How Tree Canopy Affects Happiness in Impoverished Los Angeles

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A study from the Princeton University Center for Health and Well-being by Daniel Kahneman and Angus Deaton found that people with incomes below $75,000 a year experience progressively lower levels of happiness (Kahneman & Deaton, 2010),[1] which may help to explain why in the city of Los Angeles (LA) where the average income is only $62,142, life satisfaction is significantly less than the national average (United States Census Bureau, 2021; USC Dornsife, 2019).[2] Given that the median housing cost for the city of Los Angeles (LA) was $636,900 from 2015-2019, well above the national average,[3] many lower income residents have been forced to reside inland, in less tree-covered neighborhoods compared to their wealthier counterparts (United States Census Bureau, 2021; Los Angeles County, 2017).[4] These areas often report poorer air quality,[5] raising the likelihood of conditions such as lung cancer (South Coast Air Quality Management District, 2020; American Lung Association, 2016), [6] and more extreme heat conditions, which increase the chances of heat stroke and other heat-related illnesses (Los Angeles County, 2021; Union of Concerned Scientists, 2018).[7] Research shows that physical illnesses such as those described above "have relatively… adverse effects on emotional well being" (Kahneman & Deaton, 2010). To increase well-being in low income

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[1] Study conducted by Daniel Kahneman and Angus Deaton at the Center for Health and Well Being, Princeton University.
[2] *The Livability Report* was conducted by University of Southern California Dana and David Dornsife College of Letters, Arts and Sciences Center for Economic and Social Research.
[3] The U.S. Census Bureau is an official government agency which collects population and economic data on the United States.
[4] Data from the LA County Equity Dashboard created by the Los Angeles County government
[5] Information cited is sourced from the 2020 data sheet by the South Coast Air Quality Management District, a governmental agency that regulates air quality for much of Southern California.
[6] The American Lung Association is a nonprofit organization that advocates for the prevention of lung-related illnesses across the county.
[7] LA County Climate Vulnerability Assessment was created by the Los Angeles County Government.

neighborhoods, community advocates have proposed expanding the urban tree canopy (UTC), defined by the U.S Forest Service as "the layer of tree leaves, branches, and stems that provide tree coverage of the ground when viewed from above" (United States Forest Service, 2019).[8] The city of LA has long supported these efforts, but since "extreme drought" consumes over 98% of LA County,[9] some may argue that the city must be mindful about its water usage and halt or reduce its tree planting programs (National Integrated Drought Information System, 2021). Meanwhile, the city has experienced a notable rise in development, with 14,564 more building permits issued in 2021 compared to 2020 (L.A. Department of Building and Safety, 2021),[10] and many city officials, who have stressed maintaining current trees while planting more, fear trees lost at construction sites will reduce an already-declining tree canopy. (Walker, 2018; United States Census Bureau, 2021; CAPA Strategies, 2021).[11] My paper aims to address these concerns, first by examining the ability of tree canopies to increase happiness in low income LA neighborhoods and then by analyzing how the city can improve its canopy. To promote long term happiness among the city's low income residents, I propose that the city government raise existing fees for developers that disincentivize them from removing trees, ensuring that Angelenos can enjoy the trees that already exist in their communities while continuing to plant new canopy.

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[8] The U.S. Forest Service manages national forests and grasslands, and is a part of the U.S. Department of Agriculture.

[9] Data sourced from the National Integrated Drought Information System, which partners with various federal agencies to compile data surrounding current droughts in order to better combat these events.

[10] The City of Los Angeles Department of Building and Safety is the citywide authority responsible for ensuring that building projects are built to appropriate safety standards.

[11] The Los Angeles Urban Forest Equity Assessment Report is produced by CAPA Strategies, a data analytics firm with a focus on environmental hazards and consults with local organizations and governments to help combat these hazards.

