the head-waters of the Merced River, and known as the Yosemite Valley, with its branches and spurs, in estimated length fifteen miles, and in average width one mile back from the main edge of the precipice, on each side of the Valley, with the stipulation, nevertheless, that the said State shall accept this grant upon the express conditions that the premises shall be held for public use, resort, and recreation; shall be inalienable for all time . . ."* (Whitney 1869).

This vast landscape comprising Yosemite Valley and its environs, including water runoff concerns, reflects a need for planning – and ultimately design – utilizing a geographic land unit, e.g., the watershed. Furthermore, utilization of a geographic context by Olmsted and the commission presaged the attention to "natural systems" that inspired George Perkins Marsh in the late 19th century and that is significant to urban ecology and the practice of landscape architecture today.

Olmsted's Yosemite work was preceded by Central Park that also reflects large scale considerations of landscape architecture, but of an urban nature. Looking contextually at a large tract of an urban landscape for public park purposes, Olmsted also addressed important urban design considerations of street typologies, streets' roles within a public right of way, and therefore urban form determination reflective of landscape architecture's *bona fides* in urban design practice.

Olmsted's seminal accomplishments regarding large scale landscape planning inclusive of natural land units, urban form, the public urban realm, and ultimately town planning is the work of genius, in responding to the centrifugal and centripetal forces of the Industrial Revolution. Furthermore, this momentum is reflected in various commissions for regional landscape planning and urban design as reflected in the work of the Olmsted sons, Charles Elliot, George Kessler, Horace Cleveland, John Nolen, Henry Wright, Elbert Peets, Warren Manning, and others. Their work constitutes the American Parks Movement, the City Beautiful Movement, and influences on the Social Reform Movement of the late 19th century, town planning (Martin 1999) and the emergence of modern urban planning. Furthermore, landscape architects' contribution through government mandated Depression Era projects, and the easy entre of landscape architecture into the Environmental Movement of the 1960s partially fueled by embracing earlier work of George Perkins Marsh, Gifford, Pinchot, and John Wesley Powell - are self-evident., Moreover, Olmsted's ground breaking work, and those following him in the late 19th and early 20th centuries with more recent iterations by McHarg, Steinitz, and Lyle predates the United Nations Brundtland Commission of 1987 and the coining of the term "sustainability." In other words, landscape architecture has pioneered practices of sustainability long before the recent rush towards "green" environmental practices.

With landscape architecture developing in response to the Industrial Revolution, its role in urban design became manifest and is reflected in the work of Nolen, Peets, Manning, Kessler, the Olmsteds, and Wright. Over a brief timeframe landscape architecture developed expertise in town planning and city design, neighborhood and district design, built and natural corridors such as livable streets, greenways, and "blueways," as well as individual sites as recently expressed in the ASLA's Sustainable Sites Initiative. Therefore, wherein landscape architecture practice predates recent focus on sustainability, the profession has developed and surpassed urban design as promoted by New Urbanism. Importantly, the difference here is essentially twofold. First, with New Urbanism emanating from architecture, emphasis on building design and form generally falls out of the purview of landscape architecture. Second, in evolving quickly and substantively, e.g., as reflected in The Transect's attention to "ecology," New Urbanism – and architecture in general - has not been convincing with respect to ecological contexts, particularly compared to landscape architecture's bioregional focus and longstanding practice utilizing a natural and human cultural resource data base to inform sustainable design decision-making. Within this context – including the various scales of concern referenced above – this paper focuses upon relationships of bioregions and urban design to articulate landscape architecture's historic and contemporary role in the attainment of sustainable urban form.

3 METHODS

This work relies on published data and historical method in its development, presentation, and findings. The literature has been examined and synthesized with respect to the varying definitions of the subject areas of regional landscape planning and urban design. In addition, the methodology is hermeneutical, i.e. interpretive and reflective of the author's longtime standing with the academic community and addressing of the subject matter, as is requisite within a hermeneutical approach. Therefore, in developing findings related to regional landscape planning and urban design the author concludes that while landscape architecture's significant historic roles have diminished, its historic legacy speaks to the capability and necessity of landscape architecture having a major role in addressing environmental challenges of the 21st century.

4 INTRODUCTION: Why the Region as a Unit of Study?

A criticism of the seminal Urban Design Plan for San Francisco created in 1971 is its ignorance of the city's regional setting (Kenyon, 1971). While generating a remarkable and largely durable city-wide urban design plan, the San Francisco Planning Department limited its effort to municipal boundaries without a contextual regional focus including the city's greater biosphere. Therefore, the plan is deficient with respect to landscape architecture's environmental ethic, natural systems informing design, and subsequent sustainable urban form.

Notwithstanding landscape architecture's perspective initiated by Olmsted, and recent proposals by others (Lynch 1976, Kelbaugh 1997, Calthorpe 2001) the region may seem like an unlikely basis for measurement, study, understanding, and application that informs urban design. Political and economic practices alone, and myopic views regarding urban design since World War II, have resulted in "disconnects" in this regard stemming from expediency and incrementalism. This is true regarding landscape architecture's allied professions of architecture and urban planning, and landscape architecture practice that eschew the environmental ethic of bioregionalism. However, landscape architecture's role towards sustainable urban form is important on four levels. First, the typologies typifying a bioregion – the geographical land units of watersheds, mountain ranges, or islands – provide a common unit of measure and large-scale context that cities "inhabit." Therefore, factors of regionally based place are identifiable thereby reflecting "genius loci" as arguably the most significant facet of urban design that provides meaning and identity to built, natural, and human cultural environments.

