Building Urban Heat Resilience: The Athens Case Study

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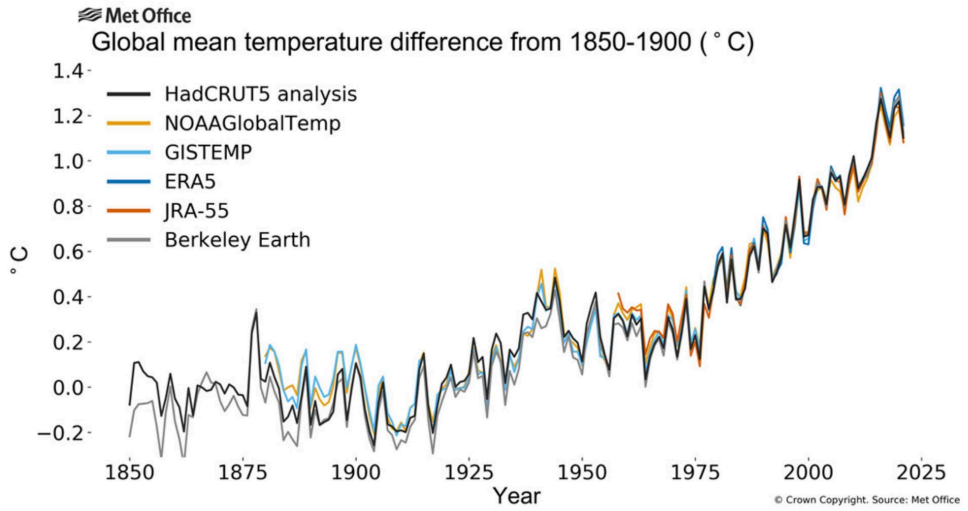
Introduction: Climate Challenge and Urban Heat Resilience

The last seven years have been the hottest ever recorded

As global warming climbs dangerously close to 1.5C, during the summers of 2021 and 2022 the world has been experiencing record braking temperatures.

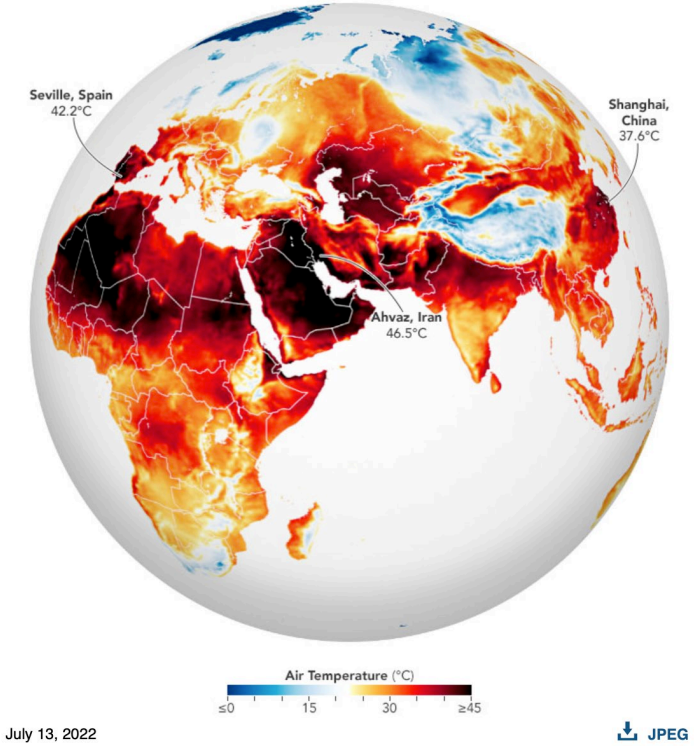
Canada and the Pacific Northwest, Siberia and the Eastern Mediterranean were scorched last year, while this year India experienced a devastating spring, while China, Europe and the US were parched during exceptional heatwaves.

Athens, in the summer of 2021, experienced two persistent heatwaves and temperatures reached 45C



Source: Met Office Hadley Centre | 2021 one of the seven warmest years on record.

Mortality & Extreme Heat



Today 200 million in 350 large cities face temperatures over 35°C

By 2050 with heatwaves far more intense, frequent and longer-lasting, 1000 cities, i.e., 1.6 billion urban dwellers, will face sustained extreme heat conditions for 3 consecutive months.

Not all are affected equally:
facing these temperatures will be nearly 215 million living in poverty in 230 cities

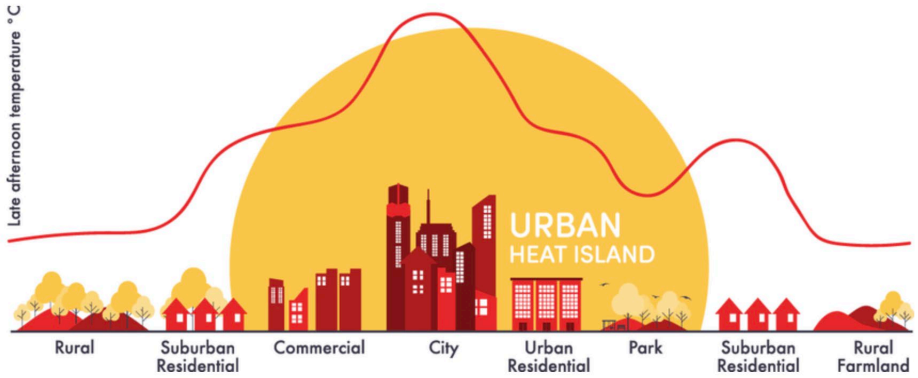
We also know that globally, from 2000 to 2018, heat-related mortality in people older that 65 years increased by 53.7%
In 2018, heat related mortality reached 296,000 deaths, the majority of which occurred in Japan, eastern China, northern India, and central Europe.

