Urban Heat, Vulnerability, and the Public Realm: Lessons from Tel Aviv-Yafo and Implications for COVID-19 Recovery

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Climate change is leaving Tel Aviv-Yafo hotter and drier. A hotter climate means more energy to cool buildings, more people staying indoors or in cars, and vulnerable people becoming sick from heat exposure. In some neighborhoods, streets were designed to channel sea air through open boulevards, while green spaces provide needed shade. But in other neighborhoods, the streets are dense, narrow, with limited vegetation or green spaces, and communities on the social margins typically have fewer resources to adapt. In the first part of this paper, we discuss the case of The Resilience Accelerator in Tel Aviv-Yafo, a program of the Center for Resilient Cities and Landscapes which supports community-based and local government actions towards climate resilience project implementation with multi-disciplinary and sectoral engagements. This process engaged a spatial heat vulnerability analysis to prioritize areas of the city most physically exposed and socially sensitive to heat impacts. Then, it brought together stakeholders from across disciplines, sectors, and scales to design projects that mitigate heat impacts and also create a vibrant and accessible public realm in the Shapira neighborhood. Soon after the conclusion of the Accelerator, COVID-19 was declared a pandemic by the World Health Organization, and decision-makers at all levels of government worldwide have faced unprecedented challenges in not only responding to the imminent public health crises, but also the compounding vulnerabilities and hazards related to climate risk in the most vulnerable communities. So, in the second part of this paper, we reflect on how the pandemic has shed new light on the intersections of risk and areas of future investigation to further unpack the role of the urban planner and designer in constructing and deconstructing oppression and vulnerability.

Keywords: *Urban Planning and Design, Climate Adaptation, Community Engaged Design, Vulnerability Analysis*

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INTRODUCTION

In this paper, we explore insights around how spatial analysis can expose interconnected risks to inform new paradigms of planning and design that seek not only climate adaptation, but also social equity at the community level. We look first to the Resilience Accelerator Tel Aviv-Yafo (referred to in this paper as the Accelerator, 2018-2019), as a case study in engaging local neighborhood stakeholders to leverage heat vulnerability analysis to guide adaptation and resilience project design in Shapira, Tel Aviv, where social sensitivity indicators compound with heat exposure. In this neighborhood, socio-political, economic, and environmental stresses meet: From displacement caused by rising housing unaffordability to disproportionate exposure to heat. These vulnerabilities are further compounded by the increasing presence of asylum seekers and migrants largely from east Africa who, in and of themselves, lie at the margins of society and the intersection of climate risk, legacies of colonization, pressures of globalization, and the disruption of social networks caused by all three (Vinyeta, et al., 2015).

After the conclusion of the Accelerator, COVID-19 was declared a pandemic by the World Health Organization (2020), and decision-makers at all levels of government worldwide have faced unprecedented challenges in not only responding to the imminent public health crises, but also the compounding vulnerabilities and hazards related to climate risk in the most vulnerable communities. So, in the second part of this paper, we reflect on how the pandemic has shed new light on the intersections of risk and the role of the urban planner and designer in constructing and deconstructing oppression and vulnerability manifest in the built environment and the social conditions inhabited within it and constructed by it.

In this frame, it is worthwhile to reflect on the initial question underpinning the mission of the Accelerator to support project-based resilience building: How can we better bridge the gaps between urban planning and design, scientific and academic research, the work of NGOs and community-based organizations, and the resources that can be leveraged in the philanthropic and private sectors towards climate adaptation in communities most at-risk to increasing urban heat?

But that question must be taken in the context of a global pandemic and ignited social movement around the world and a global dialogue around the intersectionality of social and economic justice, climate change and adaptation, and public health. So, reflection of the lessons learned through the Resilience Accelerator in Tel Aviv-Yafo and similar programs, might necessarily evolve towards greater inclusion and reckoning of the current power structures that have constructed and maintained climate change and social injustice. Until now, the global urban resilience network gained facility bridging ideas and practices between philanthropy, government, academia, and business and sought to identify and scale transformative urban projects. But can this constellation of influence still operate when it is centered on grass-roots community empowerment?

RESILIENCE ACCELERATOR: A CASE STUDY IN HEAT VULNERABILITY ANALYSIS AS A TOOL FOR NEIGHBORHOOD-BASED ACTION

Tel Aviv-Yafo is reconciling how the built environment can both support economic and population expansion, while not contributing to or exacerbating climate change and its impacts on vulnerable communities, neighborhood fabric and character, and surrounding ecosystems. For these reasons, and in pursuit of the implementation of the Tel Aviv-Yafo Resilience Strategy, which aims to build resilience in light of these dynamics, the Accelerator program advanced research and design in response to increasing risk from urban heat.

Given Tel Aviv's ongoing work on implementation of the Tel Aviv-Yafo Resilience Strategy and development of a City-wide Climate Action Plan, the Municipality applied to the Resilience Accelerator program in April 2018. Together, the Accelerator engaged an interdisciplinary and inter-sectoral partnership between the Center for Resilient Cities and Landscapes at Columbia University (CRCL), the former 100 Resilient Cities Network--Pioneered by the Rockefeller Foundation, the Municipality of Tel Aviv-Yafo, Tel Aviv University, the NASA Goddard Institute of Space Studies, and the Center for Climate Systems Research at Columbia University's Earth Institute to identify vulnerability to increasing urban heat and define action that supports the most vulnerable in the city.