Second, landscape architecture applies bioregions' various features deterministically, especially with regard to watersheds, given their ubiquity on a global scale. Therefore, the profession's addressing urban form within the regional watershed, or sub-basins therein, is justifiable given the stability and higher probability of sustainable urban form within a greater "landscape" (Forman 2008, 14; Sale 1999). Furthermore, urban form is regarded within the landscape and integral to it vis-à-vis a regional setting. Subsequently, through landscape architecture built environments can demonstrate place sensitivity, i.e., urban form inclusive of a regional context critical to sustainability. This includes natural systems and also historic relationships of bioregions and human culture, i.e., those qualities of community relative to substantive customs, traditions, craft, arts, aesthetics, language, values, agriculture, and economies passed through generations (Berry 2002; Forman 2008, Shils 2006).

Third, a geographic land unit provides a natural, logical, and clearly identifiable boundary. Moreover, the natural boundaries of ridges, rivers, or coasts have historically served to demarcate one area of human settlement from another. In contrast, modern applications of Euclidean geometry have resulted in artificial and indefensible lines of division between natural systems, natural history, and substantive cultural traditions (Rowe 2000, 20), and therefore sustainability. (See Figure 1.)

Lastly, reflecting the regional context vis-à-vis urban form may seem obtuse. However, when contemporary and ever present necessities of sustainability are factored in, this is not so. To be sustainable, urban form must be broad-based while considering the impacts of human settlement on nature's "flows," and to minimize extra-regional dependencies (Forman 2008). In addition, this approach can mitigate conflicts inherent in, on the one hand, compelling lower consumption of resources, and on the other, growth economies promoting ever growing GDPs (Allen, et al 2003), e.g., with an emphasis on "systems," with the emergence of eco-industrial parks as a case in point. (See Figure 2.)

Related to the preceding four points is 20th century regional planning's focus on transit, and consequently extension of local jurisdictions. More recently, transit concerns have evolved regarding air quality and adversities of atmospheric carbon emissions. Therefore, addressing motor vehicle emissions vis-à-vis carbon and addressing air quality relative to climate change adds new dimensions to the regional question, with particular concern for the environmental quality. Moreover, even more recently, regional land use and water quality are gaining attention where various environmental issues are significant, e.g., sprawl, mobility options, suitable housing, along with temperature fluctuations, decreased snowpack, river and stream flow disruptions, increased cycles of flooding and drought, and sea level rise. International pressures associated with coastal zone development portend sea level rise concerns for human welfare, and wetlands, salt marshes, estuaries, and their function as ecosystem services (Piro, et al). Importantly, ecosystem services are more easily implemented and have more significant positive impact at a bio-regional scale due to their natural composition – their boundedness – that characterize sustainability (Newman and Jennings 2008, 40).

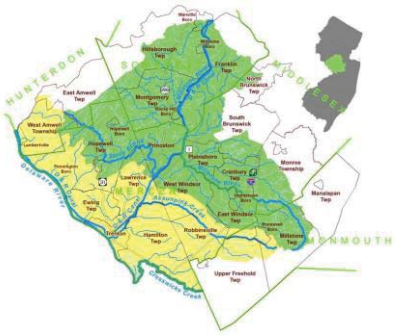

Figure 1. Watershed map overlaid on tri-county area. By permission of The Watershed Institute.

Figure 2. Early stage of Logis Eco-Industrial Park. By permission of GbLA Landscape Architects.

An even more recent trend concerning regionalism is emerging from boundless globalization in which global interests have "back-pedaled" to embrace the "new region" in reference to the metropolis or "city region." This development is territorial on the parts of some global corporate interests, i.e., it is regional, urban, local, crossing local boundaries, and values actual rather than virtual proximity to partners. More significantly, the emergence of the "new region" and its business practices are comparative rather than competitive, in concert with intentional local focuses and practices (Scott 2001, 1-5; Keating in Scott 2001, 375) Moreover, this new regionalism encompasses governance – or implementation – that potentially contributes to sustainable urban form at a regional scale. Therefore, with recent advances in regional planning cited above, attention to "city regions" by global corporations is growing in importance, and, with the proper inspiration, can be a positive force towards sustainable urban form within the region-urban nexus.

5 THE *ETIC* CONDITION OF GLOBAL CITIES AND "NEW REGIONALISM"

Etic regions are those defined, understood, and exploited through rationally descriptive and analytical means. (Rapoport in Markovich et al 1990). Within globalization, etic bases for knowing and data application predominate, without acknowledging historic regions' significance to development of human culture including land use. Specifically, etic considerations of regionalism in today's global context are twofold: first, as amorphous metropolitan regions of global cities and, second, the trending "new regionalism" relative to corporate economic competitiveness, with local and regional identity based on proximity and common interests.

Etic considerations of regions fit well with globalization, not with respect to historic regional identity and culture, but through exploitation of resources understood within the narrow etic context, e.g., regional characteristics of natural resources, climate, political boundaries, demographics, transportation, food production, and proximity of inputs and outputs. The emphasis within globalism, therefore, is one of economic, political and now regional concerns of a global city, i.e., domination of a metropolitan region to gain global advantage. This is true of New York, London, Paris, Tokyo, Hong Kong, while other global cities are emerging, e.g., Mumbai, Jakarta, Addis Ababa, Manila, Sao Paolo, New Delhi (Kearny 2014). As noted, however, the state of global cities within global regions and the new regionalism relative to their composition

in the physical areas they occupy have become integral to their governance, economics, and politics. Regardless of global cities evolution, their number, and their *de facto* regional context, their *raison d'etre* is still economic and political on a global scale with little or no conscious regard for natural systems comprising physical regions. The main concern is proximity. In other words, they are narrowly characterized as etic regions and this powerful condition is ubiquitous – in the Americas, Europe, Asia, and Europe – while being embryonic and fluid. Therefore, regarding landscape architecture and environmental awareness in the 21st century, an evolution towards sustainable regionally based urban form - minimized up to now - suggests a continued evolution of the globalists' "regional city." To wit, while the global city and city-region phenomena are enormously complex within a rapidly changing 21st century, landscape architecture can become engaged in this change, and to be a force for sustainable urban form.

