Urban Heatwave Resilience initiative

CoolCity: Application of digital technologies to enhance heatwave resilience

-- an initiative to build resilience to heatwaves and urban heat island effects –

I. Background

Cities are on the front lines of climate change, feeling the impacts of record-breaking temperatures, rising sea levels, and climate related extreme disasters. In addition to the recurring disaster events such as the floods, flash floods, cyclones, extreme precipitation events and others, extreme heat waves are becoming increasingly persistent marked by prolonged and untimely spells especially in cities and urban spaces.

Extreme heat events are responsible for more deaths annually than hurricanes, lightning, tornadoes, floods and earthquakes combined.[1] Numerous studies have documented that human-induced climate change has increased the frequency and severity of heat waves across the globe.

Heat in our cities poses a serious threat that requires more attention. The socio-economic costs associated with the heat waves have mounted. Hundreds of millions of people are impacted yearly from heatwaves, in the form of loss of life, health problems, water shortages, wildfires, loss of livelihoods, economic productivity, power outages, and other adverse consequences. Extreme heat events are linked to several health impacts viz. heat strokes, dehydration, posing a higher risk for infants and the elderly. UNICEF has warned that over two billion children around the world would face frequent heat waves by 2050). It is projected that extreme heat events will increase in intensity, frequency and duration in the future compared with historic levels *(insert metrics from RPC 8.5, for a particular region)*.

In cities, heat gets trapped resulting into what we call “urban heat islands”. Due to the peculiar built environment of cities and urban spaces, the heat island effect gets aggravated in the absence of adequate natural buffers or environmental exhausts. Surface temperatures in cities are sometimes up to 10-15°C higher than in their rural surroundings[2] and are created as heat in cities dissipates slower due to dense infrastructure. They're especially dangerous for vulnerable segments of populations such as the elderly, young children, low-income populations and manual labourers including for people with non-office environment occupations.

While some countries and cities have a long history of dealing with heatwaves and are adapting accordingly, e.g. Barcelona’s experimentation with urban design, other small and medium size cities, particularly in the Global South, with rapidly growing populations, sometimes without a history of extreme heat, that are likely to experience record-breaking extremes in the future, are lacking in resources and action. Additionally, the climate challenge and associated risks have become a health emergency in cities already, and appropriate resources and planning needs to be put into place.

II. Rationale and Theory of Change

[1] Scientific American (www.scientificamerican.com)
[2] EC Joint Research Center (joint-research-centre.ec.europa.eu)

Many cities, especially in LICs, LMICs, SIDS and others, face increasing challenges from heatwaves, exacerbated by the urban heat island effect. Heat waves and associated risks including wildfires etc. are becoming characteristic of countless cities. The lack of green spaces, natural vegetation, environmental buffers, and shade, as well as an increase in paved concrete surfaces and buildings, is causing higher temperatures in an urban area compared to surrounding regions. With the intense unprecedented heat waves affecting increasing number of countries and cities including in Europe and other countries in the northern hemisphere, the need to build resilience to heatwaves and heat island effects has been highlighted, particularly among the most vulnerable communities.

The urban heat island effect, characterized by higher temperatures in urban areas compared to their rural surroundings, leads to heat-related illnesses, energy demands, and environmental degradation.

The potential offered by digital technologies can be used to assess, understand, analyze, disseminate timely information and advisories while also supporting the implementation of appropriate interventions to help people mitigate the heatwave and heat island effects while also helping devise cities of the future with an inherent ability to address the challenge posed.

Some of the potential digital interventions for applications relate to --

Sensor Networks (Real Time Information): an extensive network of temperature and humidity sensors can be implemented across the city. These sensors provide real-time data on microclimatic conditions, enabling accurate monitoring of heatwave onset and intensity. The data is then used to inform public health advisories and emergency response strategies. These sensors will also provide everyday data to the AI model (if applied later). The sensors will be able to give an insight of the real-time changes and how it will affect our prediction for the upcoming future.

Heat Action Plans: Digital platforms provide the public with real-time heatwave information and personalized recommendations to stay safe during extreme heat events. These platforms also enable vulnerable populations to access cooling centers and resources easily.

