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Short communication

Importance of urban street tree policies: A Comparison of neighbouring Southern California cities

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ABSTRACT

Research points to numerous benefits provided by urban street trees including qualitative and quantitative public health, economic, and environmental advantages for a city and its residents. As with other key aspects of city management that help develop municipal success, urban forestry requires foresight, commitment and planning that lead to effective policies and strategies. Good street tree management based on effective policies can maximise street tree benefits. Poorly conceived policies or the absence of effective policies can lead to the opposite result. A case study of the neighbouring cities of Loma Linda and Redlands, California illustrates this difference. The urban tree care and protection policies in these two cities have evolved differently. The differences may be attributable to contrasting municipal commitments to preservation and to best-practice management principles. Based on a comparative analysis of street tree policies of the two cities, it can be concluded that a local culture favouring tree protection and reflective guidelines and policies can result in proactive and successful management of an urban forest. Such policies also include provision for gathering data essential for strategic tree planting, care and removal.

1. Introduction

Cities can be thought of as complex environments with many common and also unique factors influencing their successes or failures. Results are typically related to the state of local economy, social cohesion and safety, city identity, infrastructure and the health and well-being of its residents. Despite the nature of economic, environmental and social influences, a city leadership's level of engagement plays an important role in shaping outcomes. This is particularly visible when studying the history of municipal policies and political engagement relative to a city's built environment.

Urban street trees provide various benefits to cities and their residents, to the perceived quality of cities and quantifiable economic and environmental value. It is well documented that urban street trees improve local and regional air quality, increase property values, reduce heat island effects, reduce heating and cooling energy use, provide scale, texture and create more aesthetically pleasing and memorable spaces (Donovan and Butry, 2010; Nowak et al., 2014). Several studies have also shown that exposure to green spaces and natural elements have multiple health benefits ranging from positive effects on memory for healthy individuals and patient populations to improved mental health and recovery times after surgical procedures (Beyer et al., 2014; Ulrich, 1984).

The inclusion of natural environment, including street trees, in urban settings can aid psychological and physiological restoration by improving mental health, reducing blood pressure and anxiety, reducing mortality, reducing physician-assessed-morbidity, reducing physical inactivity and promoting physical activity with greater cardiovascular benefit as compared to other settings (Bratman, 2015; Bratman et al., 2015; Kardan, 2015; Maas, 2009). Mood disturbances and self-esteem are also positively affected when physical activity, regardless of intensity level, is based in an environment where trees are present (Pretty, 2007).

According to McPherson et al., street trees lining California's streets provide over $1 billion in benefits to the State and its residents (McPherson et al., 2016). While cities and regions show variances, for every $1 invested in tree planting or maintenance, communities see a $5.82 return, on average – a gain that does not take into account the additional, well-studied psychological and physiological benefits to humans (McPherson et al., 2016). Such returns on investment are not one-time occurrences, but rather a continual cycle of direct and indirect benefits to the local economies, safety, air quality and health of a city and its residents.

Among the number of health benefits stemming from urban greenery, studies have shown that residents report higher health perception and significantly fewer cardio-metabolic conditions

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in communities with a higher density of street trees than peers residing in areas with lower street tree density. Greater health associations have been observed along streets in contrast to parks and areas less frequently encountered, suggesting the importance and benefit of planting and maintaining urban street trees (Kardan, 2015).

After controlling for socio-economic and demographic factors, it has also been shown in Toronto, Canada that having just 10 more trees per block (a density increase of just 4%) is associated with improved health perception comparable to an increase of $10,200 in personal annual income or being seven years younger. An increase of 11 more trees per block can decrease cardio-metabolic conditions comparable to an increase of $20,200 in personal annual income or being 1.4 years younger (Kardan, 2015). Perception of health is typically higher for families with a higher median income and position of affluence. According to Kardan, that link disappears when less affluent families are living on a street with higher street tree density.

Despite such statistics, the national trend for urban tree cover indicates a statistically significant decline throughout cities between 2001 and 2009. Reduction in tree cover was observed at an average rate of 0.27% of city land per year, or approximately 4 million trees in urban US areas (Nowak, 2012).

