AI for The Resilient City

A COMMUNICATIONS TOOLKIT

City of Calgary

Evergreen / December 2022

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ACKNOWLEDGEMENTS

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Funding Partner(s):

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Gramener

Tool Partners:

City of Calgary

Region of Peel

Toronto & Region Conservation Authority

Azavea

State of Canada – Climate Change, Resiliency Planning, and the road to 2050

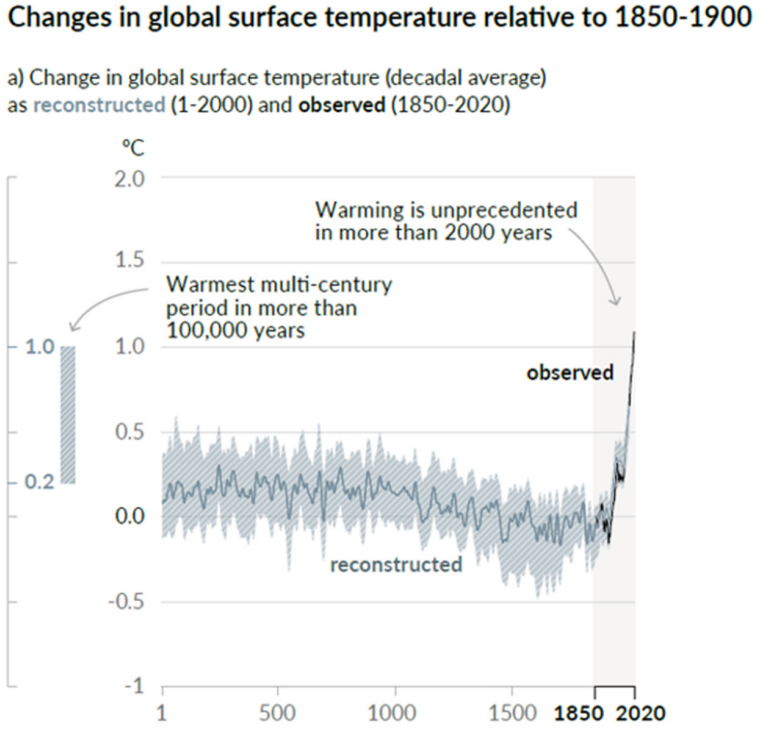
Based on overwhelming scientific evidence from across the globe, earth has been warming at an unprecedented rate since the great industrial revolution. This rise in global temperatures commonly referred as 'Global Warming ' , has attributed to the effects of climate change and altering the earth's natural patterns as we know them.

Climate Change is one of the leading crises the country will have to face today, tomorrow, and beyond. With Canada's massive and diverse landmass, the effects and impacts of climate change whether good, bad, or neutral will affect everyone differently across the country. From milder winters to warmer summers with increased storm events, droughts, and extreme heat, to flooding, wildfires, reduced sea-ice, invasive species and new diseases locally. Canada on average is warming at double the rate of the rest of the globe. Global temperatures over the last 200 years have increased by 1 ^{0}C which has exponentially increased since the Industrial Revolution. Figure 1 displays the 'hockey stick graph' of global greenhouse gas emissions in the atmosphere and indicating how they have changed over time, with Canada increasing exponentially by 1.9 ^{0}C .

As governments in Canada at all levels start or continue to plan for climate change impacts, a level of resiliency planning will be required.

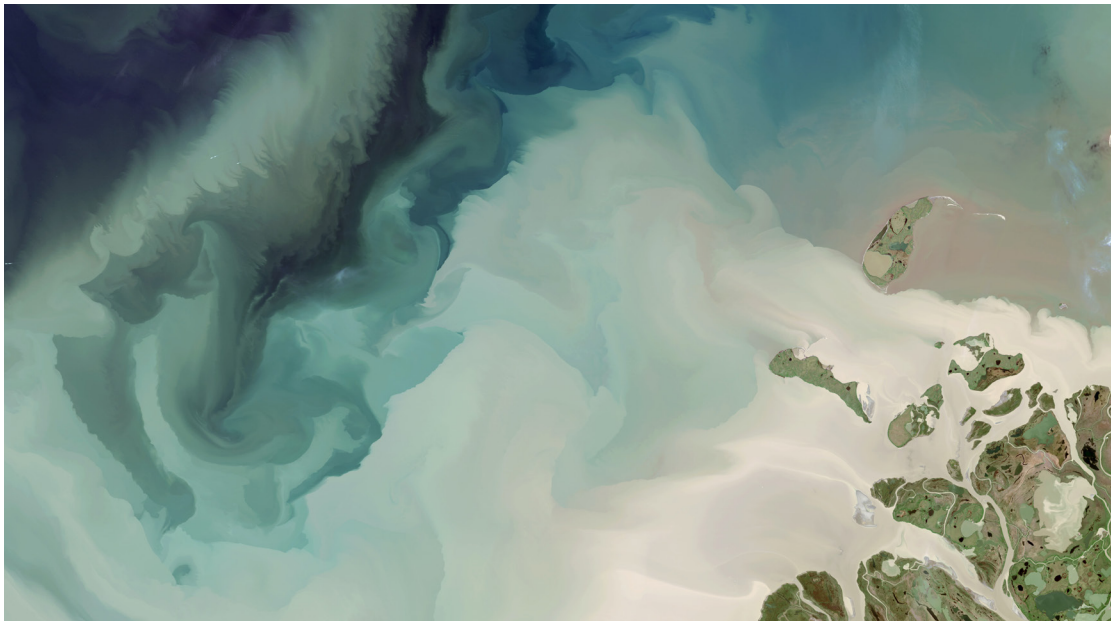
Resilience Planning in the context of climate is the ability to anticipate, prepare for, and respond to hazardous events, trends or disturbances related to climate [2] .