Predictive Analytics: Utilizing past data of climate and heatwaves combined with the machine learning analysis, predictive analytics model can be created for forecasting heatwave occurrences and their potential impact on various city sectors. This enables local authorities to proactively allocate resources and implement preventive measures. This predictive analytics model will work in the following manner:

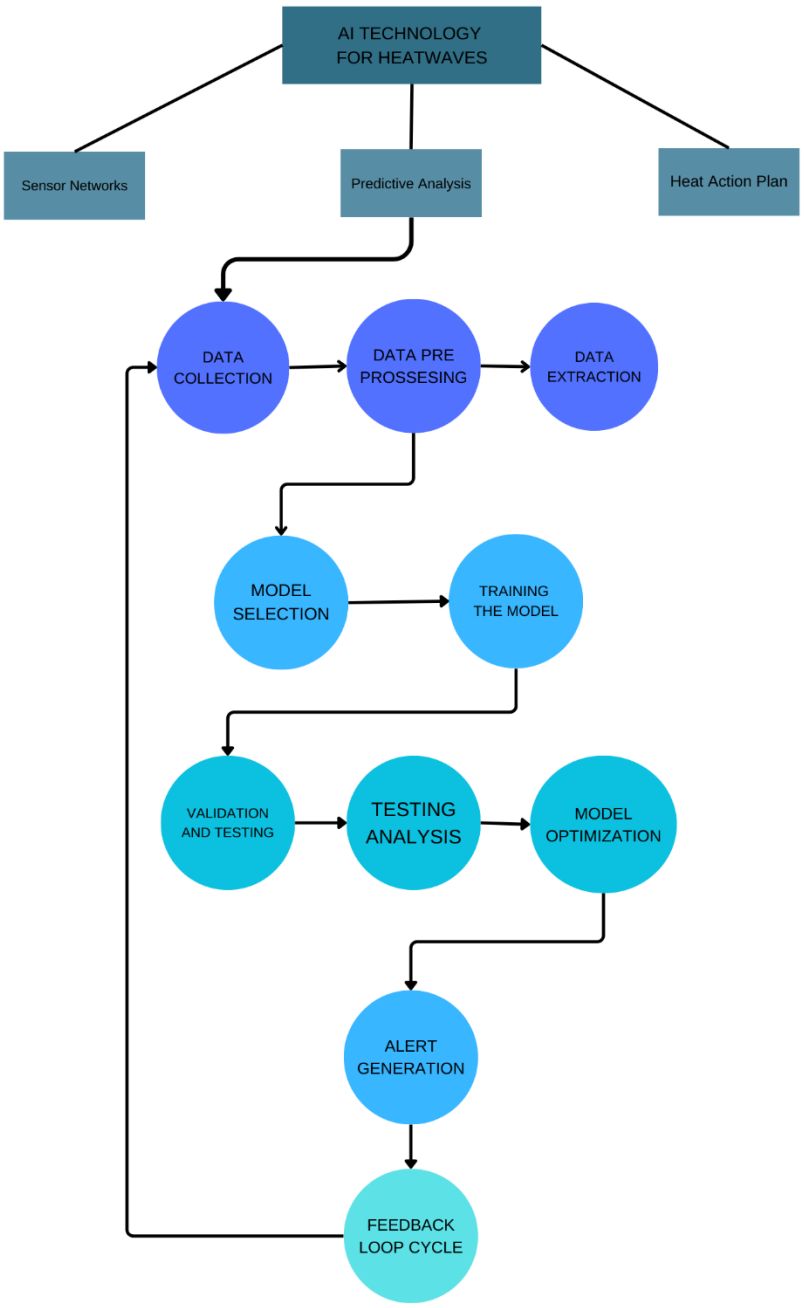


Figure 1: Predictive analytics algorithm for heatwaves[3]

[3] Definitions of each component of the algorithm are given in the Annex

While the specific factors and their importance can vary depending on the region and local climate patterns, Heatwave prediction is a complex task that considers various factors. High temperatures are the key feature, and humidity can exacerbate the impact. The duration of hot conditions, diurnal temperature range, wind patterns, clear skies, and historical data all play roles. Geographical factors like urban heat islands, soil moisture, and climate change are considered, along with population health. Advanced weather models and the heat index aid in anticipating and preparing for these extreme events.

