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Mapping urban heat from space reveals dangerous inequities in LA public parks

UC Irvine study finds those in underserved communities can reach burn-risk temps



The study's senior author, Jason A. Douglas, UC Irvine associate professor and vice chair of health, society and behavior, conducts fieldwork measuring the surface temperatures of park equipment. William Pomeroy

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- More than a third of parks and recreational spaces in South Los Angeles hit or exceeded the human thermal pain threshold, while no parks in West Los Angeles did.
- Researchers determined that South Los Angeles parks were built with far more heat-retaining materials, such as artificial turf and concrete, than those in West Los Angeles.
- The NASA-funded study also found stark inequities in park access.

Irvine, Calif., April 7, 2026 — A new study funded by a NASA grant awarded to the University of California, Irvine's Joe C. Wen School of Population & Public Health has found that public parks in underserved areas of Los Angeles can reach dangerously high temperatures, in some cases hot enough to cause pain or burns, because of the materials used to build them.

The differences stem largely from what parks are made of. Researchers discovered that parks in South Los Angeles contain significantly more heat-retaining materials – such as artificial turf, concrete and rubber – while parks in West Los Angeles are far more likely to feature natural turf and vegetation.

The research, published recently in *npj Urban Sustainability*, a journal in the Nature Portfolio, analyzed park temperatures across Los Angeles County using satellite data from Ecostress, a thermal imaging experiment aboard the International Space Station. The results show stark temperature differences

between parks in South Los Angeles and those in West Los Angeles, revealing how urban design and historical investment patterns shape exposure to extreme heat.

The study, conducted with collaborators from Chapman University and Tennessee State University, found that parks and open spaces in South Los Angeles averaged 105.8 degrees Fahrenheit during summer daytime conditions, compared with about 91.6 degrees Fahrenheit in West Los Angeles. More than a third of parks and recreational spaces in South Los Angeles reached or exceeded the surface temperature associated with the human pain threshold. No parks in West Los Angeles reached that point.

“Parks are often thought of as cooling refuges during extreme heat,” said Jason A. Douglas, associate professor and vice chair in Wen Public Health’s Department of Health, Society & Behavior. “But in some underserved communities, the parks that should provide relief are actually exposing residents to dangerous levels of heat.”

Natural surfaces, such as those more featured in West Los Angeles parks, help cool the environment through shade and evapotranspiration, the process by which plants release moisture into the air. Artificial materials absorb and retain heat.

The research also found stark differences in access to green space. Using a per capita measure to account for differences in study area size, West Los Angeles has 117.1 hectares of parkland per capita, compared to 9.1 in South Los Angeles.

“Residents in South Los Angeles face a double burden,” said Joshua Fisher, an associate professor of environmental science at Chapman University’s Schmid College of Science and Technology. “They have less access to parks, and the parks that do exist are often built with materials that trap heat instead of cooling the environment.”

The work used satellite observations collected between 2021 and 2024 to measure land surface temperatures at hundreds of parks and recreational areas, including schoolyards, playgrounds and open spaces. Employing machine-learning techniques, the team increased the resolution of the satellite data to analyze temperature differences across specific surfaces, such as grass, artificial turf and pavement.

The project was shaped in part by community concerns. Residents working with the environmental justice organization [Communities for a Better Environment](#) reported extremely hot park surfaces during community workshops and heat pocket mapping sessions. Some said that artificial-turf fields and playgrounds were hot enough to burn bare feet during summer months.

Those experiences prompted the research team to investigate whether the thermal conditions described could be measured across many parks using large-scale data, such as satellite observations.

Extreme heat is the deadliest weather-related hazard in the United States, and urban heat islands – built infrastructure that absorbs and traps heat disproportionately – tend to affect lower-income communities and people of color.

The study’s authors said the findings highlight how decades of unequal investment in urban infrastructure continue to shape environmental conditions and public health risks in cities.

"Parks should be part of the solution to extreme heat," Douglas said. "But the design and materials used in these spaces matter. If we want parks to protect communities during hotter summers, we need to invest in vegetation, shade and natural surfaces that actually cool the environment."

The study was led by Ashley Agatep, an undergraduate researcher at Chapman University. Besides Douglas and Fisher, co-authors include Kainani Tacazon of Chapman University, Reginald Archer of Tennessee State University, Ambar Rivera and Rossmery Zayas from Communities for a Better Environment, and graduate student Juan Carlos Ruiz Malagon of UC Irvine.

This work was supported by NASA through its Equity and Environmental Justice Program and Ecostress Science and Applications Team.

The researchers said their findings could help inform future urban planning and park development strategies aimed at reducing heat exposure in vulnerable communities. As climate change drives more frequent and intense heat waves across Southern California, they said, ensuring equitable access to effective cooling infrastructure will be critical for protecting public health.

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Thermal inequities in public parks and open spaces in Los Angeles determined by remote sensing



Ashley Agatep¹, Joshua B. Fisher¹ ✉, Kainani Tacazon¹, Ambar Rivera², Rossmery Zayas², Reginald Archer³, Juan Carlos Ruiz Malagon⁴ & Jason A. Douglas^{2,4}

Urban heat island (UHI) effects are amplified by disparities in community-level cooling infrastructure—such as urban public parks and open spaces (PPOS)—with the most severe impacts occurring in communities that lack sufficient city-wide cooling resources. We found that the underserved community of South Los Angeles, as compared to their neighboring West Los Angeles counterparts, suffers a double burden of inequitable (1) access to and (2) absence of cooling materials and surfaces within these spaces, resulting in significantly hotter temperatures. Identifying these inequities requires high-resolution temporal and spatial mapping of surface temperatures, which has been previously limited. In this community-based participatory research partnership, we implement novel thermal-downscaling techniques to evaluate PPOS temperature differences through fine-resolution surface temperature estimates in Los Angeles County. We found that the underserved community of South Los Angeles, as compared to their neighboring West Los Angeles counterparts, suffers a double burden of inequitable access to cooling materials and surfaces within these spaces, resulting in significantly hotter temperatures. This thermal inequity presents a major public health hazard, as 36% of all PPOS in South Los Angeles reached or surpassed the thermal burn pain threshold, while no PPOS in West Los Angeles reached this threshold. These results inform policies regarding the development of recreational spaces within underserved communities.

Extreme heat is the deadliest among all weather-related hazards, with urban areas bearing the brunt of its impact^{1–3}. However, these effects are unevenly distributed, with underserved communities of color facing disproportionately high and persistent exposure to Urban Heat Island (UHI) effects⁴ that exacerbate heat- and chronic disease-related health disparities⁵. This underscores the urgent need for targeted heat-mitigation strategies in underserved communities. Public parks and open spaces (PPOS) offer a promising intervention, as they can moderate surface temperatures through shade and ecosystem services such as evapotranspiration⁶, thereby reducing heat-related health impacts⁷.

To situate our work examining the nexus of built environments and uneven heat distribution, we draw upon Mitchell and Chakraborty's framework of thermal inequities⁸. Here, we define thermal inequities as systemic, spatially embedded, and socially patterned disparities in UHI exposure and associated thermal stress arising from the uneven distribution of heat-absorbing built environment features and heat-mitigating resources,

such as PPOS, across underserved communities^{9–11}. Critically, thermal inequities illustrate systemic inequities rooted in historical disinvestment, discriminatory policies, and unequal resource allocation⁹. In underserved communities of color, decades of disinvestment have manifested in PPOS characterized by lower quality amenities¹² and lower proportions of greenspace¹³, representing a lack of heat-mitigating infrastructure and materials. However, the material composition and thermal characteristics of Los Angeles parks have not been quantified. Building on this framework, we conceptualize access to PPOS and the material composition of these spaces as interconnected contexts through which thermal inequities are produced, reproduced, and maintained.

This pattern of thermal inequities has profound implications for Los Angeles, where PPOS in underserved communities of color is unequal in both quantity and quality as a result of decades of discriminatory policies and disinvestment¹⁴. For example, despite the City of Los Angeles passing Proposition K in 1996 to allocate funds for improving park equity, West Los

¹Schmid College of Science and Technology, Chapman University, Orange, CA, USA. ²Communities for a Better Environment, Huntington Park, CA, USA.