Between 2018 and 2019, the Accelerator convened municipal leaders and stakeholders, designers, academic and scientific experts, and community leadership, for an intensive research program and facilitated a design session to design pilot project concepts in Shapira neighborhood in November, 2019. The process included place-based design research, city-wide heat vulnerability analysis and site selection process, climate and microclimate modeling, case studies, and workshop findings. Finally, it culminated with a set of actionable pilot project design concepts and actionable next steps that can achieve impact at scale. Recognizing the connections between community vulnerability, heat, and sustainability, three core research questions emerged: What design interventions can help Tel Aviv-Yafo to address urban heat in the most vulnerable communities? What if the public realm could be reimagined with the changing climate? What if the design could cultivate a rich fabric of communities, ecologies, and economies?

July 2019 was the hottest month ever measured on Earth (National Oceanic and Atmospheric Administration. 2019). Where the desert meets the Mediterranean Sea, climate change is leaving Tel Aviv-Yafo hotter and drier. Since the 1980s, Tel Aviv-Yafo warmed nearly 2°C (Yosef et al., 2019). In the last decade, warming in the Tel Aviv-Yafo and the Middle East region has outpaced almost every other region on Earth. This trend is expected to accelerate over the next century if global emissions remain on the same trajectory. Assuming emissions remain in the business as usual scenario (RCP 8.5), average annual temperatures are expected to increase by up to

4.5°C by the 2080s and annual precipitation may decrease by up to 10 percent in the 2020s and up to 38 percent by the 2080s. There could be up to 53 more days over 33°C as soon as this decade, and the average heat wave is expected to last one week longer by the 2050s (NASA, 2015).

Today, Tel Aviv-Yafo's subtropical Mediterranean climate and urban microclimatic conditions are influenced by two dynamic factors: The Mediterranean Sea and urbanization. Meanwhile, the city is growing and expects a 37 percent increase in population by 2035, intensifying patterns of urbanization and the urban heat island effect, which represents the totality of microclimatic changes brought about by man-made alterations to the urban surface (Landsberg, 1981). Tel Aviv-Yafo is hotter than surrounding areas because of four related factors: Heat sources and particulate pollution from infrastructure, cars, buildings; materials and surfaces that absorb and radiate heat; the loss of vegetation that evaporates water and provides shade; and, the spatial relationships and geometries of streets, roads, buildings, and open spaces. None of these factors can be considered in isolation: Tall buildings may create shade, but they also trap heat and obstruct the flow of cooling breezes, even in a coastal city.

The dimensions of these impacts transcend the health and vitality of people, ecosystems, and economy; the viability of critical infrastructure and energy resources; and the vibrancy and safety of public spaces. Rapid growth is complicating decisions and affecting resources around energy, housing, infrastructure, community and cultural services, and water systems. The vulnerabilities, inefficiencies, and inequities in the built, institutional, and social systems that shape our everyday are revealed through them. At stake are the lives and livelihoods of vulnerable communities and the ecological systems on which all life depends.

Vulnerable neighborhoods are consistently those on the social margins and physical conditions interlock in a feedback loop that maintains exposure and sensitivity and disproportionate burden of risk. Those who are most physically exposed to heat due to decisions made in the built environment that favor hard and energy intensive infrastructure and housing are also often least resourced socially and financially to adapt: Small businesses with lost foot traffic, kids unable to play outside, isolated seniors, and families unable to keep up with increased energy costs for air conditioning. Cascading consequences of heat suggest the interconnected nature of risk: Small businesses, for example, with months of lost foot traffic reduce revenue and jeopardize business sustainability, livelihoods, and important community resources for residents.

Health and People

Heat isn't just about comfort. In Israel, premature deaths and mortality from heat are especially acute among the very young, very old, minorities, and those with chronic and mental illness; and, overall, hospital admissions increase during heat waves (Green et al. 2013). One study found that visits to the emergency room in

Israel increased by 1.47 percent per 1°C increase in ambient temperature (Novikov et al., 2011). Further, certain occupational groups are disproportionately impacted—outdoor workers, construction workers, and first responders—who lack access to cooling (Klein-Rosenthal and Raven, 2017).

Heat-related illnesses like exhaustion, heat stroke, and respiratory illnesses are caused in part by high temperatures, which can limit the effectiveness of some medications and impact the body's ability to dissipate heat (Green et al., 2013). One study found that emergency psychiatric response calls in Baltimore, Maryland increase by 40 percent when the heat spikes to 39°C, in part due to the decreased effectiveness of psychiatric medications (Exkert, 2019). High temperatures also cause a cascading impact by increasing particulate matter in the air and ground level ozone, and changing spatial distribution of some infectious diseases (Intergovernmental Panel on Climate Change, 2007).

Image 1: Dizengoff Square, Tel Aviv-Yafo

Energy and Infrastructure

Ironically, the more energy used to cool off, the hotter it could get. As urban heat increases, more energy for air conditioning is needed to cool buildings (Trust for Public Land. 2016). Today, 90 percent of Tel Avivians have air conditioning (State of Israel, Central Bureau of Statistics. 2017). Further, much of Tel Aviv's building stock was built with little insulation, contributing to increasing inefficiencies in energy consumption as AC use increases. The more it is used, the greater the risk of power surges, black and brown outs, and increasing peak energy loads, not only increasing emissions, but also putting critical energy infrastructure at risk of systemic disruption (Trilnick, 2012). This energy ensures that businesses can run, data can be stored, and health and transit services can be delivered (Chapman et al. 2013). As air conditioning use intensifies, so too does the amount of waste heat distributed into communities, creating a feedback loop that exacerbates urban heat island: The more you use, the more you need to use. Meanwhile, today's infrastructure may not be built to withstand the temperature of the coming decades For example, extreme heat influences the material durability of infrastructure, like roadways, railways, and even airline runways that can buckle or warp (Wichter, 2017) . Hotter air is less dense and impacts airplane engines and necessitates longer runways for takeoff (Shepherd, 2017). Extreme heat is not only a safety hazard, it also poses risks for major transportation service disruption that echoes across the social and economic life of Tel Aviv.