Some of the key factors that are commonly taken into account when predicting heatwaves:

Temperature: High temperatures are a central element of heatwaves. Monitoring both daily maximum and minimum temperatures is crucial. Heatwaves are often defined based on a threshold temperature, such as several consecutive days with temperatures above a certain value.

Humidity: High humidity can exacerbate the discomfort and health risks associated with heatwaves. The combination of high temperature and high humidity can lead to dangerous heat index values.

Duration: The duration of hot and dry conditions is an important factor. Longer periods of high temperatures are more likely to lead to heatwave conditions.

Diurnal Temperature Range: A wide diurnal temperature range, where daytime temperatures are significantly higher than nighttime temperatures, can contribute to heatwave conditions.

Wind Patterns: Stagnant or slow-moving air masses can trap heat and exacerbate heatwave conditions. Monitoring wind patterns, especially any persistent high-pressure systems, is crucial.

Clear Skies: Clear skies and abundant sunshine can contribute to higher temperatures during the day, as there are no clouds to block incoming solar radiation.

Historical Climate Data: Historical climate data, including past occurrences of heatwaves, can provide insights into the likelihood of future events. Long-term climate trends are also considered.

Geographical Factors: Local geography can influence heatwave conditions. Urban areas tend to experience more intense heat due to the urban heat island effect, where buildings and pavement absorb and re-radiate heat.

Soil Moisture: Dry soil can heat up more quickly and retain heat, contributing to higher temperatures. Soil moisture levels play a role in local temperature patterns.

Climate Change: Ongoing climate change is affecting the frequency and intensity of heatwaves. Monitoring long-term climate trends and changes in climate patterns is essential.

Health and Vulnerability: Assessing the health and vulnerability of the population in a region is vital. High heat combined with high population density can increase the risk of heat-related illnesses.

Weather Models: Numerical weather models use current and forecasted meteorological data to predict temperature trends and the likelihood of heatwaves in the coming days and weeks.

Heat Index: The heat index, also known as the "feels-like" temperature, takes into account both temperature and humidity to provide a better measure of perceived heat.

Predicting heatwaves involves a combination of these factors. The specific thresholds and criteria for defining a heatwave can vary by region, and meteorological agencies typically use local historical data to establish definitions and criteria for issuing heatwave warnings.

It’s important to note that accurate heatwave prediction involves complex interactions between various environmental factors. AI models are most effective when they are trained on diverse and comprehensive datasets that cover a wide range of scenarios. Additionally, collaboration between

meteorologists, climate scientists, and data scientists is essential for developing robust heatwave prediction systems.

III. Project approach and strategy:

The overall approach and objective of this project is to enhance the city's resilience to heat waves and to the heat island effects through the implementation of technology solutions making use of Digital Public Infrastructure (DPI), aligning with the Strategic Priorities -- SP2, SP3, SP5 -- of the UNDP's Urban Risk Management and Resilience strategy and Pillar-5 of the UNDP-UN-Habitat Enhanced Collaboration Framework related to application of digital technologies for urban resilience. Leveraging digital technologies and data, this project aims to improve early warning systems, enhance the risk management and planning capability of cities, increase public awareness, and strengthen community engagement to mitigate the impacts of heatwaves.

The global targets and priorities for actions set in United Nations' (UN) Sendai framework for disaster risk reduction (SFDRR) will be addressed, in particular: – To provide actionable information to the authorities to design prevention actions for reducing the number of affected people and the loss of life (i.e. SFDRR's 1st and 2nd global target) due to climate change, – To increase the availability of, and access to, climate change risk information and assessment to people (i.e. SFDRR's 4th and 7th global targets, respectively).

The Project will, thereby, enable cities[4] to advance an integrated DRR, CC-CCA and sustainable development approach in line with the New Urban Agenda, the Paris Agreement and the Sendai Framework for DRR.

Its analytical and diagnostic approach will help identify actionable resilience and sustainability centric actions.

