Smart Growth at UNC

Policy Recommendations to Mitigate the Urban Heat Island

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May 10, 2024

The Urban Heat Island (UHI) effect describes the phenomenon in which urban areas experience significantly higher temperatures compared to surrounding rural areas. This is primarily due to the concentrated presence of pavement, buildings, and other surfaces with low albedos that retain heat for longer periods. Conversely, parks and green spaces tend to have a cooling influence on their surroundings. The UHI has significant environmental and health implications, such as increased energy consumption, poor air quality, and increased heat-related illnesses. It is exacerbated both by climate change and human activities emitting greenhouse gasses (“Heat Islands”).

Within cities, there can be significant temperature variation between neighborhoods with more vegetation and less impermeable surfaces versus those lacking these features. Historical practices such as redlining and the "Not In My Backyard" (NIMBY) mindset have led to disinvestment in lower-income and minority neighborhoods, resulting in higher concentrations of highways, industrial zones, and other less desirable land uses. This lack of investment, coupled with increased polluting activities, contributes to these neighborhoods being hotter than greener parts of cities (“Heat Islands and Equity”).

The UHI effect can be observed on college campuses across the United States, including UNC-Chapel Hill (UNC), where historical developments have reduced the tree canopy that helps mitigate heat. future developments may impact the tree canopy that helps mitigate heat. This brief aims to illustrate the UHI effect's impact on UNC's campus and explore potential mitigation strategies. The UHI effect is particularly pronounced on campus due to the high density of buildings, impervious surfaces, and limited green spaces or tree coverage in many areas. High-traffic corridors without shade and intersections where cars frequently idle are among the locations experiencing the strongest UHI effect. This phenomenon affects student health, quality of life, and campus enjoyment, and leads to increased energy consumption and reduced air quality. Addressing this issue requires proactive sustainability measures and a focus on student well-being, while simultaneously addressing future campus development goals.

Analysis

The Sustainable Triangle Field Site of Spring 2024 conducted research on the heat index and tree canopy cover around campus, revealing a strong correlation between greater tree canopy cover and cooler temperatures. Areas closer to buildings, busy intersections, and with higher impervious surface cover showed higher temperatures and stronger UHI effects. Figure 1 illustrates temperature variations of over 15 degrees Fahrenheit across campus, consistent with existing literature that demonstrates that the UHI effect can cause temperature variations of 1–7°F and potentially up to 20°F hotter than surrounding areas. Temperatures around campus also depend greatly on the time of day and the position of the sun, as demonstrated in Figure 2. The temperatures at 2 pm and 5 pm are fairly similar, whereas the temperature at 9 pm is significantly cooler. However, the relative temperature differences between the daytime and nighttime temperatures varies considerably along the plotted transect. We hypothesize that this is because of variations in tree canopy, where areas with greater tree canopy retain less heat than areas of impervious cover. For example the Arboretum is significantly cooler than surrounding areas with less dense tree cover. Nonetheless, the temperature at 9 pm is still fairly high for the evening. Urban Heat Islands are especially dangerous because when temperatures remain high for extended periods, this prolongs heat stress on the body, limiting the body's ability to self-regulate and leading to health issues (Hubbart and Bradford, 2023).

Policy Options

As UNC continues to grow and evolve within its urban setting, the challenges posed by the Urban Heat Island (UHI) effect necessitate innovative and sustainable solutions. Urban areas like Chapel Hill experience elevated temperatures due to the concentration of buildings, roads, and infrastructure that absorb and trap heat, impacting the local climate and quality of life. To address this issue, UNC has the opportunity to implement strategic policies focused on green infrastructure, urban forests, and transportation that may potentially mitigate the UHI effect on campus. The proposed initiatives would also promote environmental stewardship, enhance campus aesthetics, and contribute to overall sustainability goals.

Policy options for UNC include the integration of green infrastructure to increase vegetation cover and reduce surface heat retention. Urban forests play a crucial role in cooling the campus environment by providing shade, reducing air temperatures, and enhancing biodiversity. Additionally, promoting sustainable transportation methods such as biking, walking, and public transit not only reduces vehicular emissions but also decreases the heat generated from transportation activities. By exploring these policy options, UNC can lead by example in fostering a cooler, greener, and more resilient campus environment that benefits both the university community and the wider Chapel Hill community.