Characteristically, the local, human cultural, and bioregional qualities developed over time, are inconsequential to etic perspectives. This occurs despite comparative historic economic practices being territorial and physical. However, when compared with prior dominant forces of globalism, an important characteristic of new regionalism is its attention to localities and their territorial circumstances. To wit, the new regionalism is not limited to artificial political boundaries, and therefore exhibits an important characteristic of broadly concerned regionalism (Keating in Scott 2001, 376), i.e., the potential to function in a realm of bioregionalism.

The new regionalism and current potential for including bio-regionalism are exemplified by Honda, the Silicon Valley, the American Northwest, and others. Honda - dating to the 1980s – has been simultaneously global and regional, and therefore in the *avant garde*. Its operations reflect a concerted effort to be localized wherein materials, labor, production, and market have regional significance. (Mair in Cox 1997, 72, 85). Dating to World War II and evolving from defense, to semiconductors, computers, and more recently to the Internet, Silicon Valley has "recreated" itself through development of clusters wherein networking and close relationships are essential (Henton in Scott 2001).

Daniel Kemmis, former mayor of Missoula, Montana and Director of University of Montana's Center for the Rocky Mountain West identifies several examples of a new regionalism in the American Northwest, and of a bioregional nature. These include communities around Yellowstone National Park, watershed councils with mutual interests, and cities in the regional setting whose interests in a global environment supersede artificial political boundaries. Communities around Yellowstone recognize and act upon their economic and ecological interests vis-a-vis their regional uniqueness. Similarly, watershed councils forming throughout the American West act to understand and safeguard important water assets in arid settings, thereby requiring governance for economic and ecological reasons. Beyond these developments, Kemmis further observes that cities in the Northwest such as Boise, Salt Lake City, and Spokane – each of which is in neighboring but different states – have cooperation between them that is bioregional and within a global environment. He asserts that in the global economy, "capital flows where it wants, when it wants, in search of the kinds of geographic differentiation of talent and cost and social and political structure that it wants" (Kemmis 2000). Therefore, global forces are considerable and in this context a bioregionalism is essential to impart important dimensions of sustainability.

Importantly, other recent advancements in regional planning in the United States supersede economics and politics pertinent to evolution of an urban-regional nexus. While still etic in nature, the Obama administration continued momentum of the 1990s focus on ecological "natural systems." This included stormwater management, and therefore, water quality, air quality, and habitat through policy development and advocacy as extensions of the 1960s' Environmental Movement. Therefore, long-term sustainability rather than five to twenty year timeframes of environmental impact assessment required by the National Environmental Policy Act gained traction. Importantly, regional and sustainability concerns continued to be *etic* in nature but multi-dimensional when compared with previous approaches. As such, natural systems considerations of watersheds, topographic areas such as mountain ranges or islands, and climate zones reflected greater analysis, environmental awareness and, therefore, opportunities for advanced policy development of an etic nature.

At other governmental levels, regionalism is evolving in California, Cape Cod, the Denver metropolitan area, and Milwaukee, to name a few. California has managed regional growth to protect sensitive landscapes, mandate transportation outcomes vis-à-vis greenhouse gases, and to shape land use and urban form. The Denver Regional Council of Governments is remarkable for the voluntary buy-in by nearly 60 city and county governments, responses to state and federal authority, while portending positive future development. Its main focus is largely transportation, air quality, and aging, however, land use efficiency, green infrastructure, and urban form reflect sustainability concerns. Cape Cod has

addressed growth and land use issues to protect a finite potable water resource: its sole aquifer. Milwaukee has addressed sewer and water issues by transforming outmoded and environmentally inefficient gray systems to mitigation incorporating regional scale green infrastructure through land conservation and forestry.

Beyond observations and examples of Honda, the Silicon Valley, and the American Northwest – and giving credence to them - are the pronouncements of geographer Allen Scott. Scott identifies four levels of governance ranging from the global at the top tier under which are multi-nationals, sovereign states, and – as a more recent development – regions (Scott 2001). Scott asserts that many regulatory economic functions of sovereign states are transferring "upwards" to global and multinational levels. Conversely – and equally significant - governance is beginning to reflect a "downward" direction towards regions. These developments equate to centripetal forces and displacement of sovereign nations' regulatory capacities as nations experience significant and uncontrollable transition due to a lack of fluidity in contrast to rapid adaptability characterizing the global corporate world. In this environment regions, according to Scott, ". . . are becoming the sites of important, if not radical, local administrative initiatives and political activities independently of the level above" (Scott 2009, 140). This response and outcome of global forces demonstrates the tangible and necessary emergence of regions nationally, internationally, and therefore, their global importance. Landscape architecture should embrace and participate in this development.

6 BIOREGIONALISM AND THE IMPORTANT *EMIC* CONTEXT

Recent etic developments, e.g., Honda, the Silicon Valley, and in America's Northwest, that exemplify emergence of global city regions are localized, tangible, and inclusive of governance. By demonstrating such activities, these and other global interests realize the advantages of local environments and geographic proximity (Storper in Cox 1997, 20; Jackson, 1984). Although etic in nature these developments require extra-market intervention and implementation to compensate for the globalization's overreach (Scott 2001, 7). Therefore, global city and regional change benefits from "horizontal" knowledge occurring in its place of origin, i.e., localities and regions such as the Silicon Valley. Additionally, "vertical" knowledge can be enhanced, and therefore contribute to balance, effectiveness, sustainability, and resiliency. As such, cooperation and information sharing – and, consequently, quality of life outcomes - are more likely to occur in contradistinction to globalized, detached, and remote competiveness. Furthermore, a beneficial byproduct of horizontal knowledge in this context is greater political legitimacy and social equity (Keating in Scott 2001), fitness for democracy movements (Scott 2000, 154), and arguably, sustainability within built, natural, and social environments.