Why Urban Heat Resilience?

Cities experience significantly higher temperatures as they are made of dense materials that absorb Heat, have fewer trees to provide shade and cooling, and have fewer permeable surfaces to cool by evaporation.

While Heat from cars, air conditioners, and other energy uses add to the increase of air temperatures, their morphology may also stop winds from cooling them down. These urban conditions have the following effects:

- **Highest mortality rates among other extreme weather phenomena**
- **Public health deterioration**
- **Higher energy consumption**
- **Higher pollution**
- **Economic and productivity losses**
- **Increased community and gender violence**
- **Droughts, wildfires, floods, and biodiversity loss**



Urban Heat Resilience

Urban Heat Resilience is the ability of our Urban Built, Natural, and Social Environments

to prepare for, cope with, and change in the face of Extreme Heat events

by developing the necessary strategies and building capacity

to meet the challenges of rising Global Heat.

Europe - Athens

- According to WMO over the last 30 years temperatures in Europe have increased more than any other continent
- The #StateofClimate in Europe presents a live picture of a warming world
- The City of Athens is the hottest mainland European Capital
- A 2019 analysis of 571 European cities by the Newcastle University Polytechnic, ranked Athens as the European city facing the single greatest impact from heat waves.
- In December 2018, Moody's released a report evaluating the credit risks to 30 European cities posed by climate change. Athens ranked highest in terms of exposure to heat and drought and among the top three cities at risk from peri-urban forest fires

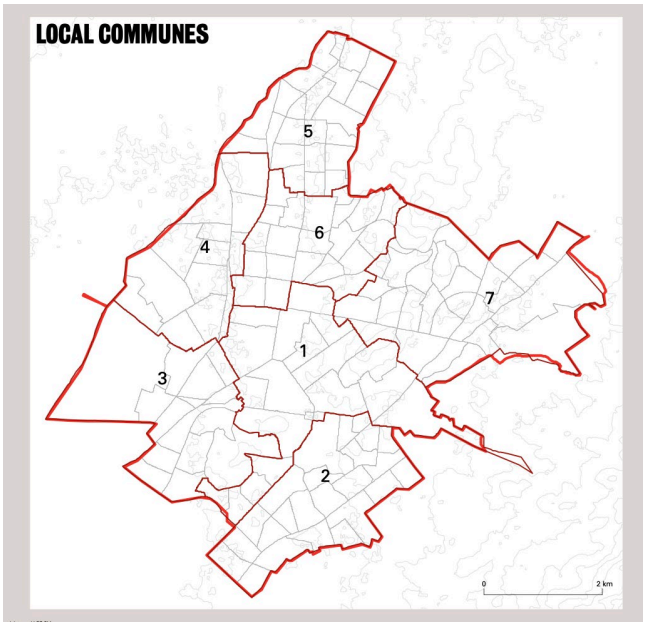
1. City of Athens Overview

CITY OVERVIEW

POLITICAL GEOGRAPHY

Athens Metropolitan Area : 38 Municipalities and 3.828.434 residents

City of Athens: 664.046 residents - around 2m daily users
39 km²
7 districts and 129 local neighborhoods



CITY OVERVIEW

SOCIO-ECONOMIC & DEMOGRAPHIC Data

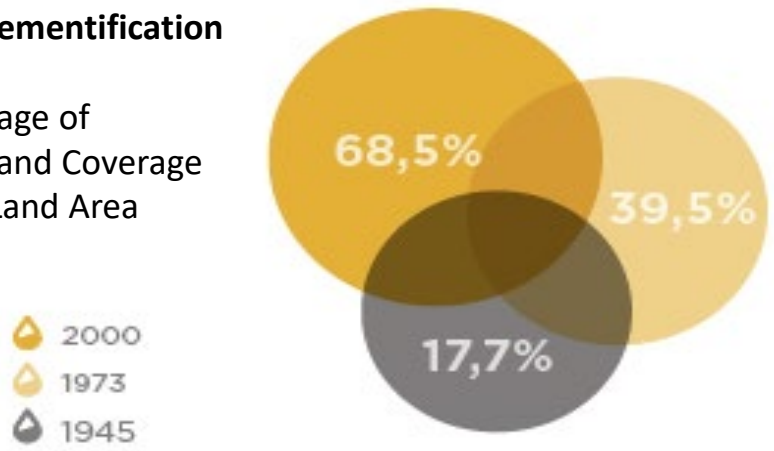
Current population in the city (millions)	Total population within region/ metropolitan area (millions)	Average annual city population growth 2020-2035 (%)	Population growth per hour (2020-2035)	Average density inside admin area (pers/km²)	City area (km²)	Total international visitors (millions)	Current older population (% of total population)	GDP per capita, 2014 (PPP, $) (thousands)	Unemployment rate (%)
0.66 (2011)	3.8 (2011)	0 (2018)	0 (2018)	16,615 (GIS)	38.9 (2020)	6.4 (2019)	19 (2011)	32 (2014)	10.6 (2021)