Green Infrastructure

To address the challenges posed by the Urban Heat Island effect, green infrastructure has emerged as a promising solution, particularly within the context of college campuses. Green infrastructure encompasses a range of practices designed to incorporate natural elements into the built environment, mitigating the heat island effect and promoting ecological sustainability. Among these strategies, green roofs, energy-efficient buildings, sustainable pavement designs, and bioretention cells stand out as effective and practical measures that can be implemented on college campuses to combat rising temperatures and foster a more resilient urban environment.

The Sustainable Triangle Field Site cohort of Spring 2023 conducted research on green roofs and bioretetion areas, such as the Battle Grove regenerative stormwater feature. As demonstrated in Figure 1, Battle Grove is cooler than surrounding areas because it is heavily vegetated. It also provides additional co-benefits because it is designed to slow stormwater runoff and reduce the pollution and eutrophication in downstream areas (Berger, et. al. 2023). Green infrastructure provides a variety of benefits to the environment and the surrounding community.

Green Roofs

Green roofs are defined as roofs with vegetation planted on the top. As the campus continues to develop, more and more forested and green areas are covered by hard surfaces. Green roofs offer a cooling solution to mitigate the increase of heat that affects the hard, concrete surfaces on buildings. Given the University's aspirations to be a Sustainable campus, green roofs should be considered when designing new buildings on campus.

Scholarly articles find that green roofs offer critical thermal reduction to urbanized spaces (Shafique et al., 2018). Vegetation on roofs absorbs less solar radiation compared to concrete or other building materials and cools the surrounding ambient environment. This allows the outside environment to experience heat mitigation (around 0.8°C) and for buildings to remain cooler in extreme temperatures and prevents the building from high energy usage (Shafique et al., 2018). Research shows that green roofs can reduce both heating and cooling consumption by 5% and 16%, respectively (Shafique et al., 2018). By reducing energy usage, green roofs also mitigate pollution emitted from buildings during heating and cooling processes, thereby decreasing the excess heat in the surrounding urban environment. Yet, disadvantages are still present with green roofs. Studies show the initial costs and multi-seasonal design of green roofs remain challenges in implementing their use. In addition, finding the most optimal plant for roof locations alongside education on vegetation and building maintenance proves a hindrance to this option (The Benefits and Challenges, 2011).

Research shows green roofs are referred to as a long-term investment with short-term benefits (Shafique et al., 2018). The United States does not have a common cost for the installation of green roofs as costs vary by location, materials, green roof types, and labor needs. Research also suggests that vegetative roofs "are most effective in regions with higher than average electricity rates, multistory building stock, and climates that readily demonstrate reductions to heat islands with the introduction of green roofs." Our research concurs with the suggestion of analyzing initial costs, annualized cost-effectiveness (operating costs and savings), and total effectiveness (physical limitation; maximum green roof coverage) as described by Blackhurst et al. (2010).

Overall, green roofs provide a solution to cool both ambient and indoor temperatures which lowers the impact of the Urban Heat Island effect. Cooler temperatures reduce heat-related illnesses and mortality rates. The addition of green roofs on buildings also decreases heating and cooling energy usage which lessens ambient pollution that may harm sensitive health populations (The Benefits and Challenges, 2011). As UNC is an academic institution, it also serves as a renowned health facility that various communities utilize. This environmental innovation would have a campus-wide positive health impact and would be cost-effective in the long term.

It is important to point out that with nearly 730 acres and over 70 existing buildings (most of which are decades old), it may be difficult to retrofit existing buildings with green roofs. The University would need to assess the weight-bearing capacity of the building, accessibility for construction and maintenance, and analyze the need for an intensive or extensive type of roof (Nikola Miletić et al., 2023). Instead, adding cooling paint – such as white paint with TiO_2 - may be an option to retrofit existing buildings and provide cooling benefits on campus.

Energy Efficient Buildings

Mitigating the Urban Heat Island effect not only comes from exterior improvements but can be lessened by interior improvements as well. Energy-efficient building designs can decrease energy consumption and heat absorption by the built environment.

Energy-efficient buildings utilize less energy for heating, cooling, electricity, and other tasks while maximizing performance (Office of Energy Efficiency, n.d.) Energy-efficient buildings effectively mitigate the campus UHI effect because they rely on renewable energy tools or green infrastructure. These methods aid in lessening the burning of traditional fossil fuels that contribute to air pollution and climate change. Traditional energy emissions from fossil fuels and increased energy usage in hotter climates create a cycle of demand for cooling, exacerbating the Urban Heat Island effect. By implementing energy-efficient building designs and practices, campuses can break this vicious cycle, reducing both their carbon footprint and their contribution to local heat buildup. Additionally, energy-efficient buildings often incorporate features such as high-performance insulation, efficient HVAC systems, and smart controls, which not only reduce energy consumption but also enhance indoor comfort and occupant productivity (Pacific Northwest National Laboratory, 2021).