Within social and behavioral sciences the converse of things etic, i.e., elements that are rationally defined and analyzed, are conditions identifiable as *emic*. Emic regions are those perceived anthropologically through local populations with regard to their history, broadly based culture, "connections" to their settings, sense of place, and inherent meaningfulness. Examples of emic regions abound because they have been crucibles of human settlement, culture, and civilization over the millennia of the pre-industrial period. In other words, substantive cultural meaning embodied in emic regions – elements that historically are easier to grasp than the etic for their local, more human scaled, cultural, and tangible dimensions - has been ignored in the globalization's onslaught. Remarkably, however, meaning and uniqueness of emic regions defining their "world" evolved from regional differences, e.g., in language, craft, art and artisanship, built form, etc., give striking signs of desirability, survival through time, and therefore resiliency not withstanding global forces (Rapoport 1990, 282).

Consideration of emic regions is not new. Bioregionalism, emanating from the 1960s and 1970s Environmental Movement, addresses economy, politics, and society that are perceived, understood and practiced locally. Ecology comes into play here but does so in emic – not etic – terms. Furthermore, the bioregional movement is in the lineage of Patrick Geddes' Valley Section demonstrating that cities should be considered and conceived as a "region-city" inclusive of the regional, natural, and human cultural elements supporting them.

Economy, politics, and culture within emic bioregionalism of the last fifty years are "eco-deterministic." Economy in this regard eschews mainstream market forces that represent merely the "surface of society . . ." wherein ". . . there is no probing . . ." that distinguishes between primary materials extracted from nature and those that are manufactured or secondary (Schumacher in Sale 1985, 5.) In other words, environmental, social, and economic impacts wrought by the global marketplace are poorly understood or ignored. By contrast, bioregional economies are grounded in understanding impacts

contextually within the region, i.e., its scale, cohesiveness, sense of place, and community that are manifested particularly in watershed, sub-watersheds, or other ecoregions.

Politics and governance in bioregionalism reflect what global interests, e.g., the Silicon Valley and Honda, have learned thorough experience, i.e., that decision-making is more likely to be effective when scale and diversity – both natural and cultural - are in play, thusly allowing for interaction that is simultaneously vertical and horizontal. This is in contrast to "giantism," centralization, hierarchy, and "monolithicity" typifying governance in today's world (Sale 1985). The implications for urban form, therefore, are significant.

An ancillary to emic bioregionalism is communitarianism (Etzioni 1996). Communitarianism emphasizes relationships between individuals and their community, and in the context of sustainable urban form, is inclusive of a neighborhood unit or so-called "urban village" within a regional context. In this respect, German sociologist Ferdinand Tönnies' (Tönnies and Harris 2001) work concerning *gesellschaft* and *gemeinschaft* is revealing, where the former is equivalent to various manifestations of etic "society" and the latter is aligned with the emic in terms of "community." Therefore, with a focus on the emic, communitarianism professes that meaningful lives are enhanced by community relationships, while not eschewing individualism. While nuclear families are significant in communitarianism, related and ongoing interactions between people in given geographical settings, e.g., neighborhoods, cities, and regions - with inherent shared interests - are more important than rational, regulatory, and formal relationships found in etic, societal, or state contexts. Attention to regional, cultural, and civic landscapes, their characteristics and form fits concerns of landscape architecture and advancement of it roles in this respect.

Further consideration of regionalism, communitarianism, and urban form, are concepts associated with *place* or "sense of place." Espoused by a host of individuals - Edward Relph (1976), Yi Fu Tuan (1977), Christian Norberg-Schulz (1980), and others - and within the landscape architecture lexicon, *place is* exclusively emic, where special qualities found in natural environments, built environments, and human cultural conditions are factored into the landscape architect's design decision making.

Given the preceding discussion, sustainable urban form for the 21st century must be inclusive of regionalism – reflective of Geddes, Sale, Berg, as well as Tonnies' concept of *gemeinschaft* - but not of an isolated or provincial nature. A corollary found in nature is "mutualism," where two co-occurring species have a positive influence on each other, much as contemporary global forces are becoming more complementary than competitive. Broadly defining urban form to be inclusive of regional green infrastructure and agriculture is essential along with cities in which people, neighborhoods, and communities in the bioregional setting derive meaningfulness, as has historically been the case. Therefore, within a geographical land unit, collaboration and cooperation are enhanced, as is exchange, and acting in mutual best interests (Sale 1985). There is a normative quality to these considerations, but in the sense that nothing new to the human condition is proposed. Newness, however, lies in delivery and experience of what constitutes sustainable urban form. Landscape architecture can fulfill this important 21st century role.

7 ELEMENTS OF FORM AT THE REGIONAL SCALE

Inspired by ecologist Richard Forman, landscape architecture's role toward achieving sustainable urban form follows three rules of thumb (Forman 2008), inclusive of the "mosaic of patches" referred to below, along with cultural considerations, infrastructure, and sound planning as follows.

- First, locate urban growth and development in areas of lower ecological value to maintain environmental health
- Second, to avoid sprawl, concentrate and direct development through careful location and expansion of infrastructure
- Third, avoid coalescence of adjacent communities, sprawl, and "giantism" through careful attention of "soft" and "hard edges" characterizing natural and built environments
- Along with the rules of thumb, maintain cultural landscapes reflecting customs, practice of craft, and agriculture in peri-urban and urban areas
- Broadly apply green infrastructure that often typifies cultural groups and approaches used over time
- Avoid incrementalism and, hence, focus on a bioregional context

More specifically, achievement of sustainable urban form at the regional scale requires retention of various typologies of greenspace. Such greenspaces are essential to well-conceived cities and towns and

therefore built and natural systems in this respect are of equal importance and integral to each other in sustainable and regional contexts. An important real and metaphoric model in this regard is the "patch," "matrix," "corridor" dynamic fundamental to landscape ecology where their spatial configurations, adaptability to change, and connectivity are important. Therefore, the following elements are foremost relative to form at the regional scale.

- Interconnected and multinuclear[1] settlement, scale and compactness, and multiple land uses inclusive of built environments associated with healthy ecosystems and greenspaces
- Sustainable agriculture
- Sustainable and intelligent uses of energy associated with carbon.