Image 2: Mesilat Yesharim Bike Lane, Tel Aviv-Yafo

Heat influences the social life of the city and capacity of neighbors to build community and engage in democratic and civic processes in the public realm (see Image 1 and Image 2). Heat influences the choices made about where we can and want to spend our time, and even changes our mood. When it's too hot, the basic building blocks of urban life are compromised: Kids can't play outside and neighbors are less likely to gather. For some, when the choice is going outside or staying indoors, it can lead to social isolation, which can in turn result in sickness or death (Klinenberg, 2002). Some studies suggest that heat also influences safety, security, and conflict. For example, inlow-income Los Angeles neighborhoods, violent crime increases by 5.7 percent when temperature tops 29.4°C, but not in wealthier parts of the city (Butchiredygari, 2019).

Today, Tel Aviv-Yafo is already feeling the impacts of heat in the amount of money spent on irrigation each month (see Image 3). In the past 10 years, irrigation spending has exponentially increased in Tel Aviv. And with more extreme heat, resource constraints on first responders and the medical sector are expected to increase in Israel (Green, et al., 2013). With projected risks to infrastructure, greater public capital may be needed to retrofit for future climate conditions.

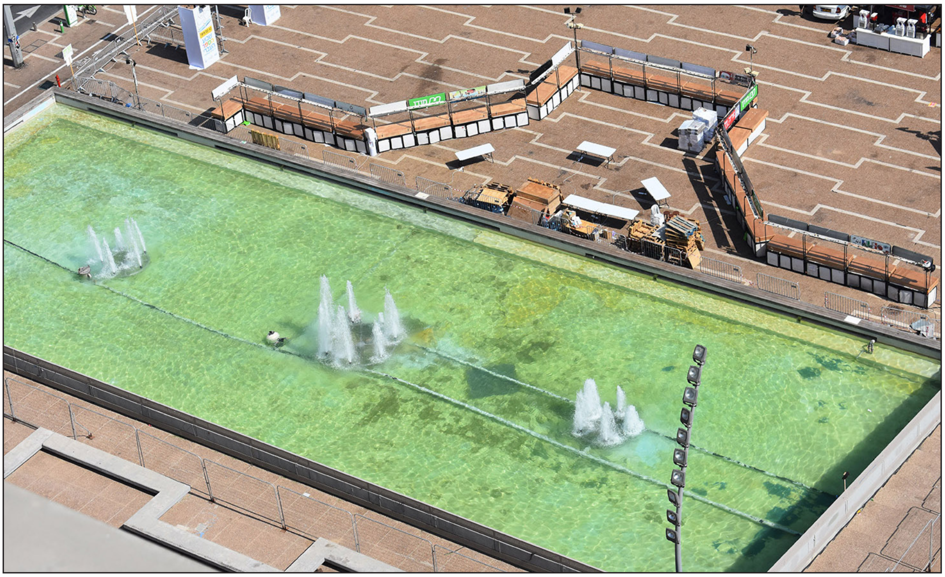

Image 3: Tel Aviv-Yafo City Hall Fountain

At the household level, heat impacts expenses and transportation mobility. As air conditioning usage increases, for example, so too do the household and public expenses used to cool homes and public buildings (Gerrard, 2016). Fixed income individuals and households may be at greater risk, for example, as they are less likely to utilize air conditioners at the expense of unaffordable energy utility bills. Further, as heat increases, so too do household transportation costs as residents become more likely to favor driving over public transportation associated with walking and waiting times at stations. Lack of shade and seating at bus stops, for example, is interwoven with heat impacts particularly for those reliant on public transit. For the most vulnerable an added financial instability decreases community capacity to adapt.

At the macro scale, heat constrains the operations of private firms and the attractiveness of Tel Aviv-Yafo to new workers. Extreme heat causes disruption to business operations and lost days at school and work. These effects are felt most acutely in people with underlying illnesses and by those in the construction and logistics industries, where delays and disruptions can raise costs, delay development, and decrease worker productivity, safety, and cognitive function (Urban Land Institute, 2019; Gerrard, 2016). In Israel, where tourism is a key factor in future economic growth planning, heat could change consumer habits and tourist activities (Israel Ministry of Foreign Affairs2019).

Ecosystems and Environment

Image 4: Typical Tree Pit, Mesilat Yesharim Street, Tel Aviv-Yafo

Urban heat island effect is driven, in part, by the loss of soil health and vegetation which is especially apparent in more socially marginalized neighborhoods. The loss of vegetation from urban development in turn can further compound risk of increasing heat and decreased precipitation. Certain species of flora, for example, may not be drought resistant, and vegetation hardiness zones may ultimately migrate northward as the climate changes (Trust for Public Land. 2016). Therefore, a warming climate may then change the geographic range of habitats and create uncertainty for city planners and landscape architects charged with decision-making around "green infrastructure" investments. The migration of species may outpace the standards and practices of landscape designers and planners pursuing green infrastructure investments (Cho et al., 2017).

Further, heat, air quality, and water are wholly interdependent as capacities to conserve water become constrained as heat increases. While rainfall is expected to decrease in Tel Aviv-Yafo overall in the coming decades, extreme precipitation events are becoming more frequent and damaging because of inadequate drainage and flood management (Peleg, Shpigel, 2020). These impacts are disproportionately acute in southern neighborhoods. Further, surface temperatures, in turn, impact the temperature of storm-water run-off that drains into local waterways. For example, pavements that are 37.7°C or higher can elevate rainwater temperature from 21°C to 35°C, complicating landscape management and impacting local aquatic life (Low Carbon Living, CRC. 2017). Intact and connected soil systems are critical to the health of trees and vegetation (see Image 4).