³Department of Environmental Sciences, Tennessee State University, Nashville, TN, USA. ⁴Department of Health, Society, and Behavior, Joe C. Wen School of Population and Public Health, University of California, Irvine, CA, USA. ✉e-mail: jbfisher@chapman.edu

Angeles (WLA)—an affluent, predominantly white community—received twice as much in bond funds as South LA (SLA), which has the highest density of children, the second-highest poverty rate, and the lowest proportion of park acres relative to its local population in the county⁵. The County's 2016 Park Needs Assessment highlighted this disparity, characterizing South Los Angeles (SLA) as having “very high” and “high” public park needs, the highest level in Los Angeles^{15,16}. These unequal patterns of investment SLA parks that are smaller and lower in quality than their WLA counterparts, with disparities in park features (e.g., soccer fields) and amenities (e.g., shade structures). However, the extent to which the material composition of these parks contributes to thermal inequities has not been systematically examined.

Comparative Land Surface Temperature (LST) studies are a powerful tool for advancing environmental justice by quantifying thermal inequities that exist within the urban landscape^{2,5,17–22}. However, capturing LST differences over large metropolitan regions presents methodological challenges. One solution is remote sensing, which can provide large coverage data²³. However, in urban environments, high spatial resolution measurements are necessary to differentiate the heterogeneous material composition of urban landscapes and land covers^{23,24}. Moreover, high frequency temporal measurements are also necessary for accurately measuring heat wave events⁷. Unfortunately, engineering limitations in sensor design have restricted the ability to obtain high-resolution and high-frequency LST measurements simultaneously²⁵. The ECOSystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS), launched on the International Space Station in 2018, overcomes this barrier by enabling both high-resolution and high-frequency measurements for mid-latitudes²⁶.

By combining high spatial and temporal resolution with the ability to capture diurnal temperature measurements, ECOSTRESS has led to an emerging wave of urban heat research focused on the Surface Urban Heat Island effect (SUHI)^{2,27}. SUHI research specifically compares LST differences in artificial materials (e.g., concrete, rubber, artificial turf, and other common buildings materials) versus natural materials (e.g., natural turf, sand, woodchips, and vegetation cover)^{28,29}. Research combining LST and hyperspectral data has revealed significant variation in the spatial distribution of these materials and their respective cooling effects³⁰. However, the previous research used coarse spatial resolution data and was thus unable to differentiate the extent to which distribution of surface materials moderate surface temperatures at the neighborhood level. The simultaneous high spatial and temporal resolutions of ECOSTRESS provide a unique opportunity to examine material-temperature relationships at the neighborhood scale.

Furthermore, emerging thermal downscaling techniques have further enhanced the spatial resolution of remotely sensed LST data, such as ECOSTRESS^{31–34}. By implementing fine-resolution reflectance imagery, these approaches sharpen coarser LST data through the learned relationship between LST and reflectance. Applying this approach, we produced 10 m resolution modeled surface temperature data, enabling the characterization of LST within specific urban contexts and highly granular site-scales, which is ideal for informing targeted health interventions and broader public policy.

Therefore, this study leverages downscaled ECOSTRESS LST estimates to examine inequities in surface material composition and associated thermal characteristics in public parks in Los Angeles. Specifically, we assess the distribution of PPOS by sociodemographic characteristics and compare surface materials and LST patterns between South Los Angeles (SLA) and West Los Angeles (WLA)—two regions that differ markedly in racial and ethnic composition, income, and historical neighborhood investment. By analyzing material-heat interactions at the neighborhood scale, we aim to demonstrate how the distribution of surface materials in public parks affects surface temperatures and produces unequal thermal exposures.

Methods

Community-based participatory research

Working in a community-based participatory research partnership with South Los Angeles (SLA) residents, we identified public parks and open

spaces (PPOS)—including natural areas (such as the Santa Monica Mountain range), golf courses, and school grounds—as primary spaces of interest in relation to urban heat and environmental health. This analysis emerged from our research team's ongoing partnership, that began in 2012, with Communities for a Better Environment (CBE), a community-based organization that leverages community organizing, research, and legal action to address environmental injustices³⁵. With support from the National Aeronautics and Space Administration (NASA)'s Equity and Environmental Justice program, CBE partnered with our research team from local and partner academic institutions (University of California Irvine and Chapman University; Tennessee State University) to found a Research Leadership Academy (RLA). The RLA supports community residents' engagement with environmental scientists and public health researchers on and use of NASA data to address environmental injustices. Additionally, this program allowed our team to engage in several collaborative community workshops and listening sessions, including participatory mapping sessions with over 100 SELA residents³⁶. These sessions, held at spaces provided by CBE, facilitated collaboration and connection—holding discussions on residents' experiences and concerns, co-creating research directions, data, deliverables, and disseminating our research findings back to members.

A major theme that emerged was community members noting that PPOS are critical for heat mitigation in urban areas. However, they raised simultaneous concerns about limited access and questionable cooling potential in SLA parks. Several residents reported experiencing thermal burns to their feet and exposed skin from high surface temperatures on artificial turf and concrete in their local parks. Residents also described episodes of heat stroke and heat exhaustion during recreational activities and sports on school grounds—health conditions they attributed to the lack of green infrastructure in their parks. Importantly, residents noted that parks in the affluent community of West Los Angeles (WLA) that borders SLA had more natural surface materials and lower temperatures. These community observations informed and served as the catalyst for our comparative study of PPOS and LST in these two communities.

Mapping PPOS and identifying materials

Los Angeles PPOS boundaries, obtained from L.A. County Department of Parks and Recreation³⁷, were delineated by region as defined by the L.A. Times Mapping Project, which generated these boundaries through public feedback and involvement³⁶. Additionally, utilizing QGIS 3.32.1³⁸, boundaries for golf courses were manually added to this analysis due to resident input and interest. Identifying the surface materials of each PPOS (i.e., woodchips, sand, rubber, pavement, natural turf, artificial turf), we visually inspected all these sites through cm-scale satellite imagery from Maxar and in situ street-level photographs (available on Google Earth)³⁹. To quantitatively differentiate natural turf versus artificial turf, we computed NDVI using Sentinel-2 Bands B4 (10 m) and B8a (20 m) from June 7, 2020. Since NDVI adopts the coarser spatial resolution when combining the bands, B4 was resampled to 20 m to match B8a, producing a 20 m spatial resolution NDVI raster for identifying photosynthetic (natural) versus non-photosynthetic (artificial) surface materials⁴⁰. A shapefile of these PPOS surface material boundaries was created, including each PPOS regional (SLA or WLA) location as well as the polygon area.

Defining sociodemographic variables

We used Calenviroscreen 4.0⁴¹ demographic data, derived from the ACS 2019 5-Year Estimate data, which represents estimates from 2019 to 2023, for California⁴², for data on the racial composition of each region. We filtered the data to the SLA and WLA regions of LA County, as defined by the Los Angeles' Times Mapping LA Project³⁶. These regional boundaries were created by data analysts at the Los Angeles' Times based on historical data, census bureau data sets, and community user feedback, standardizing regional and neighborhood boundaries of the LA area. Additionally, we merged these data with the ACS 2019 5-Year Estimate data for Median Household Income (MHI)⁴² by census tract to provide socioeconomic

context for our analysis. We used census tract-level African American/Black, Hispanic/Latine, White, and AAPI (Asian American and Pacific Islander) population data (expressed as proportions of the total population) to characterize the demographic profiles of each region. Additionally, we calculated the area of each tract using a shapefile of our study area's census tracts³⁸. We spatially joined this census tract-level data to the PPOS shapefile, assigning the corresponding tract number to PPOS material polygons.