CITY OVERVIEW

GREY INFRASTRUCTURE

Uncontrolable Cementification

Percentage of Impermeable Land Coverage over total Land Area



CITY OVERVIEW

GREEN INFRASTRUCTURE

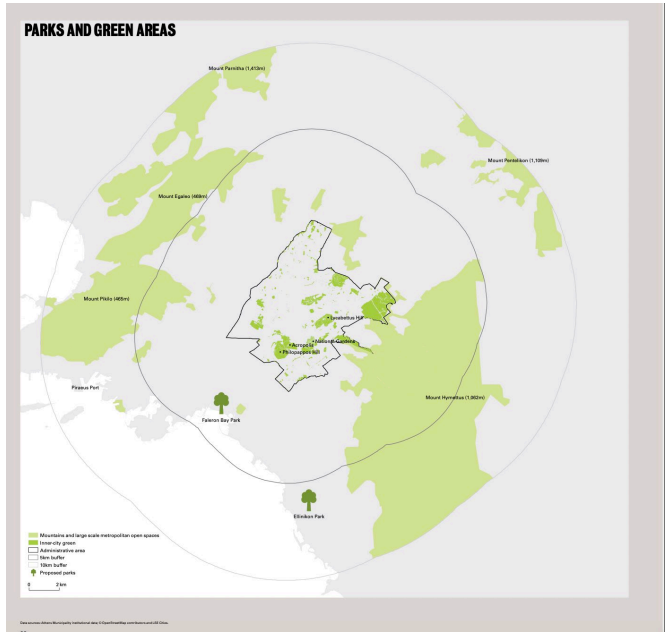
4,6 km² out of 38 km² in Athens are green

Hills - Parks - Cemeteries (72%)

Squares - Pedestrian Streets - Tree Avenues (22%)

Total number of street trees Mulberries (21%), Acacias (8%) and Seville Orange trees (19%)

Total number of trees in Athens approximately 130.000, 93.891 of which in Avenue trees



2: Athens’ Journey to Urban Resilience

Designing a Resilience Strategy

In 2016, along with 100 cities around the world, Athens started planning for a resilient future following the methodology of the *100 Resilient Cities* initiative.

It all started with understanding the risks we face and how they affect our city systems.

After a year of interviews and workshops with 1000 stakeholders, we identified the most important unexpected *Shocks and long-term Stresses*.

These provided the framework around which we co-designed data-based, cross-cutting solutions.

By then it was clear that the main Athens Climate Risk is Extreme Heat!

stresses

- **Depressed Macroeconomic Conditions**: Unemployment - Poverty
- **Mistrust**: Lack of Effective and Transparent Governance – Lack of Data-Driven Policymaking
- **Large Scale Refugee & Migration Flows**
- **Ageing Infrastructure**: Vacant Buildings – Lack of Maintenance and Long Term Planning

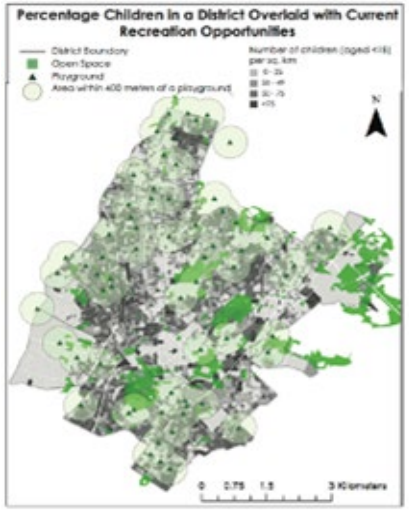
shocks

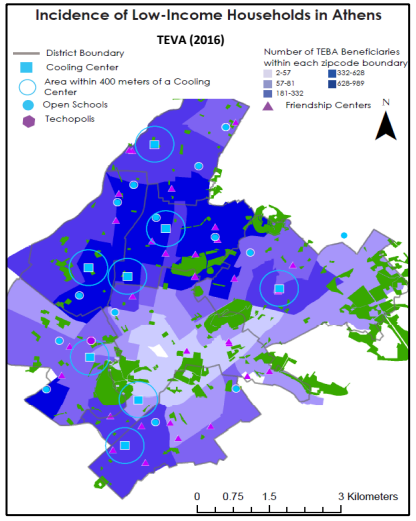
- **Climate Change**: Heat Waves/UHI, Flash Floods, Peri-Urban Fires, Drought, Air Quality
- **Earthquakes**
- **Civil Unrest:** Violence
- **Cyber-Attack**

Mapping Geospatial Correlations

To start building heat resilience, one of the first things a city should do is map-out and correlate critical geospatial parameters (climate data, land coverage, demographic, socio-economic) in order to understand heat vulnerability and how to prioritize city policies and initiatives.

Here is one of Athens such maps correlating land surface temperatures, children, green areas, & Income Distribution to understand how and where the city should intervene

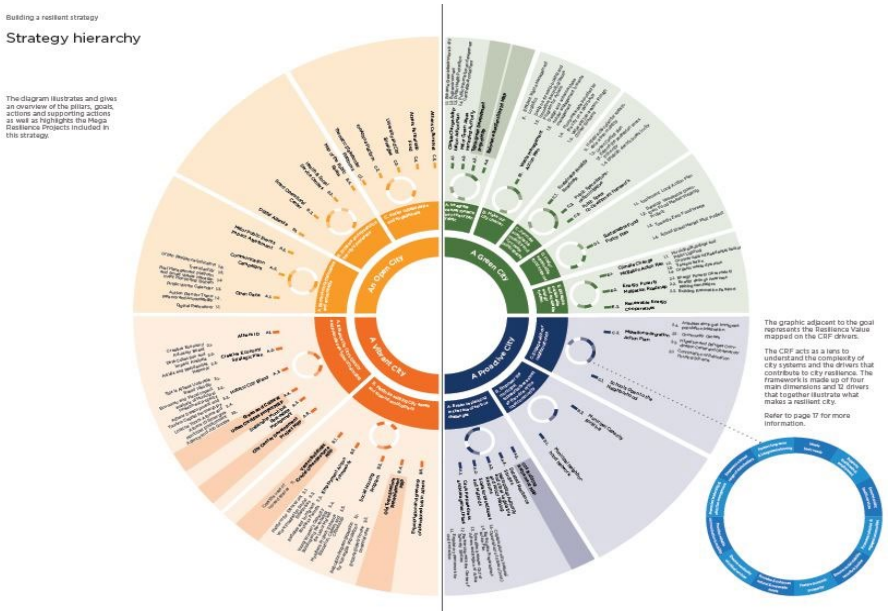




Athens Resilience Strategy for 2030

https://resilientcitiesnetwork.org/downloadable_resources/Network/Athens-Resilience-Strategy-English.pdf