Citywide Inequities

While LA is well known for its cultural and financial prominence, the city is marred by stark economic and environmental inequities. According to the South Coast Air Quality Management District, poor air quality has been a persistent issue throughout the city's history, even after stricter legislation was passed to reduce pollution (South Coast Air Quality Management District, 1997). The American Lung Association ranks LA sixth for 24 hour particle pollution, fourth for annual particle pollution, and first for high ozone days out of roughly 200 American cities (American Lung Association, 2021). Central LA, which includes low income neighborhoods such as Watts, has poorer air quality than Westwood and other areas across the city, increasing the likelihood of health conditions such as asthma (South Coast Air Quality Management District, 2020; Rage et. al, 2009).[12] According to the US Census Reporter, the median household income for Watts is only $46,276, while the income of Westwood, a high income area of the city, is over twice this value. (US Census Reporter, 2021).[13] Kahneman and Deaton find that asthma decreases happiness, particularly among low income individuals, meaning that neighborhoods like Watts are uniquely vulnerable to the negative mental health impacts of asthma (Kahneman & Deaton, 2010).

Along with air pollution, low income Angelenos are impacted by rising temperatures perpetuated by global warming. The temperature of LA has risen around 5℉ from 1906 to 2006, and the number and length of heat waves has also increased over this time (Tamrazian et al, 2008).[14] Rising temperatures increase the likelihood of periods of extreme heat, wherein one can

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[12] Study is from the peer-reviewed medical journal *Occupational and Environmental Medicine*
[13] The U.S. Census Reporter is an independent organization unaffiliated with the official U.S. Census Bureau, but compiles information directly from this source.
[14] Study conducted by Arbi Tamrazian of University of California, Berkeley, Steve LaDochy of California State University, Los Angeles, and Josh Willis and William C. Patzert of the National Aeronautics and Space Administration, Jet Propulsion Laboratory.

experience subjective heat stress, defined as “the individually perceived experience of heat” (Seebaß, 2017).[15] The likelihood of heat stress is far higher in areas of lower socioeconomic status given that lower income individuals have less resources to manage this issue, which explains why heat sensitivity in low-income Watts is far higher than Westwood (Seebaß, 2017; LA County Climate Vulnerability Assessment, 2021). Given that headaches can often arise during heat stress (Lorenzo et al, 2009),[16] it is notable that this condition, particularly when paired with low incomes, also decreases well being (Kahneman & Deaton, 2010).

Increasing happiness through tree canopy

Comparing the tree cover of these two neighborhoods provides a possible explanation for the health and wellness disparities between low and high income neighborhoods. According to the LA County Equity Dashboard, in Westwood trees cover an average of 31.49% of the land, while in Watts the number is only 12.15% (LA County Equity Dashboard, 2017). While the simple correlation between tree cover and lack of happiness is clear, is there evidence to suggest that this relationship is causal?

In fact, there is ample evidence to suggest that the presence of trees both directly and indirectly increases personal happiness among individuals. According to a study in the *Journal of Population and Environment*, “perception of neighbourhood greenness was found to be the most important predictor of residents' overall satisfaction with their neighbourhood” (Van Herzele & de Vries, 2012)[17]. Another study from the journal *BioScience* found that depression decreased up to 11% in neighborhoods with over 20% vegetation cover, and decreased further in areas with

[15] Katharina Seebaß is from the Friedrich-Alexander-University of Erlangen-Nürnberg, Department of Social Sciences.
[16] Cherubino Di Lorenzo is from the Headache Clinic at IRCCS Neuromed Mediterranean Neurological Institute.
[17] Van Herzele is from the Faculty of Medicine and Pharmacy, Department of Human Ecology, at the Free University of Brussels in Belgium while de Vries is from the Landscape Centre, Wageningen University and Research Centre, The Netherlands.