Land surface temperature downscaling

To measure Land Surface Temperature (LST) in Los Angeles County's PPOS, remotely sensed data from ECOSTRESS was downloaded, in its native 70 m spatial resolution, from the USGS LP-DAAC using the AppEEARS tool⁴³ for every summertime period (June 1st to September 30th) from 2021 to 2024 and filtered to the period between 10 A.M. and 4 P.M. Pacific Daylight Time (PDT). Characterizing interannual summertime LST conditions, a mean LST aggregate was created utilizing all clear-sky, quality overpasses available within the period. Although ECOSTRESS LST provides high-resolution spatial imagery, our analysis, at the intra-PPOS material boundary level, requires finer-scale LST data to identify material-specific LST differences. Utilizing fine-scale Sentinel-2 reflectance imagery, our ECOSTRESS LST aggregate was downscaled from its native 70 m spatial resolution to 10 m⁴⁴. We implemented an LST downscaling approach through a machine-learning pyDMS model, which utilizes an ensemble of regression trees^{31,32}. By coarsening the high resolution reflectance image from 10 m up to 70 m, these regression trees are built by learning the ratio and relationship between reflectance and LST. This relationship rule is then applied back to the 10 m resolution reflectance image, generating the downscaled LST data at this 10 m resolution. As this relationship is materially dependent, it is imperative to limit dramatic land cover shifts within the training area. For example, training over an area that is half wildland, mountainous land cover (i.e., the Santa Monica Mountain Range) and heavily urban land cover (i.e., urban SLA) would reduce the accuracy of this relationship. Therefore, to decrease training error from the excess mixing of surface material types, this downscaling process was conducted in parts. This approach ensured that the LST-reflectance relationship was learned using relatively homogeneous landcover types, thereby improving downscaling accuracy. The entire study area was divided into a 3 km² grid, and the downscaling process occurred within each individual cell. The resulting downscaled LST tiffs were then mosaiced together. Additionally, this downscaled mean summertime LST aggregate was clipped to the PPOS surface material boundaries shapefile. Within each surface material polygon, the mean LST of the clipped pixels was calculated, to characterize the interannual mean LST. Additionally, a comparison urban area LST raster was created by extracting all pixels from the unclipped LST aggregate not masked by the PPOS LST raster.

Characterizing PPOS accessibility

Relative PPOS accessibility across SLA and WLA's census tracts was evaluated through two main indicators- first, the proportion of each tract that falls within a 0.25 mile walking distance of a PPOS site, and second, available park area per 1000 residents. First, representing proximity, a 0.25-mile (402-meter) park buffer was generated around each PPOS site using the Geopandas package⁴⁵. These buffers were merged to prevent double-counting and then intersected with the tract shapefile to calculate the area and derived proportion of each tract that fell within the 0.25-mile PPOS buffer. This 0.25-mile accessibility threshold, previously applied in evaluations of park accessibility within Los Angeles County, reflects a reasonable walking distance for residents of our study area⁴⁴. Second, representing access to PPOS resources by population density, each PPOS polygon was intersected with tract boundaries to calculate the total accessible park area within each tract. Utilizing the total population of each tract, the hectares of park per 1,000 residents were calculated.

Through various geospatial packages in Python^{38,45-48}, these indicators were combined with sociodemographic variables, including derived tract-

level racial percents, poverty percents, and the classification of a tract's MHI according to the US Housing and Urban Development's median family income levels for Los Angeles County in 2025^{49,50}. Using the mean summertime LST aggregate, the mean LST of each census tract was calculated through the QGIS zonal statistics tool⁵¹. Characterizing our study area, descriptive statistics of SLA's and WLA's racial composition, MHI, and mean LST were calculated. These variables were then mapped within ArcGIS Pro and analyzed for spatial patterns⁵². Additionally, all maps of the region's and PPOS LST were generated and visualized in QGIS³⁸.

Spearman Rank-Order Correlations tested the relationships between tract's PPOS accessibility measures (by proximity and area per capita), racial composition percents, MHI, percent poverty, and mean LST⁵³. Additionally, an ANOVA and subsequent post-hoc Tukey's HSD comparison were used to test how the two accessibility measures differed across income groups⁵³. However, as golf courses can be considered financially barriered spaces, and WLA has large open spaces adjacent to communities, rather than directly within them, we repeated this analysis after removing golf courses and then large open spaces.

Determining surface material composition of PPOS

To examine regional differences in park surface composition, we used the previously delineated polygons for each surface material to calculate total PPOS area per region. We then we summed the area of each material type by region and applied a Chi-squared test⁵³ to evaluate whether the distribution of materials differed significantly between SLA and WLA. Finally, we normalized material areas as proportions of total PPOS within each region and conducted a Z-test⁵³ to determine whether the relative composition of heat-retaining vs heat-mitigating materials varied significantly.

Analyzing temperature disparities

To establish a SUHI differential between PPOS and the surrounding non-PPOS or urban areas, a t-test was first performed on the PPOS LST aggregate and then we created a comparison urban LST aggregate undifferentiated by region⁵³. To quantify regional effects and differences in PPOS temperatures, these comparison LST aggregates were clipped to the SLA and WLA regions, respectively, and the t-tests were reperformed regionally.

Analyzing LST differences at the surface material-level, a two-way ANOVA and subsequent Tukey's HSD tests⁵⁴ were run utilizing the calculated mean LST, from zonal statistics, for each surface material type differentiated by region. Additionally, to assess spatial structure in LST, we evaluated spatial dependence using Global Moran's I⁴⁸. As surface temperatures often exhibit spatial clustering due underlying urban landscape heterogeneity, Moran's I was used as a diagnostic of LST spatial clustering and potential non-independence among observations. Positive Moran's I values indicate spatial clustering of similar temperatures, near zero values indicate randomness, and negative values indicate temperature. This analysis sought to determine if (1) the distribution of surface materials has a significant effect on PPOS LST, and (2) if there are significant differences in the LST of individual surface material types by region.

All figures for this section and the former were generated through various python packages³⁵⁻⁵⁷.

Results

PPOS accessibility

The Spearman correlation analysis revealed strong and systematic associations between tract's LST, PPOS access, and sociodemographic characteristics across both regions. Foremost, increased accessibility to PPOS, through proximity and hectares of PPOS available per 1000 residents, had a significant cooling effect on a tract's mean LST. The heightened availability of PPOS area was inversely correlated to LST, with tracts containing more PPOS area per 1000 residents exhibiting significantly lower temperatures ($\rho = -0.426, p < 0.001$). A weaker but significant cooling effect was observed for PPOS proximity ($\rho = -0.161, p < 0.001$). However, indicators of park accessibility and, therefore, this cooling effect were not equally distributed across socioeconomic groups.

Table 1 | The regions of South Los Angeles (SLA) and West Los Angeles (WLA) have markedly different racial and economic population distributions, which are associated with significant differences in proximity to parks and park area available per 1000 residents

	Hispanic (%)	African American (%)	White (%)	AAPI (%)	MHI	Area of Tract Within 0.25 miles of PPOS (%)	Hectares of PPOS per 1000 Residents
West Los Angeles	15.8%	9.2%	57.2%	12.7%	94,123	82.2	117.1
South Los Angeles	64.4%	27.1%	4.1%	2.7%	55,672	81.3	9.1

SLA is majority Hispanic and African American, with an average of 9.1 hectares of park area per 1000 residents, compared to WLA, which is majority White with an average of 116.1 hectares of park available per 1000 residents.

First, characterizing access across racial groups, Hispanic population representation was negatively correlated with proximity to PPOS ($\rho = -0.227, p < 0.001$) and PPOS area per 1,000 residents ($\rho = -0.440, p < 0.001$), while White population representation was positively correlated with PPOS area per 1,000 residents ($\rho = 0.227, p < 0.001$), PPOS proximity was weakly, positively correlated but insignificant ($\rho = 0.042, p = 0.28$). African American population representation was positively correlated with PPOS proximity ($\rho = 0.389, p < 0.001$) and PPOS area per 1,000 residents ($\rho = 0.380, p < 0.001$), and AAPI population representation was weakly positively correlated with PPOS proximity ($\rho = 0.047, p = 0.234$) and PPOS area per 1,000 residents ($\rho = 0.108, p = 0.006$). Similarly to PPOS access, LST was also significantly differed across racial groups. Higher representation of White and AAPI populations showed strong positive correlations to lower LST ($\rho = -0.878, p < 0.001; \rho = -0.623, p < 0.001$), while higher representation of Hispanic and African American populations showed strong positive correlations to higher LST ($\rho = 0.693, p < 0.001; \rho = 0.243, p < 0.001$). It is important to note that although African American population representation was positively correlated with PPOS access, they were conversely positively correlated with higher LST, perhaps signaling disparities in PPOS quality and cooling efficacy within African American communities.