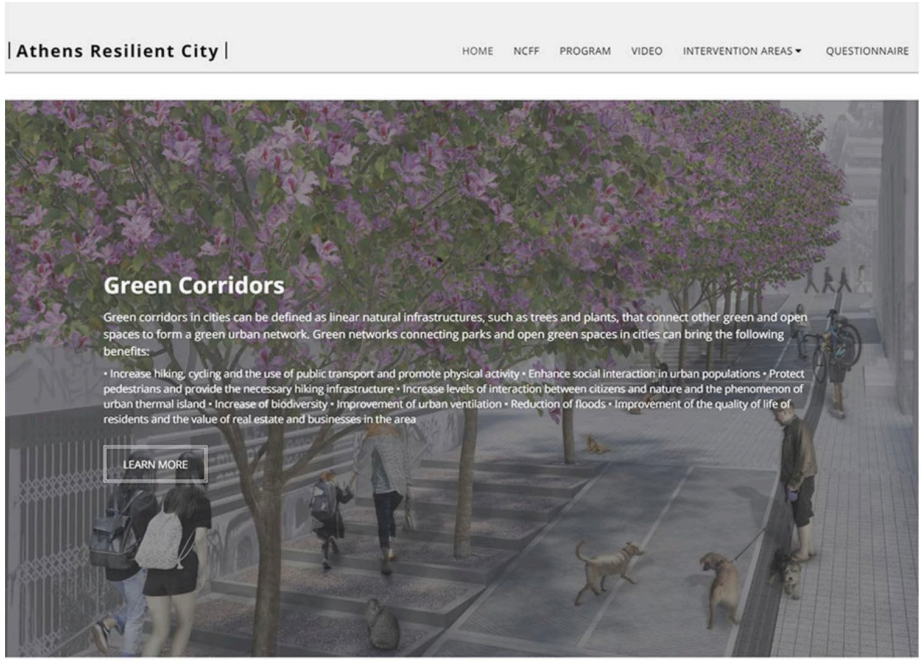
- In July 2017 we launched the Athens Resilience Strategy for 2030
- Four Pillars: An Open City | A Vibrant City | A Proactive City | A Green City
- The Green City Pillar included a **Climate Adaptation Plan** with the following categories:
  a. **Green Infrastructure**
  b. **Build Environment**
  c. **Public Health Protection**
  d. **Public Information and Awareness Campaign #CoolAthens**
- **The first heat resilience actions we implemented were: the #CoolAthens campaign and the desing of Green Corridors**



“Athens Resilient City and Integrated Development” EIB Loan

The ***Resilience Strategy for Athens 2030*** anchored a 55m Euro loan from the European Investment Bank.

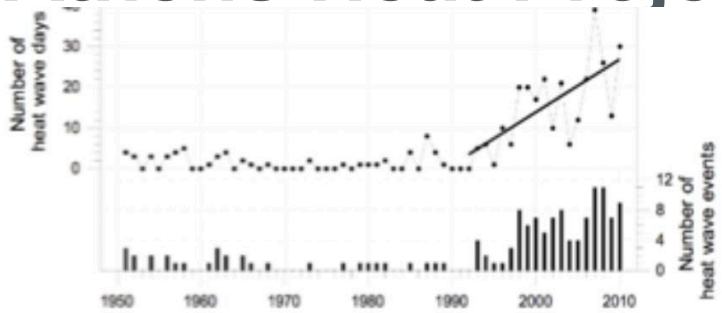
The loan included among other things, the Natural Capital Finance Facility, a tool financing the design and implementation of 4 Nature based Solutions (NbS): 3 Green Corridors and the Sustainable Water Management of Lycabettus Hill.



3: Climate Risk Information

Climate Risk Information

Athens Heat Projections



By 2050 Athens is expected to experience:

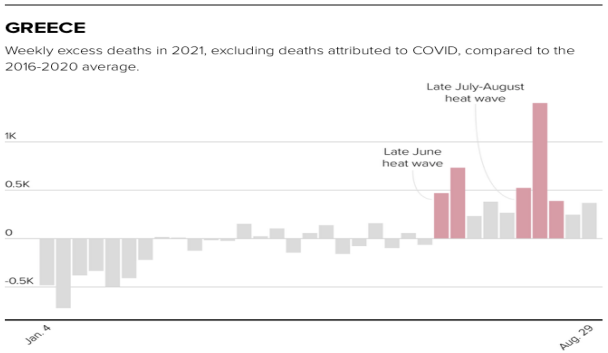
- **double the number of heatwave days, i.e. an extra 15 to 20 days each year**
- **rainfall is expected to decrease by and average of 12%.**
- **average summer temperatures are to increase:**
  - **by 2°C between 2021 - 2050**
  - **up to 4°C between 2071 and 2100**
- **As temperatures, frequency and duration of heat waves increase, the Athenian Urban Heat Island Effect currently exhibiting up to 10°C difference between the center of the city and its suburbs, will be exacerbated.**

Climate Risk Information

The summer of 2021, Greece experienced the worst heatwave in three decades. A first heatwave occurred in June, and a second one started during the last week of July, temperatures peaked the first week of August and subsided around the middle of August.