Therefore, the region should be viewed as a mosaic of patches (discrete domains) comprised of matrixes of greenspaces, cities and towns, agriculture, and the like, each of which is connected via natural and human-made corridors, the latter providing multiple forms of transit, especially with respect to energy efficiency.

7.1 A Mosaic of Patches: Multinuclear, Interconnectivity, Compactness, and Scale

Town and city arrangement reflecting a mosaic of patches should be a multinuclear framework along with multi-modal transit as the essential building block of sustainable urban form at the regional scale. This precept speaks to the basic relationship of transit and land use. However, historically land use and transit have been implemented incrementally with resultant sprawl and external impacts adversely affecting environment, social justice, economics, and energy use (Kelbaugh 1989; Magnaghi 2005).

Regional transit should reflect two essential facets of sustainability of built form and energy conservation. First, transit should be multi-modal beyond the motor vehicle dominance of most regional transportation planning, i.e., to accommodate automobiles, trucks, commuter buses, and fixed rail passenger and freight. Each of these is important, however, other circulation choices should be available to a greater populace and over a greater area. Specifically, these include a regional trail system comprising footpaths as well as simple and strategically located rest stations with seating and shelters. Similar provisions are essential for bicycles including paths distinguished from those for pedestrians in high use areas, bike racks and lockers, and linkages to regional public transit. Walking and biking trail infrastructure is cost-effective, more socially just and with fewer adverse environmental impacts, in contradistinction to high-speed rail and multi-lane freeways.

A second facet of sustainable regional transit is multinuclear arrangement of towns and cities. Through service by a multi-modal transit system, multinuclear town and city arrangements and locations are important for an ecological and therefore sustainable complexity of human order. While the region itself has the important characteristic of being bounded, towns and cities require bounding inherent to manageable and compact size and scale. i.e., the opposite condition of sprawl. In this respect other land uses are possible and desirable within the region such as conservation of habitat, watershed protection, recreation, i.e., the green spaces referenced above, sustainable agriculture, and appropriate industry, e.g., eco-industrial parks, of an exurban nature.

Within a regional context interconnectivity – likened to Wendell Berry's concept of synecdoche when applied to human scale – is desirable relative to sustainable urban form. As discussed above, to be sustainable, reduction of automobile dependence in concert with public transit, and ample opportunities of walkability and cycling should be part of a regional transit and multi-nucleated land use framework (Kelbaugh 1989; Levy 2012). Moreover, land use sensitive to a bioregional context precludes sprawl wherein a multinuclear layout of cities and towns is readily apparent, and agriculture as an essential land use providing food sources along with appropriate industry towards value-added agricultural products. And as discussed below - provision of open space that assures watershed integrity, carbon offsets, wildlife habitat, and opportunities for education and recreation are inclusive of sustainable urban form in a regional context.

Along with energy savings and carbon footprint reduction multimodal and multinuclear regional urbanization allow for two emic and requisite qualities in the 21st century. First, is the primal need for sense of place (Hiss 1991; Norberg-Schulz 1991; Schurch 1994; Tuan 1977; Relph 1976, 2008; Shils 2006) wherein a bioregional milieu can inspire identity through meaningful built environments, i.e., those that have vernacular qualities, a sense of topofilia (Tuan 1990), and human cultural resources through any variety of substantive traditions established in place through time and that are adaptable to changing circumstances. A fundamental way to consider true sense of place is relative to the elements of built environments, the setting of a given natural environment, and lastly, human culture that has evolved through local and regional

forces and that are the bases of meaningful and longstanding traditions. Each of these three elements has value in its own right, but in combination are rarely experienced in the global era due to their fragility and obscurity due to hyper mobility and rapid change. Nevertheless, they are to be conserved and allowed to evolve where they do exist, and to be developed and nurtured in localities and regions where they are largely lost. Importantly, architects, urban planners, and most significantly landscape architects should provide guidance and leadership in these respects.

A second 21st century requisite – and related to sense of place - is attainment of human scale, i.e., that important condition understood through time as reflected in settlements of ancient Greece those of today reflecting precepts of landscape architecture, New Urbanism, and Smart Growth. As a necessity, human scale is attainable by choice and integral to achieving a sense of place. Within a bioregional context, sensitivity to scale would likely require attention to "sub-regions," for example drainage basins for water courses and water runoff where the bioregion of a watershed is too large to experience or behold on a daily basis. When human scale predominates and pedestrian experiences in built and natural environments are prevalent – including within the regional scale - some sense of autonomy, feeling of "connectedness," and greater likelihood of social wellbeing are more likely to occur (Jacobs 1961; Sale 1980; Mumford, 1938, 1961; Rapoport 1990; Jacobsen 2012). In relationship to "place," these conditions are significant to fundamental needs for meaningfulness that contributes to positive individual identity, community identity, and sense of belonging.

7.2 Ecosystems, Ecosystem Services, and Land Use: Watersheds, Forests, Grasslands, Streams, Wetlands, Coastal Plains

Watersheds, forests, grasslands, streams, wetlands and coastal plains comprise critical natural components of sustainable urban form at the regional scale. They are important for their ecological complexity particularly in achieving a state of resiliency and as evidenced by important but usually overlooked centripetal and centrifugal forces of urbanization. The benefits associated with these critical components – when they retain their ecological integrity – can minimize adverse environmental and economic impacts. Consequently, their inherent ecosystem services can flourish and therefore stem reduced quality of life that otherwise occurs "downstream" when they are degraded. Furthermore, by understanding their ecological functions and value, these six components can be a source of biomimicry wherein regional ecosystem services comprise a green infrastructure and green urban form that are largely "natural" but of human origin. Significant to each of them is the hydrologic cycle as one of two important natural systems to life on Earth and understanding that as a system it is highly complex, fragile, open, but not readily visible, and therefore subject to widespread degradation as has historically occurred.