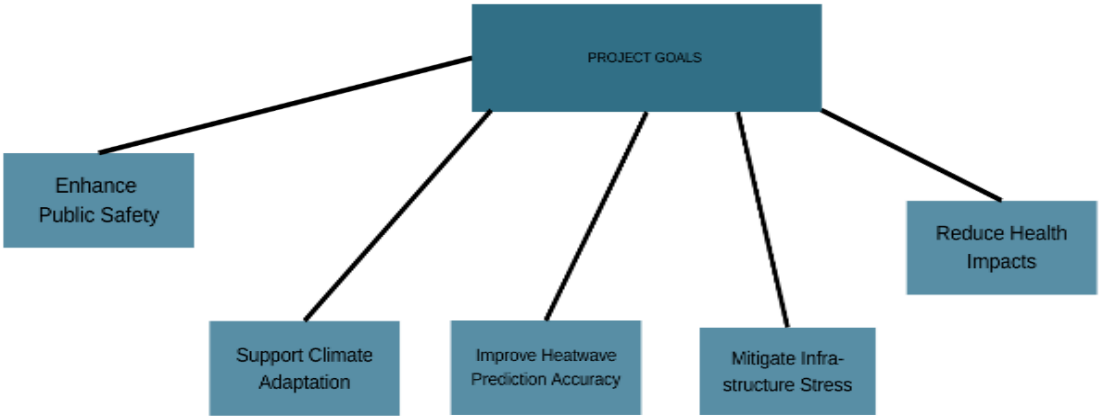
An inclusive and participatory approach will be advanced by ensuring engagement of non-governmental organizations and actors like community representatives and elected bodies, youth groups and their organizations, NGOs, private sector, academia and technical institutions, women-led organizations, and others. The Project will foster a closer relationship between regional inter-governmental organizations and sectoral city-level agencies and stakeholders.

The **direct beneficiaries** of the project will be the city administrative entities, local communities as well as stakeholder groups like the private sector, community and civil society organizations, youth groups, vulnerable segments of urban population, academic and research institutions etc. The focus here will be on reflecting the risk management and resilience building needs and priorities of the most vulnerable and the weaker segments of society in the target cities such as the women, elderly, children, disabled and disadvantaged in line with the Leaving No One Behind principle underlying the 2030 Agenda.

Other beneficiaries will be the city-level government departments, sectoral agencies/entities and functionaries dealing with disaster management, climate change, urban planning and development, and health. The project will recognize and respect institutional mandates and leverage partners' complementary and mutually reinforcing technical and operational capacities, with governments and

[4] This proposal is designed for initial implementation in a pilot city, to be determined through consultation with our partners, with the potential for future expansion to multiple cities.

communities in the lead, through simple and participatory approaches adaptable to available resources[5].



IV. Project components/ result areas

The Project aims at mapping and identifying the city areas and communities most vulnerable to heat waves (HW) and urban heat island (UHI) effects and seeks to build resilience to their adverse impacts through increased heatwave awareness, green risk reduction interventions, preparedness, EWS, and building institutional capacities through technological solutions.

The 5 (five)[6] components of the project and goals pursued include:

Phase I: City-level test pilots with focus on Result Areas 1 to 3

Result Area-1: Map and identify the most heat vulnerable areas and communities/ Impact Assessment of Heatwaves

Use available data sources to identify and map areas and community groups that are most vulnerable to heat impacts. Conduct outreach to vulnerable communities to gather information on their experiences and needs during heatwaves. This can be done through community meetings, surveys, and other methods. Qualitative and quantitative approach for mapping, considering different indicators e.g age, income, housing, access to green spaces, health status, where more calls for help are issued, etc. Existing methods and tools for mapping the vulnerable communities in cities can be used, e.g. *RCCC Heatwave Guide for Cities; The Wisconsin Extreme Heat Toolkit; Impact Forecast Mapping by the German Red Cross, etc.* Based on existing methodologies and indicators for determining vulnerability to heatwaves, the most vulnerable areas and communities, including high-risk populations, can be mapped on GIS platform. Utilize existing weather data from public sources (climate models, satellite data) and local weather stations to monitor temperature and humidity during heatwaves. If necessary, to complement the existing sources, low-cost sensor technology can be used to collect real-time data on temperature and humidity.

Activity 1.1: Vulnerability Data Compilation and Indicator Selection

Compile available data sources and select appropriate vulnerability indicators for mapping the most heat vulnerable areas and assessing the impact of heatwaves on communities. Potential data to be

[5] Issues related to 'mitigating infrastructure stress' to be discussed and decided later.
[6] At the first stage, our primary focus will be on three result areas, with the potential for proposing two consecutive ones (RA4 and RA5) if sufficient resources and extended timeframe becomes available.

utilized include demographics, income levels, housing conditions, health status, and access to green spaces. Collaborate with local agencies and organizations to access relevant data sets. Identify and finalize a set of indicators that best represent vulnerability to heat impacts. This activity lays the groundwork for subsequent mapping and assessment processes.