47C in early August in Northern Greece
45C in Athens
140+ wildfires burned 125.000 hectares between 03/08 and 03/09

Greece recorded over **2,300 excess deaths** — excluding registered deaths from coronavirus — between late July and mid-August compared with the last five years. Around **1,400 excess deaths in the first week of August.**



A jump in the number of deaths registered, coincides with the peaking temperatures in June and August, if compared with the average of the last five years, according to data collated by Eurostat.

4: Planning for Extreme Heat

Planning for Extreme Heat

In the Summer of 2021 the City of Athens in collaboration with the Arsht-Rock Resilience Center of the Atlantic Council appointed a, first in Europe and second Globaly, Chief Heat Officer.

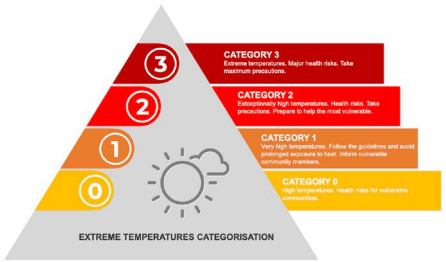
The Chief Heat Officer, who reports directly to the Mayor, is dedicated to helping Athens become a cooler city that can protect its most vulenerable to hear residents.

With the support and technical assistance from the Arsth-Rock Center, heat resilience actions became more targeted, specific and elaborate, falling under the three following pillars:

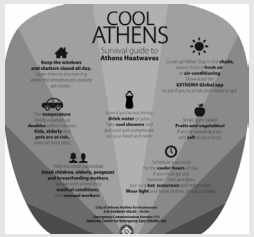
- **Awareness**
- **Preparedness**
- **Redesign**

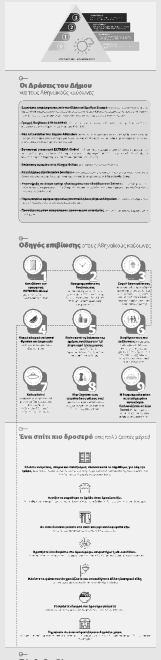
Athens Heat Action Plan

Awareness

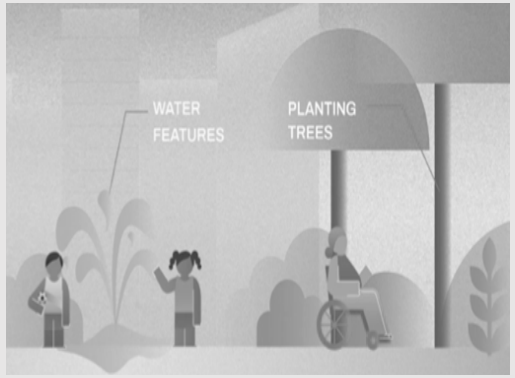


Preparedness





Re-design



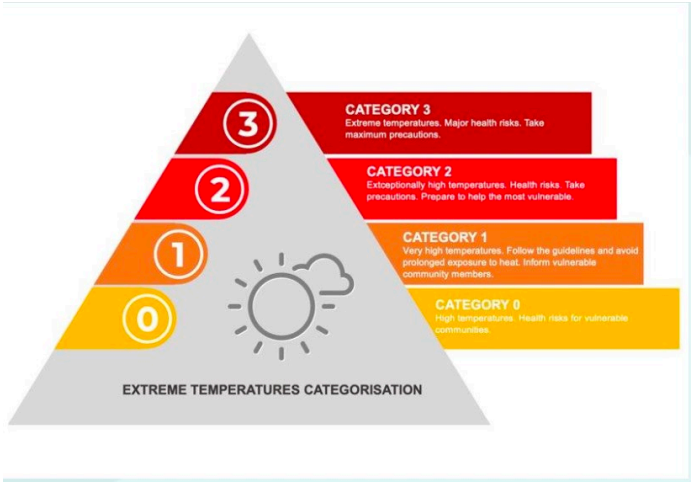
AWARENESS

The summer of 2022, we piloted a new Heatwave Categorization methodology, in collaboration with the scientific committee of the ArshtRock Resilience Center, based on the heat related mortality risk to our population.

We used “back-casting” i.e., correlating metereological and mortality data from the last three decade Athenian summers.