As previously referenced, the watershed is a desirable urban and regional context because of its characteristics as an ecosystem and boundedness that present relatively clear identification and metrics by which sustainable design intervention occurs and environmental integrity can be assessed. To these ends, a hierarchical consideration of what typifies a vast watershed land area can often – or should - be dealt with at a sub-watershed scale inclusive of the larger watershed context. The advantage of this approach stems from effectively managing impacts of land development on the environmental integrity of streams, wetlands, and coastal areas critical to healthy watersheds, realization of sustainable urban form, doing so within sub-watersheds and interactively with adjoining sub-watersheds.

Critical to relationships of watersheds, sub-watersheds, and sustainable urban form is land use. In this respect, the United States EPA recommends three land use strategies to realize sustainable urban form and that pertain to the bioregion. These are comprised of careful attention to 1.) amount and type of development, 2.) minimization of impervious surfaces such as streets, roofs, parking lots, and sidewalks, and 3.) protection of sensitive environmental areas, e.g., watersheds and the streams, wetlands, and coastal plains within them.

Land use, and therefore built urban form, is the single most important consideration regarding watershed protection and subsequent benefits of ecosystem services. To achieve sustainable built form, and to avoid adverse land use impacts associated with impervious surfaces at the regional scale, policies related to urban growth boundaries (UGB) (See Figure 3) and infill development can result in positive outcomes through avoidance of sprawl. Urban growth boundaries provide a demarcation between cities, suburbs, and towns and surrounding areas that can protect environmental and rural resources of urban consequence, including farmland, conservation area, and greenspaces critical to ecosystem services.

While UGBs can be poorly implemented, planning protocols call for them to be established for a period of ten to twenty years, and reviewed intermittently in consideration of needed modifications.

In concert with UGBs, strategic infill can direct development to transitional urban areas and simultaneously protect watershed integrity, avoid sprawl, and contribute to district and neighborhood redevelopment. The scale and design of infill can vary to allow for social and economic concerns, as well as those of an environmental nature, including consideration of critical habitats, aquatic corridors, hydrologic reserve areas, and important human cultural resources. Importantly, determinations as how much of a watershed to be conserved should be factored into the design and form at the regional scale inclusive of geography and climate.

With respect to climate and impervious surfaces, stormwater management is fundamental to maintaining watersheds' ecological integrity. Minimization of runoff reduces flooding and consequently erosion, pollutants, and degradation of various life forms and their ecological wellbeing. Furthermore, the relationship of reduced impervious surfaces and therefore avoiding increased ambient temperatures is significant in that runoff temperatures are less likely to reach levels adversely affecting ecological integrity through excessive algal blooms, harm to game fish and other life forms. Research shows that watersheds exceeding 10% impervious surface cover are less likely to support high quality stream systems. Moreover, watersheds with more than 25% impervious surfaces are classified as having non-supporting stream systems with likelihood of eroding banks, high bacterial counts, and poor biological diversity (Center for Watershed Protection 2008).

Within watersheds aquatic environments including rivers, streams, lakes, wetlands, and coastal embayments typically require protection through buffers on their edges and perimeters. By example, buffers for streams should comprise three zones that vary in width – up to 300' - and form according to regional conditions, and up to 1000' for lakes (Kusler, 2009, 49). In the American Northwest and East, streamside zones would likely be forested land. A middle zone adjacent to this would require a forested area with some clearing allowed, and an outer zone usually about 25' wide and wooded although other vegetation is acceptable. Buffers' overall form varies by region and locality requiring careful attention to existing vegetation, topography, soils, land use, and stream width (Austin, 2014, 155).

Where streams' environmental quality is substantially degraded or gray stormwater conveyances have been piped and buried with a "hard" outfall, Regenerative Stormwater Conveyance (RSC) is a reasonable replacement for reintroduction of natural processes. As such, RSC restores a complex stream ecosystem in which an appropriately engineered series of stepped pools, weirs, and plantings replicates a wetland system. Typically, these address a 100-year storm event along with construction parameters mimicking natural ecosystem services. Therefore, as with buffering, RSCs vary according to their regional and local conditions.

Wetlands fulfill different but equally important ecological functions as those of stream ecosystems. To these ends, wetlands are important for flood control, pollution removal, carbon sequestration, and provision of critical habitat. As with stream courses, wetland vegetation – especially forests and native grasslands – remediate nitrogen dioxide, carbon monoxide, ozone and particulate matter. In combination with the wetlands themselves, air temperature reductions are realized thereby limiting temperature-dependent pollutants such as ozone. Therefore, wetlands in undisturbed states should be conserved and constructed wetlands should be developed inclusive of environmentally sensitive water harvesting strategies to reduce pollutant loads in aquatic ecosystems, reduce volume and frequency of stormwater runoff, and manage peak stormwater flows from urban catchments, particularly in arid regions.

Runoff reduction through stormwater interception, storage, and evapotranspiration is also a function of wetlands. Each of these conditions along with provision of habitat is a valuable ecosystem service. A case in point is isolated wetlands within South Carolina's greater watersheds wherein water storage capacity approximates 460 billion gallons (The Southern Environmental Law Center 2004, 9). The cost to construct "gray" stormwater infrastructure to detain the equivalent amount of water exceeds $200 million (Brown and Schueler in Cappiella and Fraley-McNeil 2007, 10). Moreover, wetlands and smaller streams fulfill important roles as nutrient sinks, and therefore removal of excess nutrients - as well as sediment retention - that otherwise would result in imbalances in downstream accumulation (Meyer et al 2003 in Cappiella and Fraley-McNeil 2007, 10).

Along with isolated wetlands, headwater streams fulfill significant and often overlooked watershed and downstream ecosystem services. Importantly, they are highly vulnerable to adverse environmental impacts due to their small size and fragility. Therefore, they are easily and heavily impacted by various forms of land development in the watershed – urbanized, agricultural, logging, mining, etc.