Second, characterizing access across income groups, tract's MHI was significantly, positively correlated with PPOS area per 1000 residents ($\rho = 0.316, p < 0.001$), and weakly positively correlated with proximity to PPOS ($\rho = 0.119, p = 0.002$), while percent poverty was negatively correlated with proximity to PPOS ($\rho = -0.223, p < 0.001$) and PPOS area per 1,000 residents ($\rho = -0.454, p < 0.001$) (Supplementary Table 1).

Furthermore, the ANOVA and subsequent post-hoc Tukey's HSD test revealed significant differences in park accessibility across HUD-defined income groups for Los Angeles County ($F = 24.837, p < 0.001$). Extremely Low-Income and Very Low-Income tracts showed significantly lower PPOS area per 1000 residents (1.5 ha/1000 person; 3.8 ha/1000 person) and reduced PPOS proximity (80%; 78% tract area within 0.25 miles of PPOS), compared to Low-Income tracts (21.9 ha/1000 person; 88% tract area within 0.25 miles of PPOS). Above Low-Income tracts had slightly reduced PPOS proximity (75%) and area per 1000 residents (12.5 ha/1000 person) compared to Low-Income tracts; however, PPOS area per capita was markedly higher than Extremely and Very Low-Income tracts (Supplementary Table 2).

Within each region, SLA is composed primarily of Hispanic, lower-income communities, while WLA is composed primarily of White, comparably higher-income communities (Table 1, Fig. 1). It is worth emphasizing that these population distributions are no mere coincidence, but rather, the result of historical development and housing policies that shaped urban racial segregation^{17,58,59} and racial disparities in socioeconomic status⁶⁰⁻⁶². In turn, these racial and income distributions shape accessibility to PPOS, both in terms of proximity and area per 1000 residents. Disparities in PPOS area per 1000 residents were more pronounced across racial and economic groups. Furthermore, the PPOS area per 1000 residents had a stronger correlation with reduced LST, indicating that this cooling effect is inequitably distributed across the study region (Fig. 1).

WLA had extensive natural areas in Topanga State Park and the Santa Monica Mountains, the latter of which was represented in our study area by Westridge Canyonback Park and L.A. Sanitation's Open Space. While state parks represent UHI refuge and heat mitigation land cover, they also occupy a disproportionately large area in the analysis. Additionally, golf courses may present access limitations. Therefore, we performed an additional analysis removing them and, respectively, found no effect on the significance or direction of these relationships.

Surface material composition. Irrespective of surface material type, WLA had significantly more total PPOS area available than SLA, as WLA had 75.54 km² compared to SLA's 4.85 km² of recreational space ($p < 0.01$). This equated to 28.80% and 3.67%, respectively, of the total area of each region. As divided by surface material, the difference in total area of natural turf was statistically significant ($p < 0.01$) with WLA

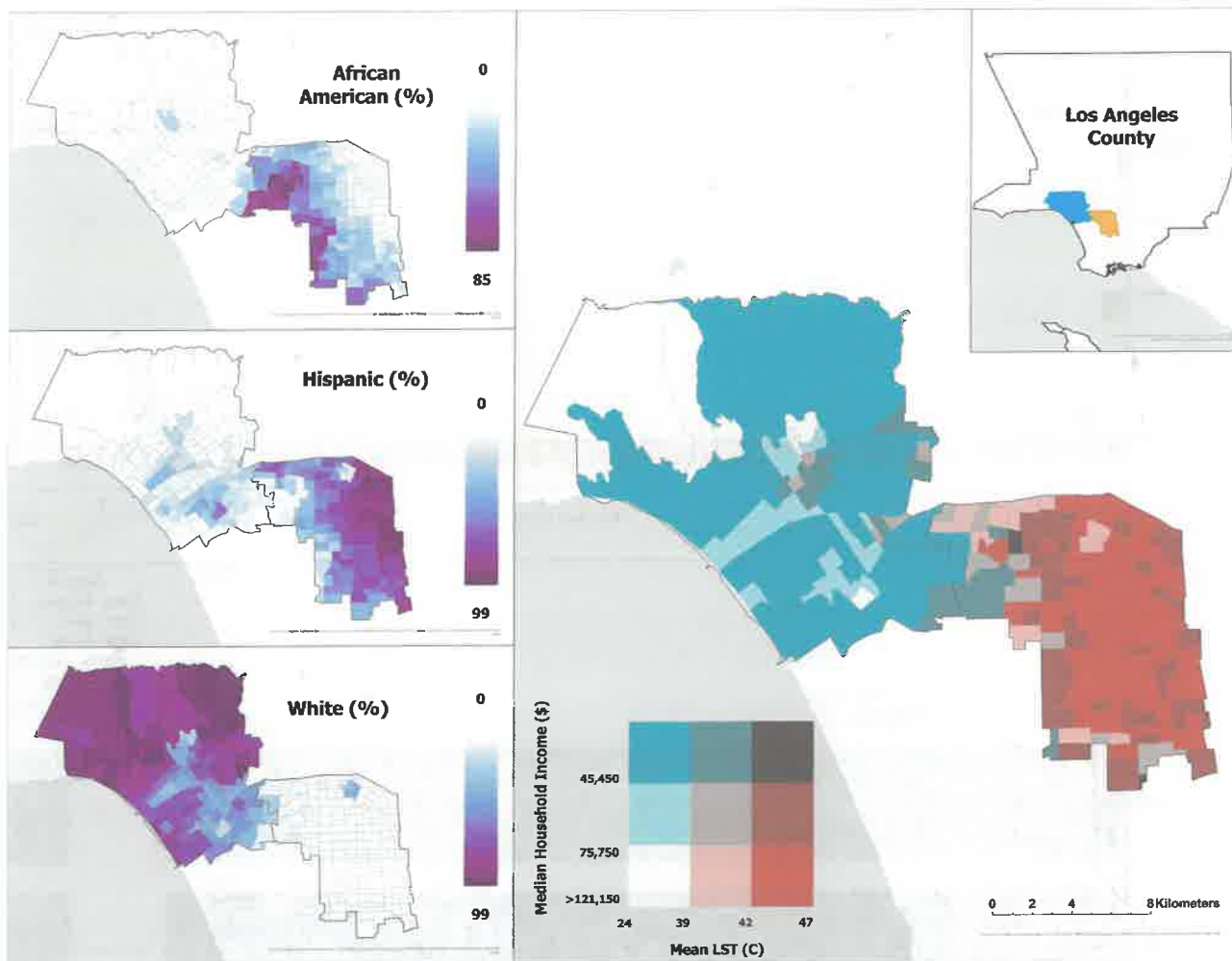


Fig. 1 | Within SLA and WLA, there is a clear visual correlation between census tract’s racial makeup and Median Household Income (MHI) and the distribution of average Land Surface Temperature (LST). On the left, top to bottom, is the distribution of percent African American, Hispanic, and White within tracts. On the

right, the distribution of MHI by established California poverty thresholds for Los Angeles in 2025^{49,50} and mean interannual summer daytime LST (2021–2024, 10:00 AM to 4:00 PM PDT).

containing 21 times that of SLA (Fig. 2A). According to a two-way Z-Test, when normalized by the total PPOS area of each region, SLA held a significantly greater proportion ($p < 0.01$) of artificial turf, concrete, rubber, and woodchips, whereas WLA had a significantly greater proportion of natural turf and sand ($p < 0.01$) (Table 2, Fig. 2B). As such, SLA PPOS contained a greater proportion of heat-retaining materials than PPOS in WLA. Within both regions, natural turf represented the largest proportion of PPOS surface material. However, there was a significant disparity in these proportions as WLA’s PPOS were 97% natural turf versus SLA’s PPOS were 71% natural turf.