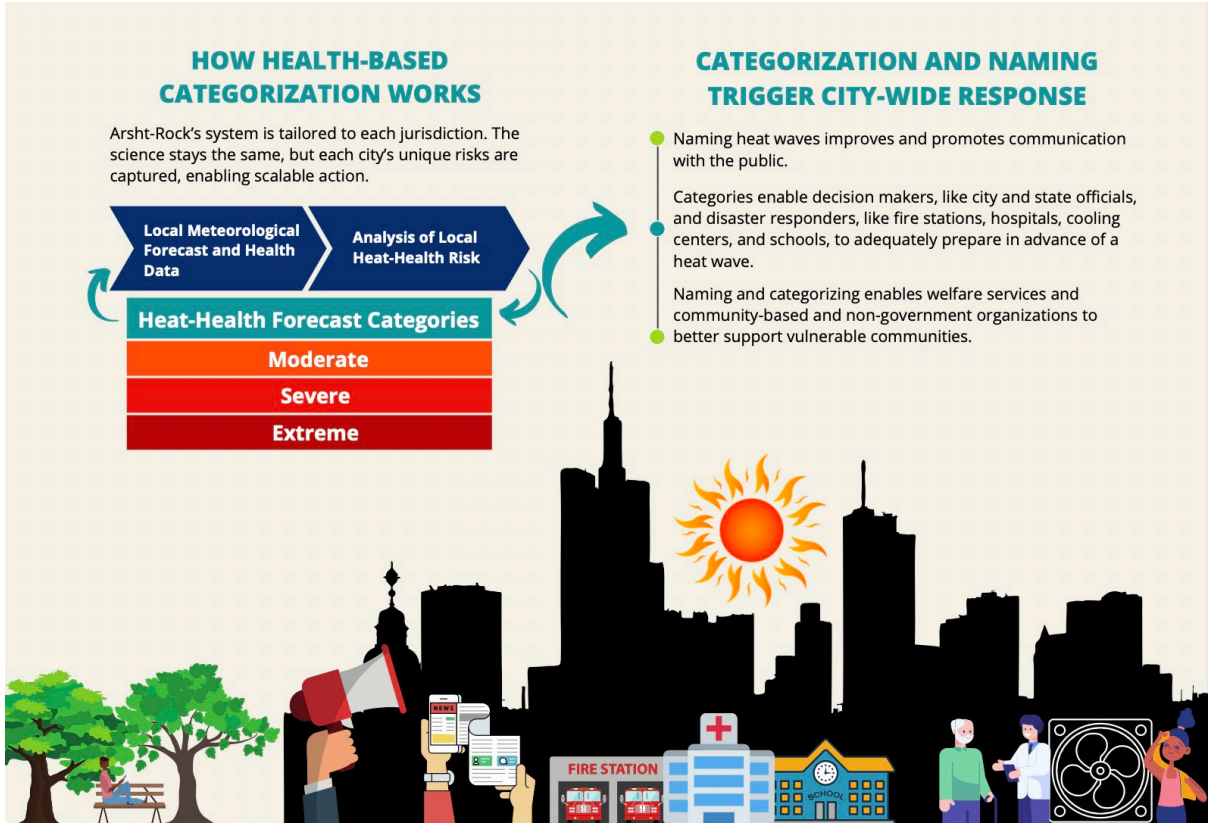
These correlations produced an algorith of Heat-Health risk specific to Athens which we then used for forecasting heatwave with the help of the National Observatory of Athens and meteo.gr

We linked the categories to an Early Warning Systmem and a series of preparedness measures established for the first time in the summer of 2022.



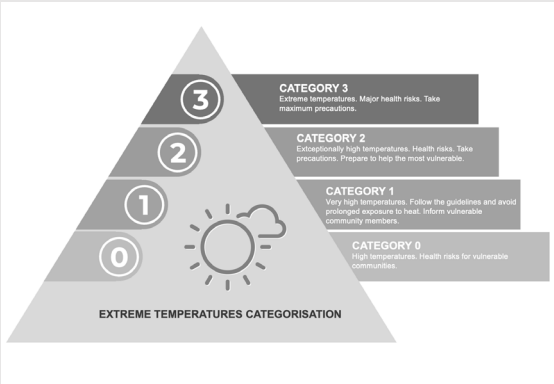
AWARENESS

Heatwave categorization | collaboration with ArshtRock Resilience Centre

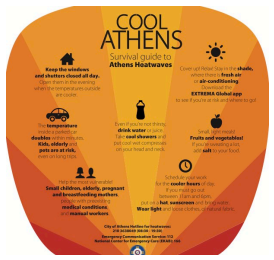


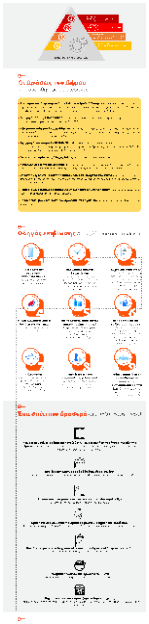
Athens Heat Action Plan

Awareness

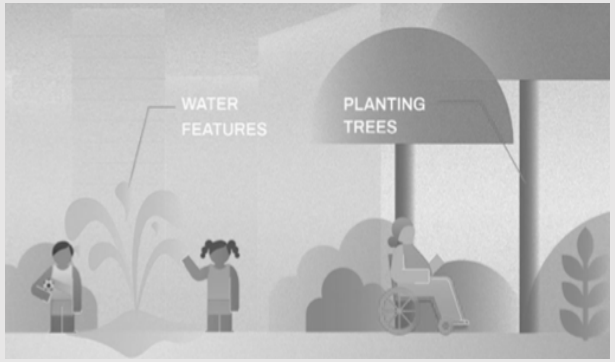


Preparedness





Re-design



PREPAREDNESS

community workshops | early warning systems | vulnerable communities

- **EXTREMA Global app**
- **"*Heat-Alerts*" messaging targeting vulnerable populations**
- ***"Heat Hot-line"* to call for information and assistance**
- **City of Athens Web-Page on how to protect yourself**
- **Public Cooling Centres**
- **Hand held fans with heat protection messaging**
- **"*Help at Home*" municipal assistance**
- ***"Buddy System"* neighbourhood networks**
- **Strategic collaboration with Hellenic Red Cross and IFRC**

PREPAREDNESS

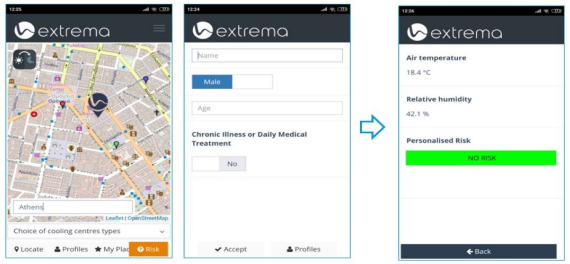
community workshops | early warning systems | vulnerable communities

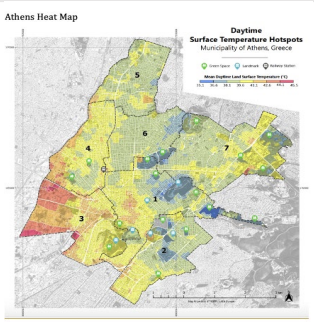
The EXTREMA Global app offers personalized real-time information about heat exposure and a map with all the neaby cool-spots where one can take cover and cool down.

