Shadeways: Exploring a new Greenway type promoting the Mediterranean bio climate in Greece

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Introduction

In a Mediterranean climate the bioclimatic design parameters greatly influence and determine a greenway's successful use in terms of human comfort and should be a key element in landscape planning and decision making. Tourism is probably the best example among human activities in which the linkages between environmental quality and economic prospects are evident (Priestley et al., 1996). Internationally, greenways have proved to be desired living places, with pedestrian access to nearby neighbouring rural towns, improving the overall quality of public space. Sustainable rural greenways geared to leisure and tourism offer mobility, conservation, reuse of natural and cultural heritage sites, recreational amenities for leisure activities, environmentally respectful touristic potential, and quality public spaces through proper greenway and landscape planning.

Background/Literature Review

Greenways serve multiple functions by providing recreational opportunities, enhancing landscape aesthetics, preserving cultural and historical, and protecting ecological corridors (Ahern, 1995). When designing green routes for a Mediterranean climatic zone, it is imperative that human or thermal comfort standards be considered and pertinent bioclimatic data be carefully assessed (Santamouris, 2012). In hot climates, with high temperatures, humidity and hot winds it is very important to consider the climatological consequences on human activity and the positive impact that can result from appropriate landscape design. The microclimate of greenways can be improved through bioclimatic landscape design and planning. The field of climatic outdoor design is relatively young starting from Olgay's seminal book 'Design with Climate' (Olgay, 1963), through Robinette's work 'Landscape Planning for energy conservation' (Robinette, 1983) and "Urban greening to cool towns and cities' (Bowler et al, 2010)

Environmental variables that are important for human thermal comfort include solar radiation, temperatures of surrounding surfaces, air temperature, humidity and wind speed (Herrington, 1978). Urban trees can ameliorate these environmental variables by preventing solar radiation from heating the surrounding buildings and surfaces, cooling the air by evapotranspiration, and reducing wind speed (Akbari et al., 2001). On the human / street level scale, bio climatically optimum performance insures the validity, viability and sustainability of the planning effort (Bowler et al, 2010). The use of high-albedo surfaces and planting of trees are inexpensive measures that can reduce summertime temperatures (Akbari et al, 2001).

Figure 1 & 2. Side by side approaches to shade show trees and a manmade structure. The trees were found to be more effective in cooling the air and providing a comfortable sitting environment. (Phoenix, Arizona, photos: Lindhult)

There are many approaches to improving landscape aesthetics, from an ecological to a purely artistic expression. Due to their linear character and landform, greenways can alternatively be viewed and perceived as a form of land art.

The artists Christo & Jean Claude created two famous projects that capture the essence of "greenway art". 'Running fence' was a temporary art installation in northern California, completed in 1976. It consisted of a veiled fence 24.5 miles (39.4 km) long, 18 feet (5.5 m) high fence. The project ran through every imaginable landscape within two counties eventually sinking into the sea. The installation made clear references to bioclimate and the wind forces. The project raised not only ephemeral landscape art awareness but issues of wind management harnessing and technology as well as structures anchoring systems (Christo, 2010).

Christo & Jean Claude in their Central Park Gates project (1979-2005) went beyond the artistic concern and expression by clearly hinting the importance of bioclimate through 7503 gates that become shading devices. The air that blew through the free-hanging saffron coloured fabric panels would lift them, converting a golden overhead river of drapes into a full scale shading structure, enhancing the shade of the trees. This was a rare if not unique blend of ephemeral artistry and bioclimatic landscape design combined in an ingenious form (Christo, 2012).

An example of creating shade for walking and riding exists on the estate of William Randolph Hearst, who built a one and a half mile long pergola that was planted with 2,000 fruit trees and grape vines. Although on a private estate, it illustrates the extreme measures that some will go to in order to create bioclimatic comfort. (Pavlik, 1992)

Goals and objectives

The main goal of this paper is to develop a landscape design strategy for outdoor environments in hot climates based on bioclimatic principals. The objectives are to: 1) determine design guidelines that improve the microclimate and can be applied to greenways; 2) show how improving the microclimate and cooling the outdoor environment sets site planning and bioclimatic landscape design recommendations that can be applied in typical hot and arid Mediterranean climates; 3) demonstrate how shade elements can provide multiple benefits on greenways, from human comfort to way finding.