Activity 1.2: Climate Data Collection and Sensor Deployment

Utilize existing weather data and deploy low-cost sensor technology to collect real-time temperature and humidity data during heatwaves. Source climate models, satellite data, and local weather stations to collect historical and current weather information. Where necessary, deploy low-cost sensors in areas identified as vulnerable from Activity 1.1. These sensors provide real-time temperature and humidity data that complement existing sources and enhance accuracy in predicting and monitoring heatwave events.

Activity 1.3: Risk Mapping and Data Integration

Utilize GIS and established methodologies to map and analyze vulnerability indicators and climate data, integrating the collected data to create heat vulnerability, hazard and risk maps. Integrate quantitative and qualitative data sources to provide a comprehensive view of heatwave risk. Visualize and analyze the results to highlight areas with the highest risk levels.

Activity 1.4: Community Outreach and Data Validation

Conduct community outreach to gather firsthand information on vulnerable communities' experiences and needs during heatwaves, validating the mapped results from Activity 1.3. Organize community meetings, focus groups, and surveys to engage with residents from identified vulnerable communities. Gather qualitative data on their experiences, challenges, and coping mechanisms during heatwaves. This information validates the heat risk mapping and helps refine intervention strategies. Engaging directly with communities fosters trust and ensures the accuracy of vulnerability assessments.

Activity 1.5: Research and analysis

Based on a comprehensive analysis of data and related information and recognizing the trans-urban, regional and sub-regional nature and characteristics of heatwave risks, the Activity will support urban, peri-urban and regional/sub-regional analysis of key factors and drivers aggravating the heatwave risk in target cities. This will help develop context-specific scenarios and help develop topical mitigation and planning measures based on the identification of seasonality, patterns of occurrence, manifestation characteristics as well as the potential socio-economic impacts. It will in particular target the weaker and marginalized segments of urban society including women, elderly, children and other disadvantaged sections such as the migrants, internally displaced etc.

Result Area-2: Develop and promote a Heatwave Preparedness Platform

Based on the results from the vulnerability mapping and data collected under RA-1, a digital platform will be established. Through the platform, digital early warning mobile system that can alert residents and authorities about upcoming heatwaves will be developed. The mobile application will provide real-time heatwave alerts, emergency contact information, and cooling center locations, similar to EXTREMA Paris, or the app develop for Athens (only based on satellite data, no citizen input or real time sensor data). This can help individuals take appropriate precautions and allow cities to activate their heat emergency plans (alternatively a heatwave alert system using email and SMS notifications to inform residents about heatwave warnings and safety measures). The application is a two-way communication tool for weather warning issues, cools spaces mapping, and other features, for both the authorities and the public and each will receive the respective risk information. Potential features of the mobile application are:

- *Mapping of cool 'islands' where citizens can seek refuge from the heat; water fountains/ distribution points; green spaces; cooling centers, etc.*

- *Warning system map highlighting the UHI areas*
- *Personalized heat stress risk alert based on location and other vulnerability indicators (age, health conditions, etc.)*
- *City authorities will get real-time images/maps of extreme temperature hazard distribution in their city, and other relevant variable, like humidity and discomfort index*
- *City authorities EWS*
- *Coolest route from A to B (see Athens)*

Activity 2.1: Development of a DPI Platform for Integrated Analysis

Develop a comprehensive digital platform that aggregates data from weather sources, sensors, social media feeds, vulnerability assessments, and other relevant sources identified under Result Area 1. Other data sources include public crowdsensing of heatwaves through social media platforms like X (Twitter), can provide real-time information and insights. Digital public infrastructure enables more accurate and timely predictions, and the crucial data sharing needed to enhance city-level preparedness and response strategies.

Activity 2.2: Heatwave Preparedness Mobile App Development

Collaborate with app developers, data scientists, and meteorological experts to design and build a user-friendly mobile app focused on heatwave preparedness. Ensure that the app integrates satellite data and vulnerability mapping from Result Area 1 to provide accurate heatwave alerts and personalized risk information. The app should include features like real-time heat distribution maps, cool spaces mapping, water fountain locations, green spaces, and directions to nearby cooling centers.

