Resilience Accelerator Tel Aviv-Yafo

Urban Heat And The Future Of The Public Realm

RESILIENCE ACCELERATOR TEL AVIV-YAFO

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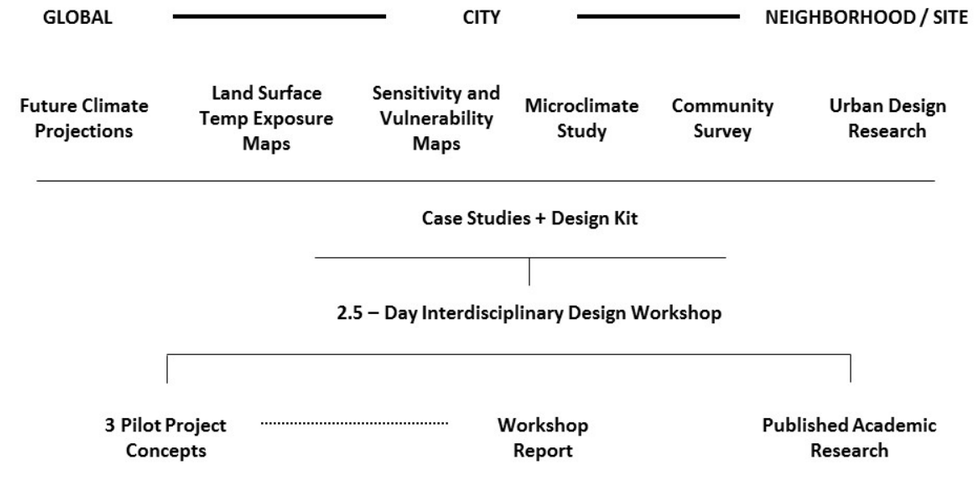
THE RESILIENCE ACCELERATOR

The Resilience Accelerator (the Accelerator) is a program of the Center for Resilient Cities and Landscapes (CRCL) at Columbia University to connect cities with design expertise and a global network of practitioners and researchers. Each Accelerator is sourced, organized, and executed in partnership with urban resilience networks and practitioner organizations. Initially established with 100 Resilient Cities (100RC), today the Accelerator works with an expanded network of partners to enhance the resilience value of projects, generate investment opportunities, deepen relationships between project teams, and accelerate implementation plans. The Accelerator supports city partners directly responsible for the implementation of priority resilience projects and is enhanced by local academic partners that coordinate local research to advance the analysis, design, and planning explorations.

The Accelerator aims to match the research, planning, and design expertise at Columbia with local knowledge and relationships of partner cities to advance pre-design work of high priority projects by:

- **Delivering analyses, visualization of issues, and design in support of project development, and leveraging Columbia University and other academic partners to advance resilience-based design, research, and decision-making.**
- **Facilitating immersive workshops that bring together multi-disciplinary teams to advance strategy, project design, and implementation.**
- **Convening the perspective of hundreds of international and place-based thought leaders, designers, and technical experts chosen for their ability to facilitate and advise on topical subject matter.**

Since the launch of the program in Spring 2018, the Resilience Accelerator has identified 13 projects across eight cities across the global network.



RESILIENCE ACCELERATOR | TEL AVIV-YAFO

In pursuit of the implementation of *Resilient Tel Aviv-Yafo,* a long-term and city-wide resilience strategy, the Municipality of Tel Aviv-Yafo partnered with the Accelerator team to advance research and project concepts that help the city adapt to climate risk from heat. The effort is coordinated with the City's comprehensive Climate Adaptation Plan and *C40 Cool Cities Initiative.*

The Accelerator draws on deep collaboration with climate researchers at **Tel Aviv University's Porter School of the Environment and Earth Sciences, Tel Aviv University's Laboratory for Urban Climatology and Bio-Climatology, Columbia University's Center for Climate Systems Research,** and the **NASA Goddard Institute for Space Studies.** Together, our aim is to deliver leading edge earth science in the service of immediate design and planning at the community level.

This research underpinned a Resilience Accelerator, which convened a workshop of municipal leaders and stakeholders, designers, academic and scientific experts, and community leadership, for an intensive facilitated design session to design pilot project concepts in Shapira in November, 2019. What follows is a summary of the process, learnings, and insights from place-based design research, citywide heat vulnerability analysis and site selection process, climate and microclimate modeling, case studies, and workshop findings.

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INTRODUCTION

July 2019 was the hottest month ever measured on Earth. Where the desert meets the Mediterranean Sea, climate change is leaving Tel Aviv-Yafo hotter and drier. As global greenhouse gas emissions continue to grow, Tel Aviv-Yafo can expect warmer than average temperatures, longer heat waves, continued drying, and an intensified urban heat island effect.[1] 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.

Like many other cities, patterns of urbanization in Tel Aviv-Yafo cause the urban heat island effect, which represents the totality of microclimatic changes brought about by manmade alterations to the urban surface.[2] 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
- The spatial relationships of streets, roads, buildings, and open spaces

Interrelated, none of these factors can be considered in isolation. For example, tall buildings may create shade, but they also trap heat and obstruct the flow of cooling breezes, even in a coastal city.[3]

Imagine, within the next decade there could be nearly two more months of days over 33°C every year, and heat waves could last and additional 10 days.

Heat is not just a matter of discomfort. It is often the most vulnerable neighbors who are most exposed to heat and least resourced 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 with months of lost foot traffic reduce revenue and jeopardize business sustainability. Livelihoods might therefore be lost and important community resources eliminated for residents.

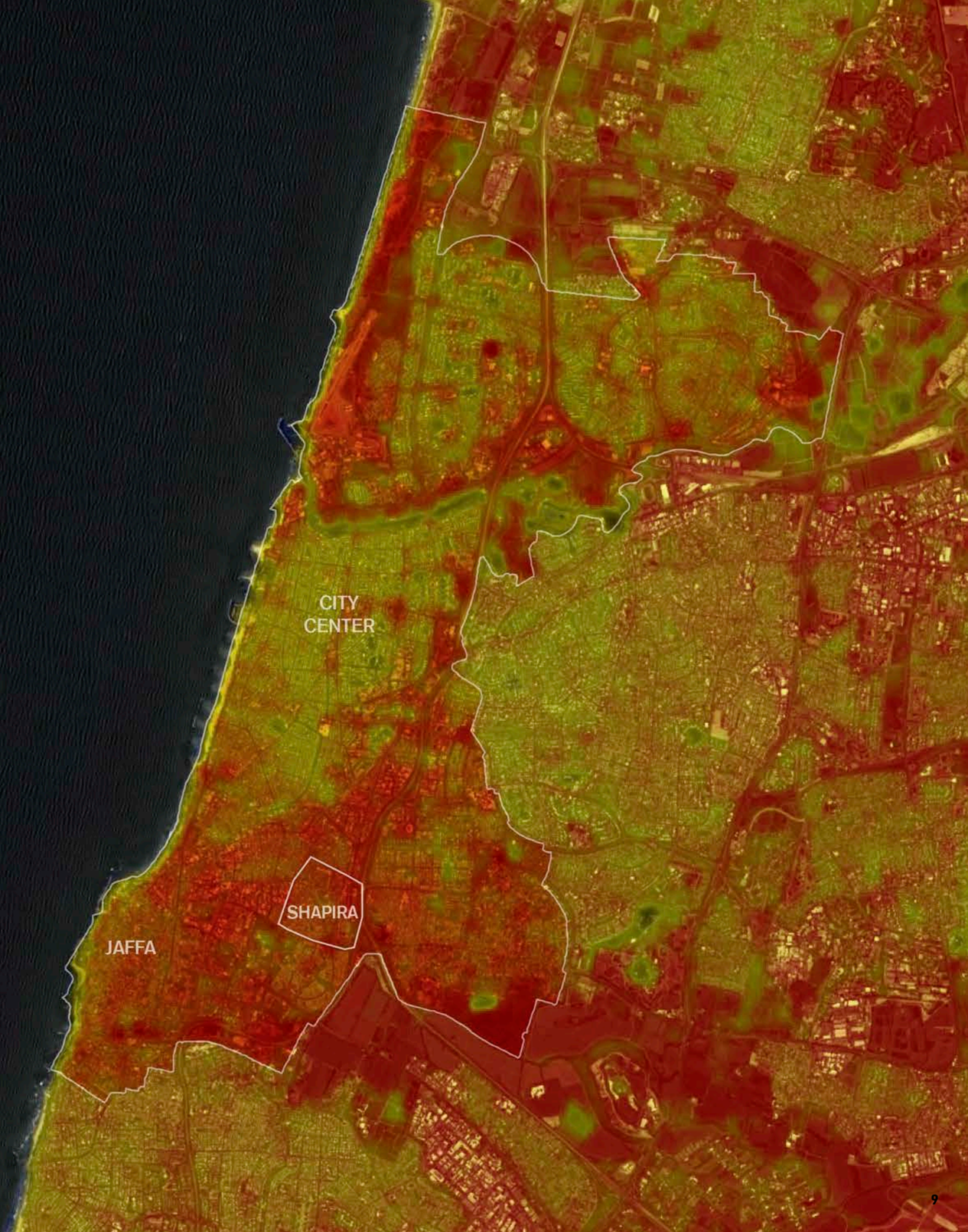
Urban Heat impacts are felt even in Tel Aviv-Yafo neighborhoods where streets were designed to channel the sea air through open boulevards and a dense canopy of trees provides shade and moves cool air through buildings. In others, such as those in the south of Tel Aviv, where the streets are more exposed to the sun and have limited tree canopy cover, communities have access to fewer resources to adapt.

But 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?

The urban form of Tel Aviv-Yafo may–out of necessity–change with the climate. And the public realm, defined by Richard Sennett as the "place where strangers meet,"[4] is at risk of becoming a place of danger, discomfort, and disinvestment. 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.

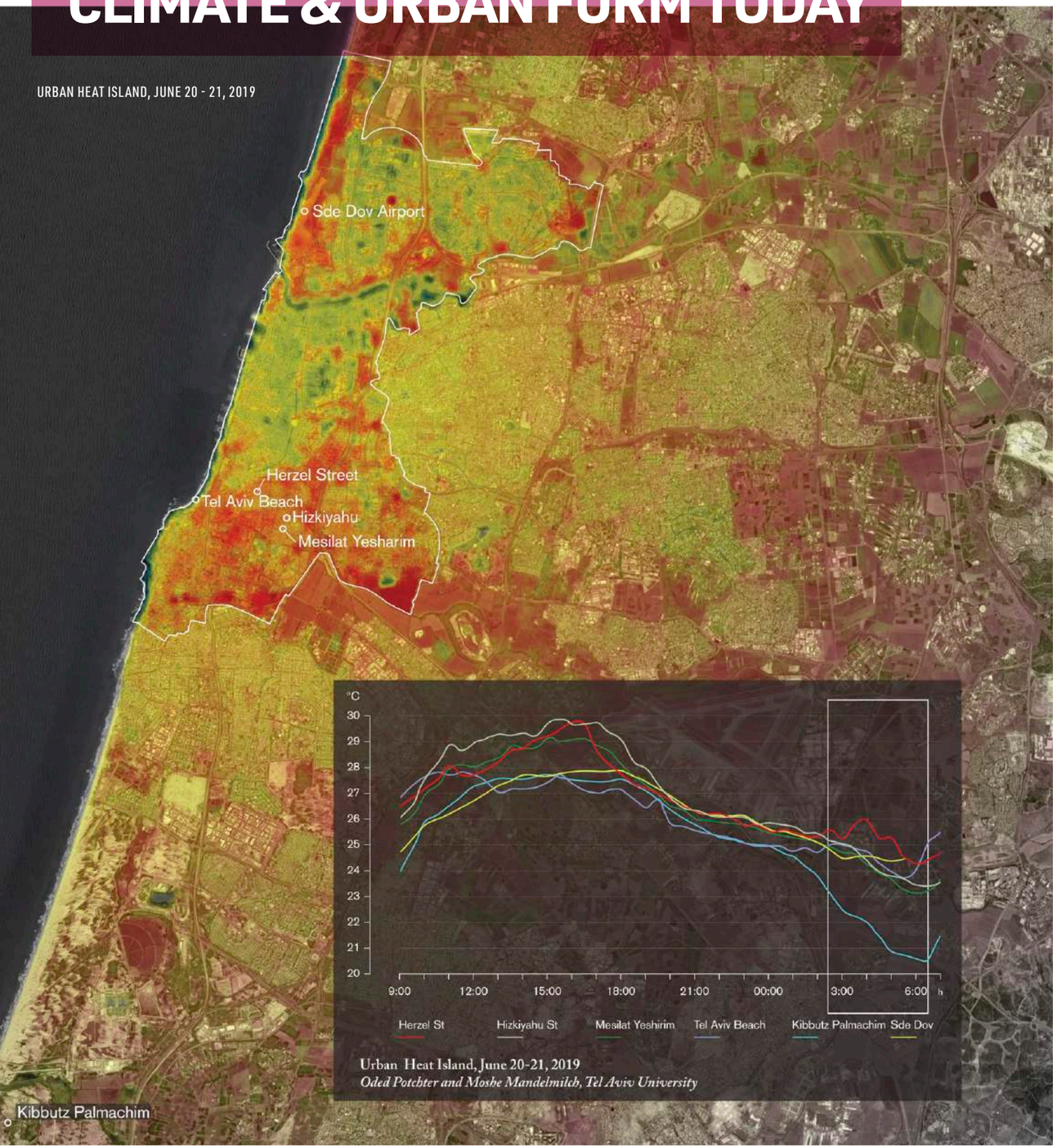
The public realm, however, can be a space for healing and transcendence of historic and sometimes violent divisions between people. The public realm is a critical asset of social connectivity - from older neighbors who's physical health depends on connection, to young people exposed or isolated from learning about cultures and practice different from that which they understand at home. It can be the connective tissue that all cities need to bridge the perceived gap between people and the natural systems upon which we rely and are a part of. The public realm consists of all land that is not private: streets and sidewalks that provide for mobility and transportation, parks that provide amenity and climate regulation, play spaces in community centers that serve families; and even tree pits, which with wide canopy trees, can cool buildings and reduce energy loads. Investments made by a local government in the public realm are powerful instruments to find and define the future of the city.

By exploring new visions for the public realm in Tel Aviv-Yafo in relation to the changing climate, we can not only cool the city but also strengthen the fabric of its communities.



CLIMATE & URBAN FORM TODAY

URBAN HEAT ISLAND, JUNE 20 - 21, 2019



"The Middle East is considered one of the most high-risk areas for global warming, and we are feeling this challenge more and more."

–MAYOR RON HULDAI, TEL AVIV-YAFO

Scientists worldwide warn that we must limit the warming of the Earth to 1.5°C to avoid the worst impacts from climate change.5 Despite this, July 2019 was the hottest month ever recorded on earth. Based on the latest science, the global community is increasingly less likely to reach this target.[6]

Today, Tel Aviv-Yafo's subtropical Mediterranean climate is influenced by two dynamic factors: the Mediterranean Sea and urbanization. During the summer, it is hot and humid, with a daily maximum temperature of around 30°C. Relative humidity can reach 95% during August.[7]

As the region urbanized and grew in population in the early 20th century, Sir Patick Geddes, a Scottish biologist, geographer, sociologist, and town planner, leveraged this climate. In his 1925 plan, large east-west boulevards carry these breezes from the Mediterranean Sea through the city. The Geddes plan provided a framework for Bauhaus Architects fleeing Europe in the 1930s and 40s to design thousands of climate- appropriate buildings, now known as the UNESCO World Heritage site, the "White City." Today, the boulevards of the White City have large canopies of trees that provide shading and shadow, and cool air as it ventilates buildings.[8]

1925 MASTERPLAN FOR TEL-AVIV, PATRICK GEDDES

However, as urbanization continued throughout the 20th century, like most cities, patterns of planning and development maximized automobile accessibility and were less focused on the particularities of local climate and geography.

Today, these patterns have resulted in Tel Aviv-Yafo becoming an urban heat island relative to the surrounding areas, which is especially acute in the south of Tel Aviv.[9] Tel Aviv-Yafo is 3°C warmer than the rural area (Palmachim) during the day, and 4°C during the night. Unlike the beach, where the Sea moderates temperature, urban heat spikes during the day inland. In some neighborhoods, like Florentine, it spikes again at night due to the urban canyon of buildings. In the summer months, when it's hottest, a sea breeze typically blows from the west or northwest. At night, a light land breeze carries wind from the east or southeast towards the sea.[10]

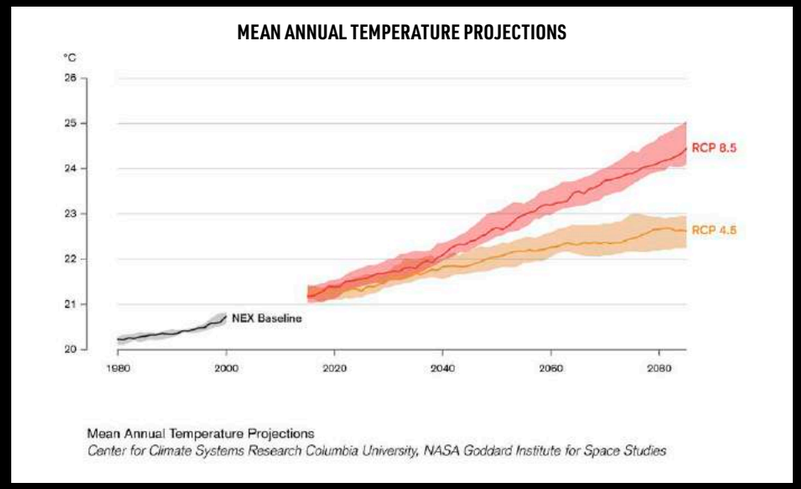
Inland and in southern districts, the urban heat island effect is more acute, where the streets are narrower and the fabric provides for less ventilation. Dense buildings and narrow streets create urban canyons, preventing heat from escaping and interrupting air flow. Transportation infrastructure and buildings give off heat in the form of exhaust and particulate matter, which becomes trapped by the dense streets and buildings. And 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.

Looking to the Future

As a part of the Resilience Accelerator, the team partnered with the NASA Goddard Institute for Space Studies and the Columbia University Center for Climate Systems Research to prepare downscaled climate projections for Tel Aviv-Yafo and the region. These climate projects use 21 climate models in the NASA Earth Exchange Global Daily Downscaled (NEX-GDDP). They use two greenhouse gas emission scenarios: RCP 4.5 (mid-range) and RCP 8.5 (high), assuming that the RCP 8.5 represents "business as usual." Projections were prepared for three time periods: 2020s (2011 - 2040), 2050s (2041 - 2070) and 2080s (2071 - 2100). The full methodology for these projections can be found in Appendix I.

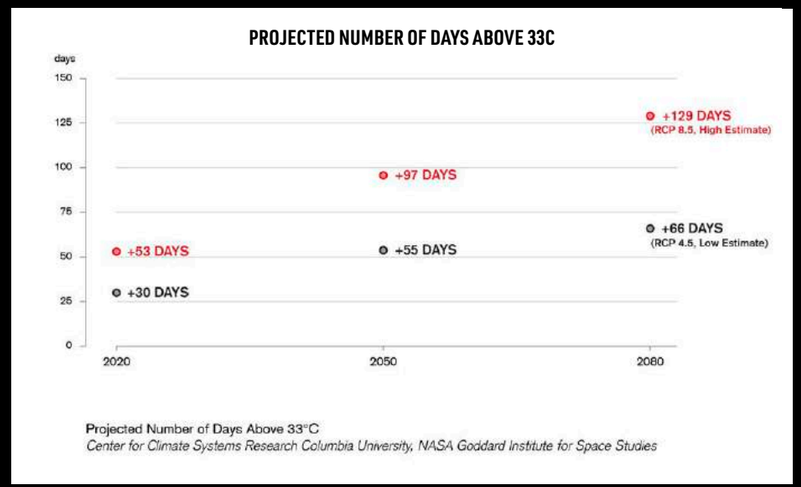
As the microclimate created by urban development has become apparent, the global climate has begun to change. Since the 1980s, Tel Aviv-Yafo warmed nearly 2°C.[11] In the last decade, warming in the Tel Aviv-Yafo and the Middle East region has largely outpaced every other region on Earth. This trend is expected to accelerate over the next century if global emissions remain on the same trajectory.

If global emissions remain on the same trajectory, average annual temperatures may increase by up to 4.5°C by the 2080s...



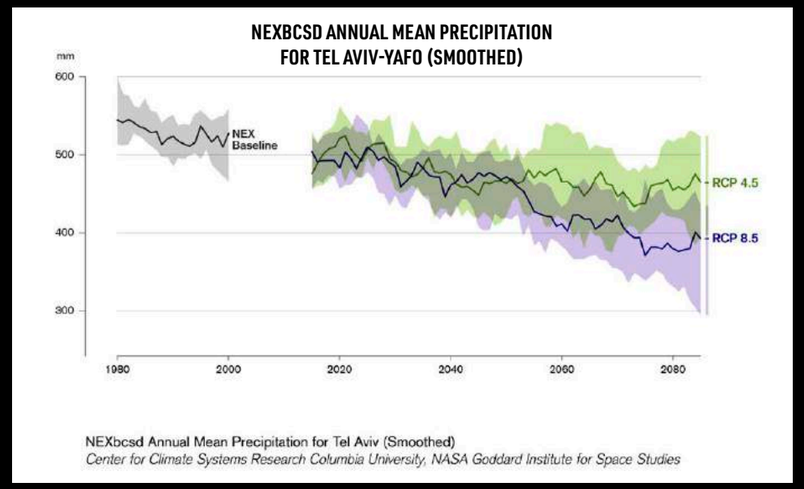
Mean Annual Temperature Projections
Center for Climate Systems Research Columbia University, NASA Goddard Institute for Space Studies

...there could be up to 53 more days above 33°C each year as early as the 2020s...



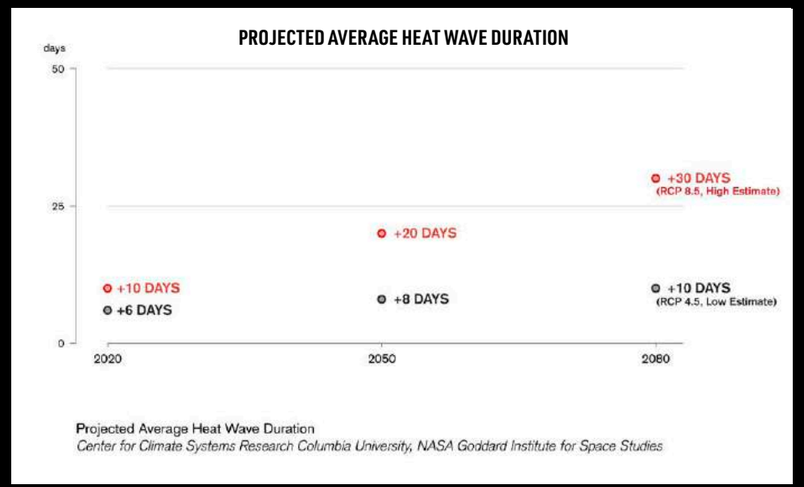
Projected Number of Days Above 33°C
Center for Climate Systems Research Columbia University, NASA Goddard Institute for Space Studies

... and annual precipitation may decrease by up to 10% in the 2020s, and up to 38% by the 2080s

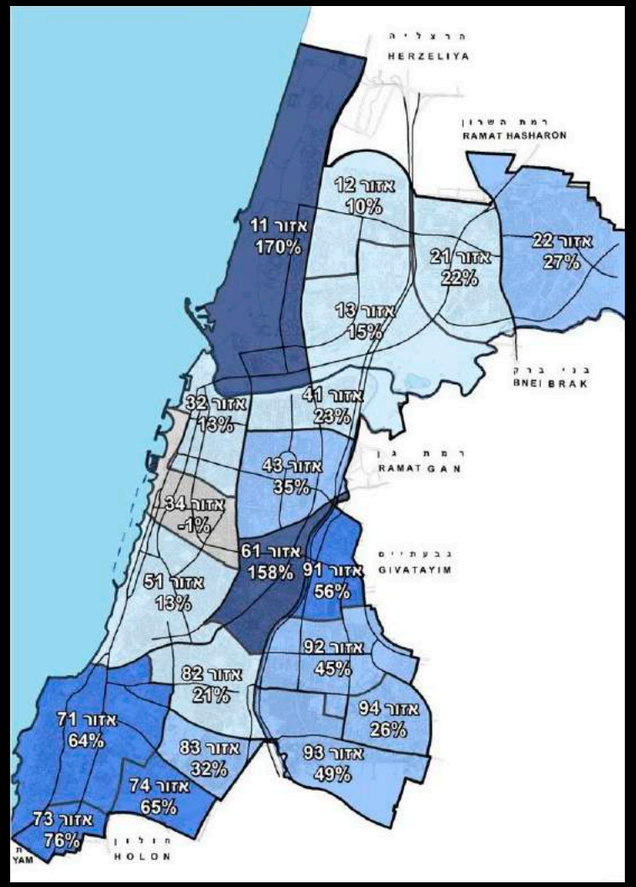


NEXbcsd Annual Mean Precipitation for Tel Aviv (Smoothed)
Center for Climate Systems Research Columbia University, NASA Goddard Institute for Space Studies

... heat waves may average up to 10 days in the 2020s, up to 20 days in the 2050s, and up to 30 days by the end of the 21st century...