To achieve the most out of energy-efficient buildings, it is important to know the location of the building and applicable technologies for that specific building. Installing natural resource technologies such as solar panels or green and white roofs on buildings are two common courses of action that make buildings more energy efficient. However, these technologies, alongside the majority of green infrastructure, rely on the environment they are built in and the materials and design methods they are constructed with. In pre-planning, buildings must be designed with the intent to utilize green infrastructure which (depending on location), may have higher upfront costs due to the novelty of the technologies and capital investments (Epstein, 2019).

While there is ample discourse on the importance and potential benefits of retrofitting existing structures to improve energy efficiency, comprehensive studies specifically addressing the feasibility and challenges of such endeavors are limited. This gap may stem from the complexity and variability of retrofitting projects, which often require consideration of diverse factors such as building age, structural integrity, cost-effectiveness, and technological advancements. Additionally, the lack of standardized methodologies and comprehensive case studies documenting successful retrofitting initiatives contributes to the scarcity of literature on this topic. Addressing this gap is crucial to inform policymakers, architects, engineers, and stakeholders in making informed decisions regarding the retrofitting of buildings to enhance energy efficiency and sustainability. Future research efforts could fill this void by conducting feasibility assessments at specific locations. Furthermore, costs for retrofitting a building are dependent on the original characteristics of the building.

Permeable Pavement

Another heat-mitigating solution gaining traction is the adoption of permeable pavement systems within campus infrastructure. Permeable pavement, consisting of porous materials like open-pore pavers, concrete, or asphalt atop a stone reservoir, efficiently manages precipitation and runoff in urban areas. By capturing water and storing it in the reservoir, permeable pavement enables gradual infiltration into the soil or controlled discharge through drain tiles. Widely employed in parking lots, low-traffic roads, sidewalks, and driveways, permeable pavement serves as a sustainable solution for reducing stormwater runoff and replenishing groundwater (Upper Midwest Water Science Center, 2019).

Permeable pavements offer multifaceted benefits in urban stormwater management. They contribute to restoring natural hydrologic balance by trapping and gradually releasing precipitation, thus reducing runoff volume and peak discharge rates into stormwater systems. Additionally, permeable pavement acts as a natural filter, reducing pollutant concentrations through physical, chemical, and biological processes. This improves water quality and helps cool urban runoff, lessening its impact on nearby water bodies. Moreover, by addressing runoff at the source, such as parking lots, permeable pavement reduces reliance on costly regional stormwater management infrastructure like wet detention ponds, resulting in cost and resource savings (Upper Midwest Water Science Center, 2019).

While permeable pavement offers significant environmental benefits, its installation and maintenance come with challenges. Initially, it is more expensive to install compared to traditional pavements. The maintenance requirements are distinct and demanding. Without proper drainage, the pavement is prone to clogging, which necessitates the removal of sand and fine particles using specialized equipment. Even routine activities like sanding for ice during winter can contribute to clogging if not managed promptly. Furthermore, permeable pavement lacks the durability of traditional or asphalt pavements, making it unsuitable for high-traffic areas like highways, as consistent pressure can cause the pavement pores to collapse, compromising its effectiveness. Despite these drawbacks, proper maintenance and careful consideration of use cases can maximize the benefits of permeable pavement in sustainable urban infrastructure (Stormwater, 2021).

Permeable pavement presents a potentially cost-effective alternative to traditional pavement, despite higher initial construction costs. Long-term savings in maintenance and stormwater management expenses can render it more economical over time. However, the cost-effectiveness of permeable pavement depends on site-specific factors such as soil conditions and stormwater management requirements. For instance, areas with clay subgrade soils may necessitate additional base material for structural support or stormwater storage volume. Similarly, regions with low infiltration capacity or high stormwater treatment needs may require deeper base layers or supplementary components like underdrains, potentially increasing overall costs (Stormwater, 2021).

Reflective Pavement

Similar to permeable pavement, reflective pavement methods offer heat-mitigating benefits by reducing surface temperatures and minimizing the Urban Heat Island effect on campus.