In California, it has been shown that while street trees have increased in quantity since 1988, their density has dropped by 30% while covering only 36% of city street tree capacity, or full stocking value (McPherson et al., 2016). What this paradox suggests is that many trees are being removed without replacement due to such factors as budgetary constraints, new street construction that does not include trees, or tree removal initiatives due to invasive pests and diseases.

Despite the setbacks, cities have an opportunity to improve their urban tree coverage and density through more deliberate and strategic planting and maintenance methods. While coverage density is on the decline, strategic efforts for managing the estimated 16 million vacant tree planting sites could include a focus on policies that guide infill planting and appropriate pruning in areas of greatest need first. Exemplified by the City of Portland, Oregon, an ongoing initiative identifies where street tree planting is prioritised based on compiled geospatial data for areas of greatest heat vulnerability, heat islands and existing tree canopy (Sustainability, 2016). Research has shown that areas with intentional tree care and protection policies are able to mitigate heat island effect temperatures by up to 3.9 °C compared to areas without tree protection policies (Sung, 2013).

2. Methods used

Research was conducted primarily through scholarly literature review relevant to the presence of street trees, the effects on health and economic outcomes when street trees and corresponding policies are present and when they are absent. Primary scholarly journals included *Urban Forestry & Urban Greening* and *Landscape and Urban Planning*. Supporting and recent scholarly literature related to the discipline of urban planning, sustainability and street trees from 2005 to June 2016 was also analysed by searching for relevant keywords in major databases such as Google Scholar.

Other keyword searches were performed throughout city-level municipal codes, city-level general plans and related street tree policies and guidelines. To highlight patterns of change, regional and city-level Esri's ArcGIS Global Land Survey Landsat data was accessed as reflected in "Figs. 2 and 3".

Historical books were included in the analysis primarily for photographic and contextual records of the region. Additionally, windshield-surveys were done throughout both cities for present-day analysis. Selected research was organised and added to this paper using EndNote X7 software.

3. The case study

The neighbouring cities of Loma Linda and Redlands, selected for this case study, are both situated on the eastern end of Inland Southern California. While they both share a similarly diverse population, socioeconomic demographics, geography and California's coastal sagebrush climate, their respective built environment policies are significantly different. This has resulted in different outcomes, particularly in the urban built and natural environments. This difference is vividly illustrated in "Fig. 1" in the two cities' approaches to street trees.

3.1. Loma Linda background

Loma Linda established initial presence as a health resort destination in 1876 amidst a railroad and citrus boom. The Seventh-day Adventist Church purchased the resort land in 1905 and established a "sanitarium," a nursing school, and later a school of medicine in 1909. From the beginning, the institution that eventually became known as Loma Linda University, has had a strong emphasis on health promotion and disease prevention that includes a commitment to create a healing environment with connections to nature and physical activity (Park, 2005). Today the University and its health system of six hospitals and numerous outpatient clinics is the largest private employer in the Inland Southern California region. The city of Loma Linda, which is home to the University, was incorporated in 1970 and has an estimated population of just over 24,000 (Bureau, 2016a; Linda, 2016).

3.2. Loma Linda policies

Loma Linda developed within the realm of healthcare, religious, educational and healing arts roots, and has emphasised a commitment to open spaces and natural resource preservation. Specifically, the City's General Plan highlights adaptive reuse and preservation guiding policies for existing citrus grove trees (Sec. 3.2.1.1), preservation of oak woodland areas (Sec. 9.4.4), recognition of tree value for energy conservation and air quality measures (Sec. 3.1.1.2 and 9.8.1) (Linda, 2009). The City of Loma Linda has a 7.5 square mile boundary and for any new development requires street tree planting as directed by the approved master street tree palette. The City however does not have a current street tree inventory or tree count and does not have comprehensive guiding policies for the planting, maintenance or removal of street trees (Bureau, 2016a; Linda, 1981). Through its guidelines or its policies, the City does not currently call for prescriptive street tree care methods, nor is there a designated and codified protocol, committee, department, or management plan for the city-owned street trees of Loma Linda.