Projected Average Heat Wave Duration
Center for Climate Systems Research Columbia University, NASA Goddard Institute for Space Studies



Meanwhile, the city is growing, complicating decisions and affecting resources around energy, housing, infrastructure, community and cultural services, and water systems. Tel Aviv-Yafo is reconciling how the built environment can support economic and population expansion, while not contributing to or exacerbating climate change and its impacts on vulnerable communities and ecosystems.

Initiatives like the Strategic Plan for Tel Aviv-Yafo, Resilient Tel Aviv-Yafo, and the development of a city-wide climate adaptation plan are steps towards this vision.

Today the city has a population of 438,000 people and forms the core of the largest metropolitan area in Israel.[12] In anticipation of 160,000 more people by 2035, the City has set growth targets for 2025[13]: 120,000 housing units, 5 million square meters of new office space, and 86,000 more workers. In parallel, Tel Aviv-Yafo has committed to meeting goals that support the resilience and sustainability of the city:

- **Increase usage of public transportation and non-motorized mobility while radically reducing private car usage**
- **Increase the Green infrastructure of the city, specifically by planting more trees and nurturing urban nature**
- **Install solar energy on all public buildings**
- **Reduce waste in landfills by 50% by 2030**
- **Encourage residents to lead a sustainable lifestyle to lower the cost of living and achieve a better quality of life and resilience.**
- **Develop the city's local social-economic potential, with a focus on disadvantaged population, small business, and local initiatives**

WHY HEAT MATTERS

The impacts of climate change and urban expansion transcend every dimension of life. 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.

Health and People

For many, 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; overall, hospital admissions increase during heat waves.[14] One study found that visits to the emergency room in Israel increased by 1.47 percent per 1° increase in ambient temperature.[15] Further, certain occupational groups are disproportionately impacted–outdoor workers, construction workers, and first responders–who lack access to cooling.[16]

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.[17] One study found that emergency psychiatric response calls in Baltimore, Maryland increase by 40 percent when the heat spikes to 39°, in part due to the decreased effectiveness of psychiatric medications.[18] 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.[19]

Heat changes how we socialize and build community.
Heat changes the choices we make about where we can and want to spend our time. It 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 of going outside or staying indoors, it can lead to social isolation, which can in turn result in sickness or death.[20]

Some studies suggest that heat also influences safety, security, and conflict. For example, in poor Los Angeles neighborhoods, violent crime increases by 5.7 percent when temperature tops 29.4°F, but not in wealthier parts of the city.[21]

Energy and Infrastructure

The more energy we use too cool off, the hotter it could get.
As urban heat increases, more energy for air conditioning is needed to cool buildings.[22] Today, 90 percent of Tel Avivians have air conditioning.[23] But the more it's used, the greater the risk of power surges, black and brown outs, and increasing peak energy loads.[24] Not only does this increase emissions, it also puts critical energy infrastructure at risk. This energy ensures that businesses can run, data can be stored, and health and transit services can be delivered.[25] 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. Beyond this conundrum, a reliance on air conditioning exacerbates the divide between rich and poor, with the expense of energy consumption out of reach for low-income families.

And today's infrastructure may not be built to withstand the temperature of the coming decades.
Heat also changes the material durability of infrastructure. Roadways, railways, and even airline runways can buckle or warp.[26] Hotter air is less dense and impacts airplane engines and necessitates longer runways for takeoff.[27] Extreme heat is not only a safety hazard, it also poses risks for major transportation service disruption.

Economy and Fiscal Planning

Heat changes the financial outlook of the city.
Today, Tel Aviv-Yafo is already feeling the impacts of heat in the amount of money spent on irrigation each month. 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.[31] With projected risks to infrastructure, greater public capital may be needed to retrofit towards future climate conditions.

Heat impacts household expenses.
As air conditioning usage increases, so do the household and public expenses used to cool homes and public buildings.[32] For the most vulnerable, added financial instability decreases community capacity to adapt.

Heat constrains the operations of private firms and 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 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.[3334] In Israel, where tourism is a key factor in future economic growth planning, heat could change consumer habits and tourist activities.[35]

Ecosystems and Environment

Urban heat island effect is driven in part by the loss of soil health and vegetation.
The loss of vegetation from urban development could be further compounded by increasing heat and less precipitation. Certain species of trees and plants may not be drought resistant, and vegetation hardiness zones may ultimately migrate northward as the climate changes.[28] A warming climate may change the geographic range of habitats and create uncertainty for city planners and landscape architects. The migration of species may outpace the standards and practices of landscape designers and planners pursuing green infrastructure investments.[29]

Heat, air quality, and water are interdependent.
Capacities to conserve water become constrained as heat increases. Rainfall is expected to decrease in Tel Aviv-Yafo in the coming decades, but surface temperature impacts run-off draining into local waterways. For example, pavements that are 37.7°C or higher can elevate rainwater temperature from 21° to 35°, complicating landscape management and impacting local aquatic life.[30] Intact and connected soil systems are critical to the health of trees and vegetation.

REVEALING VULNERABILITY:

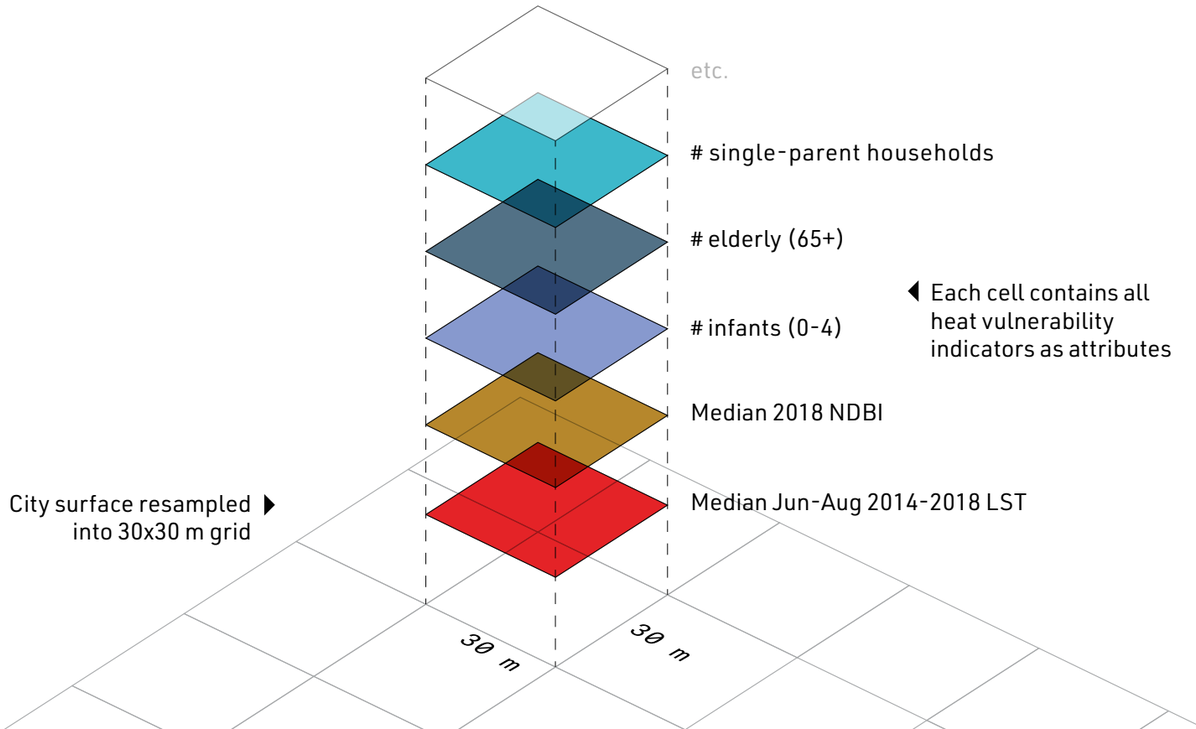
A TEMPLATE FOR ACTION

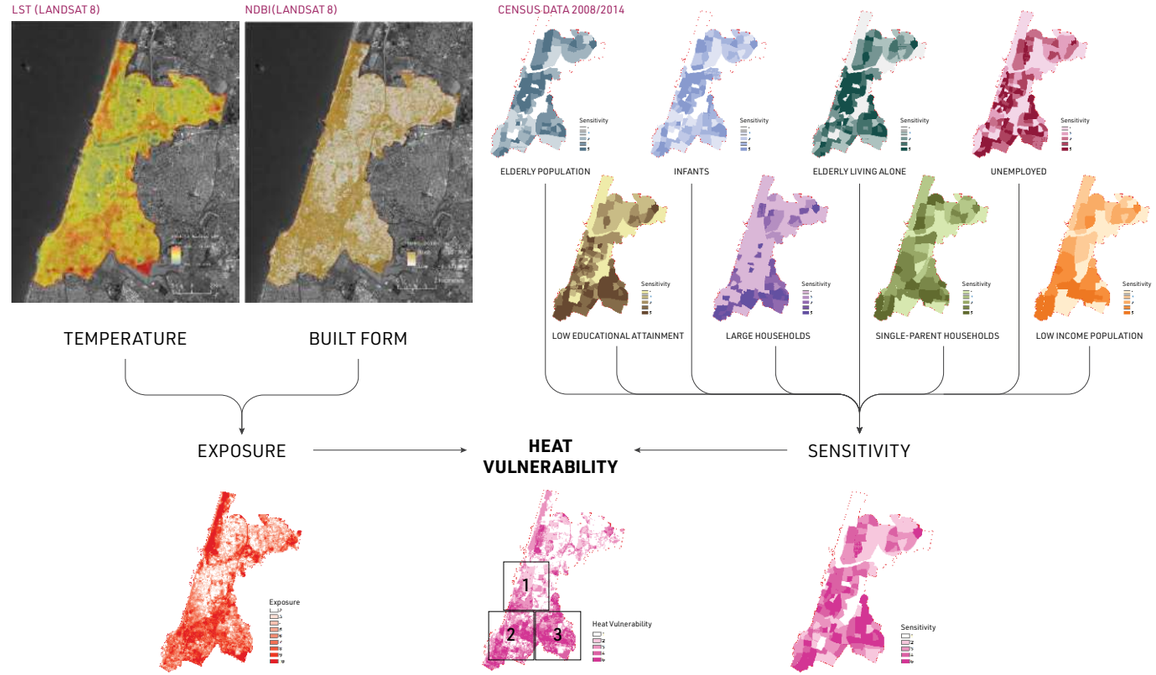
Vulnerability can be understood as the combination of exposure and sensitivity. At CRCL, in collaboration with our partners, we looked across similar indices developed for other cities, and synthesized some of the key factors associated with heat vulnerability in Tel Aviv. By using remotely sensed data from the thermal sensor of the Landsat 8 satellite and Tel Aviv-Yafo census data, we identified the neighborhoods most at risk. This process, a "multi-criteria decision analysis," is intended to help prioritize where planning efforts might be directed. Our methodology for assessing vulnerability is as follows.

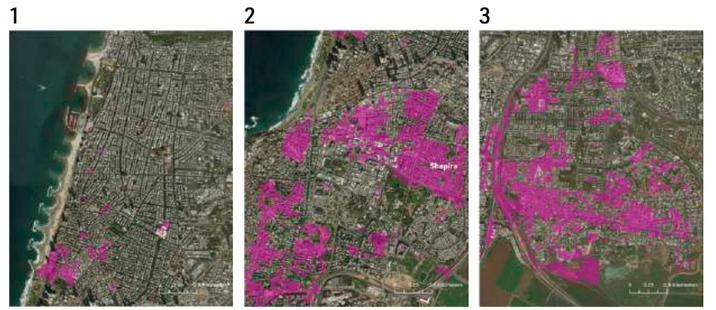
Landsat data is represented in 30x30 meter grid cells (or pixels), while census data is aggregated in statistical areas of various sizes and shapes. To overcome this difference, we re-sampled the entire area of the city and census data into this grid. This allowed us to layer multiple variables of different sizes into the same grid units. For each data set, we classified median composite values of these grids 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 is utilized throughout the months of June, July, and August between 2014 and 2018. In this composite map of land surface temperature (LST), the deeper the red, the hotter the surface relative to the rest of the city.

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.







HIGHLIGHTED IN PURPLE ARE THE AREAS OF THE CITY CLASSIFIED AS MOST VULNERABLE TO HEAT (TOP 20TH PERCENTILE OF GRID CELLS).

With a goal of prioritizing vulnerable neighborhoods, we studied demographic indicators that suggest sensitivity to heat. These factors indicate who may be may be less able to adapt or more vulnerable to the acute impacts of any type of stress or hazard.

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 the assumed sensitivity.

As a last step, we compiled all of the exposure and sensitivity maps. By stacking them we can begin to prioritize areas of the City facing the most acute impacts from heat stress. Together, these maps suggest that areas in the south of Tel Aviv-Yafo are where exposure to heat may be disproportionately impacting certain communities.

LEARNING FROM SHAPIRA

SOURCE: JODI HILTON/PRI, BOYS GATHER IN THE SHADE OUTSIDE AN ERITREAN CHURCH IN SHAPIRA, TEL AVIV

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. To ground our research and analysis in the particularities of place and urban policy, we needed to select a neighborhood through which to read these scales.

Therefore, by focusing research and a workshop on a single neighborhood research, we could more closely observe the impacts of heat and begin to devise practical strategies that address heat at the scale of a site as well as inform citywide 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, located in southern Tel Aviv-Yafo. Shapira has historically been on the periphery - both in geography and public perception. Originally a grove, the area was developed by Meir Getzle Shapira in the 1920s. Because the neighborhood was neither a part of Jaffa nor Tel Aviv-Yafo at the time, Shapira took advantage of freedom from taxes and the lax construction standards to build factories and homes.[36]

Geographically defined by Kibbutz Galyot 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 today largely residential with low- to mid-rise buildings, a mix of community facilities, and a key 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 Nave Sha'anan. Today, the station is a gateway for immigrants and asylum seekers arriving in Tel Aviv, many of whom settle Shapira and neighbouring areas, often with many people to a single apartment and marginalized from the formal economy and political processes.

Over the last decade, Shapira has battled a perception of blight and disinvestment and increasing housing pressure.

Efforts to invest in services, housing, and community assets has 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 city could dramatically change neighborhood. With those investments though, come risks to the built and social fabric of the neighborhood and nearly 8,000 people representing a wide range of ethnic groups that call Shapira home. Today, the neighborhood faces from extreme heat among others stresses, including air quality from nearby industrial and transportation uses, particularly the bus station; obesity and food access; housing affordability; mobility and public transit access; and conflict and crime. Further, the heterogeneity of the neighborhood strengthens the criticality of the public realm.

"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 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." [37]

In recent years, the City and 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 on local businesses.

SHAPIRA PARK PLAYGROUND

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

In June, 2019, the Accelerator team met for a week-long research trip in Shapira. Together, the Municipality, Tel Aviv University, and Columbia University partners documented urban design conditions, met with neighborhood leaders, and took measurements of heat in the neighborhood.

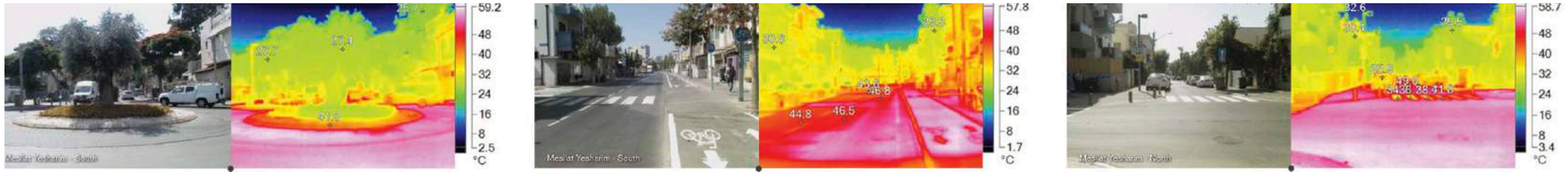
Thermal camera on Yisra'el mi-Salant

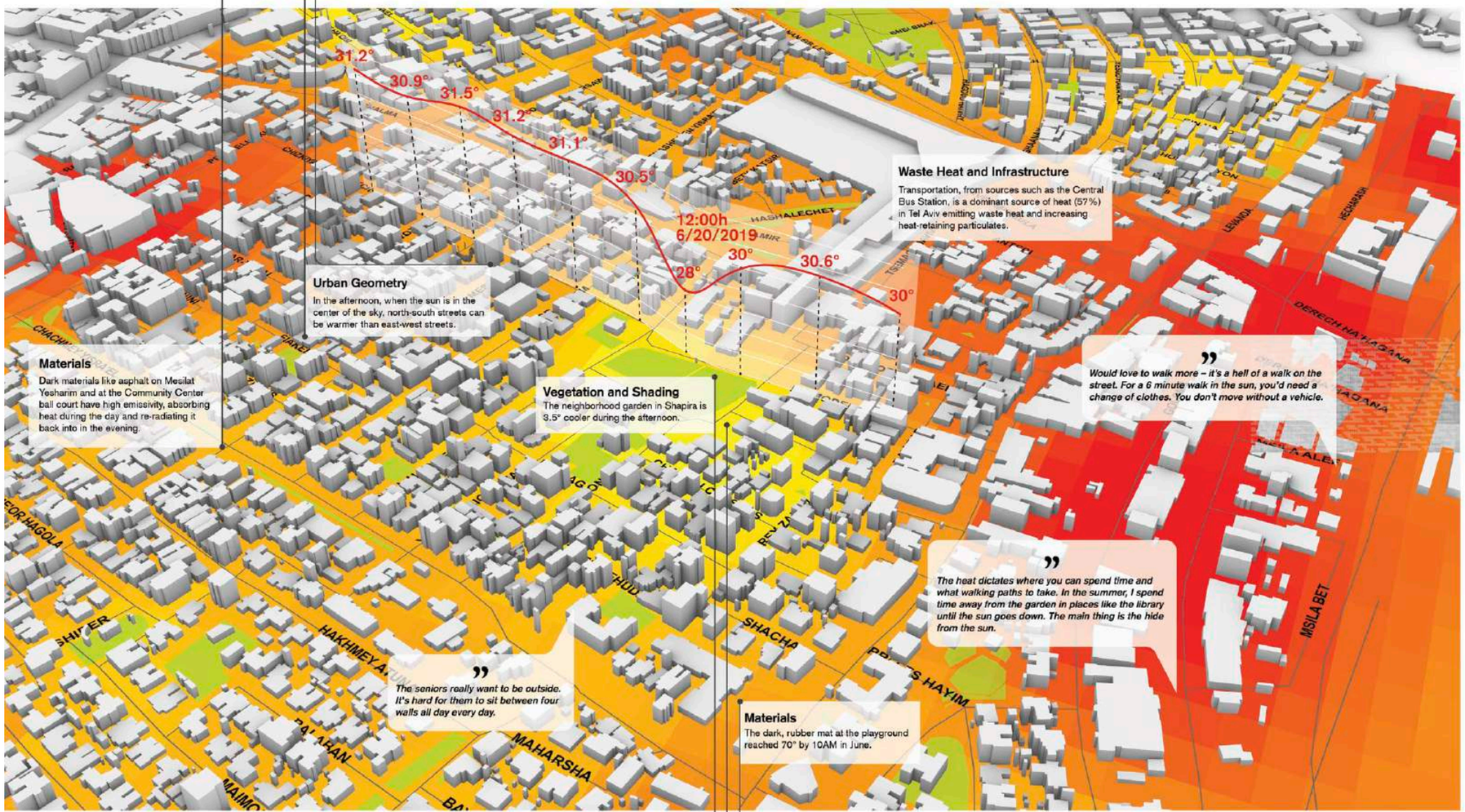
Fixed weather station on Mesilat Yesharim

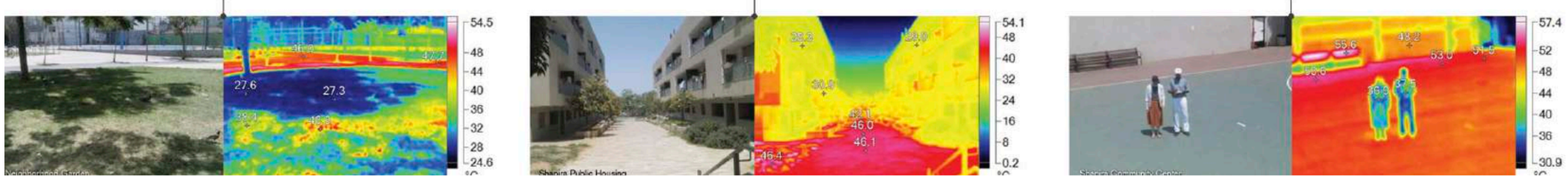
Learning from community leaders

Documentation of the built fabric on Mesilat Yesharim

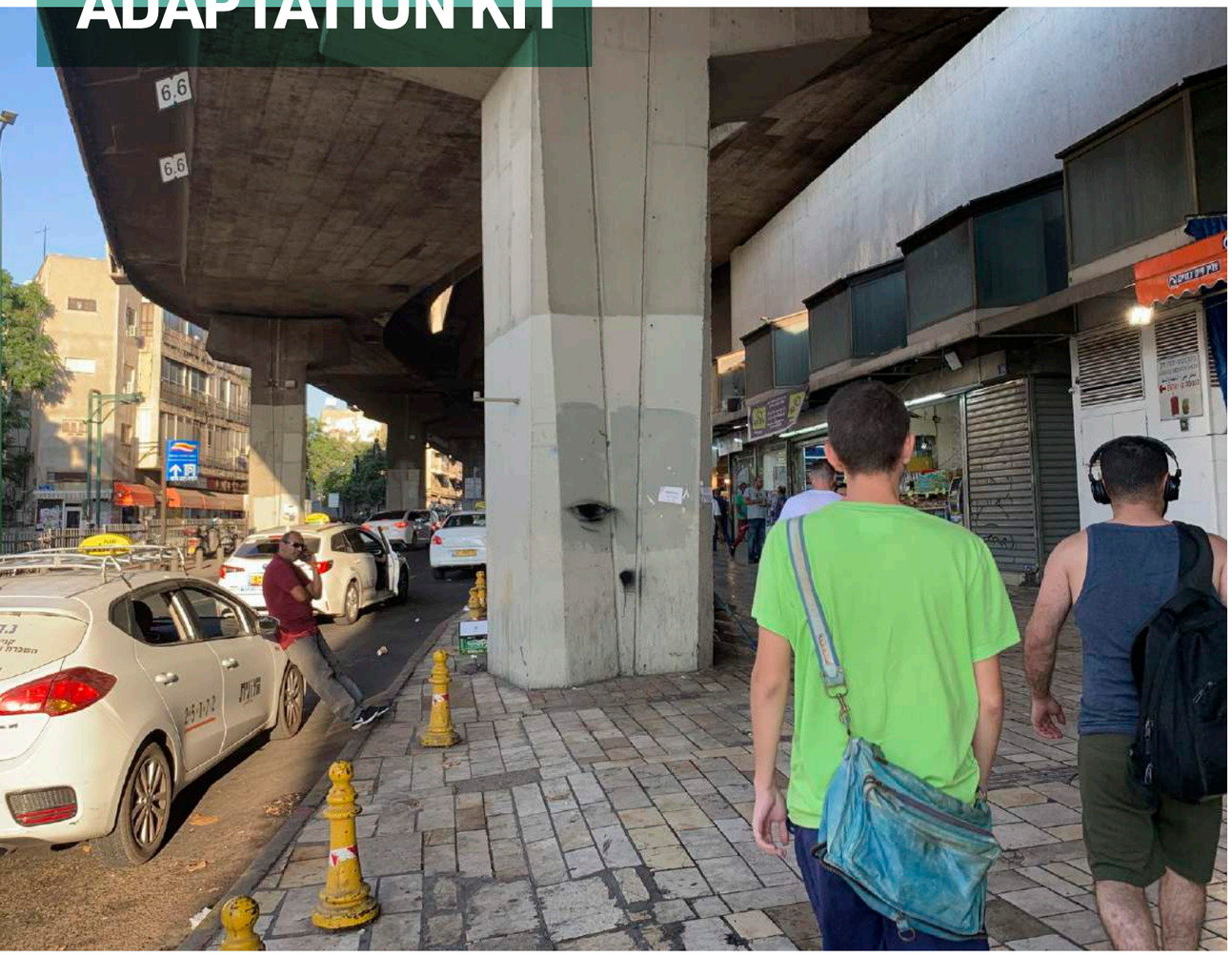
INSIGHTS FROM SHAPIRA: TEMPERATURE MEASUREMENTS, URBAN FABRIC, AND LOCAL RESIDENTS' EXPERIENCES. THERMAL IMAGERY BY ODED POTCHTER AND MOSHE MANDELMILCH, TAU, NOT PUBLISHED (2019); LST STUDY AND 3D MODEL BY CRCL; SURVEY OF SHAPIRA RESIDENTS BY MUNICIPALITY OF TEL AVIV-YAFO







ADAPTATION KIT



Designers and policymakers around the world are grappling with the complexities of reducing the urban heat island effect. We have compiled a toolkit of strategies and case studies based on relevance to the climate of Tel Aviv-Yafo and opportunities to mitigate heat in the public realm, largely organized by the four related factors that contribute to the urban heat island effect:

- **Heat sources and particulate pollution from infrastructure, cars, and buildings**
- **Materials and surfaces that absorb and radiate heat**
- **Loss of vegetation that converts solar energy to water vapor and provides shade**[38]
- **Built geometry of streets, roads, buildings, and open spaces**

These factors are interrelated and cannot be considered in isolation. For example, tall buildings may create shade, but also can trap heat and slow wind speed. In the Florentine neighborhood, the tall buildings and deep urban canyons of Herzel Street can create air temperatures 2.5°C warmer than those on Mesilat Yesharim in Shapira where buildings are lower and streets allow more air circulation (*Potchter, Mandelmilch 2019).* The thermal mass of the larger buildings in Florentine also retain heat long into the evenings, when Shapira has begun to cool down.