even more vegetation. (Cox et al, 2017).[18] The presence of tree canopy also improves air quality, benefiting the happiness of low income neighborhoods. An assessment by the United States Forest Service found that planting one million trees in LA would decrease ozone levels 3,121 tons (ozone is a component of smog)[19], a public benefit of $23 million that would decrease the likelihood of asthma, thus increasing personal happiness (McPherson et al, 2008; Environmental Protection Agency, 2021; Rage et. al, 2009; Kahneman, 2010). In addition, a study from the journal *Social Indicators Research* finds that decreasing pollution levels will increase personal happiness of individuals (Cuñado & de Gracia, 2013).[20] Increasing tree canopy does not only benefit the area of planting, but the entire city and geographic region, as trees significantly reduce atmospheric carbon dioxide, a key metric of climate change, and are critical to the general public health of everyone living or traveling into LA. (McPherson et al, 2008). The presence of tree canopy near homes and workplaces also reduces stress and increases productivity, thus increasing happiness across a wide range of incomes and occupations (McPherson et al, 2008). Given the utilitarian principle that "happiness is… the only thing desirable, as an end; all other things being only desirable as means to that end" and that happiness is "a good to the aggregate of all persons" it is clear that the presence of tree canopy in low income neighborhoods of LA would bring an enormous utilitarian benefit, increasing the ultimate end of happiness for low

[18] Daniel Cox, Hannah L. Hudson, Karen Anderson, and Kevin J. Gaston are all of the Environment and Sustainability Institute at the University of Exeter. Danielle F. Shanahan and Richard Fuller are from the University of Queensland, while Kate E. Plummer and Gavin M. Siriwardena work for the British Trust for Ornithology and Steven Hancock works at University of Maryland.

[19] The Environmental Protection Agency is the official independent regulatory agency of the United States government, conducting research on the environment and ensuring that environmental regulations are properly followed.

[20] Juncal Cuñado and Fernando Pérez de Gracia are both of the School of Economics and Business, Universidad de Navarra.

income residents in their neighborhoods of residence, individuals working in these areas, and indirectly those who live and work across the city through climatic benefits (Mill, 1863).[21]

Increasing tree canopy also reduces immediate as well as long term heat risks, further increasing personal happiness. According to an article in the *Journal of Applied Meteorology and Climatology*, trees reduce air surface temperatures, decreasing the maximum night time temperature by over 5℉ (Loughner et al, 2012).[22] A study from Spain found that "individuals living in regions with higher July minimum temperatures report lower satisfaction levels" (Cuñado & de Gracia, 2013), although it is notable that the climate of Spain is not entirely comparable to that of LA, and that the lower satisfaction levels may be a result of other factors. However, the conclusion that mild weather, which can be perpetuated by tree canopy, is a predictor of happiness remains a valuable principle. According to the Dalai Lama, most individuals' "experience of happiness is dependent on external stimuli," and a healthier environment created through expanding the tree canopy is one form of external stimuli that is repeatedly proven to increase happiness (Lama et al., 2016).[23]

Possible determinants of tree canopy

While the benefits of planting tree canopies in low income areas may appear irrefutable, the fact remains that nearly all of LA County is in an extreme drought, with 100% of residents affected and 2021 being the 12th driest year since 1894 (National Integrated Drought Information System, 2021). Therefore, it may be more responsible to conserve water and divert the water supplies for drinking or other more immediate needs instead of maintaining and

[21] John Stuart Mill was a prominent English philosopher and believed strongly in phyilisophical theory of Utilitarianism.
[22] Study was published in the The Journal of Applied Meteorology and Climatology, which in turn is produced by the American Meteorological Society.
[23] The Dalai Lama (the spiritual leader of Tibet) was interviewed by author Doug Abrams along with Desmond Tutu as part of *The Book of Joy*, which investigates happiness in the modern world.