These results remain consistent and significant when removing golf courses from both regions and when removing large open spaces from WLA ($p < 0.01$). Furthermore, even when removing WLA’s three largest open spaces (Topanga State Park, L.A. Sanitation Open Space, and Westridge Canyonback Park) consisting of over 25 km² of natural turf, WLA still has 7 times more natural turf available than SLA. Our results previously characterize strong inequity in park accessibility between the regions, both in proximity and available area per 1000 residents, due to their socioeconomic and demographic makeup. However, it is perhaps more important to note, that not only are parks less accessible within primarily Hispanic, low-income areas, representing large segments of SLA, the PPOS sites that are available are of much lower material surface quality. Containing significantly higher proportions of heat-retaining materials and significantly lower proportions of natural turf, as compared to WLA, residents in SLA

experience the double burden of decreased access to and lower material quality of PPOS.

Temperature disparities. Mean mid-day summertime LST, as captured by ECOSTRESS, showed significantly hotter LST across SLA than WLA ($p < 0.01$) (Supplementary Fig. 1). Across both WLA and SLA, PPOS areas were significantly cooler than non-PPOS areas ($p < 0.01$), with PPOS areas and non-PPOS areas having a mean LST of 33.5 °C and 38.3 °C, respectively. However, this LST difference was smaller in SLA with a mean LST difference of 1.6 °C versus WLA’s 2.3 °C. Additionally, temperatures measured within SLA PPOS were significantly hotter than WLA PPOS, with mean temperatures of 41.0 °C and 33.1 °C, respectively ($p < 0.01$) (Supplementary Fig. 2).

WLA was approximately 10 °C cooler than the coolest space in SLA, while the hottest space in WLA was 4 °C cooler than SLA’s hottest site (Fig. 3). In both regions, the coolest PPOS were composed entirely of natural turf. The hottest spaces were a mixture of materials, composed of artificial materials such as concrete and artificial turf (Fig. 3).

Many PPOS in SLA averaged 1 °C below the first-degree burn surface temperature threshold, (47.7 °C; 118 °F)⁶³; no PPOS in WLA were near or surpassed this threshold with the hottest PPOS site in WLA reaching 42.6 °C; 109 °F. Moreover, the adult perception of pain occurs at 43 °C⁶⁴. Within SLA, 123 unique PPOS sites surpassed this pain threshold, with 82 sites being schools, while no site in WLA reached this

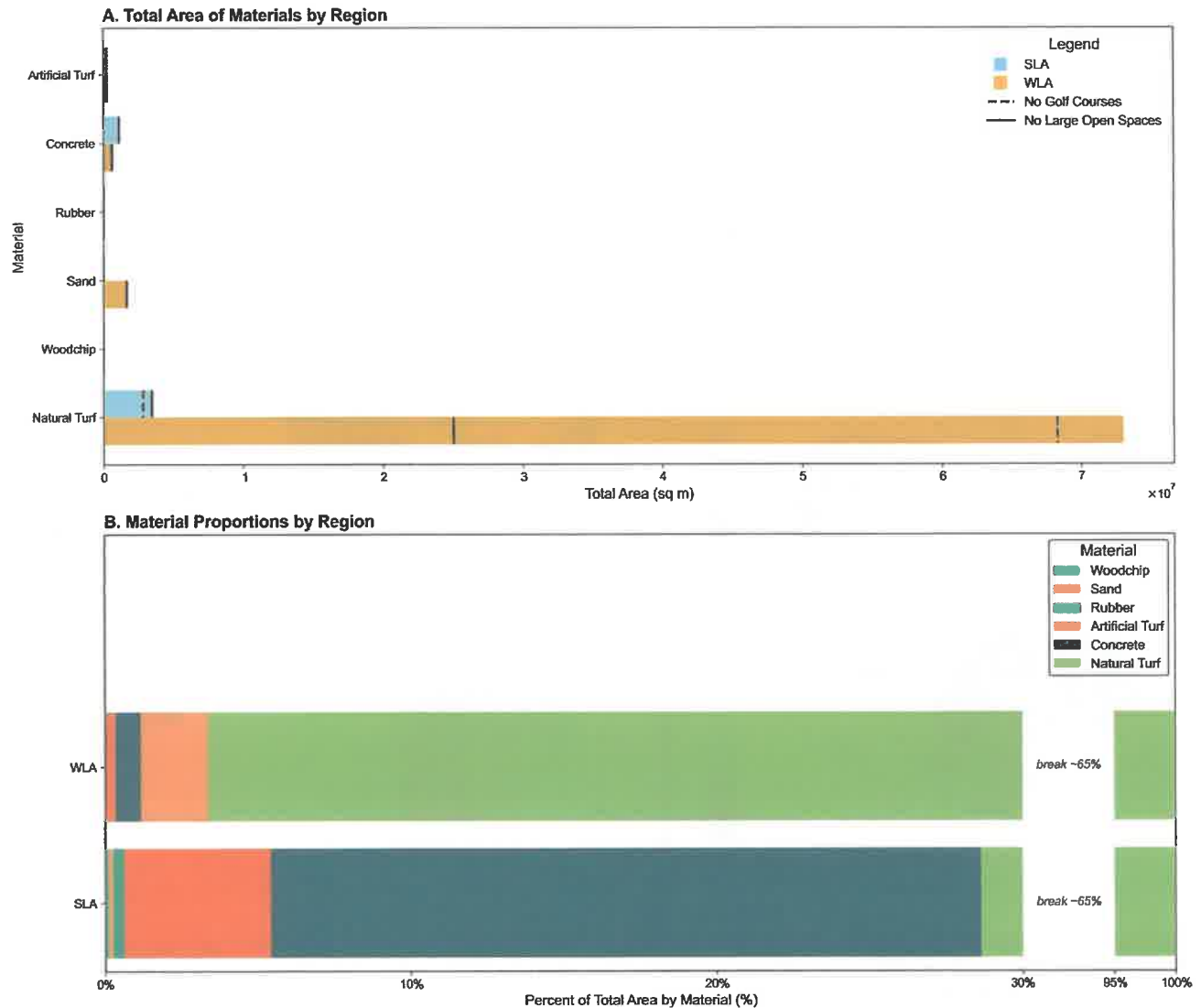


Fig. 2 | PPOS in South and West Los Angeles differ significantly in the total area of recreational space, type of material used, and the proportion of total area covered by each material type. A Area in meters squared covered by each material type, of which the most notable disparity is WLA’s dominant availability of natural turf (m² 10×7). This analysis was performed by removing golf courses and extensive open spaces, the total area for each material without these spaces are indicated by the dotted lines and solid lines respectively. B Proportion of total recreational area

covered by differing types of materials by region. South Los Angeles has a notable higher proportion of artificial and heat-retaining materials (e.g., artificial turf, concrete, rubber). Within both regions, natural turf is the dominant material, however, WLA has a significantly higher proportion ($p < 0.01$) of natural turf composing 97% of the region’s PPOS compared to SLA’s 71%. (A break in the proportion graph was added for visual clarity representing the dominance of natural turf).

Table 2 | Comparing the proportion of total recreational area covered by differing types of materials, SLA has significantly higher proportions of artificial and heat-retaining materials (e.g., artificial turf, concrete, and rubber) as compared to WLA which has significantly higher proportions of natural materials (e.g., sand, natural turf) ($p < 0.01$)

	Artificial Turf	Concrete	Natural Turf	Rubber	Sand	Woodchip
West Los Angeles	0.32%	0.82%	96.59%	.02%	2.21%	.00%
South Los Angeles	4.79%	23.19%	71.39%	0.35%	0.15%	0.12%

The most notable disparity is SLA PPOS sites are 23% composed of concrete in comparison to less than 1% of WLA PPOS sites composed of concrete. Across, both regions natural turf is the dominant surface material type, however, SLA has significantly higher rates of heat-retaining materials.

threshold. This amounted to 36% of all PPOS sites within SLA with a mean LST that meets the thermal burn pain threshold. It is important to note, as these temperatures represent the interannual mean summertime LST, PPOS sites within SLA likely far surpass these thresholds on heatwave days.