HEAT VULNERABILITY METHODOLOGY ASSESSMENT

The urban form of Tel Aviv-Yafo may—out of necessity—change with the climate. People and buildings may turn inward away from the public realm, perhaps with a proliferation of air-conditioned towers, or pockets of cool oases and private gardens reserved for the most privileged. As people turn inward, staying in their cars and apartments, the public realm is at risk of erosion and of enforcing isolation and even conflict between individuals and communities.

Defining Heat Vulnerability

To better understand these relationships we, at the CRCL, began with a city-wide mapping study that spatialized heat vulnerability. This analysis assumes that vulnerability is defined by the combination of exposure and sensitivity indicators. The Accelerator looked across similar indices developed for other cities, and synthesized some of the key factors associated with heat vulnerability in Tel Aviv. By deriving Land Surface Temperature (LST) and the Normalized Difference Built-Up Index (NDBI) from the Landsat 8 imagery, and using the Tel Aviv-Yafo census data to measure social sensitivity, we identified the most vulnerable neighborhoods. This process, also known as the "multi-criteria decision analysis", is intended to help prioritize where planning efforts might be directed.

Mapping Exposure

Landsat data is represented in 30 by 30 meter grid cells (or pixels), while census data is aggregated in statistical areas of various sizes and shapes. To overcome this difference, we re-sampled the entire area of the city and census data into the 30 by 30 meter grid (Figure 1). This allowed us to layer multiple variables of different sizes into the same grid units. For each overlaying data set, we re-classified values of the grid cells on a scale of 1–5 (e.g, the top 20th percentile is assigned a score of 5), showing relative conditions across the city.

Landsat 8 scans the same location on Earth every 16 days, generating a total of 47 usable scans that include the city: imagery we utilized had less than 10% cloud cover, and was acquired throughout the months of June, July, and August between 2014 and 2018. In the composite map of land surface temperature (LST), the deeper the red, the hotter the surface relative to the rest of the city (see Figure 2).

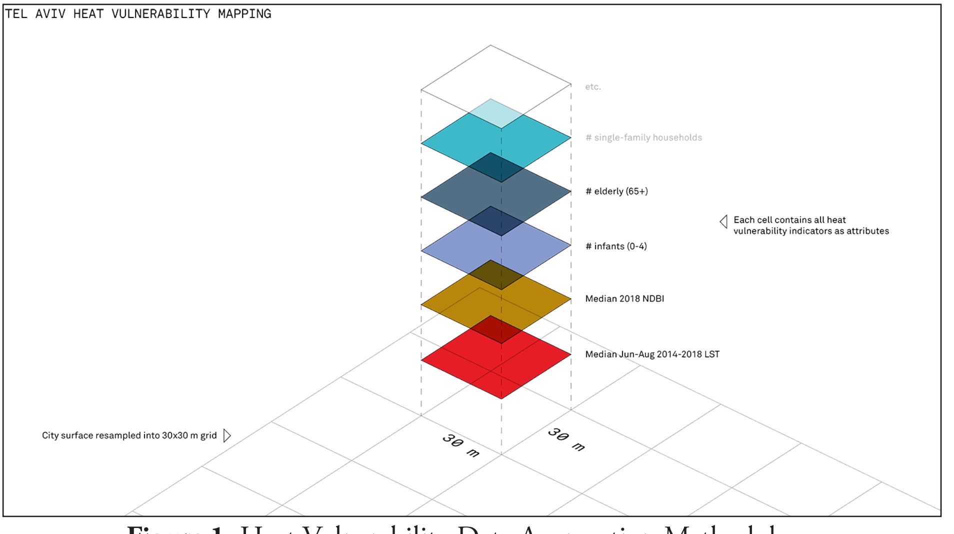

Figure 1: Heat Vulnerability Data Aggregation Methodology

Next, we investigated the areas of the city that are most "built up" using the Normalized Difference Built-Up Index (or NDBI), also derived from Landsat. This index allows for the detection of built-up surfaces as well as conditions such as bare soil and dry grasses. These areas of the city can exacerbate heat exposure.