expanding a tree canopy in low income neighborhoods, which is especially relevant given that local residents are responsible for tree irrigation and maintenance in the public right of way in the city of LA (Pincetl et al, 2013).[24] As such, it is unsurprising that property values increased minimally and decreased as much as 40% of the time with the addition of trees, with their environmental benefits considered inadequate for many residents (Pincetl et al, 2013). More broadly, the amount of green space (including tree canopy) has little impact on how residents feel about their LA neighborhoods. (Pincetl et al, 2013; USC Dornsife, 2019). Finally, trees may not increase happiness at all; an Osaka University study found that peak happiness is achieved at 13.98℃ or 57.16℉, which is far lower than typical temperatures in LA year-round and would be impossible to change by maintaining and expanding the tree canopy (Tsutsui, 2013; Tamrazian et al, 2008).[25] However, happiness is determined by a multitude of factors, and finding the ideal temperature for this emotion is relatively worthless for determining the viability of tree canopies. (Tsutsui, 2013). In reality, neighborhood trees save significant amounts of water and resources, and are far less wasteful than lawns. (Litvak & Pataki, 2017).[26] Planting trees has actually been shown to save money; according to a US Forest Service Assessment, the benefit of planting one million trees over 35 years in LA could result in a net gain of as much as $56 per year per tree including energy use, air quality, and carbon dioxide emission reductions in addition to superior water quality (McPherson et al, 2008). Furthermore, tree canopies reduce the overall consumption of water within communities through the process of hydraulic redistribution, which

[24] Stephanie Pincetl and Thomas Gillespie are professors at the Institute of the Environment and Sustainability at UCLA, while Diane E. Pataki is Associate Vice President for Research at the University of Utah. Sassan Saatchi is a senior scientist with the National Aeronautics and Space Administration, Jet Propulsion Laboratory, and Jean-Daniel Saphores is a Professor of Civil and Environmental Engineering at UC Irvine.

[25] Yoshiro Tsutsui is a professor at the Institute of Social and Economic Research at Osaka University with a Ph.D in economics.

[26] Elizabeta Litvak is a postdoctoral research associate while Diane E. Pataki is a professor at the Urban Ecology Research Lab, University of Utah.

draws groundwater to the surface and promotes the natural irrigation of other plants, while trees cool surface air temperatures, reducing water evaporation (Horton & Hart, 1998; Kurz-Besson et al, 2006). Given the clear long term financial benefits of tree canopy, residents would be able to save money on utilities, and thus increase their happiness as their disposable income increases (Kahneman & Deaton, 2010). In addition, the health benefits secured through environmental benefits for residents of LA's low income neighborhoods themselves increase happiness (Kahneman & Deaton, 2010). In brief, the social and environmental benefits of tree canopy greatly outweigh the disadvantages. The question then becomes, how does the city of LA ensure that the benefits of tree canopy reach disadvantaged neighborhoods?

Solution Implementation

While the city's investment in expanding tree canopy is evident, the substantive impact of these measures is less clear. The 2021-2022 city budget of LA currently allocates $2,160,000 to plant trees with a focus on "low canopy, low income neighborhoods" with help from non-profit organizations such as Treepeople in accordance with Mayor Eric Garcetti's Green New Deal framework (Garcetti, 2019; Garcetti, 2021). In spite of this large investment, it appears that city policies have not actually expanded the tree canopy of LA. According to the Los Angeles Urban Forest Equity Assessment Report, urban development has destroyed tree canopy faster than it is being planted, with many areas containing less tree canopy than in the year 2000 (CAPA Strategies, 2021). According to the former Vice President of the Los Angeles City Board of Public Works Heather Reppening, the city is "losing mature canopy… it's actually healthy to have trees of all different ages." (Walker, 2018). Meanwhile, the LA City Council has passed an ordinance that allows smaller residential developers only to pay a $267 fee without planting any replacement trees. (Los Angeles City Council, 2018).[27] While this solution is intended to deter

[27] The Los Angeles City Council is an elected policy-making body for the City of Los Angeles.

developers from removing trees, considering that purchasing land (at an average over $200 per square foot) is nearly one fifth of the cost for multifamily developments in the city of LA, and costs of developing land are high, paying as low as $267 to remove a tree is relatively negligible (Bond, 2020).[28] Given this, the city of LA must raise this fee in order to make it more challenging for developers to destroy needed tree canopy while continuing to fund tree planting initiatives across climatically vulnerable low income communities; their health and happiness depends on it.

[28] Analysis by the Center For Economic Forecasting and Development at the University of California, Riverside School of Business.

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