3.3. Loma Linda outcomes

Recognised as a Blue Zone, defined as a demographic or geographic area with disproportionally high longevity, the Loma Linda community has a strong emphasis on physical activity, and other health promoting factors (Buettner, 2009). Driven by the desire to preserve natural elements and open spaces for an active lifestyle, the City designated a "Hillside Conservation" area in the General Plan and the Municipal Code consisting of 1157 acres of open space in the South Hills Preserve. This area is available for public use and is a key destination for recreational physical activity in the City (Linda, 2009). While it technically allows for low density development of one dwelling unit per 10 acres, or per 5 acres conditionally,

Fig. 1. Contrasting tree cover in residential areas for Loma Linda (left) and Redlands (right).

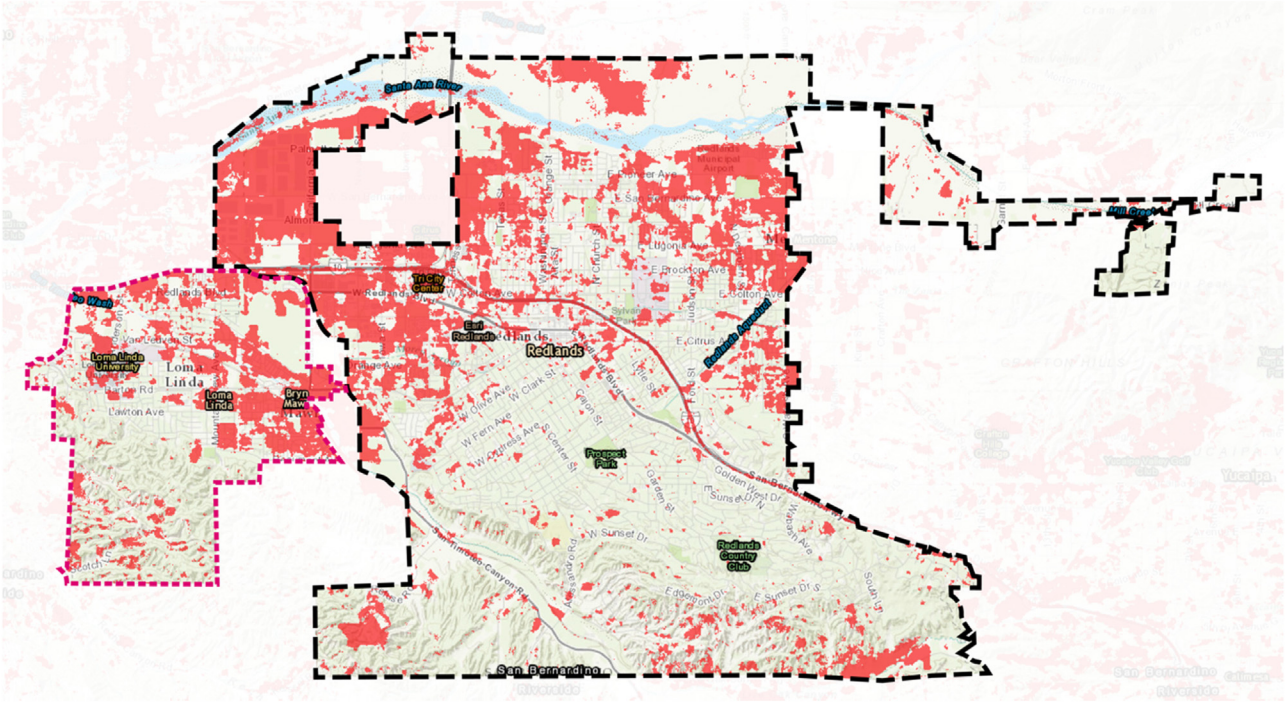

Fig. 2. 1975–2010 vegetation loss in Loma Linda (left) and Redlands (right) illustrated through Global Land Survey Landsat data (Esri, 2016).

the "Hillside Conservation" area may be the best example of natural preservation through municipal policy in Loma Linda (Linda, 1981).