Heat-reflective pavements are typically made using materials that have light-colored or reflective coatings, aggregates, or additives. These materials are chosen to enhance solar reflectance and thermal emittance properties, thereby reducing the pavement's surface temperature and the surrounding air temperature. By reducing the Urban Heat Island effect, heat-reflective pavements can contribute to improved outdoor comfort, reduced energy consumption for cooling buildings, and mitigated air pollution and greenhouse gas emissions.

Cool pavements offer a multitude of benefits for urban environments, including energy savings and emission reductions. By lowering outside air temperatures, they reduce the need for air conditioning in buildings and street lighting at night, resulting in decreased energy consumption. Moreover, cool pavements contribute to improved comfort and health by mitigating heat-related illnesses, slowing smog formation, and creating a more pleasant outdoor environment for pedestrians. Enhanced driver safety is another advantage, as light-colored pavements increase visibility at night. Additionally, these pavements help improve air quality by reducing urban air temperatures and slowing atmospheric chemical reactions that lead to smog formation. The benefits extend to reduced street lighting costs, decreased power plant emissions, improved water quality through cooler stormwater, and even a potential slowdown of climate change by lowering surface temperatures. Overall, cool pavements represent a sustainable and effective solution for addressing various environmental and public health challenges in urban areas (Cool Pavements, 2017).

Reflective pavements are not immune to disadvantages. Research finds that reflective materials can lead to an increase in reflected radiation which can cause discomfort for traveling pedestrians. As more radiation is reflected, the ambient temperatures above and around the pavement become hotter. This also poses increased health risks including sunburns and skin cancer. Light pollution is another disadvantage to this heat reduction method, as the lighter pavement reflects light more intensely than darker pavement materials. This, in turn, makes light pollution more prominent in the evenings and at night (Yang et al., 2014).

Tree Canopy Cover and Shade

More than 141 million acres of forests in the United States are situated within urban areas, encompassing a diverse array of green spaces. These urban forests consist of various elements such as parks, street trees, landscaped boulevards, gardens, waterfront promenades, greenways, river corridors, wetlands, nature reserves, tree shelter belts, and trees incorporated into former industrial sites. Urban forests are integral components of green infrastructure, providing planned connections between green spaces that communities rely upon. Green infrastructure operates at different levels, ranging from neighborhood settings to metropolitan areas and broader regional landscapes (Urban Forests, n.d.).

Urban trees offer a multitude of benefits that extend beyond simple oxygen production. Their role in carbon sequestration, a process integral to photosynthesis, not only contributes to reducing carbon but also influences oxygen levels. Despite the modest impact on atmospheric oxygen levels compared to aquatic systems, trees play a crucial role in providing habitat for various wildlife and plants, offering shelter, food, and nesting materials that sustain diverse ecosystems. For instance, native oak trees support caterpillars, which in turn become prey for birds, thereby supporting intricate food webs.

Urban trees significantly impact energy consumption by mitigating building temperatures. They provide shade, reducing solar heat gain in summer and lowering the need for air conditioning. Additionally, trees contribute to evaporative cooling through transpiration, releasing water vapor from their leaves and naturally cooling the surrounding air. In winter, trees act as windbreaks, shielding buildings from cold winds and reducing heating requirements. By moderating building temperatures year-round, urban forests indirectly reduce energy consumption for heating and cooling, consequently improving air quality and lowering carbon emissions (*Other Benefits of Urban Forests,* n.d.).

In addition, urban forests offer health equity to marginalized communities in city and town centers. City forests allow for an increase in air quality, climate protection, and mental health. As stated above, urban forests have a positive influence on oxygen levels which is beneficial for residents to inhale. The forests also help mitigate pollution that is heavily compacted in city boundaries due to increased traffic and energy usage that serves many individuals at peak times. Most notably, urban forests offer mental health benefits by providing green spaces for relaxation, recreation, and stress reduction. Access to urban forests within city and town centers is particularly advantageous for marginalized communities, offering equitable opportunities to enjoy cleaner air, climate resilience, and improved mental well-being.

Urban forests offer many benefits to their surrounding neighborhood, but, they are also difficult to implement. Particularly, there is a lack of adequate space that is specified for urban forest and green spaces to be implemented. When urban forests are planned for cities and towns, they are subjected to harsh growing conditions and are often ill-picked to offer benefits to society because of their species type. Furthermore, these forests tend to not offer much biodiversity due to inadequate planning as well (McPherson, 2003).