Waste Heat and Infrastructure

Credit: Oded Potchyer and Moshe Mandelmilch, Tel Aviv University (Not yet published)

"The dominant anthropogenic heat sources in the city (Tel Aviv) are transportation (57%) and use within buildings (34%). Industry energy consumption is small, 9%".[42]

Reducing waste heat means reducing the heat emissions of buildings and cars. This can be achieved by promoting mass transit, ride-share and electric vehicles, congestion pricing and energy efficient buildings that rely less on mechanical systems. All of these strategies have the added benefit of reducing greenhouse gas emissions and therefore, helping to mitigate global warming. Waste heat can also be mitigated for pedestrian comfort by for instance, by planting shrubs that shield sidewalks from vehicle exhaust. Increasing vegetation around and on top of buildings can also reduce the need for air conditioning. Public information can also be a critical tool: in raising awareness about the contribution of cars and air conditioners to city heating, some might elect to take a bus or turn on a fan instead. Finally, when waste heat cannot be eliminated, perhaps it can be used as a public benefit. According to architect Jeffrey Raven, waste heat from buildings and infrastructure could be captured and used to support district energy in dense, transit-oriented developments.[39]

SOURCE: CC/WIKIMEDIA COMMONS/MICHELL ZAPPA

REUSING HEAT IN STOCKHOLM CENTRAL BUS STATION

Stockholm Central Train Station in Sweden captures waste body heat generated by the 250,000 people that pass through the station each day. This heat is used to warm up water, which is then pumped through pipes to adjacent buildings for heating. The project manager expects this innovation to reduce heating costs for these buildings by 20 percent.[4041]

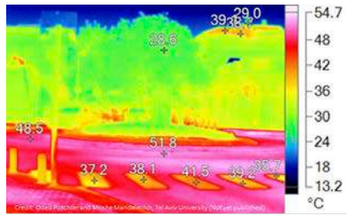
Materials and Surfaces

The materials used for buildings and streets - concrete and asphalt - have low albedo and high emissivity, meaning they poorly reflect solar radiation, and instead they absorb, retain, and slowly radiate it overnight. They are also impervious to water, which reduces the amount of moisture available for evaporative cooling into the atmosphere.[43] By contrast, vegetation has low albedo and low emissivity, meaning it absorbs and uses solar radiation for photosynthesis and also retains moisture. However, when plant material is dried out by drought or extreme heat, it can lose theses cooling properties.

In Tel Aviv, like other urban areas in Israel, streets paved with asphalt are a significant heat source during the day and into the night.[44] Further, where asphalt is more rugged or covered in oil pots and skid marks, emissivity can result in even higher temperatures.[45] The climate-appropriate buildings of the White City have light colored roofs, walls and terraces that reduce solar gain during the summer and in turn reduce energy consumption,[46] but design of the public realm requires a multi-level strategy from building roofs to surfaces of city streets. Bright-colored sidewalks might appear architecturally appropriate but they can concentrate and intensify glare and create pedestrian discomfort. And, pavements and coatings alone may not be enough to impact air temperature, so any effort to reduce heat through material, should be considered alongside other interventions that improve shading, evapo-transpiration, and ventilation.

Fortunately, opportunities to improve the thermal comfort of the public realm are constant. Paved surfaces are regularly dug up and resurfaced by municipalities and can be replaced with more appropriate materials and vegetation at low cost.

MESILAT YESHARIM, SHAPIRA, TEL AVIV



THERMAL IMAGE OF MESILAT YESHARIM AT SDEROT HACHMEI ISRAEL, SHAPIRA, TEL AVIV

PARIS SCHOOL YARDS URBAN OASIS PROGRAM, SOURCE: 100 RESILIENT CITIES

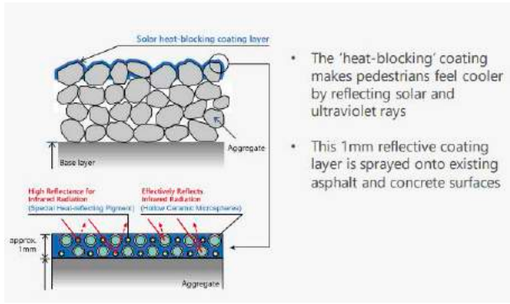
Cases of Evaluating and Using Cool Materials

PARIS SCHOOLYARDS URBAN OASIS PROGRAM

The Paris Schoolyard "Oasis" program, which emerged out of the *Resilient Paris Strategy,* retrofits schoolyards with permeable and reflective pavements to reduce urban heat island impacts, temper heat waves, provide stormwater and flood capture, and reduce energy consumption. By using light-colored, porous pavement and a low-carbon-footprint substrate the schoolyards capture rainwater and cool the environment.[47] Rainwater is cools the grounds through evapo-transpiration and is reusable for water games and gardening. Trees, gardens, and green walls provide shade, cool down schools, and reduce energy consumption. The program also aims to broaden community access to public spaces with an ultimate goal of opening schoolyards to the public during non-school hours. The City has so far implemented three pilot locations.[48] The City and has been awarded €5 million more by the EU to expand the program to 30 schools.[49] Each school is expected to cost €300,000 the goal is to transform 800 schoolyards by 2040.[50]

EVALUATING COOL PAVEMENTS

"Mitigating Urban Heat Island Effects, Cool Pavements Interventions," a study led by Bloomberg Associates, evaluates cooling strategies for surfaces and 13 reflective pavement-cooling products, such as tree-based resin overlays that bind aggregate in lieu of petroleum-based products. The study identifies cool pavement strategies that do not require reconstruction, creates an inventory of materials and manufacturers that can reduce surface temperatures, and evaluates the tradeoffs of each intervention. It also outlines implementation case studies in Los Angeles, Tokyo, Melbourne, and Paris.[51]



SOURCE. BLOOMBERG ASSOCIATES

SOURCE. JOHN MCCOY/LOS ANGELES DAILY NEWS (SCNG)

LOS ANGELES COOL PAVEMENTS PILOT

The Los Angeles metro area is 6°F hotter than the surrounding areas, and the City has a goal of reducing the temperature differential by 3°F by 2025.[59] To do this, the City is increasing the urban tree canopy, instituting a new "cool roof ordinance," and using "CoolSeal" to repave parking lots and residential streets.[60] [61] The material, one of a handful of products being tested by the Los Angeles Cleantech Incubator, absorbs less heat and can reduce surface temperature by 10°F. Since 2015 the City's Bureau of Street Services; have installed the new pavement in 15 residential blocks across the City and in the parking lot at the Balboa Sports Complex in Encino using a budget of about $150,000 for the initial pilot locations.[62] Preliminary testing shows the coating has reduced pavement surface by 5.5°C.[63] Moving forward, the City will monitor conditions at the pilot sites and seek funding for a neighborhood-level cooling project to assess the impact on ambient air temperature, not just surfaces.[64]

NEW YORK CITY COOL ROOFS INITIATIVE AND LEGAL TOOLS FOR DESIGN GUIDELINES

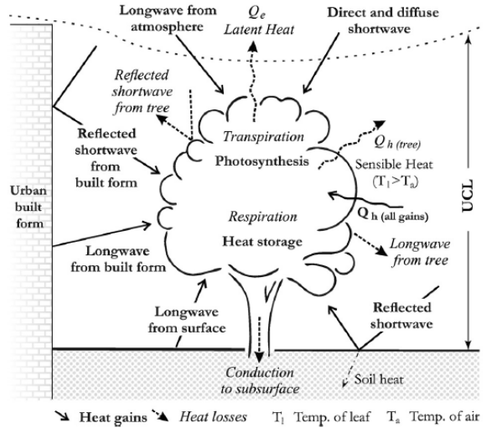
The New York City Cool Roofs initiative provides local job seekers with training and work experience installing reflective rooftops.[52] The program is a partnership among the NYC Department of Small Business Services, the Mayor's Office of Sustainability, and the Mayor's Office of Resiliency in addition to the community organizations Sustainable South Bronx and the HOPE program.[53] CoolRoofs focuses on retrofitting granulated cap sheet, asphalt, and bitumen rooftops at low or no cost to buildings owned by non-profits, affordable housing units, recreational centers, schools, hospitals, and cultural centers. The City aims to coat one million square feet of rooftops and has updated the building code, requiring that 75 percent of roofs or set back surfaces on new buildings or substantial renovations meet criteria for solar reflectivity.[54] [55] The lifespan of a roof is around 20 years, so most roofs will be light colored by the end of the next two decades. [56]

New York City has also issued "Climate Resiliency Design Guidelines" to help City-funded capital construction minimize the urban heat island effect, including through the use of legal tools such as light colored or green roofs, light-colored pavements allowances for thermal expansion, warping, softening, or other changes to materials, passive ventilation; and backup generators in case of blackouts. All of these requirements could be expanded to private construction. [57] [58]

NYC COOL ROOFS PROGRAM, IMAGE BY BEN HUFF FOR UNTAPPED CITIES

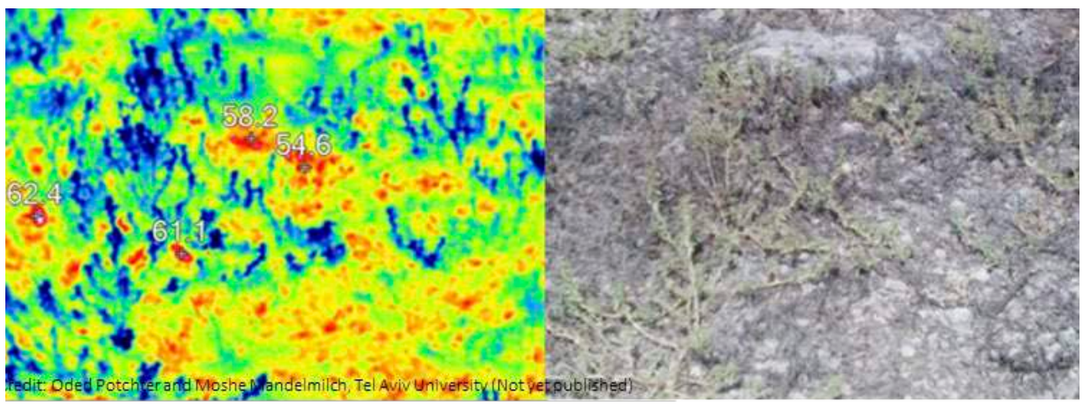
Vegetation and Shading

Vegetative cover can lower outdoor temperatures, lower building cooling demand, capture rainwater, and sequester pollution and carbon. Critical to the success of healthy tree canopy is contiguous soil volume and soil health, so in every case soil and vegetation must be taken together. With respect to energy, one study found that a 10 percent increase in shade coverage can decrease electricity consumption between 1.29kWh–4.8kWh, and reduce emissions by 10–11kg per tree.[65]



DAYTIME ENERGY EXCHANGES BETWEEN A TREE AND URBAN BUILT FORM.[71] (OKE 1989)

In Tel Aviv, like other urban centers, the cooling effect of vegetation can differ from site to site. For example, the cooling effect of trees in open spaces can be lessened if the surrounding surfaces have high albedo.[69] When combined, the placement of shading tree canopies, and shrubs, combined with cool materials can yield significantly more cooling benefits than any one of these alone.[70]



Other sources of vegetation and roofing, can also have cooling effects, which can help with evening cooling when compared to other urban materials like asphalt or bare soil.[66]

THERMAL IMAGE OF GRASS AND SOIL AT A CEMETERY IN SHAPIRA

MATURE FICUS TREE, SDEROT BEN GURION, TEL AVIV

In Tel Aviv-Yafo, broadleaf trees like the Ficus (Indian Laurel Fig) and Tipuana (Tipu) are effective in cooling shallow open spaces. When planted at minimum planting intervals, their canopies can overlap at maturity.[67] Meanwhile, while these trees can have a cooling effect during the day, they can create humidity at night.[68] So, tree planting and ventilation strategies designed in coordination with the geometry of streets and buildings as linear and connective systems should be considered together.

SOURCE. CITY OF MELBOURNE,
LIVING MELBOURNE PLAN

Cases of Nature-Based and Shading Infrastructure

LIVING MELBOURNE URBAN FOREST STRATEGY

As part of the strategic vision for *Resilient Melbourne*, which address increasing heat in a growing city, the City of Melbourne and 33 surrounding local governments are planting 3,000 trees per year, increasing tree canopy cover from 22 percent to 40 percent by 2040. They have created design standards for upgrading footpaths from asphalt to sawn bluestone pavers, which will allow rainwater to pass through and improve soil moisture and watering of adjacent trees. New design standards for the pavers are being applied with new tree planting areas.

SOURCE: SUNDANCE SQUARE
PLAZA, FORT WORTH TEXAS

SUNDANCE SQUARE PLAZA, TEXAS

Sundance Square Plaza in Fort Worth, Texas was once a two-acre parking lot. As a part of a long-term, 35-block redevelopment, the plaza is now a vibrant event programming space. It features 86-foot mechanically operable shade umbrellas which provide 5,800 square feet of shaded space in addition to the shade provided by cedar elm trees. There is also a large fountain and water wall that are integrated with terraces to provide seating, and drain and funnel water towards vegetation. Red brick pavers were used for their high solar reflective index.[72]

"Shade. It's a civic resource, an index of inequality, and a requirement for public health. Shade should be a mandate for urban designers."

- SAM BLOCH, APRIL 2019,
PLACES JOURNAL

NATURE PLAY DESIGN GUIDELINES

Access to nature, like proper nutrition and sleep, shapes a child's life and development.[73] New guidelines for designing play equipment and "nature place spaces" are being led in partnership between the U.S. Forest Service, the National Wildlife Federation, and the Natural Learning Initiative.[74] The guidelines and design info sheets can be used by institutions to show managers of schools, parks, childcare centers, and public lands how to incorporate nature into outdoor play areas. The guidelines suggest that metal and plastic structures, which can become dangerously hot when exposed to the sun, be replaced with the surrounding landscape such as with boulders to climb, streams to dam, ponds to catch critters in, logs to practice balancing, and gardens to explore. Not only can these methods reduce the urban heat island effect through increased vegetation, they also support the cognitive development, safety, and reduction of ADHD in children.[75] As an example, Silver Falls State Park in Oregon launched their first even "natural play" areas, designed through a series of workshops.[76]

SOURCE. COLLEGE OF DESIGN NC STATE UNIVERSITY

NATURE PLAY, OUTDOOR ALLIANCE

POLICY IN CONFLICT WITH SHADING

In Los Angeles, green cover and tree canopy have dramatically decreased during the last 10 years. Efforts to bring back the shade have met with political, regulatory, and social challenges.[77] [78]

There are few bus shelters along Figueroa Street, a major artery in LA with five travel lanes, two parking lanes, modest sidewalks, and storefronts. A plan to install over 1,000 new bus shelters throughout LA broke down when the operations and maintenance plan (funded through advertising) was met with community backlash. Meanwhile, installing sun shelters, such as with trees or bus stops, disrupts underground utilities near the curb, which is a right-of-way controlled by many agencies, can violate the Americans with Disabilities Act, or block driveway sight lines.[79]

Shading from trees has been further constrained by City capital improvements, such as sidewalk repairs and street widening that necessitate street tree removal (which largely do not require a public hearing) as well as clearing for private development. Further, as drought conditions intensify, instances of disease and tree death are increasing.[80]

In South-Central LA, Latino communities have transformed the fabric of shade. Makeshift porticos, patios shaded by lush trees that cool air as it blows into home, pop-up gazebos that host Catholic shrines and food stands, and large umbrella of vendors reflect a phenomenon that, in the words of urban theorist Mike Davis, "... just goes unnoticed... If they got a little financing and were better supported, it could bring about wonders."[81]


MESILAT YESHARIM, SHAPIRA, TEL AVIV

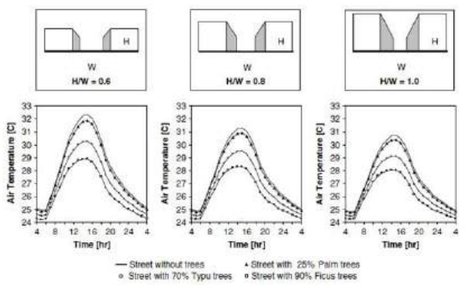
Urban Geometry and Form

The urban heat island effect is driven in part by the relationship between street width and orientation, in addition to the dimensions and arrangement of buildings. These factors contribute to the movement of air through a city and buildings, helping or hindering the dissipation of heat.

Heat can be exchanged between neighboring buildings when streets are arranged in grid-like patterns.[82] The geometry of the built fabric also controls wind paths through a city's street network.[83] The Geddes plan of Tel Aviv-Yafo oriented wide boulevards to channel the prevailing winds off the Mediterranean into the city. They are built around courtyards, skillfully manipulating building massing and open space to create passive cooling. District-scale passive cooling that enhances ventilation through linear parks and wind corridors can guide the placement and massing of buildings to avoid blocking wind paths.[84] Encouraging air flow with building forms and street orientation, and considering prevailing winds, building height and density, orientation of the sun, and the sky view factor may contribute to cooling.[85] For example, the height of buildings can modify wind movement, the width of the street can influence shading, and orientation can include the duration and timing of radiation mitigated by trees. On hot days, the cooling benefits of trees along the streets are particularly impacted by such factors.

It's been found in Tel Aviv-Yafo that as building heights grow, the cooling effect of trees is reduced.[86] Urban canyons created by very tall buildings can also negatively contribute to urban heat islands because radiation from the sun is trapped at night, which is exacerbated by the high heat capacity of buildings.[87] In contrast, cooling trends are apparent in parts of Tel Aviv-Yafo near the sea where there are more open spaces and wider streets.[88]

In Melbourne, however, researchers found that cooling of up to 2.1°C was achieved on east-west streets with large canopies as compared with little tree canopy in Melbourne, which has a similar Mediterranean-like climate as Tel Aviv.[89] The benefits were less along north-south streets, where solar radiation reached underneath the canopy in the morning and mid-afternoon. In this case, greater street canopy lowered wind speed, but it was not enough to offset the microclimate impacts of canopy shade and transpiration.



COMPARISON OF THREE TREE SPECIES ON URBAN RESIDENTIAL STREETS IN TEL AVIV. THE DEEPER THE OPEN SPACE (HEIGHT/WIDTH), THE SMALLER THE TREE COOLING EFFECT.[90]

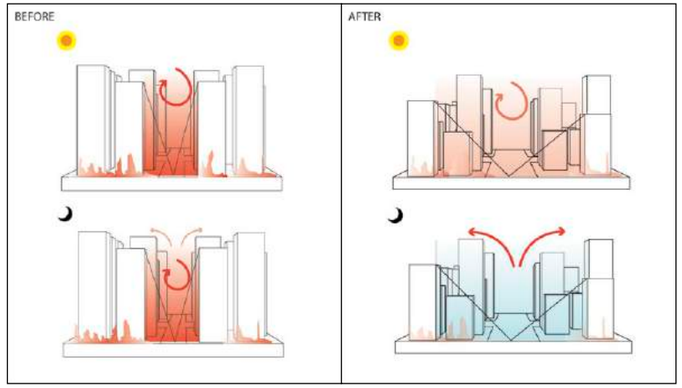
Cases of Land Use Practice and Form

STREET WIDENING AND DIVERSIFYING BUILDING HEIGHTS

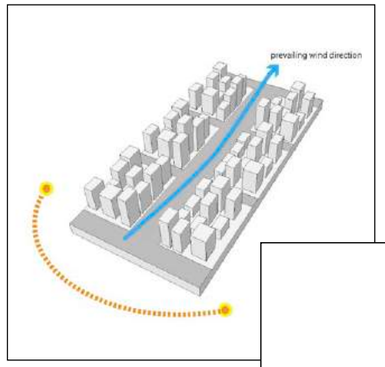
Land use practices that encourage street widening can reduce the impacts of solar radiation by increasing the amount of sky visible from the ground, or the sky-view factor. This allows radiation to dissipate in the public realm, reflecting with less intensity off of buildings and back to the ground, and allowing heat to escape at night. An increased sky-view factor can be achieved through transfer of development rights, development principles that diversify building forms and heights, and other tools.[92]

However, street widening should never come at the expense of walkability, street vibrancy and density. It's possible to expand the distance between buildings, while protecting that space for green cover and pedestrian access; the climate benefit of a wider street does not outweigh the impact of added asphalt.

The success of the Geddes Plan illustrates the importance of designing streets appropriate to the climate with wide boulevards conducting prevailing winds and narrower cross streets establishing a coherent neighborhood fabric. The alternative, in cities where there are wide streets and endless block lengths, can make walking unbearable during hot months.



URBAN DESIGN GROUP JOURNAL, WINTER 2019, JEFFREY RAVEN, "FORM AND LAYOUT"



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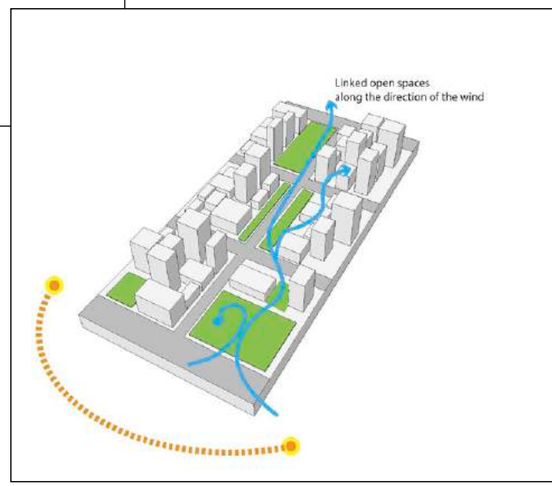


NETWORKING PARKS AND OPEN SPACES

Urban design that leverages linear parks and open spaces, such as through a network of boulevards, small pocket parks, and privately-owned-public spaces, can maximize air flow and ventilation on a district level. To this end, considering wind patterns and the sun's pathway are critical when positioning new buildings.[91]

ACCELERATOR WORKSHOP

Workshop Site Selection

After having prioritizing Shapira, the Accelerator team considered sites in the neighborhood that could be well suited to a workshop and immediate project development effort. We considered the following criteria:

- **Located in areas of high heat exposure and/ or heat vulnerability**
- **Representative of a mix of different uses and urban fabric (e,g., commercial corridor, community space, transportation use)**
- **Representative of opportunity to scale through networks and pathways in the neighborhood and city-wide**
- **Allow for a range of different interventions**

Two key sites emerged in Shapira that focused our efforts, where these risks and opportunities in the public realm register directly and where we focused the workshop:

Mesilat Yesharim Street

The north-south commercial corridor of Shapira, 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.

Shapira Community Center

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° when gauged with a radiometer, hot enough to inflict burns on a child's bare feet.