Activity 2.3: Digital Early Warning System for Heatwaves

Develop a digital early warning system within the mobile app that sends alerts to residents and authorities about upcoming heatwaves. Use data from meteorological sources and vulnerability indicators to predict heatwave events. Implement a tiered alert system that sends notifications to users based on their location and vulnerability indicators such as age and health conditions. Establish a bidirectional communication between the public and city authorities. Users should have the ability to report extreme heat hazards, suggest cool spaces, and provide real-time feedback on the effectiveness of the app's features. City authorities should receive real-time temperature hazard distribution maps, humidity data, and other relevant variables.

Activity 2.4: Health Impact Assessment during Heatwaves

During heatwave events, collect and analyze health-related data to evaluate the impact of high temperatures on public health. Collaborate with local health authorities, hospitals, and clinics to obtain relevant data, including hospital admissions, emergency room visits, and reported cases of heat-related illnesses. Integrate this health-related data into the DPI platform established in Activity 2.1.

Result Area-3: Public Awareness and Education

Support the development of partnerships between public health, social services and emergency response departments and their capacity building to respond and protect from heat impacts using digital technology, for more coordinated action. Conduct awareness campaigns using digital channels to educate residents about heatwave risks and adaptation strategies. Use social media and city websites to share the educational content with the public.

Activity 3.1: Foster Partnerships for Heat Resilience

Bring together relevant city departments, including public health, social services, and emergency response, to collaborate on a comprehensive strategy for heatwave resilience. The digital platform developed under RA2 will enable real-time communication and data sharing among these departments. This platform can be used to monitor vulnerable populations, track heat-related health incidents, and coordinate emergency responses. Training sessions and workshops can be organized to

ensure that staff from these departments are equipped with the necessary skills to effectively utilize digital tools for heat resilience efforts.

Activity 3.2: Digital Awareness Campaigns for Heat Adaptation

Design and execute awareness campaigns using digital channels to educate residents about heatwave risks and adaptation strategies. Collaborate with local influencers, community organizations, and schools to amplify the reach of the campaigns. Use social media platforms, city websites, and mobile apps to disseminate the content widely. Incorporate interactive elements, such as quizzes and challenges, to encourage active engagement and knowledge retention among residents.

Activity 3.3: Collaborative Alerts with City Utility Companies

Partner with city utility companies (water, gas, electricity) to leverage their established communication channels to share heatwave alerts and educational content for reaching a broad audience. Develop eye-catching visual alerts, such as red color blurbs or symbols, to be included in utility bills, notices, or digital communications. These alerts can provide concise information about upcoming heatwaves, safety precautions, and links to additional resources. This approach ensures that heat resilience information reaches a wide range of residents, including those who might not be as digitally connected.

Phase II: Implementation of city level activities in Result Areas 4 and 5 (contingent upon availability of resources and extended timeframe)

Result Area-4: Risk-informed Urban Planning to integrate disaster/climate risks including heatwaves

Initiate basic urban planning measures to incorporate heat-resilient elements into the city's urban planning including housing, roads, community and other development infrastructure. Collaborate with urban planners to identify low-cost interventions like making potable water easily accessible and building temporary cooling spaces during periods of extreme heat, ambulance services strategically located in places where more calls for help are issued, etc.

Activity 4.1: Risk-informed planning using heatwave vulnerability data

Utilize the vulnerability data collected from Result Area-1 to inform urban planning processes. Identify the most vulnerable areas and populations to heatwaves and other climate-related risks. Integrate this information into urban development plans to prioritize areas in need of heat-resilient interventions. The vulnerability assessment from Result Area-1 provides crucial insights into areas and communities that are more susceptible to heatwaves. By overlaying this data onto urban development plans, city planners can identify specific neighborhoods and infrastructure that require immediate attention. For example, areas with a high concentration of vulnerable populations such as the elderly or low-income residents can be earmarked for the implementation of heat-resilient infrastructure, such as cooling centers and shaded public spaces.