Transportation

Sustainable transportation offers a variety of benefits, from reduced energy and fossil fuel consumption to health benefits and a reduction in the UHI effect. Its versatility offers a variety of solutions, albeit each with its own challenges and limitations. With a wide range of options, sustainable transportation can be tailored to fit the needs and capabilities of the University.

Among these, active transportation, such as walking and biking, is the most sustainable transportation option, as well as the easiest and cheapest to incentivize and improve. Enhancing the current public transit system and infrastructure, alongside promoting public transit and carpooling, are other viable strategies. Finally, electrification of bus and vehicle fleets is crucial to meeting zero-carbon goals, while reducing the UHI phenomenon. These policy avenues will be explored in detail in the subsequent section, tailored specifically to UNC's campus.

Policy Recommendations

Green Roofs

The Urban Heat Island effect is a pressing concern for cities like Chapel Hill, where densely built environments lead to elevated temperatures and increased energy consumption. Implementing green roofs across the UNC campus offers a promising strategy to combat UHI, with multifaceted benefits including reduced energy usage, lower pollution levels, and cooler temperatures.

Research demonstrates that green roofs play a crucial role in thermal reduction within urban spaces. By absorbing less solar radiation compared to traditional building materials, green roofs help cool the surrounding environment. This cooling effect extends indoors, reducing the need for excessive energy consumption for heating and cooling. Studies suggest that green roofs can lead to significant energy savings, with potential reductions of up to 16% in cooling consumption and 5% in heating consumption (Shafique et al., 2018). Particularly on UNC's South Campus, there is a significant number of buildings with low albedo that contribute to UHI. There is an emphasis on implementing green roof infrastructure in this area as this part of campus is home to the vast majority of UNC's BIPOC community and faces other environmental justice issues due to location.

Furthermore, green roofs contribute to mitigating pollution emitted from buildings during heating and cooling processes. By reducing energy demand, green roofs indirectly lower carbon emissions and pollutants, thereby improving air quality and reducing the overall heat impact in urban areas. This not only benefits the campus community but also extends to the broader Chapel Hill community by fostering a healthier and more sustainable environment. As seen in our research, there is an increase in temperature around the UNC hospitals and medical facilities. By adding green roofs to these buildings, UNC will see significant energy cost reductions as well as improved air quality for the most vulnerable populations in the community.

The implementation of green roofs at UNC-Chapel Hill offers direct benefits to students and community members. By reducing ambient temperatures, green roofs create cooler outdoor spaces that are more comfortable and conducive to outdoor activities, enhancing the overall quality of campus life. Improved air quality resulting from reduced pollution levels contributes to better respiratory health and reduces the risk of heat-related illnesses, particularly during hot and humid North Carolina summers.

The town of Chapel Hill and its neighbor, Carrboro, serves as home to historically Black communities in the area. Reduced Urban Heat Island effect in Chapel Hill neighborhoods enhances livability by creating cooler microclimates and mitigating the heat stress experienced in urban areas. Improved air quality contributes to overall public health and well-being, benefiting residents and visitors alike while decreasing environmental injustices.

Green roofs offer an innovative and sustainable solution to mitigate the Urban Heat Island effect at UNC-Chapel Hill, providing tangible benefits to students, community members, and the broader environment. By embracing green roofs, UNC can lead by example in sustainable campus development and inspire positive change in urban environments while enhancing the health and well-being of its community.

Increased Urban Forest

UNC can leverage urban forests as a strategic approach to combat the Urban Heat Island effect, offering a range of benefits including reduced energy usage, lower pollution levels, cooler temperatures, and improved mental health for students and community members.

Urban forests play a critical role in mitigating UHI by providing shade, lowering surface temperatures, and enhancing air quality. Research shows that trees in urban areas can significantly reduce ambient temperatures through shading and evaporative cooling effects. By strategically planting and maintaining urban forests across the UNC campus, the university can create cooler microclimates that reduce the need for excessive energy consumption for cooling buildings during hot weather.

In addition to reducing energy usage, urban forests contribute to lower pollution levels by absorbing carbon dioxide and other pollutants, thereby improving air quality. This not only benefits the campus community but also extends to surrounding neighborhoods, promoting a healthier and more sustainable urban environment.

Moreover, the presence of urban forests has been linked to improved mental health and well-being. Access to green spaces and natural environments has proven benefits in reducing stress, anxiety, and depression among students and community members. By incorporating urban forests into the campus landscape, UNC can provide students and residents with peaceful and rejuvenating spaces that support mental health and enhance overall quality of life.