The benefits accrued from headwater streams include their unique biological nature that supports hundreds to thousands of species including bacteria, fungi, algae, higher plants, invertebrates, fish, amphibians, birds, and mammals. Headwaters are also important for primary concentration and processing of organic matter flowing downstream. Besides functioning within freshwater ecosystem food webs, they also fulfill ecosystem services more efficiently than larger streams while simultaneously preventing downstream degradation of water quality by minimizing excess organic matter. Moreover, in conjunction with wetlands, headwater streams moderate downstream floods and maintain water flows during dry periods that are ecologically sustainable due to their typical large surface areas, amount of available water, and therefore groundwater discharge

Related to form, wetlands and stream enhancement and restoration are important design considerations in watershed or sub-watershed contexts. Enhancement, restoration, and design – such as RSC and constructed wetlands - likely become localized within larger scale environmental considerations. Therefore, site issues vis-à-vis sustainable urban form must be addressed along with larger scale form, and design-related strategies should require establishment of resource protection areas, e.g., through vegetation and soil protection zones (VSPZs). By example, The Sustainable Sites Initiative of the ASLA requires application of VSPZs with especial attention given to greenfields and brownfields within 100-year floodplains. The initiative also calls for protection of wetlands through VSPZs, towards safeguarding significant ecosystems to avoid adverse impacts from adjacent development.

Designated resource protection areas should largely include flood plains and hydric soils, i.e., those soils formed under conditions of saturation, flooding or ponding during the growing season, and that are characterized by anaerobic conditions in their upper portions. To assure environmental integrity of flood plains and hydric soils the flowing measures should be practiced.

- Maintenance of native vegetation
- Identification, quantification and mapping of wetlands
- Identification and mapping of headwater streams
- Identification and mapping of intermittent streams
- Identification and mapping of ephemeral streams

Relative to intensive land use considerations affecting stream and wetland ecosystems as discussed above, the following are significant and directly related to formation of resource protection areas.

- Removal and minimization of impervious surfaces.
- Forecasting and quantifying impervious surfaces additions
- Avoidance of “gray” stormwater conveyance in lieu of “green” stormwater infrastructure
- Implementation of resilience standards pertaining to grading, cut, and fill operations

Coastal areas are critically important watershed environments because of their downstream location, ecological complexity and diversity, tidal fluctuations, role with respect to carbon sequestration, and international trends of population inmigration. Coastal wetlands are particularly significant as the most bio-diverse and productive ecosystems. For example, the rich habitat of wetland estuarine areas and coastal marshes provide wildlife nurseries important for shellfish and commercial fish species. In addition, well established science identifies the important ecological functions of barrier islands and sand dunes that – in concert with wetlands - provide flood and severe storm protection (McHarg 1969).

Critical issues of coastal development include attention to impervious surfaces, establishment of perimeter buffers, and protection of large and sensitive environmental areas. Urban design utilizing these strategies, with particular concern for environmental impacts of development within coastal areas, is usually localized, i.e., a topic that addresses urban form at a municipal scale with ignorance of a greater context. Therefore, with the complexity of environmental and social issues affecting coastal areas, a compelling case for urban form encompassing bioregionalism is outstanding.

7.3 Agri+Culture: An Integrated Approach

For millennia, the human condition has centered on agriculture relative to location, town building, development of customs, crafts, and trades, processing of food stuffs for sustenance, leisure time, and technological advances. These endeavors have been requisites for advancement of civilization and culture. However, since the Industrial Revolution outmigration from farms and rural areas to urban locations has occurred internationally and without cessation to the extent that recent estimates show the world’s population has become predominantly urban (World Bank 2010), with 1% to 2% of Americans directly engaged in agriculture (Berry 2009).

Within a bioregional context inclusive of urban form, agriculture and human settlements should be reciprocating, localized, and inter-regional. Agriculture – especially in peri-urban setting - should also contribute to the form of intense urban development and reflect the interconnectivity and characteristics of synecdoche that define ecologically complex, holistic, and therefore good urban form within the bioregional context (See Figure 4).

Figure 3. Washington County Metro UGB. By permission of 1000 Friends of Oregon.

Figure 4. Urban farming plot in Detroit. By permission of Michigan Urban Farming

Where agriculture is integrated with urbanization in the bioregion several sustainable practices can occur. For example, sustainable agriculture can provide a community a familiarity over time to its food source and practices associated with it. American thinker and writer Wendell Berry is well known for advocating sustainable agriculture in which longstanding familiarity realized through agricultural practices fosters and preserves a “working capital” paying dividends over time and providing cultural meaning. The sense of history and environmental awareness – and stewardship - acquired in this regard is also uniquely important within a bioregional context to ”grow” “ecological capital,” e.g., interconnectivity and mutually benefitting relationships regarding ecosystem health. In furtherance of these points, Berry argues that localized farming practices, e.g., within an urban and peri-urban context, do not assure sustainability, unless an understanding of historic and broad definition of “husbanding” of agriculture resources are applied, rather than blindly following narrow edicts of science, technology, and their inherent specializations. Therefore, practical wisdom - the environmental awareness derived from hands-on, sustainable practices of agriculture - can “mediate” between nature and community, and the various linkages and obligations inherent in them, doing so in emic terms. Conversely, modern etic technology dependent agri-industry provides this benefit minimally – if at all - no matter how many monitoring stations are provided in the exercise of “smart” practices, within remote locations. This is not to say that smart practices should be eschewed, but instead emic-based stewardship and “hands-on” approaches towards practical wisdom are superior and can thereby accrue.

7.4 Agriculture and the Land-Water Nexus

The land-water nexus as regards sustainable land use and urban form is important in the watershed context in general and particularly with respect to agriculture. Within adverse or positive agricultural practices, landscape familiarity, and the outcomes inherent in them either contribute to or degrade sustainability with potentially profound effect.