This year we added:

1. microparticle pollution risk levels to the heat risk levels
2. “cool routes” which map the coolest way to go from spot A to spot B in the city
3. the new Heawave Categorization system alerts.

The EXTREMA Global team also created an Athens Heat Map offering great granularity. This is a Land Surface Temperature mapping, using mean daytime temperatures from the last **5** years to determine urban hot spots. Unlike air temperatures which are indicators for human health, land surface temperatures are important for guiding public space, physical interventions.





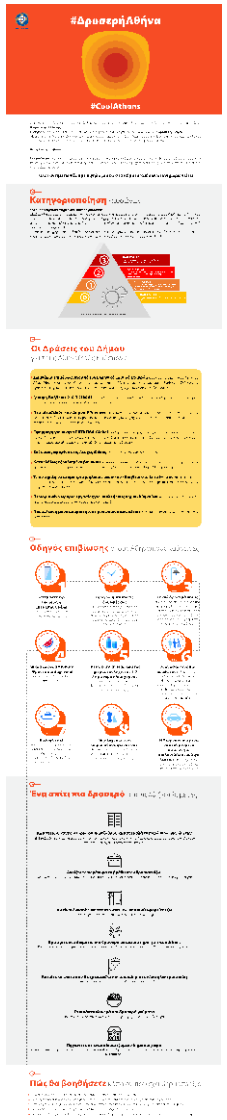
PREPAREDNESS

Probably most important preparedness measure we established for the fist time this year, is an Early Warning System based on the Heatwave Categorization and levels of risk.

Alert messages together with heat protection recommendations were dispatched from the municipal authorities to organizations or caretakers that are in contact with our vulnerable communities: health-care, social workers and Red Cross volunteers for seniors living alone; the Athens NGO Coordination Center for Immigrants and Refugees; the Nursery Schools; the Homeless street-workers and shelters.

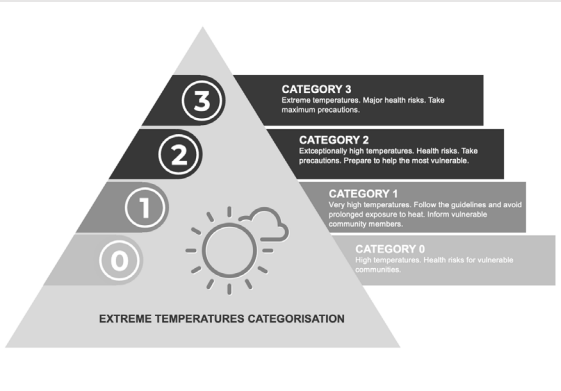
We created a *heat hot-line* supported by our Municipal Clinic nurses and the Hellenic Red Cross;

We also designed a *City of Athens web-page* that gave information about keeping yourself healthy during heatwaves, cooling your house and helping others exhibiting symptoms of heat

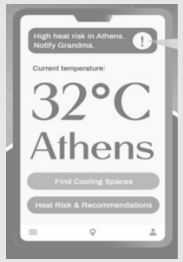


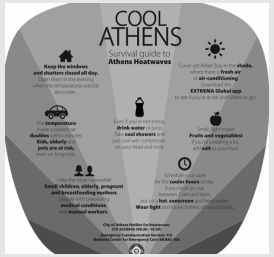
Athens Heat Action Plan

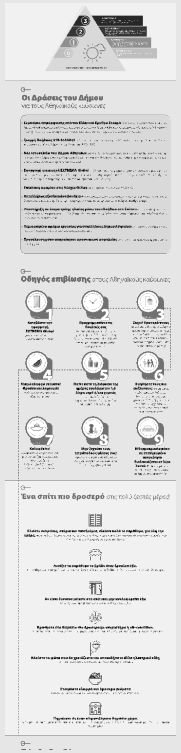
Awareness



Preparedness







Re-design

REDESIGN

- An ancient monument, Hadrian's Aqueduct, will be used again to irrigate a trans-municipal 24km Cool Corridor
- Lycabettus Hill Sustainable Water Management program
- Sewage Mining mobile units to be used for irrigation of urban parks
- Green corridors connecting existing green spaces in three neighborhoods
- New Green Areas as well as Pocket Parks
- Double Regeneration Project: two new large parks, one of which in the hottest city district
- Maintenance and support of existing Urban Nature

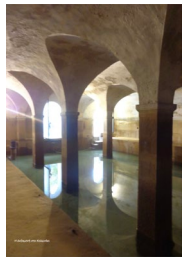


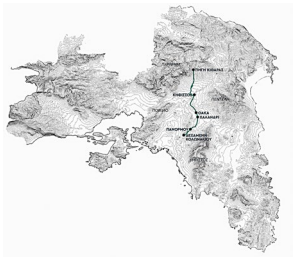
REDESIGN

Extreme heat comes with cascading effects and hazards, such as drought, wildfires, and land erosion due to flash floods. In order to best protect Athens from extreme heat, recent bibliography and the experience from other cities has shown that Nature Based Solutions (NbS) offer the best possible “resilience dividend,” i.e., multiple co-benefits.