As seen in our research, the most prominent temperatures at a given time on campus were found along the hospital corridors and deep on UNC's South Campus. Increasing our urban forestry in these areas will serve our most vulnerable and marginalized communities which may face different obstacles that affect mental wellbeing.

Students and community members at UNC can directly benefit from these environmental improvements. Cooler temperatures resulting from urban forests create more comfortable outdoor environments for studying, socializing, and recreational activities, enhancing the overall quality of campus life. Improved air quality contributes to respiratory health, reducing the risk of respiratory illnesses and allergies. Furthermore, access to green spaces and nature promotes mental well-being, providing opportunities for relaxation, reflection, and stress relief amidst the demands of academic and daily life.

To effectively utilize urban forests for mitigating UHI at UNC, the university can implement strategic tree-planting initiatives, prioritize green infrastructure in campus planning and development, and engage in community outreach and education on the benefits of urban forests. Through these efforts, UNC can harness the power of urban forests to mitigate UHI and create a more sustainable and livable campus environment for current and future generations.

Sustainable Transportation

Transportation plays a pivotal role in shaping the college and campus experience for students. One compelling approach to combat the Urban Heat Island effect is through the expansion of sustainable transportation infrastructure and the promotion of active and public modes of transportation. Sustainable transportation reduces carbon emissions, thermal emissions, and air pollution as well as reducing the amount of traffic and improving student, faculty, and staff health.

Enhancing pedestrian infrastructure is key to improving the pedestrian experience and incentivizing this mode of transportation further. A pedestrian-friendly campus with well-shaded paths and green corridors makes students feel safe and comfortable while reducing the UHI (Nieuwenhuijsen, 2021). Improving walkability goes hand in hand with increasing tree canopy cover. When making sidewalk and walkway improvements, consider using permeable pavement that helps to reduce the UHI effect and absorbs runoff water, as mentioned earlier.

Moreover, enhancing bike infrastructure and incentivizing students to opt for biking over driving can significantly mitigate the Urban Heat Island effect. Our findings indicate that intersections and heavily trafficked roads tend to experience heightened temperatures due to vehicle idling. By establishing designated bike lanes and offering incentives such as bike repair discounts and accessible bike share programs, UNC can create a safer and more enticing environment for biking (Cardenas, 2024). These improvements are not only straightforward to implement but also cost-effective.

UNC should proactively plan for funding opportunities to enhance equitable access to efficient, low-carbon transportation options. The $3 billion Neighborhood Access and Equity Grant Program is one such opportunity as part of the Inflation Reduction Act presents communities with a vital chance to invest in such improvements. This funding is a crucial complement to the bill's investments in electric vehicles, specifically targeting walkability, access to transit, shared bikes, and other micro-mobility options (Jennings, 2022). Initiatives like these also help to align UNC with environmental justice goals by supporting transportation access for low-income and historically marginalized communities.

Working collaboratively with the Town of Chapel Hill to enhance Chapel Hill Transit lines and infrastructure offers another avenue to combat the Urban Heat Island effect. Given that transportation accounts for 27% of greenhouse gas emissions in the United States, incentivizing public transportation and carpooling is essential to campus sustainability (Jennings, 2022). The effectiveness of transit ridership hinges on accessibility, reliability, and user-friendliness. Ensuring bus routes serve key populations and locations, maintaining frequent and punctual service, and addressing pandemic-induced staff shortages are crucial steps for Chapel Hill Transit to regain public trust and increase ridership. Implementing carpool incentive programs, such as parking discounts, serves as an additional, straightforward strategy to reduce greenhouse gas emissions, traffic congestion, and vehicle idling on campus.

It is also crucial for UNC to put specific plans in place for the transition to electric vehicles and buses. While this is the most expensive sustainable transportation solution, it has the potential to be the most impactful. Electrifying UNC’s car and bus fleets would greatly cut greenhouse gas emissions and thermal emissions while demonstrating UNC’s commitment to clean energy and its decarbonization goals. As a leader in education and research, UNC should aim to be at the forefront of the energy transition and vehicle electrification.

Transportation and connectivity issues are especially prominent on South Campus where the steep elevation gradient can often make the space inaccessible or difficult to navigate. The space lacks green corridors and shaded sidewalks where students can walk comfortably and safely, especially along large roads and intersections like Skipper Bowls Drive and Manning Drive. Additionally, the roads on and around South Campus are highly trafficked, leading to more car idling and greater thermal emissions that increase the UHI. Due to the built environment and the distance to main campus, academic buildings, and dining halls, over 4,800 students who live on South Campus face many disadvantages and environmental justice issues. Improving walkability and the transit system in this part of campus are two to improve student well-being while mitigating the UHI effect. Because students are further from their academic buildings and where most students spend the majority of their day, South Campus residents are more inclined to have a car on campus and drive to main campus. Creating incentives for carpooling, biking, or transit ridership for South Campus residents could have a tremendous impact.