Activity 4.2: Facilitating access to and application of heat risk data in key sectors

Facilitate access to a platform that provides city sectors, and stakeholders with easy access to heatwave-related risk data and information for informed decision-making. Create an online portal or database that compiles heatwave risk data, historical heatwave occurrences, vulnerability assessments, and climate projections. This platform can be built upon information collected in RA1, RA2 and should be user-friendly and accessible to urban planners, architects, engineers, and relevant government agencies. Through an open-source data platform and use of interactive maps, heat-vulnerable areas can be highlighted and appropriate heat-resilient measures identified and implemented.

Result Area-5: Support the implementation of nature-based solutions to address the urban heat island effects

This can be done through simple yet very effective interventions such as increased shading through awnings or tree planting in heat-prone areas; Incentive for people to implement heat resilience measures privately, e.g. install green roofs and cool roofs; increasing green areas, using materials with high reflection properties that do not absorb heat; creating artificial ponds and other water features.

Activity-5.1: Community Tree Planting Campaign

Organize and promote a community-driven tree planting campaign in heat-prone areas of the city. Provide native tree species that are well-suited to the local climate and require less water. Educate participants about the benefits of trees in reducing heat through shade and evapotranspiration. Keep track of the number of trees planted and their impact on local temperatures. Innovative incentivization schemes will sought to be developed to encourage citizen and/or institutional contribution to the campaign including for the private sector, educational institutions. For example, community and social service certificates can be issued to students participating in plantation drives or special grants can be given to schools/colleges assuming responsibility for greening nearby areas/communities.

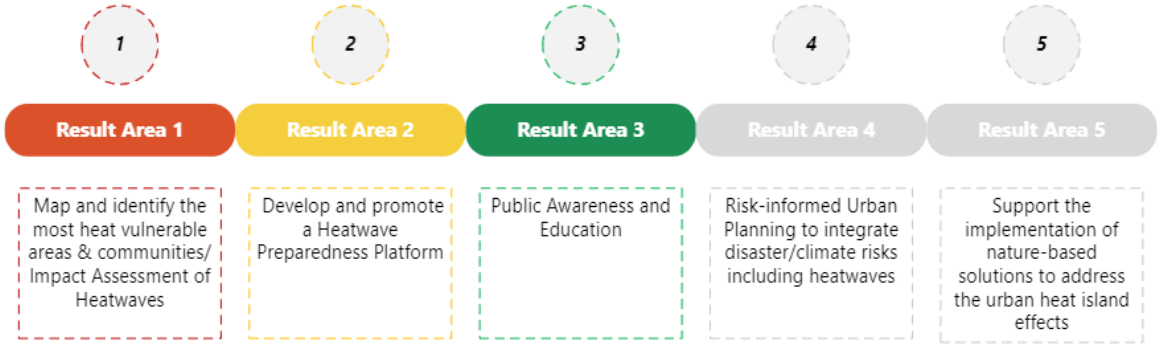
Activity-5.2: Cool Roof and Green Roof Installation Incentives

Introduce incentives for property owners to install cool roofs or green roofs on their buildings. Develop a program that provides financial incentives or tax breaks for property owners who choose to install cool roofs (reflective roofing materials) or green roofs (rooftop gardens). These solutions reduce heat absorption and improve energy efficiency. Collaborate with local roofing companies and urban planners to raise awareness about the benefits of these technologies. Implement a verification process to ensure that the installations meet the required standards. Regularly assess the impact of the installed cool roofs and green roofs on local temperature reduction.

Activity-5.3: Heat-Resilient Public Space Design with NbS

Redesign and upgrade public spaces with heat-resilient features using Nature Based Solutions. Collaborate with urban designers, landscape architects, and local authorities to identify key public spaces that can be enhanced to mitigate heat effects. Implement design changes such as adding more shaded seating areas with awnings or pergolas, incorporating water features like artificial ponds or fountains for cooling, and using high-albedo (reflective) materials for pavements and walkways. Develop a community engagement strategy to involve citizens in the design process, ensuring that the changes align with their needs. Monitor the impact of these design interventions on the local microclimate and gather feedback from residents. Tools such as UrbanistAI and others can be used to facilitate engagement of citizens and stakeholders for envisioning and designing urban spaces of the future.

V. Partnerships and Implementation Partners



Tools and methodologies: UN-Habitat's City RAP and Global City Resilience Profiling Tool, UN Common Guidance on Resilience, World Bank's Climate Change Knowledge Portal, Open DRI, WRI, INFORM sub-national risk model, D&L disaster databases, Risk Anticipation, Horizon Scanning, Foresight, MCR's 10 Principles of Resilience Building etc. and related data platforms that provide data and analysis for DRR and climate resilience planning.