Combating heat with NbS, means thinking hard about our water resources. We need more sustainable and circular water usage: discover and tap into unused or wasted water; design redundancies and back-up systems; create brown water reuse options at the point of demand for urban green irrigation, urban agriculture and other non-potable uses (fire protection, washing of municipality vehicles).

We are planning to support a large green corridor by using the water from a 24km long Roman Aqueduct, and we’ve successfully piloted a mobile sewage mining unit which we can scale up for irrigation at point of demand.





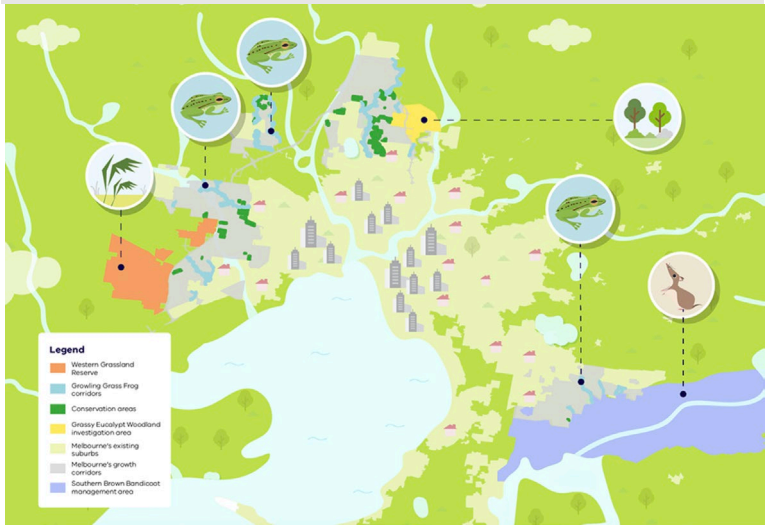
City Examples

Medellín, Colombia: 36 green corridors with surrounding areas seeing temperature reductions of up to 4°C.

Seoul, SouthKorea: The Cheonggyecheon water corridor has decreased temperature up to 5.9°C compared to a parallel road a few blocks away.

Paris, France: Paris is using the Seine River water to provide "free district cooling," is issuing permits for people to green public spaces, and is co-designing its "school-yards oases"

Melbourne, Australia: It's Urban Forest and a Nature in the City Strategy supports and creates healthy diverse ecosystems



5: Challenges and Key Takeaways

City Challenges 1

Athenian Challenges for Building Heat Resilience
and using Nature based Solutions | blue/green infrastructure

- **Inadequate Institutional Capacity**

There aren't enough people who know how to design, procure, and implement NbS and infrastructures that include natural elements instead of grey (cement and concrete). That is true both for the public sector as well as for the private sector. We need to build capacity fast.

- **Lack of prioritazation of climate risks**

Other issues are at the top of the agenda (economic, social, waste management, etc). Building climate resilience and the Athens Resilience Strategy for 2030 is not guiding decision making or budgeting. We need a stronger mandate around Climate Mitigation, Adaptation and Resilience .

- **Data gap on evaluation and impacts**

At the moment we have not institutionalised method for evaluation and monitoring of our heat policies and initiatives. Also, at a city but also national level deaths, illnesses and work related injuries caused by heat are massively under-recorded. The economic impacts of heat to our economies, labor productivity, tourism, childrens education and even gendered violence are less understood. All very important for awareness raising and data based policy making.

City Challenges 2

Athenian Challenges for Building Heat Resilience
and using Nature based Solutions | blue/green infrastructure

- **Reclaiming public space from cars and their infrastructure**

Athenian urban density leaves no space for what is needed to protect the city from the new Climate Era and rising heat: a radical introduction of nature and surface water elements in the city. Car culture still reigns and overwhealmingly monopolizes our public space. There needs to be a swift away from cars which has not happened yet. The shift to electromobility could provide a great opportunity.

- **Working in silos**

Cross departmental and cross disciplinary collaboration is still a challenge. We have institutioned two cross departmental teams (for mitigation and adaptation/resilience) but it's still hard to design and impliment policies that cross sectoral boundaries. This is true on all levels of government. For example we have national building codes that respond to earthquakes, and a whole separate set of builidng codes with a separate logic regarding energy efficiency, but there are no building codes to respond to rising heat. We are now trying, for example, to establish at central goverment level building codes that incorborate cooling efficiency and passive measures - mainly to avoid high energy use.

Conclusion: Key Take-Aways

- Heatwaves are becoming more intense, more frequent and longer in duration due to Climate Change and Global warming. Europe is a global ”hot-spot”

- Extreme heat is a silent killer: heatwaves are life threatening weather events usually underestimated and under-reported.

- The surfaces of urban centers tend to absorb and radiate heat, exacerbating dangerous to urban residents weather conditions, made even worse by man-made heat released in public spaces by cars and airconditioning
- Cities need to build Heat Resilience for health as well as social-economic reasons

- It is valuable to have someone to coordinate all the heat related efforts (like a Chief Heat Officer) as heat resilience spans across many different city departments (Health, Social Services, Infrastructure, Commerse, Budgeting)

- Cities need to start by mapping their hot-spots and their vulnerability in order to start planing their interventions

- Then it is good to think in the four major pillars: Awareness Raising, Preparedness, and Redisign