Methods

The paper examines shadeways as a new greenway type that promotes the bioclimatic planning and design approach with an emphasis on the Mediterranean bio climate of Greece. A case study for a greenway linking the town of Arta to Koronisia along a major drainage canal in the plains of Arta and the coast of Ambracian Gulf in Greece was selected as the catalyst for supporting the shadeways argument.

In this paper the research agenda is approached from a bioclimatic landscape planning and design approach trying to explore new ways of thinking about greenway bioclimatic issues. In hot climates bioclimatic landscape design considers three major environmental factors: solar radiation, evaporation, and air flow (wind). Following these design principals will greatly assist in improving the micro-climate and passively conserving energy with low water consumption rates (Attia & Duhhart, 2009).

The case of Ambracian Gulf Shadeways

The Ambracian Gulf is a place where fishermen and farmers live in humble dwellings and make a living using the rich natural resources of the shallow bay and its surrounding marshlands. It is a Ramsar wetland covering 236 km2 and a National Park of 450 km2. The area is a highly threatened conservation area due to intense agricultural use, water and aquaculture exploitation, water pollution, habitat alterations, and widespread illegal hunting and poaching (Zogaris et al, 2008). Since 1990, the Ambracian Gulf has been included in the Ramsar Convention Montreux Record as a site where ‘adverse change in ecological character’ is occurring and therefore ‘in need of priority conservation attention (Gerakis et al, 1999). Wildlife species of all kinds are the most populous visitors here. The estuary around the Ambracian Gulf with its twenty natural lagoons is a refuge to a wide variety of birds and aquatic animals, many of which are endangered species. The Ambracian Gulf is an almost enclosed, and therefore protected, expanse of sea which is connected to salt water lakes via controlled mouths. Two important rivers – Louros and Arachthos – flow into the gulf.

The paper proposes the development of a landscape design strategy for the outdoor environment in hot climates based on bioclimatic principals applied to greenways. The Ambracian Shadeways (fig. 3) were proposed as a Greenway system with an emphasis on providing shade, improving microclimate and thermal comfort, and testing appropriate techniques that improve bioclimate design guidelines.

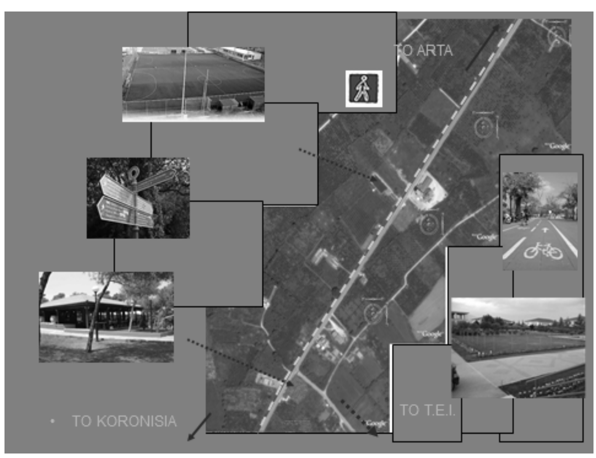

Figure 3. The Ambracian Shadeways area, extends from Arta to Koronisia.

Figure 4. A 1km section showing a rest a sporting facility, and greenway signage.

For the Ambracian Shadewaysto attain undisturbed function and successful operation, the major bioclimatic demands and parameters were manipulated within the design criteria selection process of suitable routes, sites, parks, parking lots, tree selection, infrastructure, outdoor shading structures, devices, and equipment. In developing a sustainable community, the ownership status (private / public) as well as utility rights-of-way issues were addressed in order to ensure a practical design proposal with seamless accessibility (fig,4). Lastly, habitat connectivity, surface storm water conveyance, and bio filtration were considered.

Ecosystem sensitivity and protection/conservation are probably the most common reasoning for sustainable ecological greenways or ecological corridors (Jongman & Pungetti, 1999). Ahern (2002) supports that one of the main arguments for greenways is that when a system is linked it may acquire the synergistic properties of a network, even truer as an ecological network.

The idea of an 'oasis effect' is the reduction of temperature in an isolated moisture source surrounded by an arid area. Its diurnal dynamics in the hot Mediterranean dry climate is additionally contributing and forging upgraded thermal comfort performance.

In addition to shade, additional greenway physical amenities such as parking, shelter, playground, restrooms, drinking water, benches, tables, bike racks, trash bins etc. should be integrated into such places set at certain intervals, reinforcing the shadeways concept (http://greatriversgreenway.org). Light posts are located in intervals of 20 meters alternating sides; shaded seating area with benches is provided in intervals of 500 meters; and emergency phone is designed in intervals of a kilometer.