Based on our ANOVA analysis, the distribution of surface materials had a statistically significant effect ($p < 0.01$) on surface temperatures within PPOS. Each material type, excluding woodchips (i.e., artificial turf, pavement, natural turf, rubber, and sand), reached significantly hotter temperatures ($p < 0.01$) in SLA than in WLA (Fig. 4). Of the three main surface

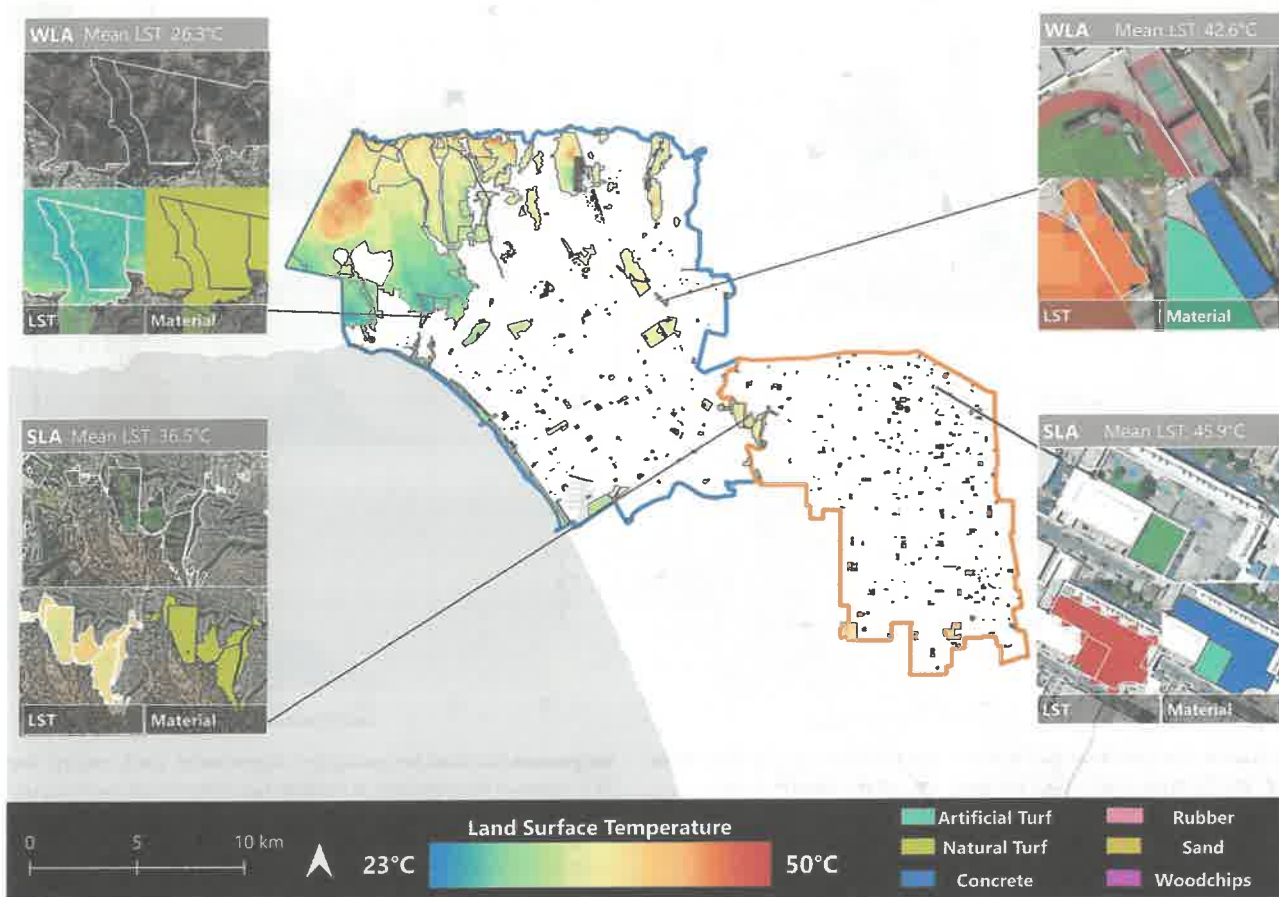


Fig. 3 | Disparities between SLA’s and WLA’s recreational sites’ size and surface temperatures are significant and visually apparent. Right insets show the hottest (WLA: Beverly Hills High School, SLA: Dolores Huerta Elementary School) and left insets show the coolest (WLA: Temescal Gateway Park, SLA: Kenneth Hann State Recreation Park) recreational sites in each region, with material composition for

comparison to surface temperature. The coolest site in WLA is approximately 10 °C than the coolest site in SLA. It is important to note that the coolest spaces in both regions are large open spaces consisting of natural turf, while the hottest spaces in both regions are recreational spaces at schools consisting of artificial materials (concrete and artificial turf).

material types shown in Fig. 4, mean LST of materials in SLA was significantly higher ($p < 0.01$) than in WLA, respectively 42.4 ± 1.4 °C and 33.6 ± 2.8 °C for natural turf, 42.9 ± 1.2 °C and 36.3 ± 2.9 °C for concrete, and 43.5 ± 1.7 °C and 37.5 ± 3.2 °C for artificial turf. Natural turf had the largest LST difference, with natural turf in SLA having a significantly higher mean temperature by 8.8 °C than WLA. Despite having significantly higher temperatures than natural materials in both regions ($p < 0.01$), concrete and artificial turf approached the first-degree burn threshold in SLA only, with multiple PPOS sites averaging temperatures of 46 °C (Fig. 4). Additionally, both the ANOVA and subsequent Bonferroni Post-HOC analysis were performed based on two scenarios in addition to the default containing all PPOS types: first, with the three largest open spaces from WLA removed, and second, with golf courses removed. The distribution of surface materials had a significant impact on surface temperatures in PPOS ($p < 0.01$) and surface temperatures for all materials in SLA were significantly higher than surface temperatures in WLA ($p < 0.01$).

Global Moran’s I indicated extremely strong positive spatial autocorrelation in LST values ($I = 0.98$, $p < 0.001$), with high- and low-temperature values clustering spatially across the region. This finding demonstrates strong spatial structure in LST but does not indicate the drivers of these patterns. Material-related differences in LST are supported by ANOVA results, while Moran’s I analysis highlights the presence of spatial clustering. Because Moran’s I was calculated on observed LST values rather than model residuals, spatial dependence was not explicitly modeled and should be considered when interpreting statistical significance.

Although PPOS within each region showed a cooling effect, SLA PPOS exhibit markedly lower cooling efficacy due to their material composition. These spaces that should serve as refuges from SUHI effects instead present immense thermal hazards, in the form of thermal burns and extreme heat exposure, to residents utilizing these spaces within SLA. Consequently, inequities in the surface material quality of PPOS directly contribute to thermal inequities within PPOS and between the overall regional LST of SLA and WLA.

Discussion

Our findings reveal intersecting dimensions of thermal inequity in Los Angeles County’s PPOS that encompass structural and material determinants of heat exposure, which are associated with vastly different LST exposures based on PPOS composition. While PPOS are commonly associated with greenspaces that provide cooling effects, this study revealed significant variability in the distribution of surface materials and relative LST levels within WLA and SLA PPOS, reflecting systematic patterns of environmental injustice. Specifically, we document three inter-related forms of thermal inequity. Underserved communities of color such as SLA (1) face unequal spatial access to PPOS, (2) experience having a greater composition of heat-retaining materials within PPOS, and (3) endure significantly higher temperatures across all material types, even when controlling for surface composition. The community would directly and immediately benefit—both in health⁶⁵ and productivity⁶⁶⁻⁶⁸—from increased greenspace and cooling infrastructure that appeal to community interests.