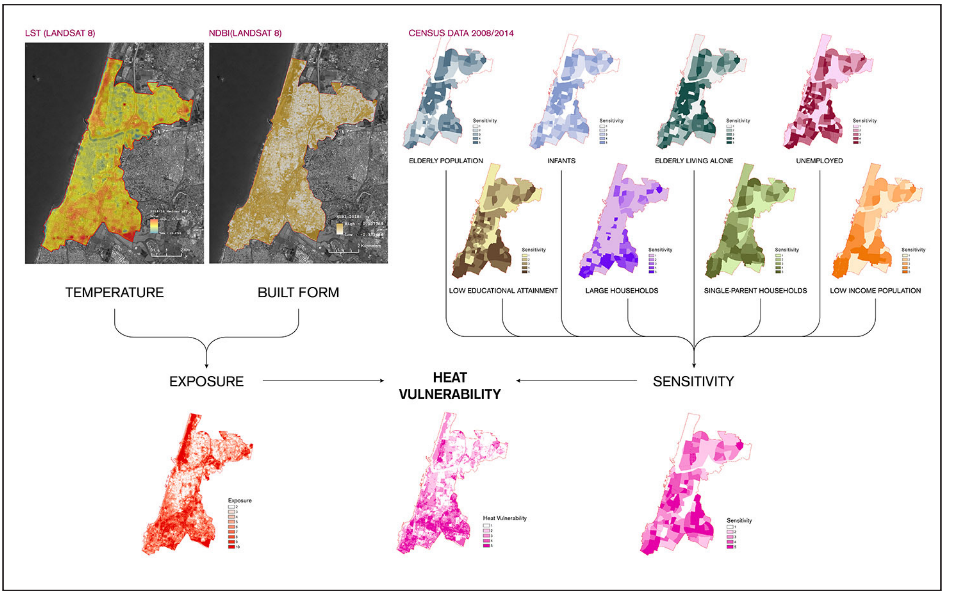

Figure 2: Heat Vulnerability Assessment Outputs

Mapping Sensitivity

With the goal of prioritizing vulnerable neighborhoods, we studied demographic indicators that suggest sensitivity to heat. These factors indicate communities and populations less able to adapt or more vulnerable to the acute impacts of any type of stress or hazard, such as poor health or financial outcomes (Figure 2).

While there are many factors that contribute to sensitivity, this composite map shows where the elderly living alone, very young, low income, single-parent households, unemployed, large households of seven or more, and low education overlap. The deeper the pink, the greater is the assumed sensitivity.

As a last step, we compiled all of the exposure and sensitivity maps. By stacking them, areas of the city facing the most acute impacts from heat stress become visually apparent. Together, these maps suggest that areas in the south of Tel Aviv-Yafo are where exposure to heat disproportionately impacts certain communities.

Today, as we learn more about COVID-19 impacts, it is important to note that some of these factors intersect with those that contribute to COVID-19 mortality such as, the elderly, lower income, and large households (Figure 2) (Mayo Clinic, 2020). Taken together, they suggest a relative difference between the north and south of Tel Aviv: The deeper the pink, the greater the relative vulnerability.

Figure 3: 1925 General Plan for Tel Aviv

These maps help to illustrate how 20th century urbanization, like most cities, maximized automobile accessibility and were less focused on the particularities of local climate and geography, while also concentrating wealth and poverty spatially. Urban heat impacts are felt even in Tel Aviv-Yafo neighborhoods where streets were designed to channel the sea air through open boulevards and a dense canopy of trees provides shade and moves cool air through buildings, but there's a clear disparity between different areas of the city. In the center of Tel Aviv, there is a notable cool spot, which corresponds to the 1925 Geddes Plan (Figure 3), designed by Sir. Patrick Geddes, a Scottish biologist and town planner. The plan laid out large east-west boulevards that take advantage of the climate and carry coastal breezes through the city. Green spaces on interior residential blocks created neighborhood spaces for people and plants. And while it has left a legacy of cooling, it is also one of historic colonialism and maintained privilege: This area is wealthy, where housing affordability is strained, and even less prone to flooding. It is a visual demarcation between Tel Aviv and historically Arabic Jaffa to the south.

In other neighborhoods, such as those in the south of Tel Aviv, streets are not only more exposed to the sun and have limited tree canopy cover, for example, these same residents have access to fewer resources to adapt and greater potential for displacement. Inland and in southern districts, streets are narrower and the fabric provides for less ventilation and opportunity for street trees and vegetation between buildings. Dense buildings, street grid orientation, and narrow streets create urban canyons and prevent heat from escaping and also interrupting air flow. Transportation infrastructure and buildings give off heat in the form of exhaust and particulate matter, which becomes trapped by the dense streets and buildings. As vegetation is replaced with materials like concrete and asphalt city-wide, more radiant heat from sunlight is absorbed during the day and radiated back at night. In places where there is already limited vegetation, loss of existing coverage of trees and vegetation to these materials is of even greater consequence.

Designing for Heat Adaptation

Design interventions to mitigate urban heat must be considered at all scales - from national scale decarbonization in transportation, energy, industrial, and construction systems; to the built form and pattern at the urban scale; to neighborhood planning; to micro scale interventions like planting, paving, and solar shading. To ground research and analysis in the particularities of place and urban policy, the the Accelerator selected a neighborhood through which to read these scales and focus a concentrated design and engagement effort. By focusing research and a workshop on a single neighborhood, the Accelerator could more closely observe the impacts of heat and begin to identify strategies that address heat at the scale of a site as well as inform city-wide and national policy. In selecting a neighborhood, we considered the following criteria:

- Relatively high heat vulnerability geographically
- Priority neighborhood and community as defined by the Resilient Tel Aviv-Yafo Strategy process
- Overlaps with other planning efforts, projects, and programs such as the Sustainable Neighborhoods Program
- Presence of a range of public space typologies
- Presence of other chronic stresses not illustrated in sensitivity mapping (e.g., mobility, gentrification)
- Proximity to future investment and development areas

For these reasons, we selected Shapira neighborhood, located in southern Tel Aviv-Yafo. Originally an orange grove in former Palestine, the neighborhood is dotted with abandoned well houses that were once central to the social, political, and economic life of Arab communities. Dense sabres plants denote a historic legacy of intra-neighborhood boundaries embedded in the landscape. Then, in the 1920's, the area was developed by America contractor Meir Getzle Shapira, erasing this preexistent community fabric. And because the neighborhood was neither legally a part of Jaffa nor Tel Aviv-Yafo at the time, Getzle Shapira took advantage of freedom from taxes and the lax construction standards to build factories and homes, the legacy of which remains the defining feature of the built fabric today (Sela, 2009).