At a minimum, prime agricultural land occupying peri-urban locations must be protected and used for agricultural purposes and in a manner compatible with the land-water nexus characterizing sustainable urban form in the watershed and bioregion. Prime agricultural land in this case is that land pressured by development, and relatively flat, well drained, and best suited for food, forage, fiber, and oilseed crops (Carver and Yahner 1992, 2). Importantly, given an urban location, high-valued crops (vegetables and fruits) should take precedence over other agricultural production. Emphasis here is on food security in peri-urban and urban settings to provide for populations located there. Agriculture in this context can offer scenic pastoral landscapes as a variation of open space within an urban-rural watershed context, as well as economic development through product value-added endeavors, agri-tourism, you-pick opportunities, contract growing, and farm to table endeavors. Opportunities for recreation and education can abound for school children, inhabitants, and visitors through sustainable urban agriculture.

Beyond land use, many practices of sustainable agriculture are essential to long-term environmental and human cultural wellbeing, e.g., by mimicking the complexity of resilient ecosystems. These include value-added industry that increases the worth of agricultural product to build markets, develop sustainable economies, and allow for place-based built and landscape environments in which these activities might occur. In addition, energy can be conserved by reducing dependency on long-distance transport typifying agri-industry and through avoidance of farming practices having high levels of embodied energy, e.g., chemical fertilizers, pesticides, and herbicides. Also, a "closed loop" approach through recycling and waste management can occur through proximity of producers and consumers and their shared experiences of a range of agricultural practices.

All in all, mutual dependencies between agriculture, urban form, and urban inhabitants speak to tangible and intangible conditions of sustainability in the bioregion and within a whole systems context inclusive of watersheds and sub-watersheds. Therefore, agriculture is highly significant with respect to the land-water nexus along with an incumbent provision of undisturbed areas comprising buffer zones, ecologically complex riparian zones, forests, wetlands, and headwaters.

7.5 Carbon, Ecosystems, and Land Use

Atmospheric carbon can be mitigated at various scales from individual buildings and sites to global levels. In the range from buildings to regions, a bioregional focus is desirable to avoid collective adverse impacts of greenfield conversion, increases in impermeable surfaces, and subsequent additions to atmospheric carbon. Conversely, benefits of appropriately managed ecosystems – including land use - can affect the balance of carbon (Pataki et al 2006) to avoid adverse impacts vis-a-vis the carbon cycle.

Through understanding of a regional context, the atmospheric carbon challenge can be circumspectly addressed. By example, the regional imperative is particularly true when considering North America where – ironically - population impacts increase significantly in the midst of declining population growth. To wit, demographic change has resulted in greater numbers of households, reduction in household size, subsequent sprawl, and a subsequent larger carbon footprint. This phenomenon occurs in the United States, Canada, and Mexico where 40% of emissions originate from fossil fuels with the preponderance of emissions emanating from transit and residential land uses (World Resources Institute in Pataki et al 2006). Therefore, land use planning and urban design that guide form should be holistically considered and the bioregional scale is an appropriate milieu in which to do so. Moreover, particularly important with respect to a holistic bioregional perspective are population densities and housing. When these factors are ignored or partially mitigated, urban sprawl results along with more atmospheric carbon (Gonzalez in Pataki et al 2006). Aside from population and housing density, undisturbed ecosystems, robust public transit, and sustainable agriculture play important roles in reducing carbon release, carbon sequestration, and resilience of the carbon cycle.

Within ecosystems numerous variables are significant to carbon sequestration, including factors of time, location, climate, land use, etc. Importantly, carbon sequestration occurs through regional plant communities, i.e., in trees, shrubs, grasses, and soils that offset atmospheric carbon buildup, and therefore, within ecosystems comprising bioregions. For example, much data has been accumulated that reflect trees' importance to carbon sequestration. A 1991 study by Rowntree and Novak demonstrates that the amount of carbon storage by trees is linear. That is to say, the greater the amount of tree canopy in the landscape the greater the amount of carbon sequestration (Rowntree and Novak in Tratolos et al 2007, 310). However, an ecosystem service in the form of a biological carbon sink, natural ecosystems – including forested lands - will not unilaterally allow for offsetting of carbon emissions in urbanized areas, but must be considered within a larger policy framework that includes cities and their component parts (districts, neighborhoods, corridors, sites, and buildings).

In recent years, attention given to agricultural practices that, instead of contributing to atmospheric carbon, have enhanced carbon sequestration (Warnet 2015 and Melancon 2015) through soils management. Additionally, coastal wetlands are efficient sources of carbon sequestration along with other ecosystem services they provide. Specifically, coastal wetlands contain high amounts of submerged – and therefore anaerobic – soils. Due to these soils' low oxygen content and high growth levels of plants in wetland ecosystems, they sequester great amounts of carbon (NOAA 2016, 2).

8 CONCLUSION

In planning, design, and management as emphasized herein, a regional context, i.e., the watershed-bioregion nexus, is the suitable milieu for contextual urban design, i.e., urban form reflecting the

need to be inclusive of a larger built and natural fabric to achieve sustainability. With global population growth, demographic changes affecting land use and energy consumption, wide-scale loss of habitat and attendant life forms, much work must be done on all levels. This includes, comparisons of diverse regions, and types, amounts, and uses of renewable energy sources – including fossil fuels – and carbon budget "accounting" to achieve sustainable urban form.

Additionally, responsibility, oversight, and enforcement are inherently problematical at local levels emanating from political jurisdictions inspired by Euclidean geometrics and narrower regional perspectives limited to transportation and economic activity. These conditions are exacerbated by the recent evolution towards global "transnationalism," although some global interests have made strategic retreats in this regard without foregoing global enterprises. This bodes well for sustainability and resilience of urban form as applied to bioregions and maturation of the city-region concept. The role of landscape architecture towards these ends suggests considerable opportunity for the profession.

9 ENDNOTES

1. "Multinuclear" refers to urban form wherein distinct urbanization has not coalesced into sprawl.

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