Approach

The Resilience Accelerator Workshop brought together municipal leaders, stakeholders, designers, academic experts, and community leadership for an intensive facilitated design session from November 3-5, 2019. Focusing on three sites–two on Mesilat Yesharim and one at the Shapira Community Center playground and ball courts–three interdisciplinary teams visualized project concepts, outline implementation plans, and shape principles for future planning. The workshop will include intensive facilitated breakout sessions, expert panels and critique sessions, and a public exhibition and presentation.

WORKSHOP GOALS

Frame heat risk and impacts.

Contextualize the future of Tel Aviv-Yafo and position neighborhood spaces that register that future; establish measurable baselines and indicators of success; integrate science into planning and design process.

Clarify mitigation and adaptation options.

Define design and planning principles to approach heat for planners, designers, and architects; humanize the experience of heat in Shapira.

Determine implementation and scaling pathways for three pilot projects.

Develop and visualize pilots for three sites; ensure feedback from City leadership and potential implementation and funding partners to establish pre-design buy-in.

The workshop included a series of expert presentations, site visits, and intensive team-based and facilitated design sessions among participants related to each project site. Teams were encouraged to build off and design concepts that met a specific design criteria that would test a design method that meets a new climate reality and broader resilience challenges in Shapira:

WORKSHOP DESIGN CRITERIA

- **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
  - 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 (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**

A PUBLIC EXHIBITION WAS INSTALLED AT THE COMMUNITY CENTER SHOWCASING THE DESIGN KIT AND VULNERABILITY STUDY. VISITORS WERE INVITED TO CONTRIBUTE TO A "MEMORY MAP," BY TAGGING AND MAPPING THEIR STORIES OF THE HOTTEST DAY THIS PAST SUMMER. THE EXHIBITION WENT TO THE *"NEIGHBORHOOD SHAPIRA COMMUNITY SCHOOL"* AND THEN WAS ON DISPLAY AT THE TEL AVIV MUSEUM OF ART FOR *"THE 4TH ISRAELI CLIMATE CONFERENCE"*

Participants

112 stakeholders participated in the workshop discussions and a selection were assigned into one of three breakout teams for the majority of the workshop. Each team consisted of a mix of City representatives, stakeholders, and subject matter experts who were selected based on their specific expertise from across academia and the private sector. Table assignments were considered based on the goals of engaging across City agencies, the perspective of multi-sector actors, as well as community-based and advocacy groups. Additional participants were invited to attend the presentations and site visits on the opening day of the workshop. A full list of participants can be found in Appendix III.

Workshop Table Seating: Each table was composed of 10-12 interdisciplinary stakeholders, lending diverse viewpoints and skill sets across agencies, sectors, and disciplines.

(1) Mid-level municipal rep, planner
Local planner with in-depth knowledge of Shapira planning context

(1-2) Director-level public agency representatives
City department leader garnering support for implementation and ownership over action

(1-2) Civic society representatives / community stakeholder leaders
Shapira stakeholders representing use and operations of public spaces and/or representing the most vulnerable (e.g., asylum seeking community, community center operator, local business network leader)

(1-2) Professional designers, architects, landscape architects
Experienced designers with local knowledge of Tel Aviv, leading workshop visualizations

(1-2) Outside Subject Matter Experts
Experts representing specific content and input depending on the table needs (e.g., Atmospheric scientist, landscape ecologist, climate scientist)

(1) Table Facilitator
Expert communicator, trained to deliver the team through breakout exercises

CITY LEADERSHIP CRITIQUE PANELISTS

Vice Mayor	**Assaf Harel**
Director General of the Tel Aviv-Yafo Municipality	**Menahem Leibe**
Chief Resilience Officer	**Efrat Makin-Knafo**
City Architect	**Yoav David**
Environmental Authority, Manager	**Eitan Ben - Ami**
City Engineer	**Udi Carmeli**
Deputy Director General Manager	**Rubi Zluf**
Director of Building & Infrastructure Administration	**Sharona Hershko**

PROGRAM AND DELIVERY TEAM

City Agency	**Omri Carmon**	Resilience and Social Equality Authority
City Agency	**Noa Regev**	Environmental Authority
City Agency	**Tali Bergel**	Office of the City Architect
City Agency	**Guy Deknuydt**	Environmental Authority
City Agency	**Ron Govezensky**	Office of the City Architect
Resilience Accelerator	**Johanna Lovecchio**	Center for Resilient Cities and Landscapes
Resilience Accelerator	**Grga Basic**	Center for Resilient Cities and Landscapes

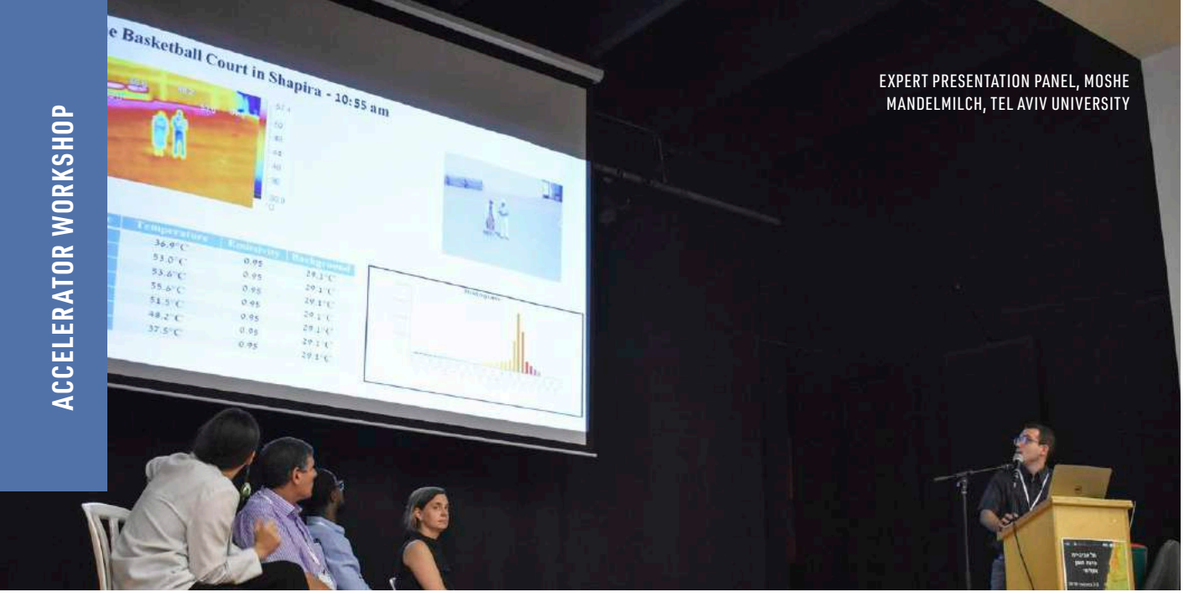
Workshop Format and Structure

The Accelerator workshop was structured to model the design and implementation process in a compressed period in order to begin the coordination process and help anticipate partnership and challenges early in the pre-design process. It began with grounding content and research prepared by external experts, City partners, and the Accelerator program team as well as site visits. Then, teams of 10-12 participants were assigned into breakout tables for the remaining time. Teams worked through a process of visioning and goal setting on the first day, then design concept refinement and visualization, then implementation planning. The workshop included pin-up critique sessions with feedback from key city leadership, and conclude with closing pitches to leadership including the General Manager, Chief Resilience Officer, City Architect, and Director of the Environmental Authority. A final agenda for the workshop can be found in Appendix IV.

"Tel Aviv-Yafo is growing rapidly, and we are grappling with the pressures of urban expansion - from housing to transportation - that register directly in communities like Shapira. While we begin to imagine a path forward, we can't repeat the same patterns of urbanization that strain our natural resources, contribute to climate change and urban heat island, and mostly - stress our communities.

People in this room represent diverse talents and disciplines from across our municipality, our community, and from around the world. And the way you'll work together over the next few days embodies a new way of planning. I encourage you to not only imagine a City that has adapted to the extreme urban heat that the climate now demands but one that can lead the world on a path of sustainability and equity. A city that not only supports its residents with critical infrastructure but also uses that infrastructure to cultivate a rich social fabric and environment."

- VICE MAYOR ASSAF HAREL



EXPERT PRESENTATION PANEL, MOSHE MANDELMILCH, TEL AVIV UNIVERSITY

Expert Presentations

DESIGNING FOR RESILIENCE

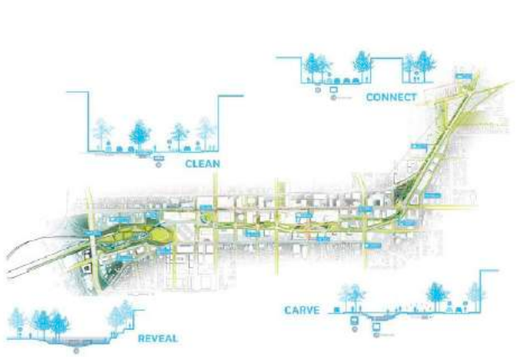
"We need to consider urban heat at multiple scales - from the geometry of city fabric, to water systems and forest mosaic of the region, to the middle neighborhood scale and elements such as shade, ventilation, and planting, to the scale of the body and comfort & even the clothing we wear."

–Kate Orff, Columbia University and SCAPE

MATCHING COMMUNITY NEEDS WITH CLIMATE RESILIENT SCIENCE

"Urban Climate Change Network (UCCRN) Urban Design Climate Workshop sessions engaged representatives from Durban to integrate and scale up mitigation and adaptation principles by reducing energy consumption in the built environment, strengthening urban climate resilience, and enhancing human comfort and quality of life. Through the participatory engagement of Durban stakeholders, sessions demonstrated that through energy-efficient urban planning and urban design, compact urban districts can work synergistically with high-performance construction and landscape configuration to create interconnected, protective, and attractive urban areas that promote mitigation, adaptation, resilience, and transformation. The Durban Urban Design Climate Workshop was sponsored by the German government Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ) GmbH in collaboration with the Government of Durban."

–Christian Braneon, NASA Goddard Institute for Space Studies



CASE STUDY OF TOWN BRANCH COMMONS

THE EFFECT OF URBAN SPATIAL PATTERNS ON HEAT VULNERABILITY: RESULTS AND INSIGHTS BASED ON FIELD MEASUREMENTS IN THE SHAPIRA AND FLORENTINE NEIGHBORHOOD

"The Florentine neighborhood is warmer than the Shapira neighborhood during day and night due to the narrower street canyon. East-West orientated streets are warmer during the day than North-South oriented streets. Dark surfaces such as basketball courts and playgrounds and unshaded grass can dramatically increase the surface temperatures and may have a negative effect on human thermal comfort. Our goal is to understand how the Shapira neighborhood can be developed, (higher building density and more stories) without producing the negative warming effect that Florentine has been experiencing."

–Prof. Oded Potchter, Mose Mandelmilch

HEAT: DESIGNING WITH THERMAL SENSITIVITY

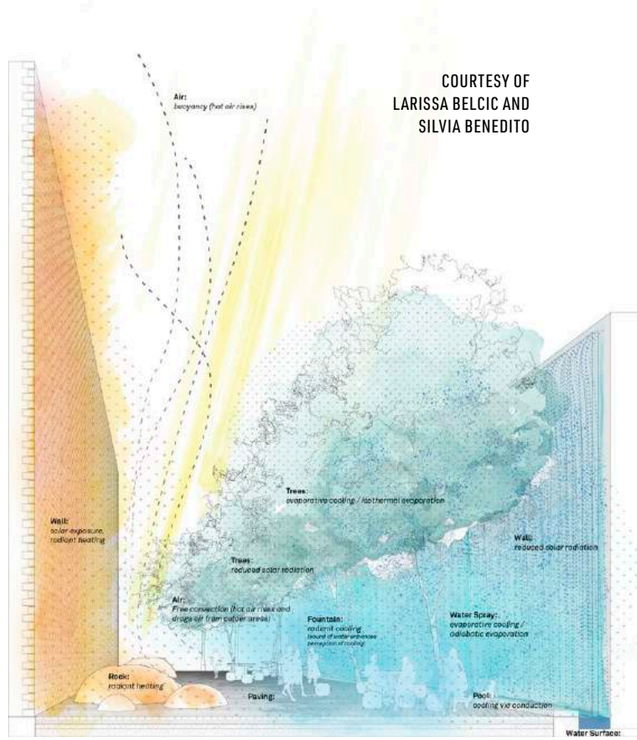
"The elements of the 'climatic parfait' are the simple components of a microclimate (humidity, wind, solar radiation). Together, they compose the parfait - a complex, layered, delicious and drippy concoction, that like the thermodynamic world, is in constant interaction with itself. The radiant heating from the metal fence as it absorbs solar radiation, high albedo of the white gravel reflecting sunlight, the evapotranspiration of the leaves of the tree, the radiant cooling of the gabion wall due to its high thermal mass. Combined, we are creating a hot and cold zone, and air buoyancy between them. These are things we don't see, but we ***SENSE*** *them."*

Larissa Belcic, Nocturnal Medicine & OFICINAA

COMPLEXITY AND CONTRADICTION IN ENVIRONMENTAL DESIGN OF THE BUILT ENVIRONMENT

"Fifty three years ago Robert Venturi challenged the prevailing philosophy of modern architecture, which was based on the writings of Le Corbusier and Mies van der Rohe. Instead of rationality and minimalism, he posited complexity and contradiction as the guiding principles of post-modern architecture. Seeking to provide the scientific basis for designing a built environment in the desert, I too have found that simple, clear-cut solutions have eluded me. Rather, I have found, repeatedly, that widely held prescriptions that seemed superficially logical were in fact fundamentally flawed when examined in depth. Not because they were 'wrong', per se, but because they were framed in response to the wrong questions. Light colored pavement can reduce both surface and air temperature, yet rather than mitigate intense daytime heat may actually increase thermal stress for pedestrians. Adding floors to low-rise buildings will undoubtedly intensify the nocturnal urban heat island, but may still reduce energy demand in buildings, even in Israel. Windows can provide daylight, fresh air and passive heating (in winter), but may frequently result in increased energy consumption for lighting, air conditioning and heating. My talk will use these examples to argue that environmental design of the built environment must embrace these apparent contradictions and seek to understand the full complexity of the processes involved. In doing so, we may need to accept that designing the built environment is an inherently 'wicked problem', with no correct answer, only better or worse ones."

–Evyatar Erell, Ben Gurion University



COURTESY OF LARISSA BELCIC AND SILVIA BENEDITO

DESIGN APPLICATIONS FOR PRIVATELY-OWNED PUBLIC SPACES

"The use of incentives by the public sector as a means to rely on the private sector to provide public amenities has became a catalyst for urban development in the past three decades. Privatized urban public space is the spatial manifestation of such incentives, which constitutes a platform for a broad debate among sociologists, political scientists, economists and policymakers about the notion and consequences of commodification of urban public space. This presentation discusses the role of incentives for urban development by examining the case of privatized urban public spaces in NYC as a result of 1961 zoning resolution and its impact on the proliferation of Privately Owned Public Spaces (POPS) in advanced global cities.

Case studies of POPS in Tel Aviv known as exaction – developers' requirement to provide public amenities as a condition for receiving permits – reflect the struggle of implementing the NYC model without a well-established infrastructure of laws and regulations. This study critically evaluate the process of exactions, which also takes place as 'planning deals". It raises questions about the notion of POPS as a truly public space by investigating the effectiveness of using incentives. Are incentives the only choice? What can be the alternatives?"

–Liat Eisen, The New School

DESIGN CONCEPTS & ACTION STEPS

What follows are the ideas and recommendations developed in the Accelerator workshop in Shapira. Participants were asked to define implementable pilot project concepts that could be installed in the near term, while also considering the broader scale of urban fabric and heat. A set of common design and planning principles emerged in our three days of work together:

- **Culturally specific to the diverse character of Shapira**
- **Integrated within the neighborhood fabric and current municipal planning and project implementation efforts**
- **Utilizing shade, breezes, and urban form for cooling**
- **Inclusive of nature-based solutions**

Taken together, all three pilot projects suggest the beginnings of a district-scale approach to cooling, community resilience-building, and guidelines for future development. The principles aim 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.

PROJECT: SOCIAL STREET HUB

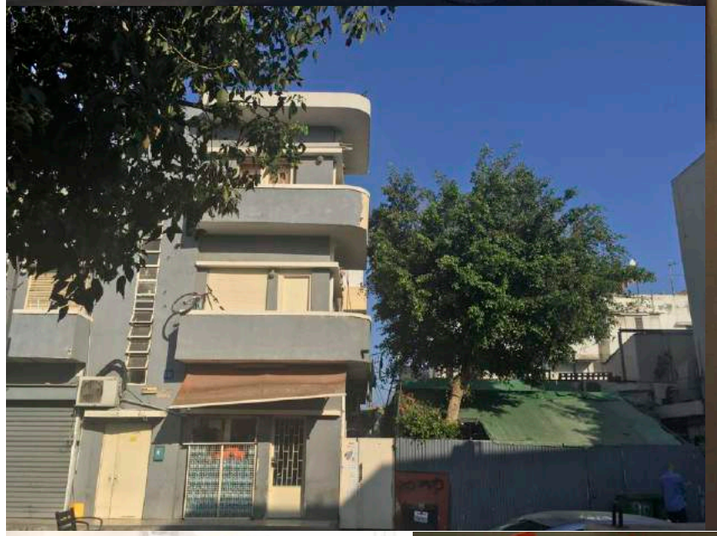
CONCEPT

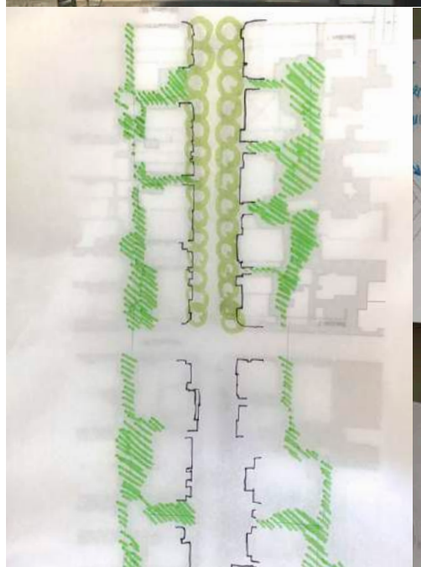
The intersection of Salameh Street and Mesilat Yesharim was once a vibrant gathering place for the neighborhood residents of Shapira. Remembered as a space that welcomed arrival into the neighborhood, today's block is a loud and aggressive environment - exposed to exhaust and noise from traffic as well as harsh sunlight, and struggling to maintain active street life.

The Social Street Hub concept reminds us of that history and aims to bring forward a new vision of Mesilat Yesharim that considers an entrance to the neighborhood through the creation of a new street typology that knits together new open space in the public right of way and activates a system of backyard green spaces. The concept invites connection amongst the residents and businesses as well as the existing network of key spaces and facilities in the Shapira and the city: the school, community center, the Shapira garden, and even the bus station that connects to the rest of Tel Aviv-Yafo and region.

The Social Street Hub leverages two linear systems: the right of way on Mesilat Yesharim and the network of backyard spaces in the back sides of buildings. By reorganizing the right of way to remove private car access, while promoting public transportation, pedestrian, bicycle, and micro transit options, new public space can engage diverse segments of the community. The design aims to soften the experience of the street through vegetation and public program; improve the climatic performance through planting, expansion of the tree canopy, and innovative water capture; and activate local businesses through incentives and subsidies.

MESILAT YESHARIM AT SALAMEH ROAD



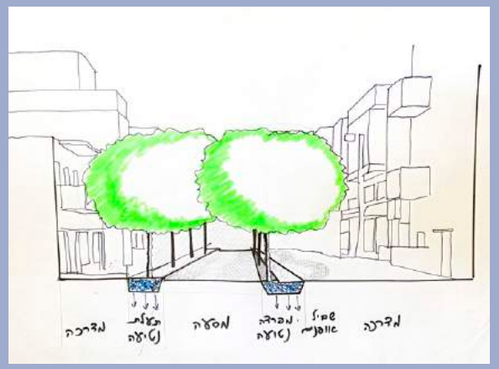


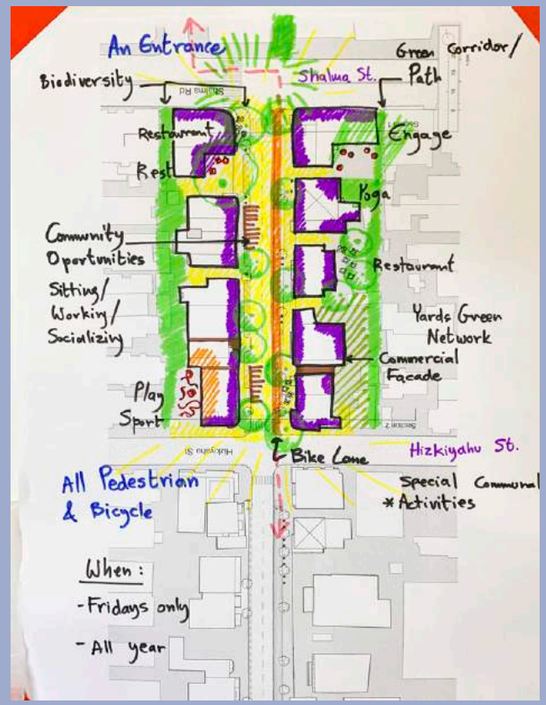
PROJECT: SOCIAL STREET HUB

ELEMENTS

Project Objectives	Measuring Outcomes
Create a more vibrant, walkable, and livable network of open green spaces	• Increased coverage and performance of ecological surfaces • Improved air quality • Reduced thermal stress (PI) • Increased commercial activity • Increased pedestrian and bicycle activity
Connect culture, community, and history **Create an entrance to shapira**	• Increased time spent in space • Improved pride in the street
Establish a new model for learning from a new street typology	• Adoption of street typology to similar neighborhood entrances • Replicated model for public/private design

Physical	Programmatic
Built Form • Closed street to pedestrian, bus traffic, bicycle, and micro-transit (phased) • Varied seating and convening spaces in the new right of way **Vegetative** • Tree planting in the right of way for long term shading • Green garden ordinances and incentives to activate back of building network • Trellaced or facade-anchored climbers and vines for short-term shading and thermal comfort (to complement tree planting) • Elongated tree pits to support long-term tree growth • Connected back lots to new open space in the right of way through green alleys **Water Management** • Groundwater capture for seasonal groundwater recharge and tree irrigation	• Flexible spaces for public program such as dynamic work stations, play areas, sports grounds, markets, kids, commercial activity, and elderly residents • Community-based programming in back-yard spaces and newly reclaimed space in right of way • Operations and maintenance supported by a new Mesilat Yesharim Business Improvement District (BID) over time





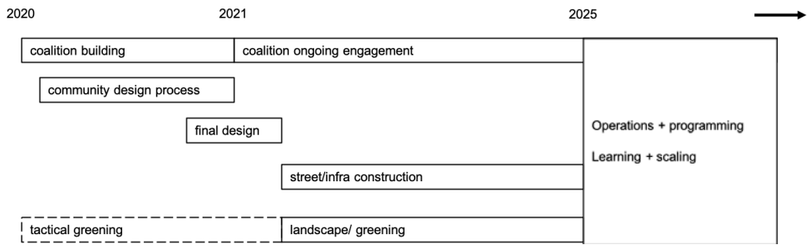
PROJECT: SOCIAL STREET HUB

IMPLEMENTATION

Scaling Pathways

The concept of "neighborhood entrance" can be scaled across other similar street typologies in neighborhoods across Tel Aviv-Yafo. Further, a successful public-private model of connecting ground floor uses and backyards and engaging businesses owners can be replicated across similar business corridors in Tel Aviv-Yafo.

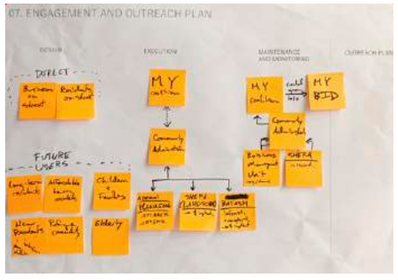
Next Steps

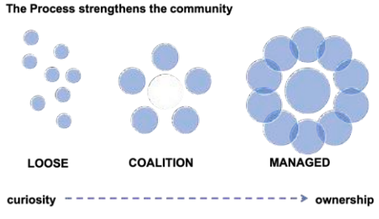


1. LOCAL BUSINESS AND RESIDENT ENGAGEMENT

Owner: Sustainable Neighborhoods Program, Community Administration

- Support the continued coordination and organization of a local business network that can help to define the process by which the space is designed, operated, and maintained in the long-term
- Work with local NGOs, community administration, and others to identify and engage local refugee and immigrants who may be using backyard spaces and ask for feedback around their needs
- Design a public engagement process that brings together the business community and residents (e.g, "Mesilat Yesharim Coalition") to determine a phasing schedule for street closures and identify public programs that meet the unique needs of the diverse communities that live in Shapira
- Design a local stewardship program over green spaces with community groups that is integrated into the maintenance and operations plan of the project





2. POLICY AND FUNDING

Owner: Business Permitting Department and Business Promotion Administration

- Develop incentives and subsidies for local business investments in the corridor could, for example, encourage commercial activity and investment while requiring vegetation coverage requirements on our outside of their buildings and/or encourage street facade connection with backyards.
- Create a business plan for revenue generating activities that can support long-term planning and investment. For example, markets, festivals, events in the public realm can provide for ongoing operating support and stewardship funds. Revenues collected, such as through fee structures, could be administered through a local BID or special fund that ensures the community investment remains in the neighborhood.