Conclusion

The Urban Heat Island effect poses significant challenges to urban areas like Chapel Hill, impacting not only the local climate but also the health and well-being of residents, especially UNC students. As demonstrated by the Sustainable Triangle Field Site’s research findings, and in agreement with the existing literature on the UHI, areas with greater tree canopy cover experience cooler temperatures, highlighting the importance of green infrastructure in mitigating the UHI effect. UNC has a unique opportunity to lead sustainable change by implementing policies that prioritize urban forests, green infrastructure, and sustainable transportation. These initiatives combat the UHI effect while enhancing campus aesthetics, improving life on campus, and contributing to broader sustainability goals. By adopting these strategies, UNC can create a cooler, greener, and more resilient campus environment, setting a positive example for other institutions and fostering a healthier community for all.

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Appendix

Figure 1

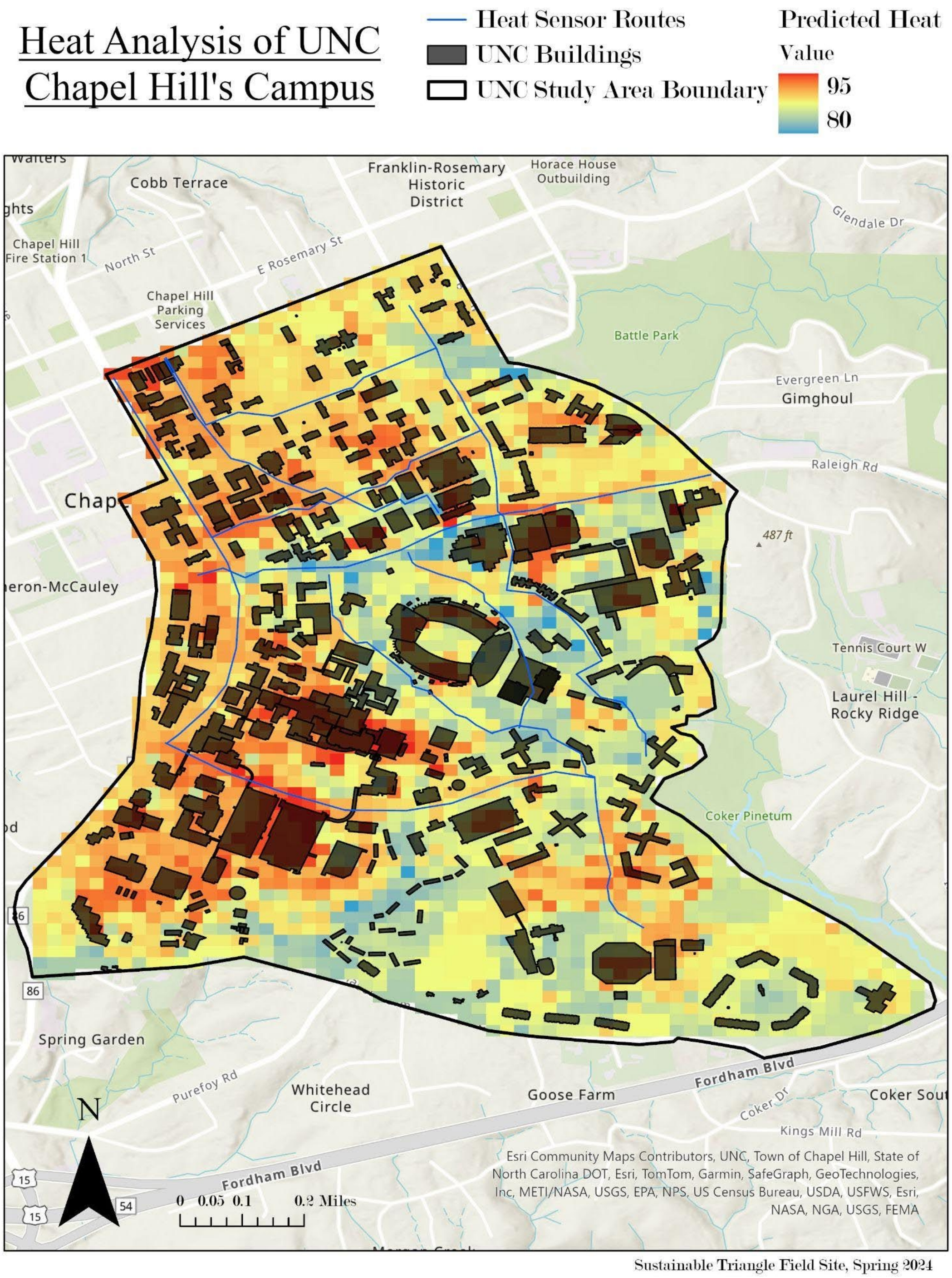
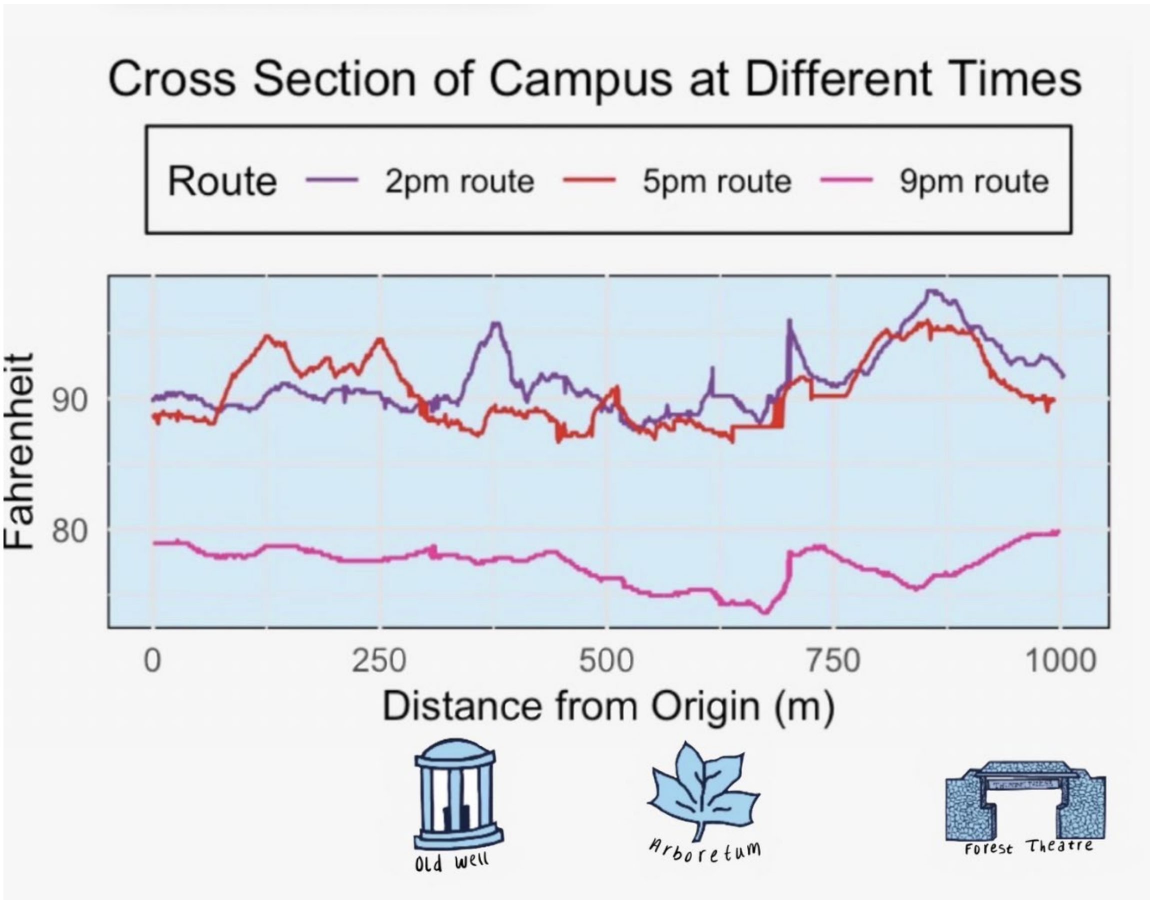


Figure 2


Cross Section of Campus at Different Times
Route
2pm route
5pm route
9pm route
Fahrenheit
90
80
0
250
500
750
1000
Distance from Origin (m)
Old Well
Arboretum
Forest Theatre