Discussion

Every bioclimatic zone is associated with landscape-design decisions that reflect a desired climatic comfort objective. For Greece's bioclimatic zone, site plans were drawn with climate responsive design in mind to provide microclimate thermal comfort at the pedestrian level.

Key considerations were solar radiation, wind, and evaporation control achieved through vegetation, water and hardscape that address shade, humidity, temperature, albedo, reflectivity/absorption of surfaces and materials, thermal comfort indices, radiation, heat, emissivity, glare, and dust control.

Thermal comfort in the outdoor built environments is defined as a subjective response of a person in regard to satisfaction with the thermal environment and responsible for developing a bioclimatic chart (ASHRAE, 2010). Thermal comfort is influenced by environmental factors, (air temperature, air movement, humidity, radiation), personal factors (metabolic rate, clothing, state of health) and acclimatization (Szokolay, 2008). Trees and water elements were incorporated because of their potential to improve outdoor thermal comfort due to shade and humidity control. The combination of shade trees, ground cover, water and wind control elements was predictably found to be the most effective landscape strategy.

Vegetation control was considered as the most effective surface and air temperature cooling through shading and evaporation modification at the micro environment or human scale. The Mediterranean climate is hot and arid so for the Ambracian Shadeways, trees, shrubs, groundcovers, vines and turf, all function as solar control devices: a) filtering, reflecting, transmitting, reducing direct and reflected solar radiation, b) acting as a buffering agent (on overhead trellises), c) absorbing heat (on hot walls), d) moderating outdoor environment temperatures and abrupt temperature changes (Georgi & Zafiriadis, 2006), while offering a large variety of forms, textures, and colours.

Wind/cooling control through vegetation was a critical factor for bioclimatic control. Placement of drought tolerant and indigenous species was paramount to vegetation patterns and wind flow/cooling (horizontal and vertical). Plant material being multifunctional; provide more than just solar control. Care was taken to consider all aspects of site design requirements before final placement of vegetation (Miller, 1980). The degree to which plants function as effective climate control devices depends on their size, shape, density, and location and were best determined using sun path diagrams in conjunction with overheated period data. Trees act as windbreaks lowering the ambient wind speed. The shade cast by trees reduces glare while its canopy blocks the diffuse light reflected from the sky and surrounding surfaces (Akbari, 2002).Canopy trees reducing the temperature and raising the wet bulb temperature were utilized not only across the length of the pedestrian routes but also around parking places (Attia & Duhhart, 2009).

When compared to ground temperatures, water is normally warmer in winter and cooler in summer, and usually cooler during the day and warmer at night. Water distribution, wind availability and speed determine the rate of evaporation modifying climatic impact and thermal comfort. Related strategies to improve microclimate included: water surfaces, fountains, reflecting pools, irrigation channels, and porous permeable paving favouring air cooling by evaporation (Miller, 1980, Givoni, 1996). Concerning water consumption, trees provide the most efficient means to reduce outdoor ambient temperature through evapotranspiration, while the ground cover and water elements consume greater water quantities.

Bioclimatic topography with respect to solar orientation is the single most important factor in determining site-specific bioclimatic conditions. Sites protected from cold winter prevailing winds and open to southern solar exposure exhibit much better bioclimatic performance. Proximity of water bodies was found to moderate extreme temperature variations year-round, and in summer lower the heat peaks. Sites located leeward of large bodies of water or irrigated fields will benefit from evapotranspiration cooling and temperature modification. Earth sheltering and berms were bioclimatic design techniques that contributed to human comfort and cooling loads year round both outdoors and indoors. A continuous-'through the landscape' bio-berm design was one of the innovative techniques proposed.

Shade structures such as pergolas, tents, pneumatic structures, and vertical or overhead gardens were another response to solar control. Economy and design of shading structures were of crucial importance for solar radiation, reflectance, and human thermal comfort.

Conclusion

The Ambracian Shadeways System (green routes) will provide for greater human comfort for both locals and tourists alike which should have positive impact on the economy, tourism, recreation and social life.

The proposed Ambracian Shadeway System was presented as a case study to support the benefits of providing shade along greenways and introducing strategies to fight the heat island effect and improve thermal comfort in urban, peri-urban and rural environments. Creating a greenway with these bioclimatic benefits along with providing non-motorized, safe, easy, accessible and continuous transportation infrastructure can facilitate environmental benefits and simultaneously help to stimulate the local economy and further facilitate rural revitalization programs while respecting ecological processes.

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