Despite the historical drivers for preventive health, heritage of healthcare and wellness and the connection to nature and open spaces, the City is not currently in a position to strategically plant and then maintain its urban street trees based on best practices found throughout the State of California and the Inland Southern California region. Throughout its founding years in the early 20th century, Loma Linda was a place with many mature tree-lined roads leading to the original Sanitarium, but in recent decades there has been observed tree canopy loss, potentially due to poor trimming methods and frequent tree removal. The city also had numerous natural open spaces and gardens surrounded by citrus groves, many of which have been lost and not restored (Park, 2005). Many of the street trees have been removed and not replaced, most noticeably on major thoroughfares and throughout Loma Linda University which is often considered downtown Loma Linda. Effects on resident's perception and potential public health and environmental impacts require further study. Between 1975 and 2010 as illustrated in Global Land Survey Landsat data in "Figs. 2 and 3", Loma Linda has experienced substantial vegetation and tree cover loss throughout commercial and residential zones, showing minimal growth, mostly throughout citrus groves (Esri, 2016).

Currently, Loma Linda does not officially utilise the American National Standards Institute (ANSI) A300 pruning standards. These standards are evidence-based preventive approaches to urban forest care and are reflective of those guided by the International Society of Arboriculture. Additionally, the City of Loma Linda and Loma Linda University are not recognised as Tree City USA or Tree Campus USA, respectively. The national awards are sponsored by the Arbor Day Foundation, the U.S. Forest Service and the National