3. SITE PLANNING AND EXECUTION

Owner: City Planning, City Architect

- Engage owners and operations at 2-3 initial test sites (e.g., Studio Naim and restaurants) to define initial backyard activation, possibly issues a local garden ordinance
- Clarify use, tenure, and ownership of backyard spaces and define which are available in the near term to activate
- Begin engagement process of key city agencies in design strategy including the Community Administration, Planning Department, Shefa, and Batash
- Leverage existing resources and planned "place-making" work on Mesilat Yesharim to integrate with and advance design concept
- Begin process of evaluating traffic and transportation impacts of road closure to private vehicles
- Pursue a gardening ordinance to begin phased approach to back alley concept

Project Team

Role / Expertise	Name	Organization / Agency
City Agency (Manager)	**Yoav David**	Office of the City Architect
City Agency (Local Planner)	**Avigail Shem Tov**	Community Administration
City Agency	**Irit Lev Har**	Traffic Unit
City Agency	**Yaffa Ben-Eliyaho**	Beautification Unit
City Agency	**Atalia Reznick**	Planning Department, North Tel Aviv
City Agency	**Shlomit Zunenshine**	Planning Department, North Tel Aviv
City Agency	**Shir Kimhi**	Office of the City Architect
Non-Government	**Gali Freund**	Merchav
Designer	**Schahar Tzur**	Studio Zura
Designer	**Tali Wexler**	The Commons
Academic Expert (Microclimate Modeling)	**Evyatar Erell**	Ben Gurion University
Facilitator	**Sam Carter**	*Resilient Cities Catalyst*

PROJECT: SOCIAL STREET HUB

SOCIAL STREET HUB

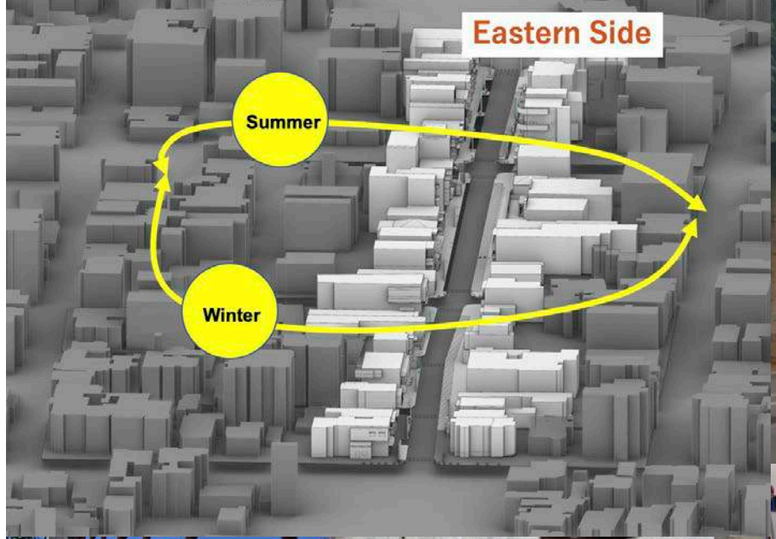
PROJECT: COOL CORRIDOR

CONCEPT

Mesilat Yesharim's commercial character, bicycle and bus transportation options, and centrality to the Shapira neighborhood situate the street as a key corridor in the community. However, the street is underutilized by the diverse communities that live and work in the neighborhood, the bike lane competes with pedestrian access, and long stretches of inactive building frontages suggests a need for a reimagined streetscape. Moreover, narrow corridors that constrain airflow, lack of shade and vegetation, and exposed street furniture deepen the declining thermal comfort of the street.

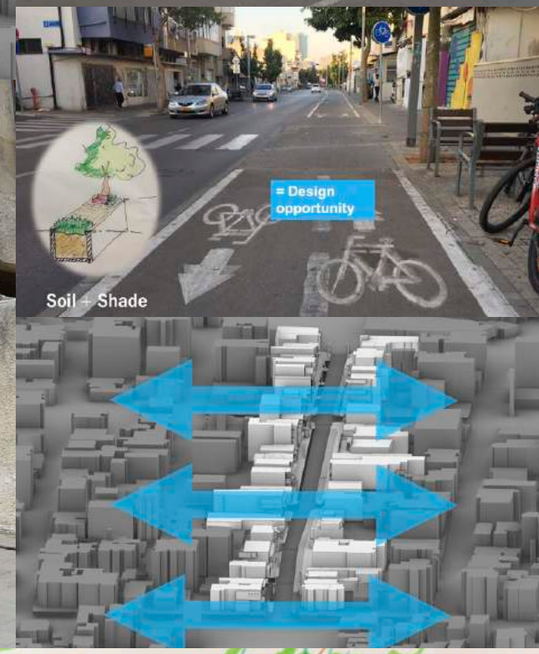
The Mesilat Yesharim Cool Corridor concept seeks to embrace and encourage street vitality, the thermal comfort of pedestrians, expression of social diversity, and varied character of buildings and their frontages. The concept imagines that the meeting points between the street and alleys can be areas of oasis and refuge for pedestrians and that the area reclaimed from the existing bike lane can be programmed with community uses that expand on the expressed desire for bright color and pattern from neighborhood residents. The approach aims to take advantage of the linear nature of the existing bike lane by using it to expand soil volumes for newly planted trees, create segments of uniquely designed programs that support community meeting of the diverse constituencies that live and work in Shapira: families, asylum seekers, elderly residents, business owners, visitors. In this scenario, the bike lane would move onto the street level as a painted bike lane. The approach also aims to capture prevailing winds running east-west and in between buildings to create cooling corners as well as encourage investment in shade infrastructure and water capture on private properties. Importantly, any future upzoning or redevelopment should take into account the need for East-West cooling winds to be able to reach the ground level. In the short-term, measures like continuous and expanded soil trenches, diverse tree planting and installation of rotating public program, canopies for local businesses and seating in the reclaimed bike lane can begin the process of activating the street and improving thermal comfort on Mesilat Yesharim.

This approach suggests a comprehensive and long-view neighborhood strategy that anticipates future development. A cool building and/or climate zoning overlay can begin the process of defining design guidelines for retrofits and future development that creates investment opportunity and also cools the neighborhood. For example, where there are receding building frontages, new public spaces can become cooling areas through incentivizing the installation of water foundations, trees, awnings, and water capture. Regulation might encourage shading across the street and in between buildings, with new buildings having an open floor and balconies shading activated public spaces




WALLED OFF PUBLIC SPACE


GATED ENTRANCE TO SYNAGOGUE



PROJECT: COOL CORRIDOR

ELEMENTS

Project Goals

- Reduce thermal stress through wind and shade
- Enhance commercial activity and support local business
- Cultivate neighborhood identify

Objectives and Elements

Take advantage of linear nature of existing bike lane by:

- Enhancing planting alongside the street to reduce and replace asphalt
- Creating a continuous soil strip to enhance water filtration and habitat of trees that can grow significant canopy
- Creating segments of unique programs that support social interaction and play such as through new cafes, business kiosks, and pedestrian activities
- Remove the fencing from two synagogues to support new open spaces and tree planting
- Creating spaces for micro-transit options

Create "Cool Alleys & Corners" that take advantage of prevailing winds running along east-west streets and between buildings by:

- Ensuring sufficient distance between buildings remain so airflow can continue to cool the streets in future development
- Ensuring variety building heights and typologies in future development
- Using the existing building facades to create shading infrastructure

Implement spatial design guidelines and a zoning overlay that encourage cooling and public space vitality, addressing the need for effective public-private partnerships:

- Infrastructure: Creating infrastructure for anchoring various shading means (artificial and natural) on the facades of buildings and public space
- Water Conservation: Pooling of air conditioners and irrigation channels for private and public spaces

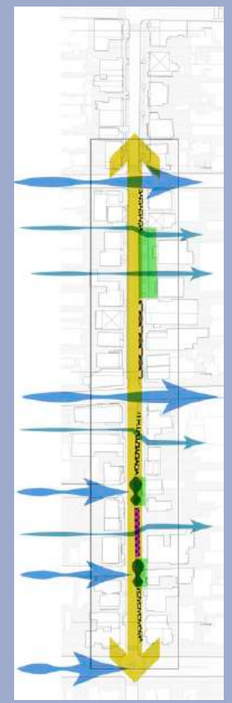
  Air Flow: Channeling breeze into public space through cool alleys and passageways

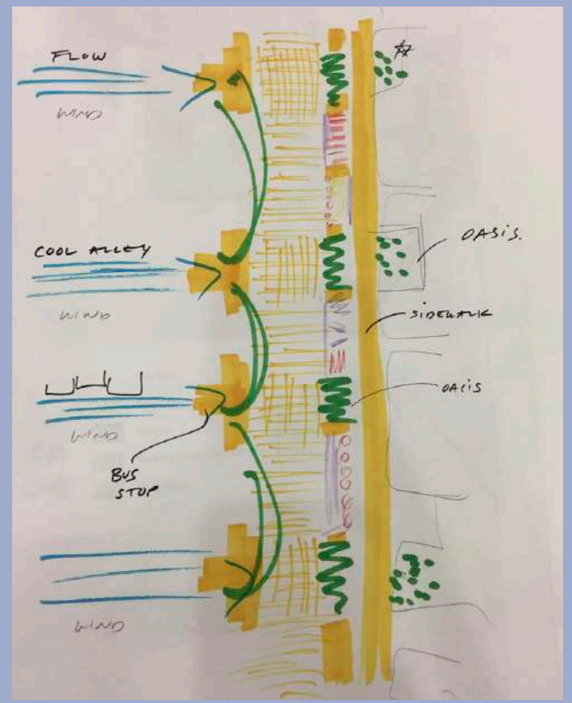
  Building Lines: Utilizing an uneven building line and encouraging diverse typology of buildings to create cool public spaces (e.g., colonnades and arcades; variable building lines; maintenance of side building lines)

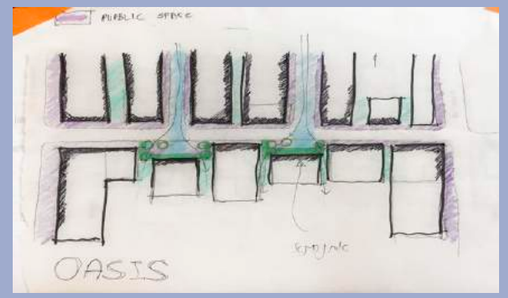
  Roofing: Institutionalizing white and green roofing policy as well encourage roof utilization of renewable energy infrastructure

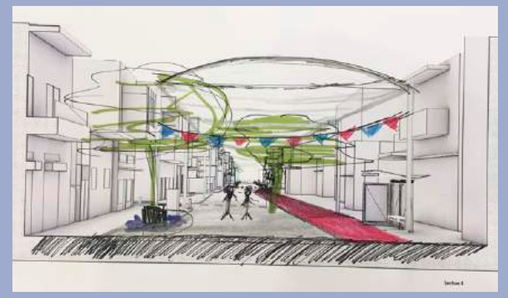
  Materials: Using insulated and refrigerated materials, using passive techniques for cooling and acclimating the buildings, such as through structure orientation, openings, and slats

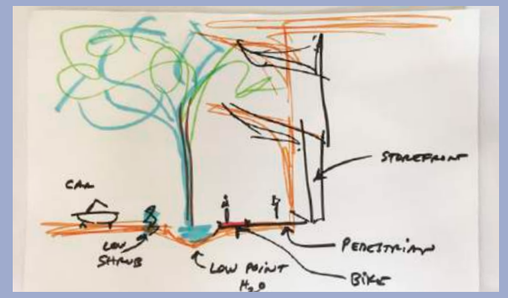
  Accessibility: Ensuring a diverse mix of apartments and income thresholds for different populations





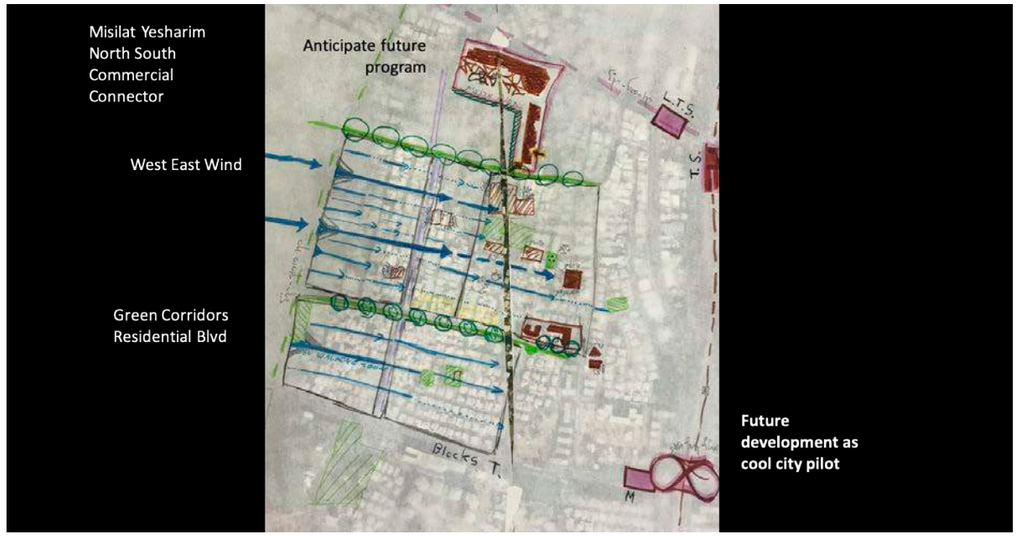


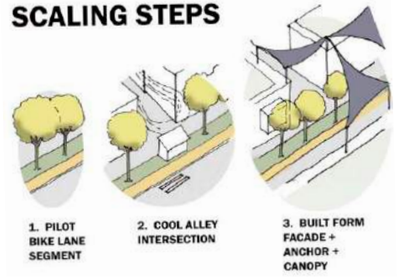




PROJECT: COOL CORRIDOR

IMPLEMENTATION





Scaling Potential

Cool Corridors can be scaled as a part of a district-wide planning approach that is implemented through new design standards for development, such as through a zoning "climate overlay." Incentives that encourage retrofits of existing buildings that encourage shading infrastructure and investment in tree planting can be scaled city-wide.

Next Steps

1. ENGAGEMENT
Owner: Sustainable Neighborhoods Program, Community Administration

- Determine open space programming together with an intensive community outreach process so that local community groups are empowered to make decisions about programs that inhabit the public realm.

2. POLICY AND FUNDING
Owner: City Planning, City Architect

- Define a district-wide standard for cool building overlays and zoning to allow incentives for developers for citizens and those who own businesses to help them invest in cooling

3. SITE PLANNING
Owner: City Architect

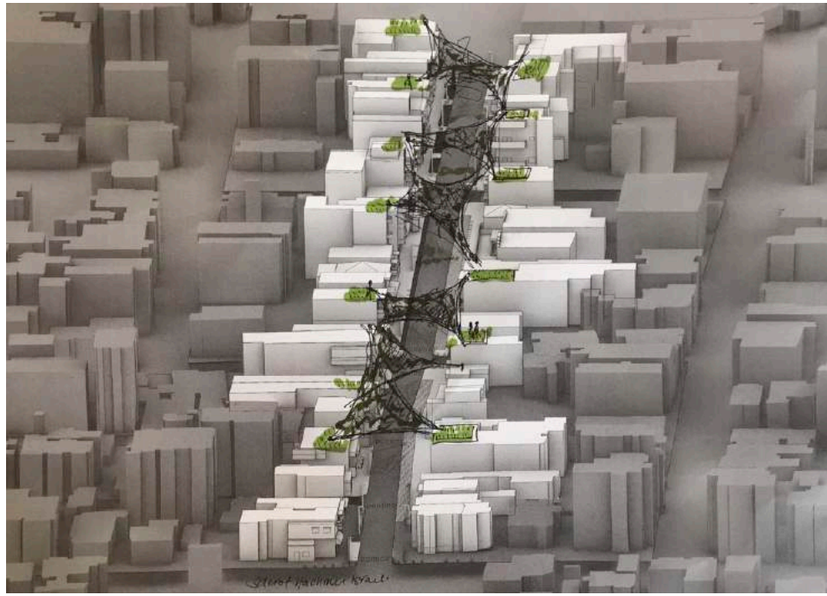
- Pursue immediate opportunity for oasis at the site of both synagogues
- Identify initial corners and alleys for cool corridor implementation

Quotes

"Small scale meetings points can enhance the climatic influence and the community by utilizing small opportunities already in the space"

"As the street changes we may have an uneven street section. We can use it."

"By improving public spaces it can allow for more flexibility for the asylum seeking community to integrate into the general spaces of the City instead of isolation with some sort of infrastructure."



Project Team

Role / Expertise	Name	Organization / Agency
City Agency (Manager)	**Vered Crispin**	Environmental Authority
City Agency (Local Planner)	**Adi Basis**	Planning Department, South Tel Aviv
City Agency	**Ira Rosen**	Planning Department, East Tel Aviv
Non-Government	**Dror Boimel**	Society for the Protection of Nature in Israel
Non-Government	**Ayelet Kraus**	Merchav
Designer	**Sagi Golan**	City of New York, Planning Department
Academic Expert (Policy and Design)	**Liat Eisen**	The New School
Academic Expert (Microclimate Modeling)	**Oded Potchter**	Tel Aviv University
Academia	**Tali Datner**	Tel Aviv University
Outside Expert (Landscape Ecology)	**Liav Shalem**	Yashua Parks
Facilitator	**Christian Braneon**	*NASA Goddard Institute for Space Studies*
Co-facilitator	**Kate Orff**	*Center for Resilient Cities and Landscapes and SCAPE*

PROJECT: COOL CORRIDOR

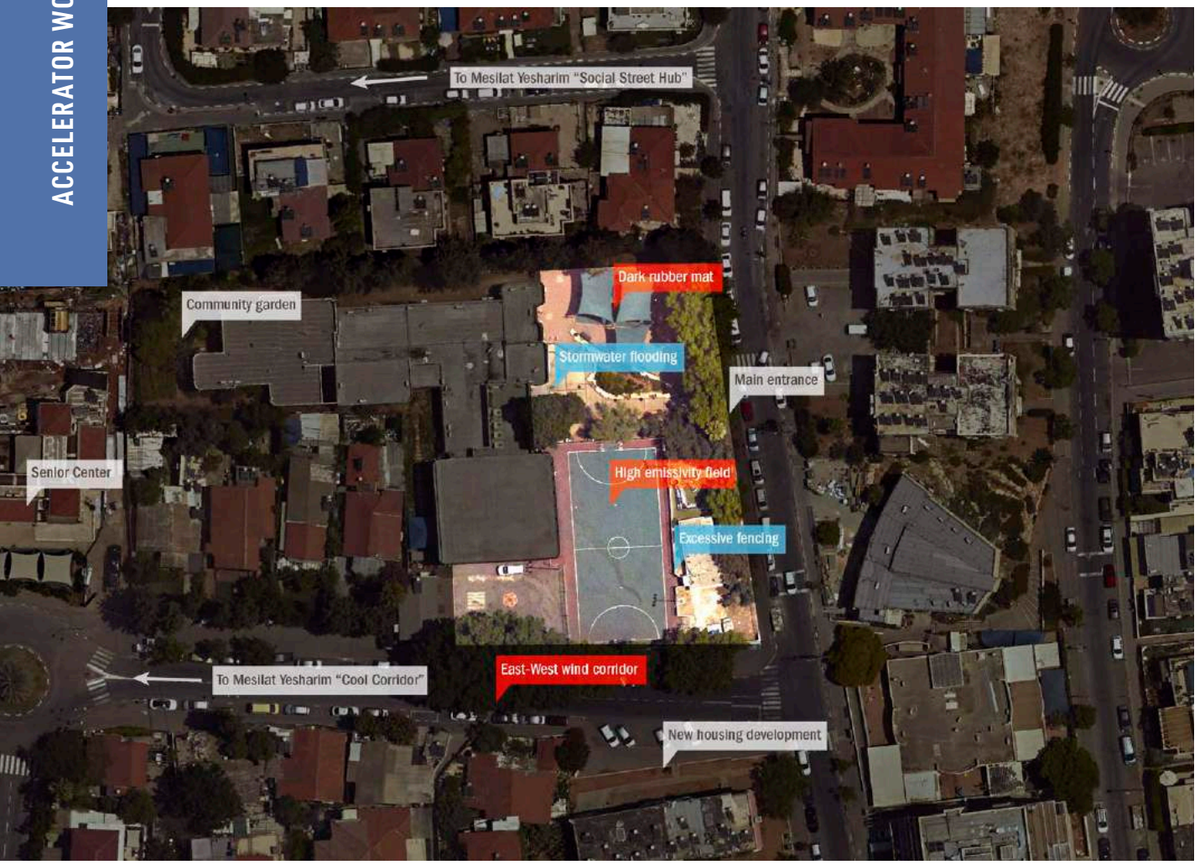
BIKE LANE

COOLING OASIS 2021

COOLING OASIS 2025

PROJECT: SHAPIRA CHILDREN'S ZONE: CLIMATICALLY TUNED PUBLIC SPACE

CONCEPT

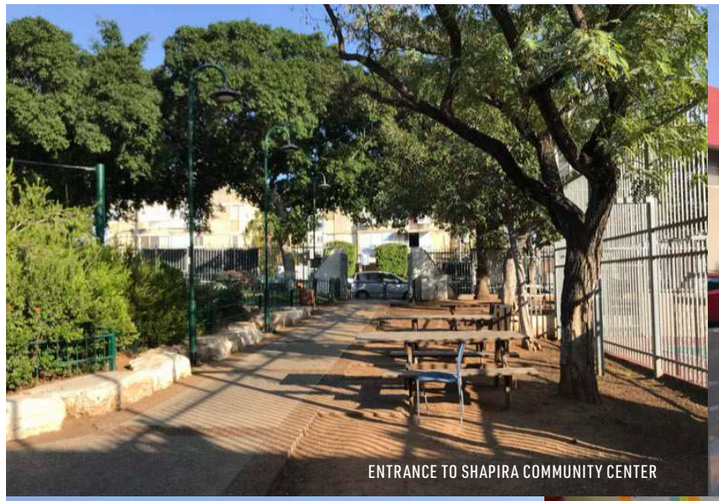


The Shapira Community Center is located in the center of the neighborhood, in the immediate vicinity of the Senior Center and several youth related public facilities. The site can become extremely hot during the day, with unshaded paved surfaces and play equipment that absorb and retain heat. Beyond heat, fencing limits site movement and signals exclusion, lack of stormwater management strategies and repetitive flooding, including loss of water as a resource, building functionality challenges and disconnection from site, and missed opportunities to connect programs among seniors, garden area, and play spaces. These current challenges will be exacerbated by the projected heat increases and even the dependency on existing tree canopy may be challenged if those species cannot tolerate the projected heat levels. In the near future, projected new housing developments across the street, may further change the microclimatic conditions on the site and its relationship to the neighborhood. The team therefore imagined a concept that reaches outside the boundaries of the community center to consider the role it plays in the larger community and the neighborhoods and a network of public facilities.

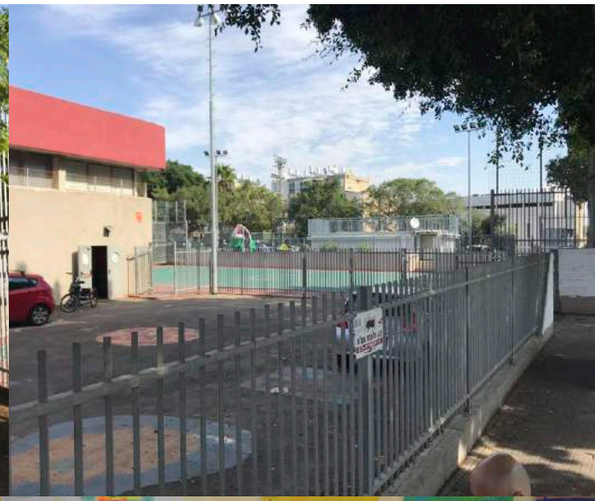
The *Shapira Children's Zone* builds a collaborative network linking public spaces and institutions in the neighborhood through shared programming and environmental curricula. The physical connectivity between the community center, two schools, kindergarten, scouts, and neighborhood parks would be enhanced by planting more vegetation and creating shading along the pedestrian paths. In addition, the team proposed that the urban design elements within the clusters of facilities (such as paving and planting) adhere to the unified design identity, further highlighting the character of the "zone."