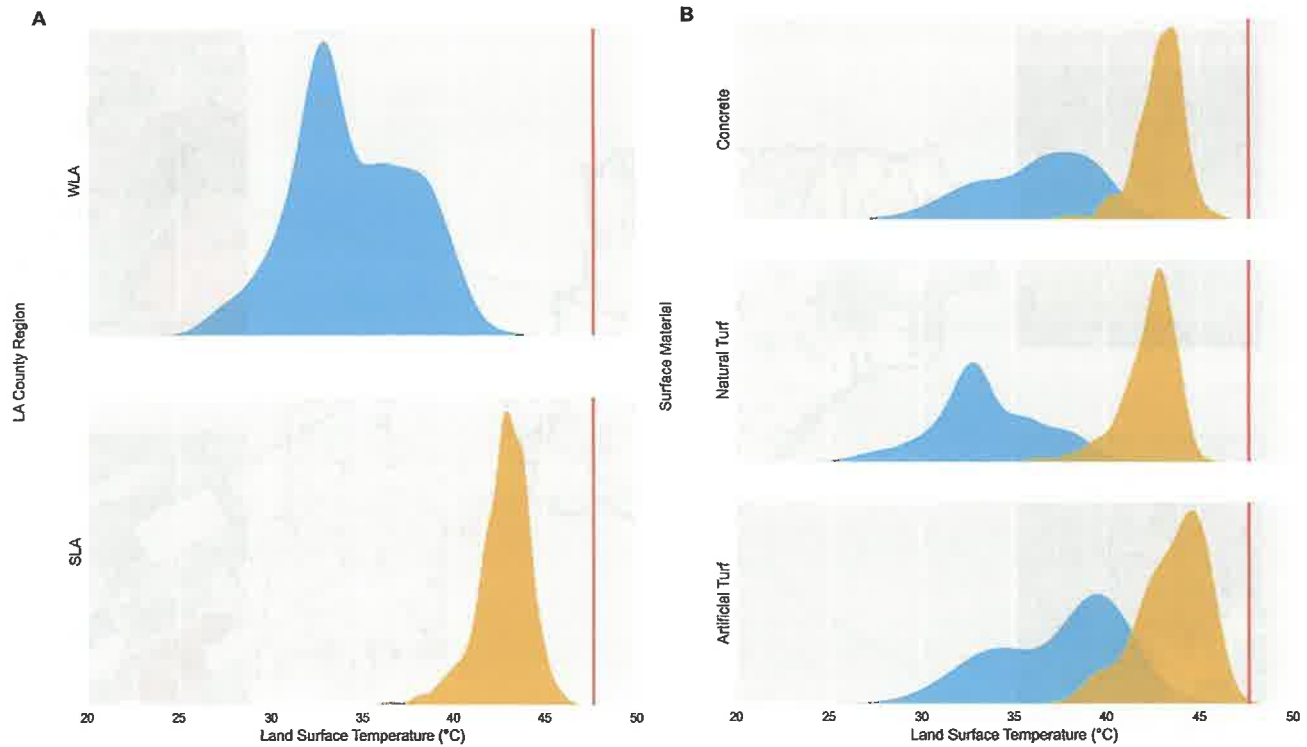


Fig. 4 | Across all recreational spaces, as well as recreational spaces of the same surface material type, land surface temperatures are significantly higher ($p < 0.01$) in South Los Angeles than in West Los Angeles. Additionally land surface temperatures in PPOS are significantly lower ($p < 0.01$) in comparison to non-PPOS surrounding areas. Red vertical line indicates 47.7 °C, the surface

temperature threshold for causing first-degree burns, which multiple sites within SLA approach this threshold. A Land Surface Temperature across all recreational spaces within West Los Angeles and South Los Angeles, undifferentiated by surface material type. B Land Surface Temperature across the three primary surface material types for recreational spaces (concrete, natural turf, and artificial turf).

Within numerous studies, PPOS have been shown to significantly decrease the UHI effect within dense urban areas^{8,69-71}. However, this effect is mainly due to the increased presence of vegetation and greenery within these areas. In comparison to typical urban materials (i.e., concrete, rubber, artificial turf, rubber etc.), vegetation exhibits the “Oasis Effect” caused by evapotranspiration from vegetation, which cools the surrounding air⁷¹. Additionally, increased urban tree canopy within PPOS provide substantial shade reducing SUHI within PPOS⁷². This cooling effect within PPOS often corresponds to a reduction in surrounding urban temperature and provides a refuge for community members to escape heat⁵¹. However, as found in this study, great disparities in the distribution of surface materials of PPOS exist within Los Angeles County. Compared to WLA, SLA has a much greater concentration of heat-retaining materials within PPOS. WLA’s PPOS are primarily composed of natural turf, which supports the oasis effect and critical ecosystem services. In contrast, SLA’s PPOS were composed of concrete and artificial turf at much larger proportions, both of which are heat-absorbent materials. These heat-retaining materials have led to increased temperatures within SLA PPOS compared to WLA, decreasing the efficacy of PPOS in providing a cooling effect to SLA residents. While PPOS should serve as refuges from the substantial SUHI effect within SLA, they are wholly unable to provide this essential cooling effect due to their material composition.

While PPOS should be serving as a community resource, particularly within the already LST-burdened areas of SLA, their inability to fulfill this essential cooling effect has immense implications for public health. This persistent exposure to higher temperatures in underserved communities of color puts residents, particularly those with diminished thermoregulatory capacities, such as the elderly⁷³, youth, and those with preexisting medical conditions, at a higher risk of heat-related health disparities⁷⁴. For example, inequitable urban heat and heat-mitigating infrastructure in SLA may exacerbate extant chronic disease disparities, such as asthma⁷⁵ and cardiovascular disease, due to higher levels of heat stress⁷⁶. Given that 36% of SLA

PPOS exceeded the thermal burn pain threshold during average summer conditions, residents face chronic heat stress and acute injury risk during normal park use. This hazard is absent in WLA parks. Thus, in the SLA context, these health impacts will only be exacerbated by the increasing probability of heatwaves within Southern California, with an increase of 42% in frequency and 26% in duration⁷⁷. As urban heat increases, the material quality of these PPOS does not provide adequate or equitable infrastructural resources for SLA communities to cope with extreme heat exposure.

Furthermore, the reduced material quality of SLA PPOS is already associated with resident disuse and avoidance. Residents within this area already tend to avoid parks due to the lack of maintenance, inadequate facilities, and the lack of shade-infrastructure, impacting their perceived comfort and relative safety while utilizing these spaces^{78,79}. Additionally, SLA and other underserved communities of Southern California already face disparities in access to alternative cooling infrastructure, such as air conditioning³⁰. While we acknowledge that higher LST of SLA PPOS may not accurately reflect residents’ heat exposure, due to existing and evolving avoidant behaviors, this thermal inequity compounds existing community vulnerabilities by further reducing the resources available to cope with extreme heat. Furthermore, the dangerously high LST within a disproportionate share of SLA PPOS may represent an environmental disamenity or hazard rather than a potential community resource. As heatwaves continue to rise in frequency and intensity, this thermal inequity in Los Angeles County’s PPOS represents a major environmental injustice that compounds existing community vulnerabilities and impacts on public health.

To assess the relationship between PPOS quality and resident use, community consultation⁸¹ will be essential in developing PPOS and broader built and natural environments that support the health and well-being of underserved communities^{65,66}. Additionally, in agreement with our results, previous studies utilizing ECOSTRESS have characterized a significant negative relationship between LST and median income, creating heat hazard

disparities across income groups in Los Angeles County^{4,82}. These income disparities are the result of historic and contemporary inequities within the region⁸³. To address these thermal inequities in SLA, it is insufficient simply to increase the number of PPOS within the region, without considering the distribution of surface materials in existing and proposed PPOS. Increasing vegetation and greenspace within current and planned SLA PPOS will be essential in addressing thermal inequities and the substantial SUHI effect within SLA.