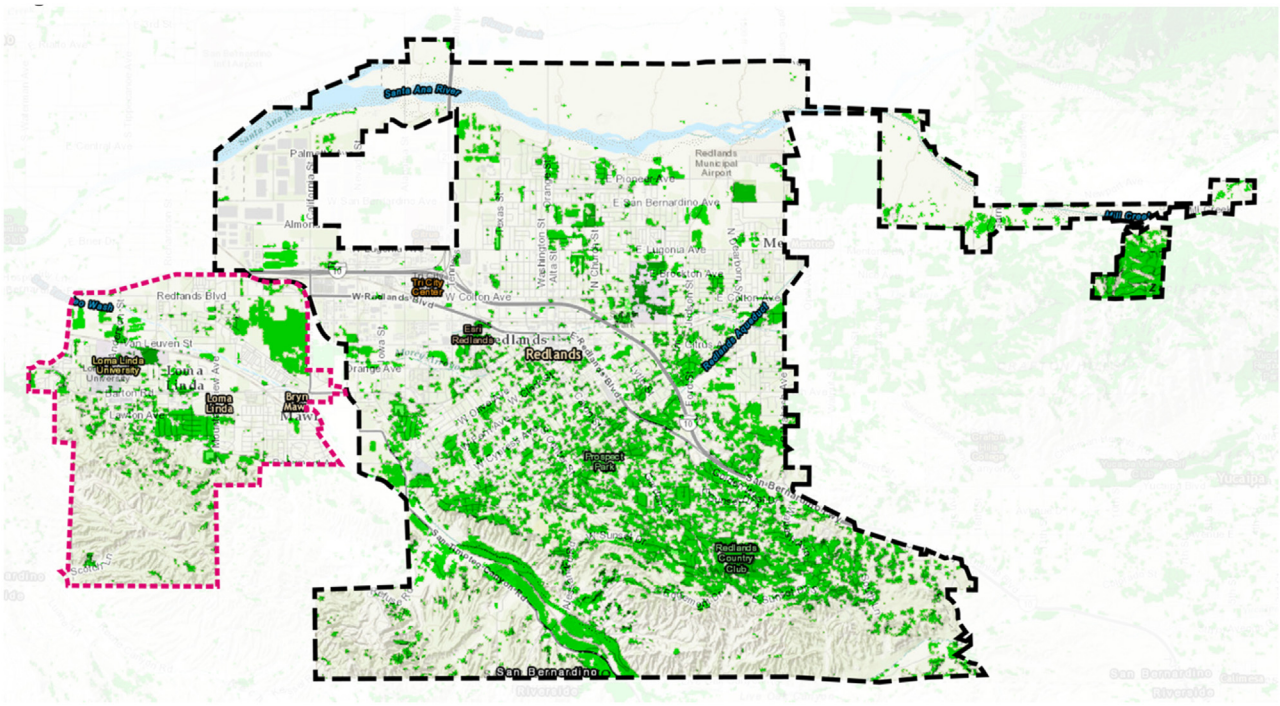

Fig. 3. 1975–2010 vegetation growth in Loma Linda (left) and Redlands(right) illustrated through Global Land Survey Landsat data (Esri, 2016).

Association of State Foresters and are intended to provide the necessary framework for cities and campuses to maintain and develop their urban forests. Requirements for award eligibility for cities include "maintaining a tree board or department, having a community tree ordinance, spending at least $2 per capita on urban forestry and celebrating Arbor Day" (Foundation, 2016b). Campus recognitions are given to colleges and universities that maintain a campus tree advisory committee, have a campus tree care plan, have a campus tree program with dedicated annual expenditures of $3 per student, observe Arbor Day and have service learning project opportunities (Foundation, 2016a).

3.4. Redlands background

Neighbouring to the immediate east of Loma Linda and also developing out of the very core of the largest citrus fruit producing region of the world in the late 19th century, Redlands has become a home to 71,000 people today (Bureau, 2016b). Redlands is known as a city dedicated to its quality image and one that is proud of its architectural, cultural, and agrarian heritage. Street trees in the City of Redlands date back to when streets were initially laid out in 1881 by founders Judson and Brown, prior to City's incorporation in 1888. Through a culture and commitment to tree care, approximately 32,900 street trees are covering nearly 300 miles of public roadways today. An additional 4100 park trees make up the public realm of Redlands' Community Forest, with an estimated 70,000 private trees throughout the City's 37 square mile boundary. Not immune to recent issues of pests, disease and drought throughout California, Redlands has observed a loss of approximately 1200 street trees since 2012, leaving more than 6100 total vacant street tree sites (Redlands, 2013).

3.5. Redlands policies

Recognizing the important value that trees provide to the City's quality of life and the meaningful heritage that they represent, Redlands has undertaken a number of steps to ensure that tree longevity and their care is appropriately guided based on best available practices. On November 2, 1998, the City Council established Resolution No. 5574, the Redlands Street Tree Committee. Appointed by the City Council, citizen representatives comprise the Committee, serving as an "advisory to the City Council and staff, on policies for the planting, care, and removal of trees and shrubs in all parkways in the City" (Redlands, 2013). The Committee oversees and makes recommendations on public comments related to trees, in addition to recommendations for tree-related funds received from the Honorary Tree Program, the Redlands Community Foundation and other private donors.

Although the street tree practice in Redlands dates back 130 years, official policies governing their current and future care did not form until 2013. Complementing advocacy and promotion of Arbor Day and Tree USA Celebrations, the Street Tree Committee has also played a leading role in developing an ongoing city tree inventory and the Street Tree Policy and Protection Guidelines Manual (ST Manual). Not unlike City of Pasadena's Urban Forest Management Plan, the ST Manual guides and defines all city street tree care, planting and removal (Pasadena, 2015; Redlands, 2013). By incorporating the guiding policies of the ST Manual into the Municipal Code, Redlands is in a position that helps ensure its goals of street tree preservation and other historically vital elements are retained throughout the City. Recognizing trees as a "major capital asset of the City", the Municipal Code dedicates Chapter 12.52, Trees and Tree Protection Along Streets and in Public Spaces, to preserving and growing the Redlands canopy (Redlands, 2016b).