The design strategy for the public space in the Shapira Community Center includes rearranging the courtyard into a series of climatically tuned programmatic areas that will accommodate a host of different activities and provide a cool sanctuary for the community it serves. Connectivity and access within the courtyard will improve by removing excessive fencing, particularly around the football court and the shelter structure. This uncluttering will also allow the winds from Sderot Hachmei Israel (the east-west street and the only wind corridor touching the site) to enter the site. The team imagined a gathering space with public seating area and outdoor fan – the *Community Living Room* – at the southeast corner of the site that utilizes shelter top structure and benefits from the breeze.

The ground in front of the community center is slightly sloped towards the building, leaving the center susceptible to stormwater. The team proposed a stormwater management system by planting pocket rain gardens throughout the playground and around the court. The rain gardens play a double role: as a green infrastructure, and as nature and water play features within the reimagined playground. The team also proposed a redesign of the playground that would use additional tree planting for shading, incorporate water spray features for cooling of the body, and take advantage of the existing topographic grade change to create cool pockets. The 'hard surface' areas of the playground that accommodate the recreational equipment can also function as a test site for evaluating various ground materials' heat properties.



ENTRANCE TO SHAPIRA COMMUNITY CENTER



PROJECT: SHAPIRA CHILDREN'S ZONE: CLIMATICALLY TUNED PUBLIC SPACE

ELEMENTS

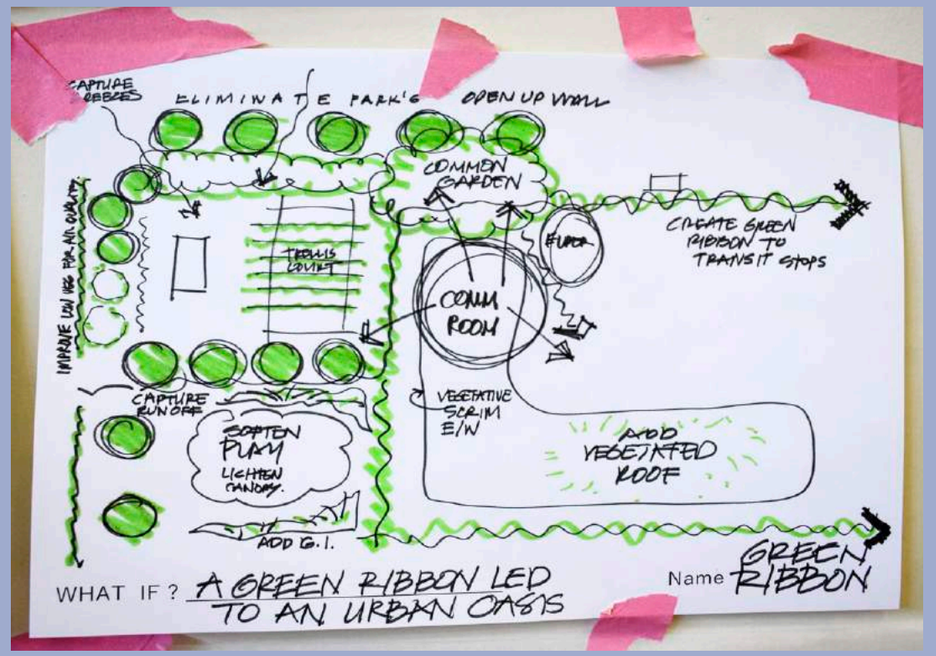
Project Goals

- Improve community connectedness, health, and learning opportunities
- Improve climatic performance of the site, especially with respect to heat and water
- Create opportunity for neighborhood-based economic opportunity

Goal	Physical Elements	Programmatic Elements
Community, health, and learning	• Linkages to schools and other community activity sites	• Intergenerational connected campus that links seniors to children and others in the community • Urban ecology curricula and ability to scale to families throughout Shapira • Kids program and citizen science performs climate tests while supporting long-term monitoring
Climate and environment	• Stormwater for reuse in planting programs and urban garden • Demonstrations of home garden plots • rain garden demonstration site, • Rain barrel neighborhood training • Material alternatives to reduce heat absorption • connectedness to the neighborhood and alternatives to existing fence that would allow for security when needed • Pathways to schools that provide cooling, educational points of interest, and safe passage for children	• Technical training site for energy security and solar technology for the community • Programmatic timing to optimize use of shading across site • Anti-idling regulation on children's path-ways to improve air quality • Liaison program with new development sites, anticipating how linkages on Sderot Hachmei Israel could welcome children and new residents in general to the neighborhood
Economy and livelihoods	• Vertical expansion of the community center	• Training for on-site water management techniques that demonstrate financial value to homeowners

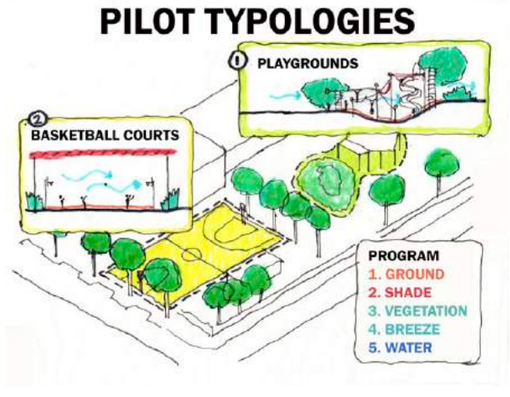
Defining and Measuring Success

Example Outcomes	Example Indicators
Climate and environment • Improved thermal comfort • Additional green space • Improved water resource management program • Replicable pilot	• Physiological Equivalent Temperature (PET) index - air temperature - relative humidity - wind speed - wind direction • Liters of water captured (increased) • Frequency of flooding • Recharge rate of coastal aquifer recharge • Number of additional schools testing the methodology
Community, health, and learning • Enhanced and improved role of the community center as the neighborhood backyard • Increased integration between different sectors of the community	• Rate of loneliness • Rate of conflict • Level of individual stress • Number institutions with joint programming • Number of nature-based solutions implemented in private houses • Money spent on healthcare
Economy and livelihoods • Improved future work opportunity • Improved opportunity for community-based economic opportunity	• Number of trainings delivered taught • Number and diversity participants in classes • Savings from water efficiencies



PROJECT: SHAPIRA CHILDREN'S ZONE: CLIMATICALLY TUNED PUBLIC SPACE

IMPLEMENTATION



Scaling Potential

There are three major paved surfaces at the Community Center which contribute to the thermal (dis) comfort of the site and drainage issues: the basketball court, playground and canopy, the paved lot, and compacted soil at the entry-way. These spaces are replicated many times over throughout the city, so investment in each of these spaces could be viewed as micro-pilots that test typologies for these discrete typologies. These pilots can test, for instance, the best materials to use for play equipment surfaces in view of climate performance of materials high heat and exposure conditions, safety requirements, and community needs. These pilots can set a template for all playground, basketball courts, and small lot play spaces.

Next Steps

1. ENGAGEMENT
Owner: Sustainable Neighborhoods Program, Community Administration

- Invest in citizen science program to begin environmental curriculum development, working with Tel Aviv University partners to design a microclimate monitoring program

2. POLICY AND FUNDING
Owner: City Planning, City Architect

- New development sites across the street have the potential to impact this space in terms of wind movement, shading, and sun exposure. One aspect of this project may include adjusting the design standards, such as through setting back of the street wall, applied to this site to consider and address climatic performance and mutually encourage thermal comfort on both site
- Use the Community Center as a testing ground for new material surfaces that improve thermal comfort and stormwater management city wide
- Identify where there may be existing overlapping budgets across City agencies and youth initiatives to begin investment in full design concept development and implementation

3. SITE PLAN
Owner: City Architect, Community Administration

Shapira Children Zone
- Tear down the fence around individual buildings
- Increase accessibility for pedestrians
- Increase vegetation along paths
- Create a unified design identity

Wind Corridor
- Remove or relocate walls and fencing
- Create public seating area
- Utilize shelter top structure as occupiable space
- Design outdoor Community Living Room with vine trellis and fan

Playground
- Use planting and topography to manage stormwater and create cooling
- Test preferred surface materials
- Introduce nature play and water play equipment
- Increase shading through tree planting

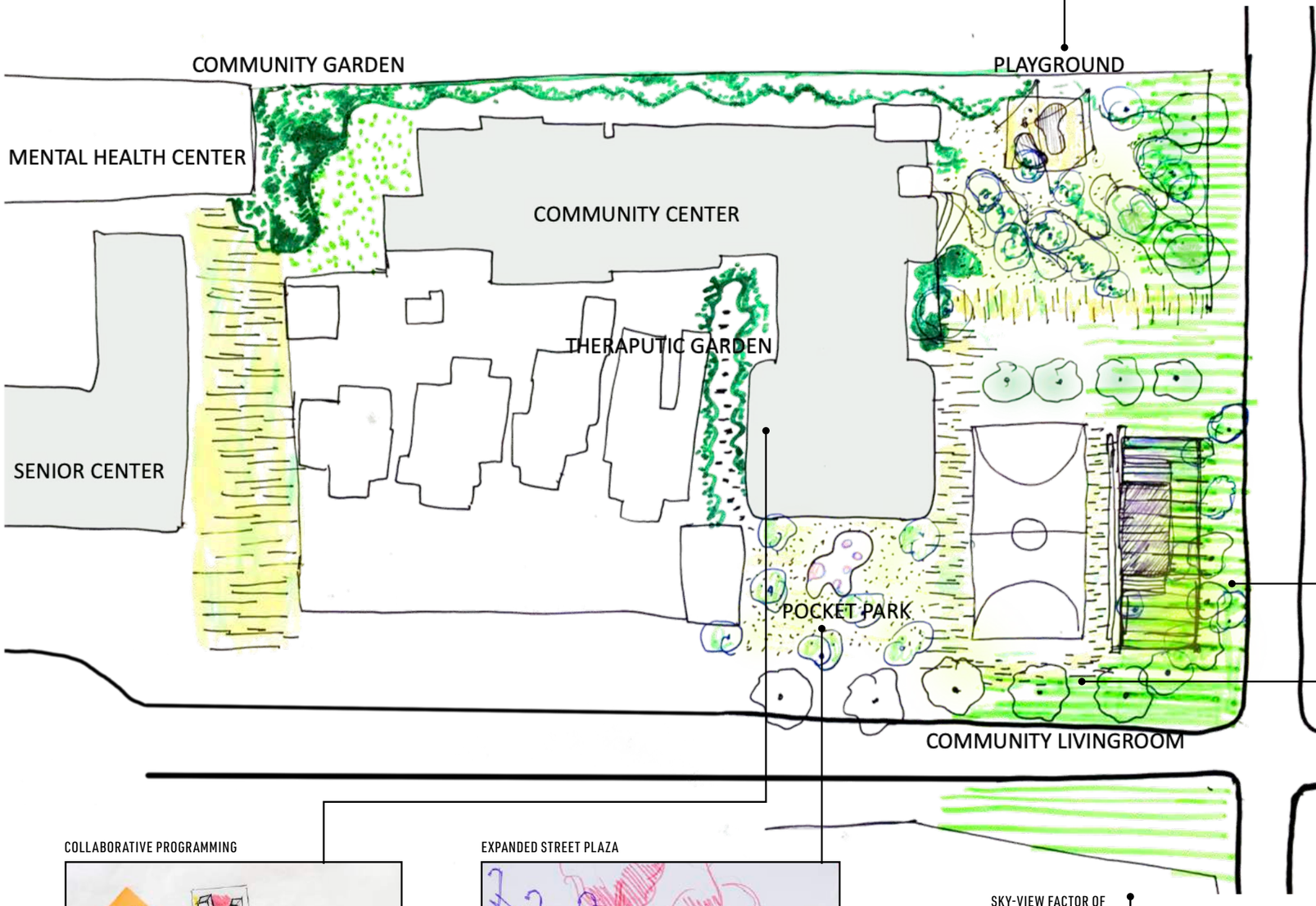
"As we look at the issue of heat, we immediately get to the question of what systemic shifts need to happen to achieve heat reduction and mitigation while also thinking longer term about systemic changes. So, we started looking at issues around water, water quality, ultrafine particles, density, and children near idling cars. In leading with heat, we want to wrap around the other systemic issues that can be adjusted to improve the environmental experience of the site. The center is a node in the community network – and we can look at how the community center can become even more of a resource."

– JANICE BARNES, CLIMATE ADAPTATION PARTNERS

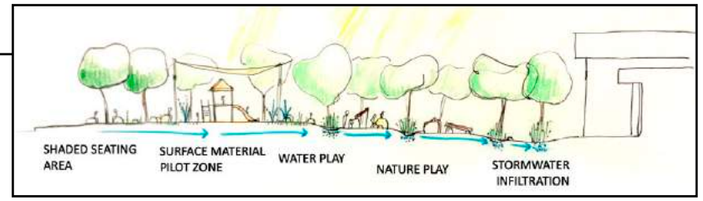
Project Team

Role / Expertise	Name	Organization / Agency
City Agency (Manager)	**Boaz Keidar**	City Architect's Office, Sustainable Planning
City Agency	**Dana Tennenbaum**	Urban 95, Community Administration
City Agency	**Laura Hoffman-Schaefteler**	Planning Department, East Tel Aviv
City Agency	**Tali Gozolan**	Community Administration
City Agency	**Orit Mandel**	Public Buildings
Designer	**Larissa Belcic**	Nocturnal Medicine
Designer	**Lee Altman**	SCAPE
Non-Government	**Keren Schwetz**	ILGBC
Academic Expert (Microclimate Modeling)	**Moshe Mandelmilch**	Tel Aviv University
Academic Expert (Environmental Policy)	**Orli Ronen**	Tel Aviv University
Outside Expert (Resilience)	**Konstantina Kayrdi**	Urban Innovative Actions, 100 Resilient Cities (Formerly)
Outside Expert (Urban Foresty)	**Ruth Edmonds**	Studio Zura
Facilitator	**Janice Barnes**	*Climate Adaptation Partners*

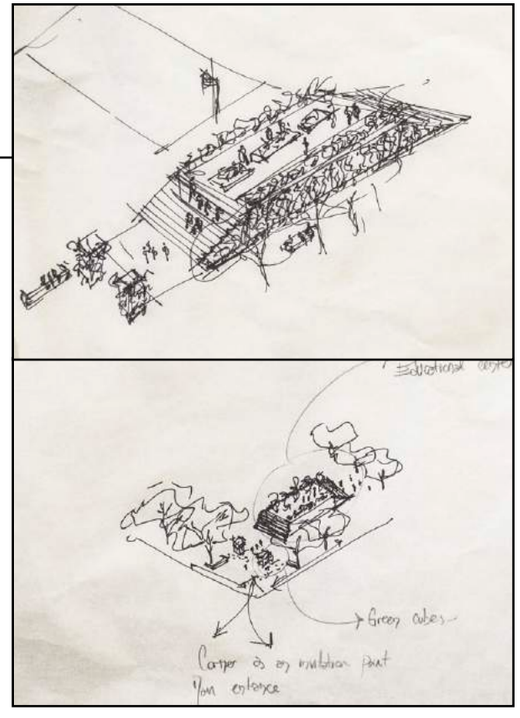
PROJECT: SHAPIRA CHILDREN'S ZONE: CLIMATICALLY TUNED PUBLIC SPACE



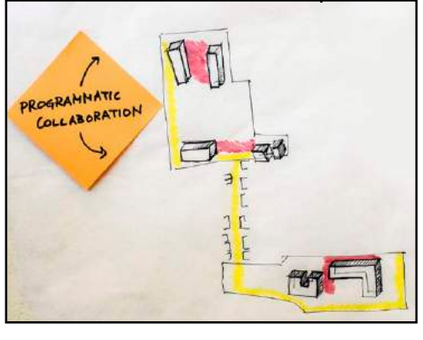
PLAYGROUND SECTION



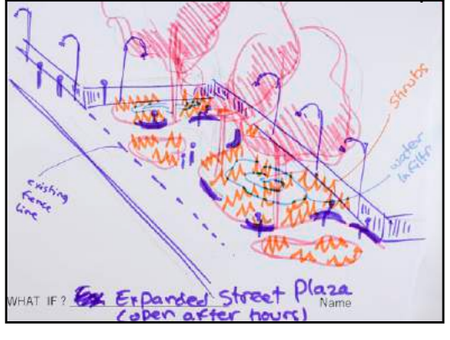
PERFORMANCE SPACE



COLLABORATIVE PROGRAMMING

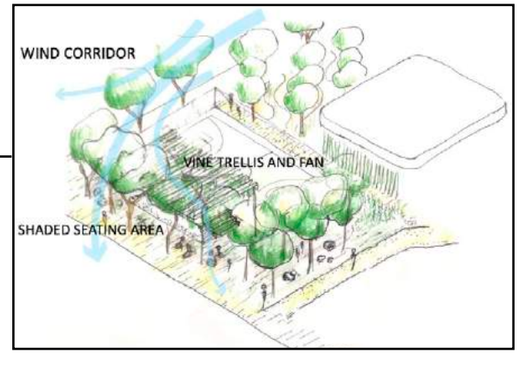


EXPANDED STREET PLAZA



SKY-VIEW FACTOR OF NEW DEVELOPMENT

COMMUNITY LIVING ROOM



A PUBLIC PRESENTATION OF THE DESIGN CONCEPTS WAS LED BY THE ACCELERATOR TEAM AND CITY PARTNERS AT THE COMMUNITY CENTER ON WEDNESDAY, NOVEMBER 6TH. COMMUNITY MEMBERS DISCUSSED AND REVIEWED DESIGN IDEAS AND CONSIDERED HOW THE COMMUNITY MIGHT BEST BE ENGAGED IN NEXT STEPS.

Policy and Planning Directions and Next Actions

Out of the three project concepts emerged a key set of policy directions that can advance planning in Shapira and City-wide. The City currently has four city-wide plans that can be brought together and explicitly tested in Shapira: Resilience Tel Aviv-Yafo, The City-Wide Master Plan (2017), the Sustainable Neighborhoods Program, and the ongoing Climate Adaptation Plan effort. An update of the *Shapira Neighborhood Master Plan* can unite these plans through a set of prototypic regulations, design guidelines, and incentives.

Beginning with Shapira as a testing ground, the City Architect and Planning departments can lead an effort that aims at three key actions:

1 Pursue an update to the *Shapira Neighborhood Master Plan* within which the "Climate Overlay Zoning District" can be implemented as a prototype in Shapira.

- Conduct a localized multi-hazard risk assessment that studies of factors additional to heat, including localized flooding, food and water scarcity, waste heat sources, energy load, and seismicity
- Conduct a comparative review of existing plans and policies governing future development in Shapira, and establish baseline research against which to evaluate zoning overlay success. For example, baseline microclimate measurements, socio-economic, heat exposure, and energy usage indicators can be used to establish a long-term monitoring and evaluation effort

Elements to study and standardize might include:

System		Example Standards and Strategies
Environment	Cooling	Cool roofs and cooling centers
	Microclimate	Air flow, groundwater recharge, shading and solar impact planning,
	Water	Condensation capture; Groundwater recharge; water conservation
	Energy	Power redundancy, conservation, local renewables, solar expansion from H20 to broader systems
Built	Mobility	Parking and idling; pedestrian planning and transit
	Buildings	Open space, canopy, and vegetative cover; Energy efficiency and embodied energy standards
	Housing and Develop-ment	Incentives and expedited permitting for climate sensitive planning; Contextual building standards; Community-based housing investment areas, such as with community development corporations or land trust models
Community	Education	Active professional capacities and family programming
	Health	Population health and air quality; Ultrafine particle (UPF) management
Economic	Businesses	Growth and cultivation of locally-based investment

"In doing a neighborhood level master plan with climate overlay in concert with these pilot interventions, over time you'll end up with a district scale understanding how these different efforts reduce energy drain. In layering solutions, mitigation and adaptation can be achieved in concert."

- SAM CARTER, RESILIENT CITIES CATALYST

2 Develop climate resilient urban design and architecture standards for future development, codified through building code and zoning

- Work with existing permitting and review processes to ensure feasibility of standards.
- Leverage upcoming procurement and urban renewal project development to develop and test climate resilient urban design standards.
- Develop and test standards for new housing and mixed-use development that take into account shading and sun exposure, vegetation and canopy, air flow and ventilation, waste heat, and energy efficiency and passive cooling through:
  - Site specific study of microclimate conditions at the site and in relation to nearby public space (shading and sun study, thermal comfort, ventilation and airflow).
  - Scenario modeling for future development programs and environmental modeling of potential climate impacts and benefits.
  - Convene local designers, advocates, planners, and developers with city agencies to test new development requirements, expedited permitting, and review procedures for private development and urban renewal projects.
- Develop and test standards and process for investment in the public realm that balance factors such as:
  - Cycles of existing and planned capital improvements
  - Best in class climate and microclimate analysis
  - Best in class materials and technologies of infrastructure
  - Coordination of capital investments among agencies for operational efficiency, long-term maintenance, and funding optimization

EXAMPLE RESILIENCE ZONING POLICIES

The City of Norfolk, Virginia adopted a new zoning ordinance in 2018 to enhance flood resilience and direct new more intense development to higher ground. The ordinance establishes a Coastal Resilience Overlay (CRO) zone, where new development and redevelopment will have to comply with new flood resilience requirements, and an Upland Resilience Overlay (URO), designed to encourage new development in areas of the city with lower risk of flooding.

The District of Columbia (Washington D.C.) Green Area Ratio (GAR) is an environmental sustainability zoning regulation which sets requirements for landscape elements and site design to help reduce stormwater runoff, improve air quality, and mitigate urban heat. The GAR sets minimum lot coverage standards for landscape and site design features to promote greater livability, ecological function, and climate adaptation in the urban environment. The GAR requirements provide a firm retention target and allow local governments to weight the elements they prefer in order to influence behavior, while providing some measure of flexibility for property owners.

New York City released new Climate Resiliency Design Guidelines that apply to all City capital projects, aside from coastal protection projects. The guidelines direct planners, engineers, architects, and others involved in project delivery on how to use regionally-specific future climate projections in the design of City facilities. For example, with respect to increasing temperature and heat wave projections designers are asked to ensure the physical components of the project itself are less vulnerable to increasing heat (e.g., by considering alternate materials and additional backup power), but also so help reduce the urban heat island effect (e.g., by integrating cooling features like green roofs). The guidelines suggest different benefit-cost analysis methods to ensure cost-effective investments, and contain information about approaches to address uncertainty (e.g., by building in flexibility to implement future adaptations).

Source: Georgetown Climate Center Adaptation Clearinghouse

3 Support multi-hazard retrofits of existing buildings

- Identify the range of possible retrofits that can be made to existing building stock including, for example: shading structures for balconies and awnings, green roofs and walls, energy efficiency upgrades, on-site tree planting and canopy coverage, public realm planting and maintenance, on-site water conservation towards aquifer recharge and public vegetation recharge
- Design financial incentives and subsidies that promote private building owner investments in multi-hazard climate mitigation strategies for energy savings, shading coverage, and water conservation measures
- Work with National ministries to quantify benefits of climate retrofits to private properties in order to size and therefore fund incentives for energy savings and water conservation

"We cannot take the impacts of climate change lightly – the environmental, social, and economic consequences are too great. We have learned new ways of thinking about how to think about how a single site can represent what's needed in a neighborhood, a city, and even the national scale."

- MENAHEM LEIBA, GENERAL MANAGER TEL AVIV-YAFO

CLOSING THOUGHTS

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, the policies and plans that the pilot project concepts implicate city-wide and even national-level policies and programs that build capacity of cities to understand their climate risk, energy policy, and future adaptation plans. To this end, there is 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.

Building resilience is as much about strengthening communities, systems, and institutions as it is about the physical dimensions of a project or plan. The same planning and design tools that created these challenges may not be able to solve them. Should business as usual ways of making decisions, building infrastructure, developing housing, and using energy persist, neighborhoods like Shapira and cities like Tel Aviv-Yafo risk greater social and ecological erosion. In vulnerable neighborhoods like Shapira, where the effects of climate change, pressures from urban expansion, and globalization meet in explicit ways, the imperative to protect and enhance the public realm is ever greater. It is in these neighborhoods and communities that deep listening and inclusion will ensure that the patterns that created inequitable exposure are reimagined. As urgency mounts, the robustness and feasibility of the solutions we imagine depends first on their inclusivity.