Geographically defined by Kibbutz Galuyot Road to the south, Salame Road to the north, the Ayalon Highway to the east, and Sderot Har Tsiyon to the west, the neighborhood is largely residential with low- to mid-rise buildings, a mix of community facilities, and a north-south commercial corridor on Mesilat Yesharim, which is considered a gateway to Shapira. To the north-east, the Tel Aviv Central Bus Station, which in 1967 destroyed the menorah-shaped street grid of bordering Neve Sha'anan, is a gateway for migrant workers, refugees, and asylum seekers arriving in Tel Aviv. Many settle in Shapira and neighbouring areas, often with many people to a single apartment and marginalized from the formal economy and political processes. In many ways, Shapira registers the consequences of global displacement due to conflict, economic and political oppression, and climate change, as well as local patterns of urbanization that enforce marginalization based on class and race. It registers how local urban context facilitates the visibility of the privileged and the invisibility of the marginalized. Those already most at risk continue to carry disproportionate burden and risk not only of climate change impacts, but also the consequences of localized displacements driven by housing policy and gentrification.

Over the last decade, Shapira has battled a perception of blight and disinvestment all while housing costs increase driven by population expansion. Efforts to invest in services, housing, and community assets have begun to accelerate both by the City and by private interests. Further, plans to implement a light rail line at the northern edge of the neighborhood could dramatically change the area. With those investments though, come risks to the built and social fabric of the existing neighborhood and nearly 8,000 people representing a wide range of ethnic groups that call Shapira home. Today, the neighborhood faces extreme heat among other stresses, including poor air quality from nearby industrial and transportation uses, particularly the bus station; obesity and food access; housing affordability, crowding, and displacement; mobility and public transit access; and conflict and crime. Further, the relative heterogeneity of the neighborhood strengthens the criticality of the public realm (See Images 5, 6). One study represents this diversity as a harmonious experience in Shapira's public realm, and is worth deeper examination given the likely complex and potentially contrary points of view of underrepresented groups presented by its authors:

> All these groups live in Shapira side by side, brush against each other, ignore one another, act by the social code of the neighborhood - 'live and let live' - and carry out, each separately, its unique lifestyle. These diverse activities are veteran Bucharians playing backgammon in the daytime beside barbecue feasts of Arab cooperators on Friday evenings in the public park, celebrations of the diverse independence days of migrant workers (each for his/her country). Silence falls on the neighborhood when Jewish Shabbat begins, and there is a colorful parade of Africans walking to church on Saturdays instead of Sundays against the unified look of prayer shawls and black and white customs of the Ashkenazi religious Ultra-Orthodox Jews and the Mizrachi religious Jews. (Schnell & Harpaz, 2006).

Image 5: Signage in Shapira for Ethiopian Coffee Ceremony, Mesilat Yesharim

In recent years, the City and some community members have tightened coordination through programs like the *Sustainable Neighborhoods Program*, taking steps to improve access to locally sourced food, build the neighborhood energy independence and local generation, and support tree planting. The City has also begun to work with the community to improve conditions on Mesilat Yesharim, installing a bike lane and beginning to support the organization and networking of local businesses.

To deepen our understanding of Shapira, support the design work of the Accelerator workshop, and to set a baseline of conditions and experience in the neighborhood, the Accelerator prepared a microclimate study of Shapira, measuring air temperatures, air flow, radiation, and humidity throughout the day and learned that the Shapira Park is one of the coolest spots in the neighborhood. Interviews of neighborhood residents suggest how people avoid walking to the bus stop and avoid public gardens due to the heat. Finally, to visualize the neighborhood, public spaces, and heat impacts, we took thermal images of key sites and developed a 3D model of the buildings.

Image 6: Shapira Park Playground, June 2019

Some of the findings suggest unacceptable conditions: For one, the mat under the playground at the Shapira Community Center reached 70°C on a June morning exposing not only a clear design challenge that is completely solvable but also an access and health equity issue (see Figures 4, 5).

Supported by vulnerability and microclimate and urban design research, the Resilience Accelerator convened community leaders, designers, academics, facilitators, NGO's, over a 2.5 day intensive workshop at the Shapira Community Center (see Images 7, 8). Participants designed pilot project concepts and considered their implications for city-wide policy. Residents participated in feedback sessions and mapping exercises that served as a starting place for community-based co-creation of design (see Images 9, 10). Project teams were asked to design with criteria in mind that built off of research and the needs of the City and community communicated by the Municipality and neighborhood partners. The principles aimed to ensure that quality of life is improved for the diverse communities that live and work in Shapira, that the neighborhood serves as a focal point for climate adaptation and mitigation, and that the fabric of the built and social environment maintains integrity in light of new infrastructure and housing development plans:

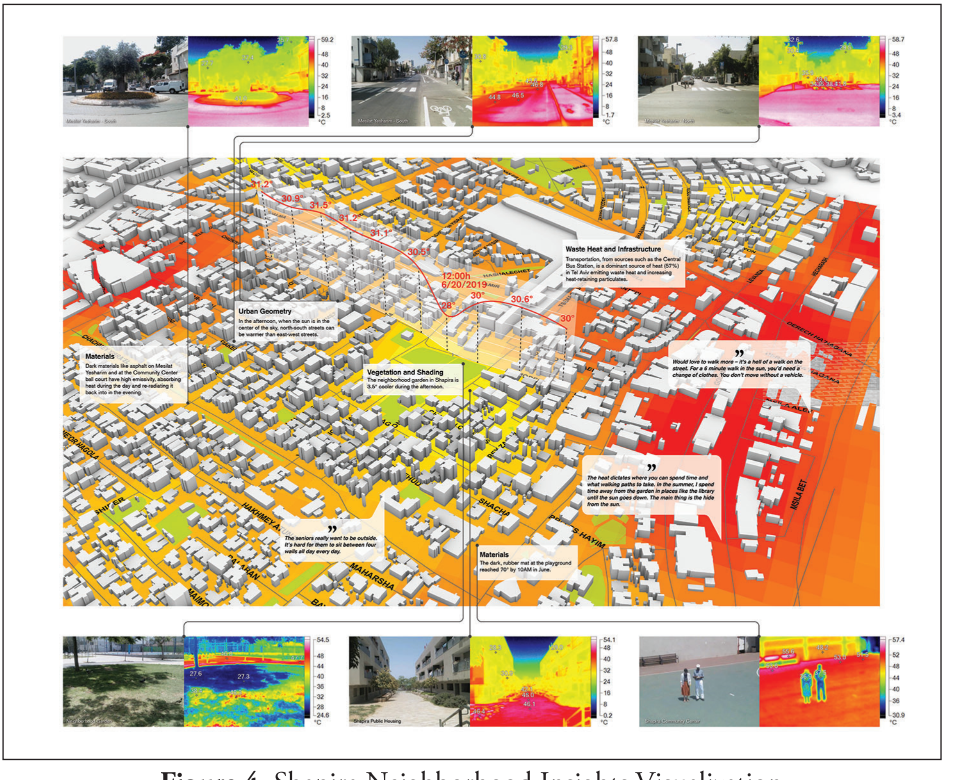

Figure 4: Shapira Neighborhood Insights Visualization

Design Criteria and Considerations

- Microclimate dynamics and influencers, such as: Natural ventilation, air flow; urban geometry and built form; sources and sinks of waste heat; Materials and their albedo and emissivity; sources of shade; vegetative cover and transpiration; and, time of day and seasonality
- The future of Tel Aviv-Yafo as more populous, warmer, and drier
- Animation of critical social infrastructure in the public realm, and encourages intergenerational and cross community gathering and conflict resolution (such as through opportunities for play, art, business operations, mobility)
- Prioritization of the most vulnerable to heat impacts at the forefront, such as seniors most at risk from isolation and health impacts
- Opportunity for partnerships across sectors, agencies and organizations through programming, operations, and maintenance
- Scaling potential across built or social systems city-wide
- Culturally specific to the diverse character of Shapira and integrated within the neighborhood-built fabric and current municipal planning and project implementation efforts

Figure 5: Shapira Community Center Playground, June 2019

Image 7: Resilience Accelerator Workshop Drawing Session

Image 8: Workshop Participant Teaming

Image 9: Shapira Community Feedback Session

Image 10: Community Heat Memory Mapping

Pilot project concepts were developed for three sites:One at the Community Center and two on Mesilat Yesharim, the neighborhood's commercial corridor.

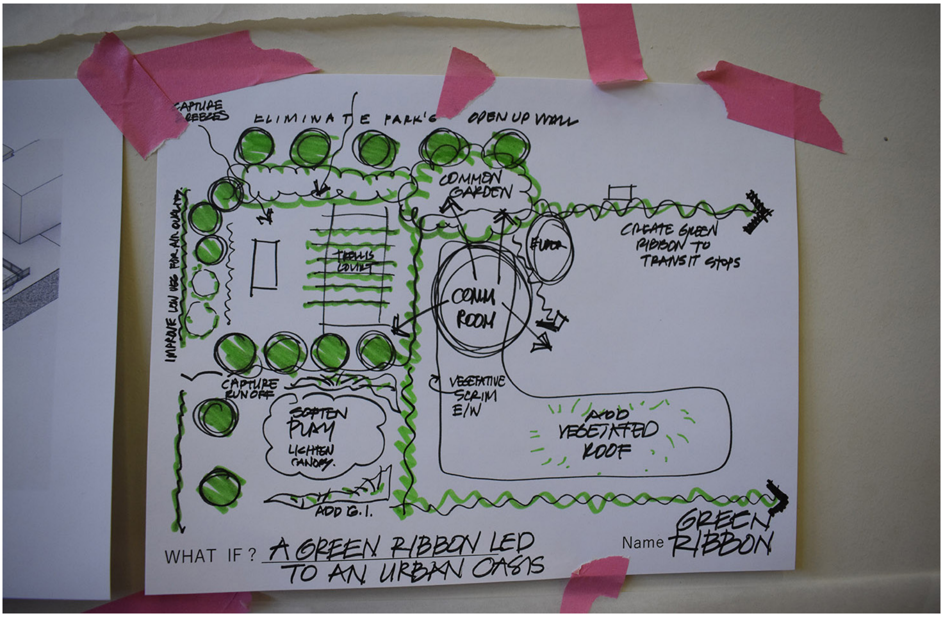

Image 11: Community Center Concept Plan

Mesilat Yesharim Street: The north-south commercial corridor of Shapira is characterized by limited storefront activity, a bike lane that inhibits pedestrian access, highly exposed to heat and solar radiation, unused street furniture, and walled off community assets and public spaces (e.g., synagogue). Recently, the City has invested in a placemaking effort for the street to improve conditions, such as through lighting and public art as well as remove the bike lane. Another team looked at a section of Mesilat Yesharim, using the east-west breezes and continuous tree plantings to create moments for rest. The concept seeks to engage local artists and the community to design the programming (see Image 11). Another group looked at pedestrianization of another section of Mesilat Yesharim, creating a cooling entrance to the neighborhood. The concept also activates the backyard spaces behind buildings to create multiple layers of cooling and connectivity (see Images 12, 13).