Furthermore, the higher concentration of and proximity to artificial and heat-retaining materials in SLA PPOS may reduce the cooling efficacy of the natural materials that are present. Regardless of geography, the surface temperatures of identical materials should maintain similar temperatures in the same atmospheric conditions. However, other factors could influence surface temperatures. Additional factors not included in this study—e.g., vegetation cover, nearby shade-producing architecture, watering schedules and subsequent vegetation health, and varying forms of pavement (i.e., concrete, asphalt, cement)—may also influence temperature and would be valuable areas of further study to identify beneficial cooling infrastructure. Regardless, there still exist significant differences in the LST of PPOS between WLA and SLA. However, although the region's topography and proximity to the ocean create unique microclimates, differences in greenspace and vegetation cover are the most significant factors explaining LST variations in Los Angeles County⁸². Furthermore, analyzing the east-west longitudinal distribution of LST along the 105 Freeway, that runs through and directly parallel to the longitudinal extent of our study area from the coast through central Los Angeles, there were no clear gradients in LST from WLA to SLA. This further confirms that surface material LST variations are not a result of regional microclimates within our study area.

We acknowledge some limitations to our study. Our analysis incorporates the novel use of thermal downscaling of ECOSTRESS LST from 70 m to 10 m, utilizing a pyDMS model^{31,32}. It is important to note that thermally downscaled data is not directly produced by one sensor but is the product of, in this case, remotely sensed ECOSTRESS LST data and Sentinel-2 VSWIR data^{43,44}. Although these are not ground-truth values, utilizing downscaled ECOSTRESS LST to 10 m provides an important representation of SUHI behavior and characteristics at the material-level for these small PPOS sites. Additionally, thermal downscaling is a popularly emerging field within urban heat analyses due to its ability to address high heterogeneity in urban surfaces^{2,33,34}.

Furthermore, our accessibility analysis found that African American population shares were positively correlated with PPOS access by proximity and area per 1000 residents, which contrasts with widely established patterns on racial disparities in park access. However, this analysis also showed that African American population shares were associated with higher LST, contradicting the well-known cooling effect linked to greater PPOS access. This paradoxical relationship suggests that proximity to PPOS does not necessarily provide thermal benefits. Instead, park quality—particularly regarding material composition and cooling effectiveness—may be a more important determinant of community thermal resilience than access alone.

Through our findings, we show that thermal inequities within urban areas are not solely the result of UHI effects, but rather, an outcome of demographic segregation, economic stratification, and differential distribution of heat-mitigating infrastructure. The material composition of PPOS represents an understudied dimension of thermal inequities. Our analysis highlights that communities facing the highest baseline of heat exposure, are often lacking critical cooling infrastructure. Furthermore, these outcomes reflect patterns of disinvestment in marginalized communities where PPOS have become potential hazards. Critically, material composition serves as a visible marker of broader patterns of neighborhood-level infrastructure quality, maintenance, and investment that systematically marginalize communities such as SLA.

Our findings, enabled by remote sensing data and satellite imagery resources, such as ECOSTRESS, demonstrate how these tools can advance environmental justice by revealing the relationship between material

infrastructure and public health outcomes in underserved communities¹⁹. Our results reveal that SLA residents suffer a double burden of inequitable (1) access to PPOS and (2) presence of heat-retaining materials within local PPOS, associated with significantly hotter temperatures within these spaces. These inequities not only cause discomfort but compromise the health and well-being of residents. Chronic high temperature hazards within SLA have the potential to increase the rate of heat-related health issues, such as heat stroke⁸⁴ and stress, and worsen extant health disparities^{85,86}.

Importantly, while both WLA and SLA recreational spaces remain cooler than their respective surrounding urban areas overall, the cooling effect of these spaces is less efficient in SLA than WLA, likely due to the region's higher concentration of heat-retaining materials, lowering its material quality. Overall, our findings have valuable implications for policies regarding urban planning and the future development of recreational spaces in underserved communities. In closing, addressing the double jeopardy of thermal inequities requires increasing access to PPOS and fundamentally transforming the material infrastructure of existing parks in underserved communities. As climate change intensifies urban heat exposure, ensuring equitable access to effective, nature-based cooling infrastructure is imperative for achieving environmental justice and health equity.

Data availability

ECOSTRESS Land Surface Temperature data is available at <https://appears.earthdatacloud.nasa.gov/>. Sentinel-2 reflectance data is available at <https://www.sentinel-hub.com/develop/api/>. Los Angeles Public Parks and Open Spaces boundaries area available from L.A. County Department of Parks and Recreation at <https://geohub.lacity.org/datasets/labos::open-spaces-and-parks-los-angeles-county/about>. Maxar and in-situ street-level photographs are available through Google Earth. Sociodemographic variables utilized are available through Calenviroscreen 4.0 at <https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-40>. The pyDMS based downscaling approach is available at <https://github.com/ECOSTRESS-Tutorials/ECOSTRESS-Sharpener-Tutorial>, and the original pyDMS documentation is available through <https://www.mdpi.com/2072-4292/4/11/3287>.

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Author contributions

A.A., J.F., J.D., and J.C.R.M. wrote the main manuscript text. A.A. Created all main figures, and completed the major analyses. R.A. and K.T. helped design the study question and methodology. A.R. and R.Z. provided integral community knowledge and facilitated connection with community members. All Authors reviewed manuscript

Competing interests

The authors declare no competing interests.

Additional information

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Correspondence and requests for materials should be addressed to Joshua B. Fisher.

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by Rob.
04/16/26.



**Reseda Park
requesting to change the boards!**

LA Rec and Parks Commission

Reseda, April 16, 2026

TO: Members LA Commission of Recreation and Parks.

From: All Basketball Players.

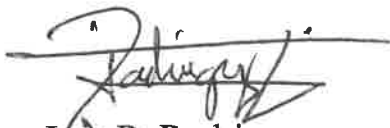
Subject: Request to change basketball boards.

Dears Members:

First of all, I would like to give “thank you” for the quick response to the renovation of the courts in Reseda Park. Looks great and everyone is so graceful.


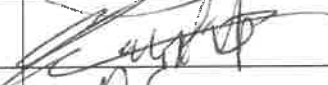


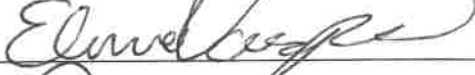
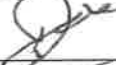



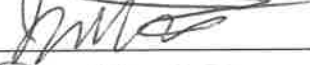

Now in this meeting we want to request to replace the basketball boards, after thirteen years ago they were installed and donated by LA Clippers. Today some are broken therefore must be changed, If possible for LA Lakers can contribute to this cause. It’s the desire of many of us, so our communities can support their teams.

Thank you!



Jose R. Rodriguez

NAME	LAST NAME	FIRMS
Nestor	Gonzalez	
Joel	Johansen	
David	Zavala	
Raul	Merino	
Joshua	Esmerjanda	Joshua Esmerjanda
GUAN	VILLAMARIN	
Jesus	Velazquez	
Robert	Inturiano	Robert
Muborie	Sumakthor	
Amir	CUL	
SHARIF	HUSSAIN	
Leo	Rosa	
Christ	Hern	
Aug	Ally	
Jake	Gonzalez	Jake Gonzalez
Shivam	Dharpur	
JASON	CONTRERAS	J.C.
Adam	AVENDANO	A.A.
ARVIN	NOPRADA	AU
Sheela Eastman	Eastman	
Jacob	ONSPOUGH	
Mark	Sarkissian	
EDGAR	AMIR	
Ben	De la Rosa	
Carlos	Sanchez	
Austin	VASQUEZ	
Michael	Jobson	
Joel	Esquivel	
Elijah	Dunston	
Joel	De la Rosa	
Isaac	SARAVIA	Isaac S.
Joel	BERNAL	
Rashid	Umer	
Makai	Pelpay	
Emmanuel	MORALES	

NAMES	FIRMS
Lucas Bashaar	Tom Tom
ALEKSANDR Goldberg	m r m
Genno Ines	Gen Ines
Bryan Campagno	
Enrique Alvarez	
Braylon Thompson	BT
Chris Koscek	
Bryan Onelio	Bryan
Nick Bezayo	
Elmer Vasquez	
Joe Johnson	
Gavriel Pinchas	Gavriel Pinchas
Fernando H. B.	F-H-B-
Marvale Washington	Marvale
Matthew Revels	Matthew
Lissa Coe	Lissa
Dayon Coulter	
Luis Duque	
Brandon Lam	
Justin Fitzsimmons	
Leonel ROSA	
Antwon Ellis	Antwon Ellis