Potential Partners: Adrienne Arsht-Rockefeller Foundation Resilience Center (Arsht-Rock); WHO; Coalition for Disaster Resilient Infrastructure (CDRI); C40 Knowledge Hub; UNDP's Singapore Global Innovation Center and Smart Cities Initiative; WCCD; private sector tech companies like Google, Meta etc.; research and technical institutions; regional, national and local training institutions; private sector consortiums and entities.

ORGANISATION	***RELEVANCE***
Coalition for Disaster Resilient Infrastructure (CDRI)	CDRI supports countries to upgrade their systems to ensure disaster and climate resilience of existing and future infrastructure, in alignment with the Sustainable Development Goals, the Paris Agreement on Climate Change, and the Sendai Framework.
WHO	WHO provides guidance and support to national and local authorities in essential preparation and response to health emergencies, including extreme heat events.
UNDP's Singapore Global Innovation Center and Smart Cities Initiative	The Smart Cities Initiative uses ***technology*** and ***innovation*** to improve the urban environment, leading to improved quality of life, greater prosperity and sustainability
C40 Knowledge Hub	C40 Knowledge Hub provides a wealth of resources and tools to help cities develop effective heatwave resilience programs: ➢ The C40 Knowledge Hub provides a ***Heatwave Guide for Cities*** that offers information and recommendations for technical staff within city government; ➢ The C40 Knowledge Hub's ***Urban Cooling Toolbox*** provides approaches to lower urban temperatures and reduce the impact of the urban heat effect. This toolbox can help cities develop strategies to reduce the impact of heatwaves. ➢ The ***Heat Resilient Cities Benefit Tool*** helps city planners and decision-makers quantify the health, economic, and environmental benefits of adaptation actions. This tool can help cities evaluate the effectiveness of their heatwave resilience programs.
World Council on City Data	WCCD collects ***standardized data*** from cities around the world, which is used to create smart, sustainable, resilient, and prosperous cities. The data are collected across different themes and are shared in the open data portal creating standardized

	metrics that can be used to assess and compare measurements across cities.
Adrienne Arsht-Rockefeller Foundation Resilience Center (Arsht-Rock)	Focused on building human and community resilience in the face of climate impacts. Their project ***One Billion People More Resilient*** aims to build resilience to extreme heat by bringing together deep expertise to mobilize innovative and replicable solutions.

ANNEX

Predictive Analysis

Definations

Data Collection

Gathering and collecting all the relevant data from different sources including old weather data, temperature records, humidity levels and other environmental variables. This data will be needed to make prediction for the future and collection of data will be useful in the broad scale aspect of the working of the AI model.

Data Pre-processing

Clean and preprocess the collected data to ensure its quality and consistency. This step involves handling missing values, outlier removal, and data normalization. Any missing data that is to be needed will be assumed and worked on.

Data Extraction

Identify the most important features (variables) that contribute to the occurrence of heatwaves. These features can include past temperature trends, humidity levels, solar radiation, wind patterns, and more.

Model Selection

Choose an appropriate AI model for heatwave prediction. Machine learning algorithms like Random Forests, Gradient Boosting, Support Vector Machines, and deep learning architectures such as Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) can be considered.

Training The Model

Train the selected AI model using the preprocessed data. The model will learn patterns and relationships in the data to make predictions about heatwave occurrences.

Validation and Testing

Split the data into training and validation/ testing sets to evaluate the model's performance. Cross-validation techniques can also be employed to ensure the model generalizes well to unseen data.

Feature Importance

Analyse the model to understand which features have the most impact on heatwave predictions. This information can provide insights into the factors that contribute to heatwave occurrences.

Model Optimization

Fine-tune the model's hyperparameters to achieve the best possible performance. This step may involve techniques like grid search or Bayesian optimization.

Alert Generation

When the model predicts the likelihood of a heatwave exceeding a certain threshold, it can trigger alerts to relevant authorities, meteorological agencies, and the general public. These alerts can help people prepare and take preventive measures.

Feedback Loop

Continuously update and refine the model using new data. This helps the model adapt to changing climate patterns and improves its predictive accuracy over time.