The City also encourages preservation of the native species, historic citrus groves and other natural and agricultural areas deemed as having scenic or cultural importance that provide Redlands a sense of place. Preservation and care efforts of street trees can be found throughout the City General Plan's guiding policies, implementation policies and throughout preservation area ordinances, including those related to hiring certified arborists and tree care professional contractors (Redlands, 2010). The City requires that

any contracted tree care work and any tree care under city purview follows the minimum standards of ANSI A300. This is reflective of policies in Claremont and Pasadena, both of which are recognised as Tree City USA communities. Additionally, all city street trees and honorary trees are geospatially inventoried, categorised and labeled with height, biological and common names utilising the ArcGIS platform (Redlands, 2016a).

According to the ST Manual (Sec. 12.52.140), "No person shall plant, chemically spray, fertilize, preserve, prune, remove, cut or otherwise disturb any public tree without first procuring a permit from the director. All persons/companies obtaining such permits shall abide by the arboricultural specifications and standards of practice and any other rules promulgated by the superintendent" (Redlands, 2013). Such policy framework allows the City of Redlands to better retain the health and uniformity of its urban forest.

3.6. Redlands outcomes

As a result of commitment to its urban forest through policies, plans and guidelines, Redlands has been able to maintain and develop its urban street tree canopy, particularly through times of drought and pest distress. Between 1975 and 2010 as illustrated in Global Land Survey Landsat data "Figs. 2 and 3", Redlands, not unlike Loma Linda, has experienced substantial vegetation and tree cover loss primarily throughout industrial zones and partially throughout citrus groves. In contrast to Loma Linda, residential and downtown areas experienced consistent tree and vegetation growth (Esri, 2016).

In March 2016, Redlands received its 20th-year award recognizing Redlands as a Tree City USA community (Facts, 2016). Redlands' higher education institution, the University of Redlands, has also been designated as a Tree Campus USA school (Foundation, 2016a). To care for the street trees, the City sets aside an annually variable budget dedicated to the maintenance of its urban forest and is actively engaged in promoting care for City-owned and privately owned trees within the urban forest.

4. Conclusions

In order for a city to strategically and successfully maintain its urban forest health and density, it must remain proactive in its policy approaches towards street tree planting and maintenance. The benefits of street trees are calculable and not limited to positive economic impact, mitigation of heat islands, environmental and air quality benefits, city character, heritage preservation and the promotion of preventive public health measures such as active transportation. Tree protection and care policies have been shown to be effective in mitigating negative environmental effects and thus aiding in health-promoting physical activity engagement (Pretty, 2007; Sung, 2013).

Municipalities and institutions that focus on urban forest preservation through policies, guidelines, dedicated committees and master plans are more readily positioned to achieve desired aesthetics, have greater street tree density and are recognised as memorable places of character. Exemplary street tree management can also be reflective of commitment to walkability, more strategic land use patterns and street designs that promote active transportation. As an example, Walk Score is a measure for ease of travel without a car and while it is not solely reflective of aesthetical qualities of a street, a comparison for designated downtown areas of Loma Linda and Redlands shows a significant difference in walkability between the two, at 51 and 83 out of 100, respectively (WalkScore, 2016a, 2016b). Further study is needed to show more precisely how well-planned urban forest management strategies may affect walkability for both downtown areas.

Research shows that municipalities that choose not to proactively plan for and manage their urban forests will encounter higher total costs over the lifespan of trees and may experience a loss of net benefits from urban street trees. Urban trees provide their maximum benefit during the mature phase of a tree while their costs without proper maintenance show an inverse relationship, thus highlighting the importance of proper care over their entire lifespan (Hauer et al., 2015).

Without strategic planning and related data and policies in place, a municipality may over time fail to retain scheduled and proactive street tree planting and maintenance that may further contribute to local and statewide urban tree density loss as is experienced in California (McPherson et al., 2016). Given such outcomes, cities such as Redlands can work to strengthen and enforce their current policies while taking advantage of their existing databases and infrastructure to become more strategic stewards of their urban forest. Cities such as Loma Linda that do not have guiding policy approaches to urban forest management would strongly benefit from prioritizing efforts such as engaging the public, establishing inventories, strengthening existing policies and partnering with local and regional entities for strategic support. Such municipal commitment to preservation can be particularly vital during periods of drought and disease in Southern California when perceptive tree care and strategic planting are most critical.

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