Shapira Community Center: This is a vital heart of the neighborhood, and actively programmed and used by families. The community center is adjacent to planned renewal and redevelopment sites on Yisra'el mi-Salant Street. The site can become dangerously hot: At 10:00 a.m. on a June morning, the rubber mat of the playground registered 70°C when gauged with a radiometer, hot enough to inflict burns on a child's bare feet. At the Community Center, project teams explored cooling with wind and shading. They looked at how storm water capture and cooling materials could be piloted and scaled to play yards city-wide. Finally, they also proposed engaging local schools through citizen science to measure outcomes as well as pursued better connections with the local senior care facility (see Image 14).

Image 12: Mesilat Yesharim Cooling Lane

Taken together, all three pilot projects suggest the beginnings of a district-scale approach to cooling, community resilience-building, and guidelines for future development. Both concepts are now in the design development and engagement phase by a local landscape architect and the municipality. The City is also now considering the possibility of a Microclimate Zoning Overlay District as well as developing climate resilient urban design and architecture standards for future development and public infrastructure investments, codified through building code and design standards.

Image 13: Mesilat Yesharim Cooling Pathways

Accelerator Conclusions

While the urban heat island effect is caused by conditions in the built environment, neighborhoods and cities are made up of more than just physical elements, and climate impacts are multidimensional and manifest across multiple scales. Design interventions to mitigate urban heat must be considered at all scales—from national scale decarbonization in transportation and energy systems, to urban scale built form and pattern, to middle scale neighborhood planning, to micro scale interventions like planting, paving, and solar shading. At the regional scale, global climate trends are creating a warmer and drier environment and more extreme temperature events. At the city-scale, heat exposure and sensitivity to heat impacts are uneven and disproportionately felt by more vulnerable populations and neighborhoods where past planning and design decisions have created conditions that exacerbate urban heat island. In neighborhoods like Shapira, district-wide planning around housing development, population change, and neighborhood revitalization can balance community needs with future climate and energy security. Finally, individual sites can serve as rich testing grounds for new standards - both private and public.

While the Accelerator workshop focused on a single neighborhood and sites within it, it advanced a broader set of adaptation policies, programs, and programs that could be implemented at the City and National scales. To this end, there remains a need to understand how City-level policy, such as zoning and building standards, can mutually support adaptation to an already hotter climate, mitigation of heat and energy-intensive uses, and build community-based resilience. Further, the intersection of social justice and those unseen in the neighborhood and in civic life remain of critical importance, and climate adaptation necessitates centering these voices of the marginalized and bravely rewiring standard practices in planning, design, and the policy that governs housing, economic opportunity and wealth distribution, energy planning, transportation, social services, community safety, and urban design.

Image 14: Mesilat Yesharim Pedestrianization Concept

REFLECTIONS ON COVID-19 AND URBAN HEAT VULNERABILITY

As the impacts of COVID-19 are felt worldwide, a 2020 summer and fall of unprecedented heat and storms, layered on top of COVID-19 response and recovery in Tel Aviv-Yafo and around the world. Worldwide, heat stress is made more urgent by a global pandemic, with an unclear time horizon for vaccinations or eradication, unstable healthcare systems, and worsening economic crises disproportionately affecting the poor and marginalized. The underlying conditions such as diabetes, asthma, and heart disease that make morbidity and mortality from COVID-19 are also those that predispose communities to heat health events. Like Shapira, these communities are consistently those that have historically been exposed to environmental conditions that underlie these health outcomes, such as proximity to industrial and noxious uses, presence of environmental contamination, lack of access to food, lack of access to public transit, and economic marginalization. These risks are all inextricably linked and are manifest in cities and communities worldwide and at all scales of decision-making.

In the backdrop, researchers and practitioners of urban planning are reckoning with how urbanization has systematically constructed oppression and disenfranchised, and is further exacerbating social vulnerability and exposure to environmental hazards. We see how these risks combine when we consider how the tools for managing heat stress are inadequate to the current COVID-19 crisis. For example, the moment demands rethinking of traditional methods of cooling centers as a primary tool given social distancing measures, management and design of public open spaces, small business losses in summer tourism, and further reductions in factors that contribute to underlying respiratory stress and health conditions in vulnerable groups. Further, while air conditioning is essential but it may not be available to all and as Eric Klinenberg discusses in *Heat Wave: A Social Autopsy of Disaster in Chicago* (2002), many older people, often also people of color, may perilously choose to suffer personal discomfort rather than unpayable utility bills. On top of that, air conditioning is a source of waste heat, ultimately accelerating the urban heat island effect.

For many cities, reclaiming streets as cool public spaces has become a focal point for policymakers. But this rethinking of public space has occurred in conjunction with a global movement around social, racial, and economic justice as well as exposure of how the prioritization frameworks used to implement street closures, for example, disproportionately benefits white and upper-class neighborhoods (Laris, 2020).

Already, examples of progress around the world are clear from Tel Aviv-Yafo where the Municipality is closing major roadways for pedestrianization to Milan, Washington D.C., and Montreal, where the shut-down and dramatic reduction in vehicular traffic driven by COVID-19 accelerated once-delayed investments in bike lane infrastructure (Kloosterman, 2020; Cobbs, 2020). These, and efforts like them that introduce cooling strategies through street lightening, shade, water that can also reduce car dependency and create socially-distant space for businesses, play, and art in the public realm are critical not only for the response to the pandemic in the summer months, but also are setting important precedent for longer-term and strategic remaking of the public realm in cities.

As we reflect on the Accelerator and Shapira, we offer that planners are at risk of reinforcing the same systemic conditions and power structures that have historically driven vulnerability by repeating top-down processes despite intentions to serve those at risk. So, as the intersections of vulnerability and the assumptions now reasonably made around their consistent spatial distribution are increasingly obvious and overlapping, we offer that the placement of these investments and centering of activists in design decisions become nearly as, if not more, important than the actual intervention regardless of the hazard.

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