"Apart from the growing separation between north and south, Tel Aviv-Yafo is a city that contains extremes and contrasts in several spheres. The city has a large concentration of extremely wealthy individuals, but also homeless people; poor residents, but also gated communities; upscale homes owned by the new bourgeoisie who settled in Yafo, but also slums and neighborhoods where crime runs rampant; a city of law and order, but also grey areas controlled by criminal groups. As such, the Tel Aviv-Yafo Municipality has written its RESILIENCE flag to support the ones who most need it FIRST. Where strategy meets implementation, equity, responsibility, and trust are embedded in the city's most pressing future challenges and dealing with urban heat."

–EFRAT MAKIN-KNAFO

APPENDIX

I. Climate Projections Methodology

The Columbia Center for Climate Systems Research (CCSR) has developed a set of climate projections for the Resilience Accelerator program in collaboration with Columbia's Graduate School of Architecture, Planning and Preservation (GSAPP) Center for Resilient Cities and Landscapes (CRCL). These climate projections draw from the NASA Earth Exchange Global Daily Downscaled Projections (NASA NEX-GDDP) dataset released in 2015 (NASA, 2015). The NEX-GDDP dataset includes downscaled projections (0.25 degrees, ~25 kilometer resolution) from 21 global climate models (GCMs) which were run as part of the Coupled Model Intercomparison Project Phase 5 (CMIP5) (NASA, 2015, CMIP5, 2016). CMIP5 simulations were developed in support of the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (IPCC, 2013).

Outputs from the NEX-GDDP dataset were used to calculate annual and seasonal (May through July) mean and extreme temperature projections and annual mean precipitation projections for three time slices in the 21st century; we refer to these as the "2020s" (2011-2040), "2050s" (2041-2070) and "2080s" (2071-2100). The baseline period is defined in NEX as 1980-2005. We focus on two emissions scenarios, or Representative Concentration Pathways (RCPs; Moss, 2010), including a mid-level emissions scenario (RCP 4.5) and a high-emissions scenario (RCP 8.5). Results are provided for each scenario (unique combination of 30-year time slice and RCP) to present the most accurate long-term projections, while recognizing that individual model dynamics and interannual variability provide several dimensions of uncertainty. Due to these uncertainties, we present climate projections as a range of possible outcomes, rather than a single number for a given scenario. Our "low estimate" projections represent the 25th percentile across the 21 GCMs under each RCP, and the "high estimate" projections represent the 75th percentile across the 21 GCMs.

In addition to changes in annual precipitation and annual and seasonal daily temperatures, in which we assess the distribution of daily minimum, mean and maximum temperature, it is important to examine changes in high temperature days. To look at extreme heat events, we calculated changes in three metrics:

1) The frequency of hot days, defined as days with a maximum temperature at or above 33 degrees Celsius

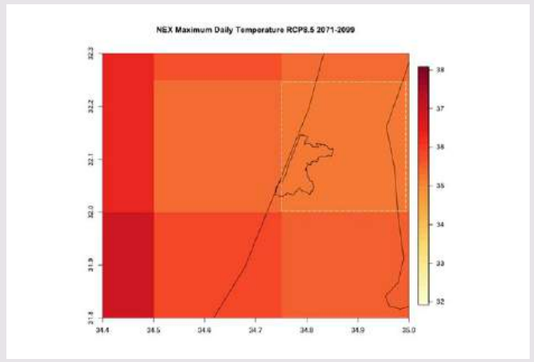
2) The frequency of heat waves, defined as two or more consecutive hot days, and

3) The average length of heat waves.

Using these metrics, projections were developed for each individual time slice and RCP, and are presented at annual and seasonal time scales.

We also calculated a metric for the assessment of changes in extremely high precipitation events. We define a "high-precipitation" threshold for each model using the 26th highest daily rainfall amount in the 26 years of the model's baseline (1980-2005). This serves as a way to estimate an average "rainiest day of the year" event. We present the average annual number of days above this threshold for each future scenario.

GEOGRAPHY



GEOGRAPHIC PIXEL OF NEX GDDP USED FOR DOWNSCALED CLIMATE PROJECTIONS

REFERENCES

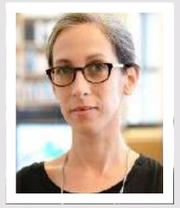
CMIP5. (2016). CMIP5 Coupled Model Intercomparison Project. Available from: http://cmip-pcmdi.llnl.gov/cmip5/ index.html.

IPCC. (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp.

Moss, R. H., Edmonds, J. A., and Hibbard, K. A. (2010). The next generation of scenarios for climate change research and assessment. Nature, 463(7282), 747–756.

NASA. (2015). NEX Global Daily Downscaled Climate Projections 2015. Available from: https://nex.nasa.gov/nex/projects/1356/.

II. Outside Expert and Bios



LEE ALTMAN,
SCAPE

Lee Altman is an architect and urban designer at SCAPE Landscape Architecture where she manages projects that integrate urban design and landscape strategies with sustainable and resilient public infrastructure. She is an Adjunct Assistant Professor at Columbia University's Graduate School of Architecture, Planning, and Preservation, where she teaches in the Urban Design program.

Lee has previously worked for New York City's Department of Design and Construction where she led the agency's efforts on projects and initiatives to improve public health through the design of the built environment, and collaborated on interagency efforts that employ design, policy, and evidence-based practices to improve public health outcomes. In addition, she promoted high-quality public design through the Design and Construction Excellence program. Prior to joining DDC, Lee worked with artists, scientists, and media professionals to form a multifaceted perspective and allow different voices and interests to participate and impact the design process of complex urban projects.

Lee serves as the co-chair of the Design Trust for Public Space Former Fellows Forum, and the advisory council for Transportation Alternatives. She holds a Bachelor of Architecture degree from the Israel Institute of Technology, and Master of Science degree in Architecture and Urban Design from Columbia GSAPP.

JANICE BARNES,
CLIMATE ADAPTATION PARTNERS

Janice Barnes founded Climate Adaptation Partners, a New York City-based business connecting technical experts, organizational leaders and community voices with public and private sectors for the purpose of advancing resilience in policy and built environments. With 30 years of design experience and empirical research, Janice enables organizations to critically evaluate their possible pathways given current and expected exposures and link these to appropriate design and financing options.

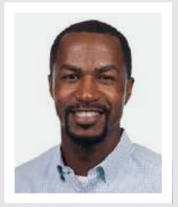
Her current work includes collaboration with the National Academies of Science, Engineering and Medicine on the Resilient America Roundtable on Flooding, Extreme Heat and Managed Retreat. She also recently served as Expert Reviewer with the Urban Land Institute on their work, Scorched, a critical assessment of extreme heat and development impacts. This followed earlier work on the Gowanus Technical Assistance Panel which addressed upzoning and extreme heat.

Previously she led the Dutch Dialogues efforts in the Medical District for the City of Charleston with the Historic Charleston Foundation and the City of Charleston Vulnerability Study. She also led the Phase 2 Resilient Hampton Newmarket Creek Pilot Study with City of Hampton, including Environmental Impact Bond funding as well as assessment of tree canopy and impervious surface as related to heat and flooding exposures.

LARISSA BELCIC,
OFICINAA AND
NOCTURNAL MEDICINE

Larissa Belcic is a landscape architectural designer working with climate and ecological change adaptation in multiple capacities. First, on adaptation and resiliency to extreme heat in the outdoor built environment through her work with OFICINAA, a multi-disciplinary firm working with thermally-sensitive design. Second, on the emotional and social challenges that arise when facing complex environmental problems through her firm Nocturnal Medicine. Recent extreme heat resiliency projects include a pamphlet on urban cooling design strategies grounded in thermodynamic principles, in collaboration with OFICINAA principal Silvia Benedito, and participation in the development of the city of Cambridge, Massachusetts Climate Change Preparedness Response Plan. Larissa holds a Masters in Landscape Architecture from the Harvard University Graduate School of Design and a BA in Linguistics from Boston College, with a professional background in community engagement. She works, builds, collaborates, and publishes as both a designer and an artist. She is a past recipient of the Harvard University GSD Penny White Prize for research on robotics and interplanetary colonization. Recent publications include in the design journals Thresholds and Scapegoat; recent collaborations include with Brooklyn cultural pro-

gramming platform Talk | Show and Los Angeles conceptual horticultural store Plant Material. Larissa is ultimately devoted to justice-oriented world-building in response to environmental challenges.



CHRISTIAN BRANEON,
NASA GODDARD INSTITUTE
FOR SPACE STUDIES

Dr. Christian Braneon is a scientist at NASA's Goddard Institute for Space Studies in New York. His primary responsibilities there are focused on integrating stakeholder engagement, satellite imagery, and climate projections into urban and regional planning. Dr. Braneon supports the Urban Climate Change Research Network's (UCCRN) Urban Design Climate Workshop series focused on helping cities utilize NASA datasets to enhance climate resiliency. He also serves as a principal investigator for the Climate Change Research Initiative.

He previously served as faculty at the Georgia Institute of Technology (Georgia Tech) where he was the Assistant Director of the Center for Serve-Learn-Sustain. Prior to joining Georgia Tech, Dr. Braneon served as Co-Director of the United States Environmental Protection Agency's (USEPA) inaugural Environmental Justice Academy for community leaders. He led regional community engagement efforts associated with the Clean Power Plan in four states and was recognized for his service with a White House Climate Action Plan Award during his tenure at USEPA.

Dr. Braneon serves as a reviewer for the Journal of Hydrology as well as Urban Climate. He earned his BS, MS, and PhD degrees in Civil Engineering from Georgia Tech. Dr. Braneon also earned a BS in Applied Physics from Morehouse College.

SAM CARTER,
RESILIENT CITIES CATALYST

Sam Carter is a Founding Principal of Resilient Cities Catalyst (RCC). In this role, he serves as RCC's lead on climate and urban transformation, and leads several strategic partnerships, including the Resilience Accelerator with Columbia University's Center for Resilient Cities and Landscapes and The Rockefeller Foundation, and the Southern California Resilience Initiative with the Conrad N. Hilton Foundation.

Sam was a leader at 100 Resilient Cities where he served on the Executive Team and developed the Resilience Accelerator as a valuable program supporting eight 100RC cities across the globe. Prior to that, he served as Managing Director leading the Resilience Team at The Rockefeller Foundation. In that role he led the Foundation's partnership with the US Department of Housing and Urban Development on the National Disaster Resilience Competition, as well as its work in the New York region post Sandy and in the Louisiana state ongoing long term recovery efforts. He also served as an advisor on the Global Resilience Partnership, a collaboration with DFID and USAID to connect humanitarian response to long term planning to improve the strength of communities and reduce repetitive losses.

In 2007, Sam helped to establish the Institute for Public Knowledge at New York University, where he served as Associate Director and managed the research phase of Rebuild by Design. Prior to working at the IPK, Mr. Carter worked as Program Coordinator for the President's Office of the Social Science Research Council, where he coordinated the SSRC Katrina Task Force and developed two books for the Privatization of Risk Series with Columbia University Press.

LIAT EISEN,
THE NEW SCHOOL

Liat Eisen is an architect, urban planner and a PhD candidate for public and urban policy at the Milano School of Policy, Management, and Environmental at the New School. Liat's PhD research examines the role of incentives for urban development in two neoliberal cities: New York City and Tel Aviv. Her research interests include privatization of urban public space, incentives for urban development, spatial politics and conflict resolution in divided cities. In her last position, Liat served as the chief architect of Jerusalem at the Planning Administration at the Ministry of Finance in Israel, where she played a pivotal role in the decision making process on municipal issues and in determining future policies in accordance with the demographic, economic and political changes. Liat achieved her master degree in Architecture and Urban Design from Columbia University. Upon graduation Liat joined IBI group Gruzen Samton and worked on urban renewal and government projects in NYC and Washington DC. Additionally, she has gained international experience in teaching architecture and urban design in Tel Aviv, Jerusalem, Paris and NY.

EVYATAR ERELL,
BEN-GURION UNIVERSITY

Associate Professor Evyatar Erell is an architect and geographer at Ben-Gurion University in Israel. Prof. Erell's research addresses flows of energy in the built environment at different scales, and how they affect the spaces we inhabit, both indoors and outside. He has studied glazing systems, daylight control and passive cooling techniques for buildings; and several aspects of the urban microclimate, in particular computer modeling of air temperature in urban street canyons and pedestrian thermal comfort in hot dry environments. Prof. Erell has co-authored several books, including 'Urban Microclimate: The Design of Spaces between Buildings'. He is a member of several expert committees at the Israel Institute of Standards, and has contributed to drafting national standards for thermal insulation and energy certification of buildings.

KONSTANTINA KARYDI

Konstantina Karydi is an executive level professional with horizontal experience specialised in urban policy, resilience and social vulnerability issues in conditions of volatility and increased complexity. Most recently she has worked as EME Associate Director and Global Climate Transformation Lead for 100RC, Special Advisor to the Greek Minister of State and European Commission Urban Innovation Expert. She holds a Global Executive Masters on Innovative Governance of Large Urban Systems from EPFL, Switzerland and an MSc on European Public Policy from UCL, UK. As a volunteer she works with Art & Culture as means of development, promoting democracy and integration in the Balkan region and became co-recipient of the 2018 European Economic & Social Committee (EESC) Civil Society Prize for Cultural Heritage.

SAGI GOLAN,
NYC DEPARTMENT
OF CITY PLANNING

Sagi is the Senior Lead Urban Designer for Brooklyn at the New York City Department of City Planning (NYCDCP) where ensures a high level of design excellence in projects across the Borough of Brooklyn. Sagi works on large scale housing projects, neighborhood planning initiatives, waterfront open spaces, redesigning streets, public spaces, and mixed-use developments. His work strives to achieve the best design outcome through collaboration with developers, designers, various agencies, local and city-wide organizations and other stakeholders to make New York a more sustainable, resilient, livable, and equitable city.

Sagi currently teaches the summer semester's urban design studio at Columbia University's Graduate School of Architecture, Planning and Preservation (GSAPP) and is a visiting critic at Syracuse University, Cornell University, Columbia GSAPP, NYIT and Parsons.

Sagi holds a Bachelor's degree in architecture from Tel Aviv University and an M.S. in Architecture and Urban Design from Columbia University. He is the recipient of the GSAPP award for excellence, the Lucille Smyser Lowenfish Memorial Prize and the 2015 AIANY Urban Design Merit Award for "9x18".

MOSHE MANDELMILCH,
TEL AVIV UNIVERSITY

Moshe Mandelmilch is a PhD student in the Department of Geography and Human environment, at Tel-Aviv University. HIS PhD field of study is remote sensing and urban climatology. In remote sensing, he has an experience working with hyperspectral and multispectral remote sensing. The topic of his PhD work is mapping and investigating Mediterranean plant species features in forest in Israel. He works in a research collaboration with Prof. Oded Potchter on issues of urban Heat Island (UHI) in cities in Israel, incorporating various methodologies such as: performing climatic measurements and using different methods of remote sensing.

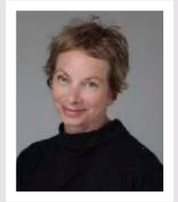
KATE ORFF,
COLUMBIA UNIVERSITY AND SCAPE

Kate Orff is the Faculty Director of the Center for Resilient Cities and Landscapes, an Associate Professor at the Columbia Graduate School of Architecture, Planning and Preservation, and Director of the Urban Design (MSAUD) Program. She coordinates complex, interdisciplinary studios centered on urban systems of the future

with a focus on ecological infrastructure, global cities and climate adaptation. Kate is a registered landscape architect and a principal of SCAPE, an award winning, 50-person professional practice based in lower Manhattan. The firm has won national and local American Society of Landscape Architecture Awards for built projects, planning, and communications work. The work of the office has been featured on the cover of Landscape Architecture Magazine, Landscape Architecture Magazine China, and Topos, and in The New York Times, The New Yorker, and The Economist, among other publications.

ODED POTCHTER,
TEL AVIV UNIVERSITY

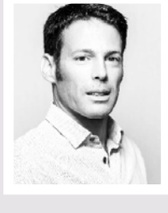
Prof. Oded Potchter is the vice dean and chair of the Academic Council Faculty of Society and Culture, at the academic college Beit Berl and a lecturer at Tel Aviv University. His area of expertise is Applied Climatology focusing on climate related urban planning, green buildings and the urban heat island phenomenon. His PhD thesis was on the Climatic Aspects of the Building of Ancient Urban Settlements in the Land of Israel. In recent years, his research has focused on the environmental impact (climate, air pollution and noise) of urban green spaces. In terms of teaching, he specializes in field studies, climatic measurements and environmental monitoring. Oded is a climatic consultant and was involved in the planning process of the desert city of Beer Sheva and the new city of Ramat Beit Shemesh as well as smaller scale projects.



ORLI RONEN,
THE PORTER SCHOOL AT
TEL AVIV UNIVERSITY

Orli Ronen is the head of the Urban Innovation and Sustainability Lab, at the Porter School for Environmental and Social Studies, Tel Aviv University. The Lab is a cooperation between the Porter school and Tel Aviv-Yafo Municipality, enabling graduate students to work directly with policy actors in local authorities, helping them use environmental data to devise new sustainability programs and policies for their local area. Previously, she headed the Heschel Center for Sustainability, one of Israel's leading environmental and social NGO's. She founded the Heschel Center's Local Sustainability Center, a joint project with the Porter School, the Ministry of the Environment and ICLEI. Dr. Ronen drafted Israel's National Report to Habitat III, and the Tel Aviv Yafo Declaration on Civic Engagement and Smart Cities, which is part of the Habitat III New Urban Agenda. Since 2018, she is the thematic consultant for Urban Climate Adaptation for the National Climate Adaptation Administration. Ronen is also the thematic focal point for ICZM at the Israeli Coastal Authorities Forum.

Orli's research and policy interests include; transition to sustainable and smart urban communities, climate adaptation, Integrated Coastal Zone Management, resiliency, and expansion of local democratic mechanisms. She holds a PhD in Urban Planning from Tel Aviv University and a Master's Degree in Public Administration as well as a Master's in Business Administration. She participated in the Tedex-Jaffa in 2017, and is the 2009 recipient of the Green Globe for Local Sustainability



SHACHAR ZUR,
STUDIO ZURA

Shachar Zur is a Licensed Landscape architect (B.LA,) and a Landscape Architecture Master of Science (M.Sc.) from the Technion in Haifa. His field of study deals with urban forestry and street trees habitat in urban environments. Since 2013 he has been lecturing in this field at the Technion. From 2005 to 2012, Shachar worked as a landscape architect at the West8 firm in the Netherlands, one of the top firms worldwide, there Shachar specialized in the integration of "Green Infrastructures" in Urban Environments.

Co-Founder of "Studio Zura", providing multi-disciplinary based solutions emphasizing the integration of ecological, social and infrastructural related processes in design procedures.

PROGRAM TEAM

GRGA BASIC,
CENTER FOR RESILIENT
CITIES AND LANDSCAPES

Grga Basic is an Associate Research Scholar at the Center for Resilient Cities and Landscapes (CRCL) and Adjunct Assistant Professor at the Columbia Graduate School of Architecture, Planning and Preservation (GSAPP); his work and research focus on critical, narrative, and investigative cartography. He joined CRCL in 2018, coming from the Center for Spatial Research. At CRCL, Grga acts as a mapping expert, developing and overseeing spatial analysis and cartographic representations for all Resilience Accelerator projects. At Columbia, he also teaches GIS and Points Unknown, an interdisciplinary course focused on pairing journalistic techniques with design practices through spatial data analysis and visualization.

Prior to joining GSAPP, Grga held academic appointment at the Harvard Urban Theory Lab and worked as an architect at the Atelier Seraji in Paris. His cartographic representations have been exhibited at the Venice, Hong Kong, Shenzhen, and Rotterdam Biennials of Architecture. Grga holds Bachelor and Master of Architecture degrees from the Academy of Fine Arts Vienna, and a Master in Design Studies in Urbanism, Landscape, Ecology from the Harvard Graduate School of Design.

JOHANNA LOVECCHIO,
CENTER FOR RESILIENT CITIES
AND LANDSCAPES

Johanna Lovecchio is the Associate Director of the Center for Resilient Cities and Landscapes (CRCL). She specializes in urban climate adaptation planning and public infrastructure project design that is forward-looking and conscious of community-based and ecosystem resilience. At CRCL, she manages the Resilience Accelerator, which delivers strategic support, technical design and climate systems research, and intensive local workshops to advance resilience project design and implementation in partnership with local governments around the world.

Prior to joining CRCL, Johanna worked as a Senior Analyst at HR&A Advisors, where she scaled national and global capacity-building efforts, including the National Disaster Resilience Competition and Global Resilience Academy programs. She began her career at the New York City Department of City Planning, where she researched flood risk, environmental contamination, and land use in post-industrial, waterfront communities impacted by Hurricane Sandy. Johanna holds a Masters of Urban Planning from the Robert F. Wagner School of Public Service and dual Bachelor of Arts degrees in Environmental Studies and Metropolitan Studies from New York University.

IV. Full Workshop Participant List

Meir Allweil	Tel Aviv-Yafo Municipality
Lee Altman	SCAPE Landscape Architects
Adi Ashkenazi	Tel Aviv-Yafo Municipality
Ronit Averbuch	Tel Aviv University
Ran Avraham	Ministry of environmental protection
Uriel Babczyk	Ministry of Energy
Larissa Balcic	Nocturnal Medicine
Janice Barnes	Climate Adaptation Partners
Daniel Baron	Tel Aviv-Yafo Municipality
Grga Basic	CRCL, Columbia University
Adi Basis	Tel Aviv-Yafo Municipality
Yafa Ben Eliyahu	Tel Aviv-Yafo Municipality
Etan Ben-Ami	Tel Aviv-Yafo Municipality
Tali Bergel	Tel Aviv-Yafo Municipality
Dror Boymel	The Society for The Protection of Nature in Israel
Christian Braneon	NASA GISS, Columbia University
Udi Carmeli	Tel Aviv-Yafo Municipality
Omri Carmon	Tel Aviv-Yafo Municipality, Resilience Office
Sam Carter	Resilient Cities Catalyst
Ronen Cohen	Tel Aviv-Yafo Municipality
Maya Crabtree	Forum 15
Vered Crispin Ramati	Tel Aviv-Yafo Municipality
Elad Damesek	Tel Aviv-Yafo Municipality
Misha Danilov	Tel Aviv-Yafo Municipality
Tali Dattner	Tel Aviv University, Porter School
Yoav David	Tel Aviv-Yafo Municipality
Francine Davidi	Tel Aviv-Yafo Municipality
Guy Deknuydt	Tel Aviv-Yafo Municipality
Tomer Dovrat	Tel Aviv-Yafo Municipality
Liat Eisen	The New School
Anat Eizik-Caspi	Tel Aviv-Yafo Municipality
Evyatar Erel	Ben Gurion University
Tzwitz Eucharia*	
Luise Evers*	
Samer Fakhoury*	Tel Aviv University
Michal Ferenz	Tel Aviv University
Keren-Or Fish	Tel Aviv-Yafo Municipality
Gali Freund	Space Association (Merchav)
Iren Fruru	Tel Aviv University, Porter School
Shiri Fundaminsky	Ministry of Construction and Housing
Haim Gavriel	Tel Aviv-Yafo Municipality
Sagi Golan	NYC City Planning
Elad Goldman	Tel Aviv Foundation
Alon Goldman	Tel Aviv-Yafo Municipality
Ron Govzensky	Tel Aviv-Yafo Municipality
Orly Hacohen	Tel Aviv University
Ittay Hacohen	Tel Aviv University
Sharona Hershko	Tel Aviv-Yafo Municipality
Laura Hoffman Schaeftler	Tel Aviv-Yafo Municipality
Asaf Hareli	Tel Aviv-Yafo Municipality
Roi Ivri	Tel Aviv-Yafo Municipality
Shmulik Kachelnik	Tel Aviv-Yafo Municipality
Gaby Kaminsky*	CityZone
Max Kaplanzantop*	Rochester
Konstantina Karydi	UIA
Tommy Kay	Tel Aviv University, Porter School
Boaz Kedar	Tel Aviv-Yafo Municipality
Hadas Keren	
Shir Kimchi	Tel Aviv-Yafo Municipality
Prof. Arch. Sari Klaus	Tel Aviv University
Gali Koren	Tel Aviv University, Porter School
Ayelet Kraus	Street Wisdom
Jacob Kravshinsky	
Menachem Leiba	Tel Aviv-Yafo Municipality
Johanna Lovecchio	CRCL, Columbia University
Hila Lubanov	Tel Aviv-Yafo Municipality
Efrat Makin-Knafo	Tel Aviv-Yafo Municipality, Resilience Office
Moshe Mandelmilch	Tel Aviv University, Porter School
Orit Marom	Tel Aviv-Yafo Municipality
Orit Mendel	Tel Aviv-Yafo Municipality
Rinat Milo	Tel Aviv-Yafo Municipality
Michal Nahari	Tel Aviv-Yafo Municipality
Ezra Nave	Tel Aviv-Yafo Municipality
Olivia Nordland	
Alana Norris	Tel Aviv University
Rebecca Oltheten	Tel Aviv University
Kate Orff	CRCL, Columbia University
Evgenia Plotkin	Tel Aviv-Yafo Municipality
Oded Potchter	Tel Aviv University, Porter School
Debora Rachmani	
Noa Regev	Tel Aviv-Yafo Municipality
Alma Revivo	Tel Aviv-Yafo Municipality
Atalia Reznik	Tel Aviv-Yafo Municipality
Dr. Orli Ronen	Tel Aviv University, Porter School
Ira Rosen	Tel Aviv-Yafo Municipality
Hadas Sagi	Tel Aviv-Yafo Municipality
Perry Samnon	Tel Aviv-Yafo Municipality
Irit Sayag	Tel Aviv-Yafo Municipality
Keren Schvetz	Green Building Council
Salit Sela	Kfar Saba Municipality
Liav Shalem	Ganei Yehoshua Park
Neta Shalev	Tel Aviv-Yafo Municipality
Jacky Shamay-Barbi	Tel Aviv-Yafo Municipality
Tamar Shamir	Tel Aviv-Yafo Municipality
Aviva Shemesh	Heschel Center
Alma Shiran	Tel Aviv-Yafo Municipality
Dereje Simon	Tel Aviv-Yafo Municipality
Shay Solomonov	Tel Aviv University
Vidya Sondhi	Tel Aviv University
Michal Tausig	Tel Aviv-Yafo Municipality
Dana Tennenbaum	Tel Aviv-Yafo Municipality
Bosmat Tzfadia-Wolf	Tel Aviv-Yafo Municipality
Bat El Ungar	Tel Aviv-Yafo Municipality
Caroline Wagner*	
Eran Wexler*	
Tali Wexler	The Commons
Keren Zaguri	Tel Aviv-Yafo Municipality
Inna Zass	Tel Aviv University, Porter School
Rubi Zluf	Tel Aviv-Yafo Municipality
Shlomit Zonenstein	Tel Aviv-Yafo Municipality
Shachar Zur	Zura Architects
Amit Zvigoren	Tel Aviv-Yafo Municipality

V. Final Workshop Agenda

SUNDAY, NOVEMBER 3 | PROBLEM FRAMING AND IMAGINING THE POSSIBILITIES

8:30 – 9:00	**REGISTRATION, COFFEE, AND BREAKFAST**		
9:00 – 9:20	**WELCOME REMARKS**	Yoav David, City Architect Etan Ben-Ami, Director of Environmental Authority Orli Ronen, Tel Aviv University Lauren Sorkin (Video) Acting Executive Director, Global Resilient Cities Network Sam Carter, Director of Resilience Accelerator Program	Plenary
9:20 – 9:50	**RESILIENCE ACCELERATOR TEL AVIV-YAFO: URBAN HEAT, EQUITY, RESILIENCE AND THE FUTURE OF THE PUBLIC REALM**		Plenary, Presentations
	Accelerator Process	Omri Carmon, Deputy Chief Resilience Officer Guy Deknuydt, Environmental Authority	
	Defining the Problem	Johanna Lovecchio, Center for Resilient Cities and Landscapes Christian Braneon, NASA GISS	
	Workshop Goals, Agenda, and Participant Overview	Johanna Lovecchio and Omri Carmon	
9:50 – 10:00	**OPENING: RESILIENCE IN TEL AVIV-YAFO**	Efrat Makin-Knafo, Chief Resilience Officer Vice Mayor Assaf Harel	

10:00 – 11:00	**EXPERT PANEL: FROM CLIMATE IMPACTS TO RESILIENCE DESIGN** *Microclimate in Shapira* *Lessons in Adaptation Design from Durban* *Resilience-Based Design* *Design for Thermal Sensitivity*	Oded Potchter and Moshe Mandelmilch, Tel Aviv University Porter School Christian Braneon, NASA GISS Kate Orff, Center for Resilient Cities and Landscapes and SCAPE Larissa Belcic, Nocturnal Medicine	Plenary, Panel Session
11:00 – 12:00	**TEAM INTRODUCTIONS AND SITE VISITS** Participants and facilitators gather into workshop groups; Each group is led on a walking tour of Shapira to review existing plans and projects, visit assigned project sites	Tour Leaders: Omri Carmon, Noa Regev, Guy Deknuydt	Walking Tour
12:00 – 12:30	**LUNCH**		Community Center
12:30 – 1:30	**EXERCISE 1. REFINING THE DESIGN CRITERIA** Teams review preliminary design criteria, and brainstorm outcomes that can address interdependent risks in Shapira, at the site, and in Tel Aviv-Yafo more broadly	Project Teams; Facilitator Led	Breakout Tables
1:30 – 4:00	**EXERCISE 2. VISUALIZING THE SITE AND IMAGINING POSSIBILITIES** Designers and planners head to the site to perform a site diagnostic of microclimate conditions and prepare rapid sketches of potential design concept; Teams discuss and select top three directions	Project Teams; Facilitator Led	Project Site; Breakout Tables
3:30 – 6:00	**PUBLIC EXHIBIT AT SHAPIRA COMMUNITY CENTER**	Everyone, Public	Community Center, Main Entrance
6:00	**CLOSE**		

MONDAY, NOVEMBER 4 | DESIGN AND IMPLEMENTATION CHARRETTE

8:30 – 9:00	**BREAKFAST AND COFFEE**		
9:00 - 9:20	**DAY 1 RECAP, DAY 2 INTRODUCTION AND FRAMING**	Johanna Lovecchio and Omri Carmon	Plenary
9:20 – 9:30	**TRANSITION TO BREAKOUT GROUPS**		
9:30 – 12:00	**EXERCISE 3. CONCEPT REFINEMENT AND PROJECT STATEMENT** Discuss and select a way forward ; Develop concept plans and sections; Write project statement	Project Teams; Facilitator Led	Breakout Tables
12:00 – 1:15	**EXERCISE 4. PIN-UP CRITIQUE SESSION (OVER LUNCH)** Pin up to senior municipal leaders, expert panel, and community stakeholders	All Project Teams; Team Representative Led; Senior Officials and SME's	Plenary
1:15 – 1:30	**EXPERT PRESENTATION : IMPLEMENTATION IN TEL AVIV**	Professor Evyatar Erell	Plenary
1:30 – 2:30	**EXERCISE 5. MEASURING SUCCESS** Defining outputs and outcomes; Identify measurable indicators; clarifying where there can be multiple benefits	Project Teams; Facilitator Led	Breakout Tables
2:30 – 4:00	**EXERCISE 6. COSTS, BENEFITS, AND FUNDING** Define use elements, monetize benefits, and match funding sources	Project Teams; Facilitator Led	Breakout Tables
4:00 – 4:45	**EXERCISE 7. ENGAGEMENT PLAN** Define stakeholders and stage of inclusion in project lifecycle	Project Teams; Facilitator Led	Breakout Tables
4:45 – 5:30	**EXERCISE 8. ACTION PLAN** Identify key milestones, actions, ownership, and critical issues	Project Teams; Facilitator Led	Breakout Tables
	DESIGN REFINEMENT CONTINUED Designers have the option to continue refining and/or digitizing drawings in preparation for final presentation; Designers iterate on design based on implementation exercises as needed	Designers	Breakout Tables
5:30 – 6:00	**GROUP DISCUSSION. SYNTHESIZING REGULATORY CONSTRAINTS AND OPPORTUNITIES**	All Project Teams; Facilitated by Professor Evyatar Erell, Yoav David, Kate Orff	Plenary
6:00	**CLOSE OF DAY**		

TUESDAY, NOVEMBER 5 | SCALING AND THE PATH FORWARD

8:30 – 9:00	**COFFEE AND BREAKFAST**		
9:00 – 9:30	**DAY 3 FRAMING AND EXPERT PRESENTATIONS** *Design Applications to Privately Owned Public Spaces*	Liat Eisen, The New School	Plenary
9:30 – 10:45	**EXERCISE 10. SCALING THE VISION** Determine and test possible pathways to scale using planned projects; Diagram the concept	Project Teams; Facilitator Led	Breakout Tables
10:45 – 12:00	**EXERCISE 11. PRESENTATION PREPARATION** Prepare a 10-minute pitch to senior officials that synthesizes the project concept, action plan, and scaling approach	All Project Teams; Team Representative Led; Senior Officials	Plenary
12:00 – 1:00	**FINAL PITCH PRESENTATIONS AND DISCUSSION** 10-minute presentations of proposals with feedback from the Senior City leadership	All Project Teams; Team Representative Led; Senior Officials	Plenary
1:00 – 1:15	**CLOSING REMARKS AND WORKSHOP CLOSE**	Menahem Leiba General Manager, Tel Aviv-Yafo Municipality	

III. Endnotes

1 Hochman A, Mercogliano P, Alpert P, Saaroni H, Bucchignani E. (2018). High-resolution projection of climate change and extremity over Israel using COSMO-CLM. Int J Climatol. 2018;1–12. https://doi.org/10.1002/joc.5714

2 Landsberg, H. (1981). The Urban Climate, Volume 28, 1st Edition.

3 Erell, A, Kalman, Y. (2015) Impact of increasing the depth of urban street canyons on building heating and cooling loads in Tel Aviv, Israel. ICUC9 - 9th International Conference on Urban Climate joint with the 12th Symposium on the Urban Environment. http://www.meteo.fr/icuc9/LongAbstracts/udc8-1-2181230_a.pdf

4 Sennet, Richard (2017), "The Public Realm," The SAGE Handbook of the 21st Century

5 IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp. https://www.ipcc.ch/sr15/chapter/spm/

6 U.S. National Oceanic and Atmospheric Administration. (2019). "July 2019 was hottest month on record for the planet." https://www.noaa.gov/news/july-2019-was-hottest-month-on-record-for-planet

7 Shashua-Bar, L., Potchter, O., et al. (2009). Microclimate modelling of street tree species effects within the varied urban morphology in the Mediterranean city of Tel Aviv, Israel. International Journal of Climatology 30(1):44 - 57. DOI: 10.1002/joc.186. https://www.researchgate.net/publication/227882360_Microclimate_modelling_of_street_tree_species_effects_within_the_varied_urban_morphology_in_the_Mediterranean_city_of_Tel_Aviv_Israel

8 Welter, V. (2009). The 1925 Master Plan for Tel-Aviv by Patrick Geddes. Israel Studies, 14(3), 94-119. Retrieved from www.jstor.org/stable/30245874

9 Saaroni, H., Ben-Dor, Bitan, A., E., Potchter, O. (2000). Spatial distribution and microscale characteristics of the urban heat island in Tel Aviv, Israel. Landscape and Urban Planning, Volume 48, Issues 1-2. https://doi.org/10.1016/S0169-2046(99)00075-4

10 Ibid.

11 Yosef Y, Aguilar E, Alpert P. Changes in extreme temperature and precipitation indices: Using an innovative daily homogenized database in Israel. Int J Climatol. 2019; 39:5022–5045. https://doi.org/10.1002/joc.6125

12 The City in Numbers. (2019). Tel Aviv-Yafo Municipality. https://www.tel-aviv.gov.il/en/abouttheCity/Pages/CityinNumbers.aspx

13 Noy, B. (2019). Tel Aviv Master Plan: Addition of 120,000 Residential Units and Covering the Ayalon Freeway. Jerusalem Online. https://www.jerusalemonline.com/tel-aviv-master-plan-addition-of-120000-residential-units-and-covering-the-ayalon-freewa-25435/

14 Green, MS., et al. (2013). Climate change and health in Israel: adaptation policies for extreme weather events. School of Public Health, University of Haifa, Haifa, Israel. Isr J Health Policy Res. 2013 Jun 27;2(1):23. doi: 10.1186/2045-4015-2-23. https://www.ncbi.nlm.nih.gov/pubmed/23805950#

15 Novikov, Ilya & Kalter-Leibovici, Ofra & Chetrit, Angela & Stav, Nir & Epstein, Yoram. (2011). Weather conditions and visits to the medical wing of emergency rooms in a metropolitan area during the warm season in Israel: a predictive model. International journal of biometeorology. 56. 121-7. 10.1007/s00484-011-0403-z. https://www.researchgate.net/publication/49786012_Weather_conditions_and_visits_to_the_medical_wing_of_emergency_rooms_in_a_metropolitan_area_during_the_warm_season_in_Israel_a_predictive_model/citations

16 Klein-Rosenthal, J., Raven, J. (2017) Urban Heat and Urban Design – An Opportunity to Transform in NYC. The Sallan Foundation, Snapshot. https://www.sallan.org/Snapshot/2017/07/urban_heat_and_urban_design_an_opportunity_to_transform_in_nyc.php#.XeVbKEZKiUm

17 Green, MS., et al. (2013). Climate change and health in Israel: adaptation policies for extreme weather events. School of Public Health, University of Haifa, Haifa, Israel. Isr J Health Policy Res. 2013 Jun 27;2(1):23. doi: 10.1186/2045-4015-2-23. https://www.ncbi.nlm.nih.gov/pubmed/23805950#

18 Exkert, N. (September 4, 2019). How High Heat Can Impact Mental Health. National Public Radio, Morning Edition. https://www.npr.org/2019/09/04/757034136/how-high-heat-can-impact-mental-health

19 Intergovernmental Panel on Climate Change. (2007). Climate Change 2007 - Impacts, Adaptation and Vulnerability. Working Group 2, Impacts, No author, Intergovernmental Panel on Climate Change, Groupe d'experts intergourvernemental sur l'évolution du climat. Working Group II., Intergovernmental Panel on Climate Change Staff.

20 Klinenberg, E. (2002). Heat wave: A social autopsy of disaster in Chicago. Chicago: University of Chicago Press.

21 Butchireddygari, L. (June 24, 2019). Heat Waves Precipitate More Crime in Poor Areas, Study in L.A. Finds. Wall Street Journal.

22 Trust for Public Land. (2016). The benefits of green infrastructure for heat mitigation and emissions reductions in cities. Climate-Smart Cities ™. https://www.tpl.org/sites/default/files/Benefits%20of%20GI%20for%20heat%20mitigation%20and%20emissions%20reductions%20in%20cities.pdf

23 State of Israel, Central Bureau of Statistics. (2017). Household income and expenditure data from the Household Expenditure Survey, 2017 General Summaries. https://www.cbs.gov.il/he/publications/DocLib/2019/households17_1755/h_print.pdf

24 Trilnick, Itai. (July 10, 2012). Israel Electric Will Send Brownout Alerts by SMS, Online. Haaretz. https://www.haaretz.com/israel-news/business/cutting-remarks-israel-electric-will-send-brownout-alerts-by-sms-online-1.5265428

25 Chapman, L., Azevedo, J., Prieto-Lopez, T. (2013). Urban heat and critical infrastructure networks: A viewpoint. Urban Climate, Volume 3, May 2013, pp. 7 – 12. https://doi.org/10.1016/j.uclim.2013.04.001

26 Wichter, Z. (June 20, 2017). Too Hot to Fly? Climate Change May Take a Toll on Air Travel. New York Times. https://www.nytimes.com/2017/06/20/business/flying-climate-change.html

27 Shepherd, M. (June 20, 2017). The Science of Why It's Too Hot For Some Planes to Fly In the Southwest US. Forbes. https://www.forbes.com/sites/marshallshepherd/2017/06/20/the-science-of-why-its-too-hot-for-some-planes-to-fly-in-the-southwest-us/#2827b12f54ce

28 Trust for Public Land. (2016).

29 How Climate Change Affects New York's Plants and Animals Renee Cho-Renee Cho-C. Morse-Stephanie Mitchel-Sam-Renee Cho-Gregg Baier-Michelle Ashkin - https://blogs.ei.columbia.edu/2017/01/06/how-climate-change-is-affecting-new-yorks-plants-and-animals/

30 Low Carbon Living, CRC. (2017). Guide to Urban Cooling Strategies. http://www.lowcarbonlivingcrc.com.au/sites/all/files/publications_file_attachments/rp2024_guide_to_urban_cooling_strategies_2017_web.pdf

31 Green, MS., et al. (2013). Climate change and health in Israel: adaptation policies for extreme weather events. School of Public Health, University of Haifa, Haifa, Israel. Isr J Health Policy Res. 2013 Jun 27;2(1):23. doi: 10.1186/2045-4015-2-23. https://www.ncbi.nlm.nih.gov/pubmed/23805950#

32 Gerrard, M. (2016). Heat Waves: Legal Adaptation to the Most Lethal Climate Disaster. Columbia Univerity Climate Law. UA Little Rock Law Review, Volume 40. http://columbiaclimatelaw.com/files/2016/09/6-Gerrard-formatted-embedded.pdf

33 Urban Land Institute. (2019). Scorched: Extreme Heat and Real Estate. https://americas.uli.org/wp-content/uploads/sites/2/ULI-Documents/Scorched_Final-PDF.pdf

34 Gerrard, M. (2016). Heat Waves: Legal Adaptation to the Most Lethal Climate Disaster. Columbia Univerity Climate Law. UA Little Rock Law Review, Volume 40. http://columbiaclimatelaw.com/files/2016/09/6-Gerrard-formatted-embedded.pdf

35 Israel Ministry of Foreign Affairs. (2019). Economy: Sectors of Israeli Economy. https://mfa.gov.il/mfa/aboutisrael/economy/pages/economy-%20sectors%20of%20the%20economy.aspx

36 Sela, M. (2009). Tel Avi'vs Forgotten Neighborhood. Haaretz. https://www.haaretz.com/1.5055167

37 Schnell, I., Harpaz, M. (2006). A model of a heterogeneous neighborhood. GeoJournal (2005) 64:105-115. DOI: 10.1007/s10708-005-4093-0

38 Eleftheria, A., Jones, P. (2008). Temperature decreases in an urban canyon due to green walls and green roofs in diverse climates. Building and Environment, Volume 43, Issue 4, April 2008, Pages 480 - 493. https://doi.org/10.1016/j.buildenv.2006.10.055

39 Raven, J. (2019). From Climate Science to Design Practice. Urban Design Group Journal. Winter 2019, Isue 149. ISSN 1759 712X. http://www.udg.org.uk/sites/default/files/publications/UD149_magazine.pdf

40 Hinchey, X. (2011). "Harvesting energy: body heat to warm buildings). BBC News. https://www.bbc.com/news/business-12137680

41 "Swedish commuters' body heat to warm office." (2008) Reuters. https://www.reuters.com/article/environment-sweden-bodyheat-dc/swedish-commuters-body-heat-to-warm-office-idUSL1054956720080110

42 EPU-NTUA and ICTAF. (1994). Energy in the urban environment – an action plan for the city of Tel-Aviv. Interior Report, Athens, Tel-Aviv.

43 Klein-Rosenthal, J., Raven, J. (2017)

44 Studio 2, Ryerson. Urban Heat Island Mitigation Strategy Toolkit. https://www.cip-icu.ca/Files/Resources/STUDIO2-RYERSON-UHI-TOOLKIT-FINAL-REPORT.aspx

45 Saaroni, H., Ben-Dor, Bitan, A., E., Potchter, O. (2000). Spatial distribution and microscale characteristics of the urban heat island in Tel Aviv, Israel. Landscape and Urban Planning, Volume 48, Issues 1-2. https://doi.org/10.1016/S0169-2046(99)00075-4

46 Ibid.

47 Oppla. Paris Oasis Schoolyards Programme. https://oppla.eu/casestudy/18474

48 Municipality of Paris, 100 Resilient Cities. (2017). Resilient Paris. https://www.100resilientcities.org/wp-content/uploads/2017/10/Paris-Resilience-Strategy-English-PDF.pdf

49 Bloomberg Associates. (2019). Mitigation Urban Heat Island Effects Cool Pavement Interventions. https://www.bbhub.io/dotorg/sites/32/2019/08/20190516_Cool-Pavement-Research-FINAL.pdf

50 Ibid.

51 Ibid.

52 City of New York, Department of Small Business Services. NYC CoolRoofs. https://www1.nyc.gov/nycbusiness/article/nyc-coolroofs

53 City of New York, NYC Cool Roofs Program. (2017). https://coolroofs.org/documents/NYC_CoolRoofs_6-14-17_Presentation.pdf

54 Ibid.

55 Gerrard, M., McTiernan, E. (2018). Legal Tools for Cities to Cope with Extreme Heat. New York Law Journal, Volume 260, No 91. http://columbiaclimatelaw.com/files/2018/11/legal-tools-for-cities-to-cope-with-extreme-heat.pdf

56 Ibid.

57 City of New York, Mayor's Office of Recovery and Resiliency. (2019). Climate Resiliency Design Guidelines. Version 3. https://www1.nyc.gov/assets/orr/pdf/NYC_Climate_Resiliency_Design_Guidelines_v3-0.pdf

58 Gerrard, M., McTiernan, E. (2018).

59 Ibid.

60 Ibid.

61 Ibid.

62 Ibid.

63 Ibid.

64 Ibid.

65 Trust for Public Land. (2016).

66 Saaroni, H., Pearlmutter, D., Hatuka, T. (2015). Human-biometerological conditions and thermal perception in a Meditteranean coast park. International Journal of Biometerology. 59(10):1347-62. doi: 10.1007/s00484-014-0944-z. Epub 2014 Dec 20.

67 Shashua-Bar, L., Potchter, O., et all. (2008).

68 Ibid.

69 Shashua-Bar, L., Potchter, O., et all. (2008). Microclimate modelling of street tree species effects within the varied urban morphology in the Meditteranean city of Tel Aviv, Israel. International Journal of Climatology. 30(1): 44 - 57). DOI: 10.1002/joc.1869

70 Trust for Public Land. (2016).

71 Oke, T.R. (1989) The micrometerology of the urban forest. Atmosphereic Science Programme, Department of Geography, the University of British Columbia. https://royalsocietypublishing.org/doi/pdf/10.1098/rstb.1989.0051

72 Urban Land Institute. (2019).

73 National Wildlife Federation. (2019). Nature Play Spaces. https://www.nwf.org/en/Kids-and-Family/Connecting-Kids-and-Nature/Nature-Play-Spaces

74 NC State Design, Natural Learning Initiative. (2019). https://naturalearning.org/

75 Ibid.

76 State of Oregon, Oregon Parks and Recreation Department. (2014). Grand opening of "Nature Play Area at Silver Falls May 31). https://www.oregon.gov/oprd/Pages/news/nature_play_opening.aspx

77 Bloch, S. (2019). Shade. Places Journal. https://placesjournal.org/article/shade-an-urban-design-mandate/?cn-reloaded=1#ref_4

78 Chaffee, I. (2017). Where have the trees gone? L.A. area's green cover down dramatically in just 10 years. USC News. https://news.usc.edu/120872/mass-produced-dwellings-home-expansion-reduce-l-a-areas-residential-green-cover/

79 Bloch, S. (2019).

80 Walker, A. (2019). Who will save LA's treets? LA Curbed, Los Angeles Environment. https://la.curbed.com/2018/6/6/17394448/los-angeles-trees-removal-climate

81 Bloch, S. (2019). Shade. Places Journal. https://placesjournal.org/article/shade-an-urban-design-mandate/?cn-reloaded=1#ref_4

82 Klein-Rosenthal, J., Raven, J. (2017)

83 Ibid.

84 Ibid.

85 Urban Land Institute. (2019).

86 Shashua-Bar, L., Potchter, O., et all. (2008).

87 Saaroni, H., Ben-Dor, Bitan, A., E., Potchter, O. (2000). Spatial distribution and microscale characteristics of the urban heat island in Tel Aviv, Israel. Landscape and Urban Planning, Volume 48, Issues 1-2. https://doi.org/10.1016/S0169-2046(99)00075-4

88 Ibid.

89 Sanusia, R., Margaret Johnstone, D., et al. (2014)., Street Orientation and Side of the Street Greatly Influence the Microclimatic Benefits Street Trees Can Provide in Summer. Journal of Environmental Quality. DOI: 10.2134/jeq2015.01.0039

90 Shashua-Bar, L., Potchter, O., et all. (2008).

91 Klein-Rosenthal, J., Raven, J. (2017)

92 Exkert, N. (September 4, 2019). How High Heat Can Impact Mental Health. National Public Radio, Morning Edition. https://www.npr.org/2019/09/04/757034136/how-high-heat-can-impact-mental-health