Figure 1: Change in global surface temperature (decadal average) as reconstructed (1-2000) and observed (1850-2020)



This planning may come in the form of flood prevention and management, energy resilience through energy sources such as wind or solar that don't rely heavily on external fuel sources or even planning for homes being built today to withstand and stand up to the climate impacts of tomorrow and decades from now. Infrastructure built today, including homes, roads, bridges, and culverts are all likely to be around in decades to come. In addition, cities and governments in Canada (and around the world) have agreed to, targeted and signed commitments to reach net-zero carbon emissions by 2050. This 2050 goal will require cities, regions and countries to rethink our power grids, the way we build homes, neighbourhoods and communities and move across our cities, provinces and countries.

The *International Panel on Climate Change* recently released a warning to curb global emissions and keep the warming on earth below 1.5 ^{0}C before 2040. It is important to understand that if we in Canada don't do our part, we could see a temperature increase in Canada alone of 2.4 ^{0}C, creating dramatic effects on Canadians. These effects are already being witnessed through extreme heat waves, droughts, wildfires, flooding, ice storms and more.



Global Warming: Global warming is the long-term heating of Earth's surface observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere. This term is not interchangeable with the term "climate change."

Climate Change: Climate change is a long-term change in the average weather patterns that have come to define Earth's local, regional and global climates. These changes have a broad range of observed effects that are synonymous with the term.

Changes observed in Earth's climate since the mid-20th century are driven by human activities, particularly fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere, raising Earth's average surface temperature. Natural processes, which have been overwhelmed by human activities, can also contribute to climate change, including internal variability (e.g., cyclical ocean patterns like El Niño, La Niña and the Pacific Decadal Oscillation) and external forcings (e.g., volcanic activity, changes in the Sun's energy output, variations in Earth's orbit).

[1] *https://climate.nasa.gov/global-warming-vs-climate-change/*

Understanding the needs of municipalities

Municipalities and regional governments are stuck between a melting icecap and a raging wildfire.

Government officials have made goals, agreements, and targets to act on climate change in order to adapt and prevent the worst impacts for their homes, families and regions. This action to largely rethink how we plan cities, mitigate existing climate stresses and threats as well as prepare to adapt for the future is full of challenges, barriers, and obstacles. Cities in Canada are home to 80% of the country's population. The dense concentration of people, businesses, infrastructure, and economic resources in cities makes them uniquely vulnerable to the growing risks of a warming world and contribute largely to increasing emissions across Canada. The choices and actions that government staff take will affect everyone from the onset to a new project to generational changes to the way we live over the course of the coming decades.

Many local and regional governments have begun or ramped up the transformational change to take climate action and plan for future resilience but among the barriers to getting started or making informed decisions are the foresight, tools and applications staff need to understand how the impacts of climate change will affect specific geographic regions and how climate solutions may lessen, mitigate or adapt to those future impacts, stresses, hazards and events. Municipalities are eager to create, develop or access the climate tools needed to understand which communities are most at risk from the impacts of climate change like extreme heat or flooding, and how capital investment can be best utilized to get the largest return on investment and benefit local communities.

The AI for the Resilient City tool is a data-visualization and scenario planning solution to act on climate change and measure, understand and visualize the impacts of climate change, such as extreme heat and urban heat island effect. This tool uses satellite imagery, local heat data, infrastructure data, and demographic data from 2013 to 2020 to show communities in Canadian cities are being affected. Additionally, the tool shows how changes to these regions have impacted Urban Heat Island (UHI). Allowing the user to narrow in on what is important to them for their investments, solutions, planning and projects, the tool provides the ability to understand extreme heat and how both older and newer buildings and land use planning is impacting it. The tool also demonstrates how socio-demographics play a role and indicate which communities are at higher risk of extreme heat. In its current form, the UHI tool provides three main modes for better resiliency planning and decision-making.

[2] *https://www.c2es.org/content/climate-resilience-overview/#:~:text=Climate%20resilience%20is%20the%20ability,better%20cope%20with%20these%20risks*

[3] *To 'go net zero' is to reduce greenhouse gas emissions and/or to ensure that any ongoing emissions are balanced by removals. https://netzeroclimate.org/what-is-net-zero/*

Story Mode

Allows users to see data insights (like heat temperature, Infrastructure, demographic data) as easily digestible stories.

Explore Mode

This mode provides a granular view of the data. For example, Identifying the UHI hotspots within an area or city, identifying different building types and clusters of buildings, or understanding a high-level breakdown of population age demographics and how that may relate to extreme heat, vulnerability, infrastructure stresses etc.

Compare Mode

This mode allows users to compare correlating variables at the same time, or the same variables at different points in time. For example, changes in extreme heat and UHI in comparison to building age or vegetation cover or pervious (plants and grass)/impervious (concrete and homes) surfaces.

In its pilot phase, the AI for the Resilient City was supported by Microsoft's AI for Earth program and in the next phase, received funding from RBC Foundation through RBC Tech for Nature to further enhance the tool and scale up the program.

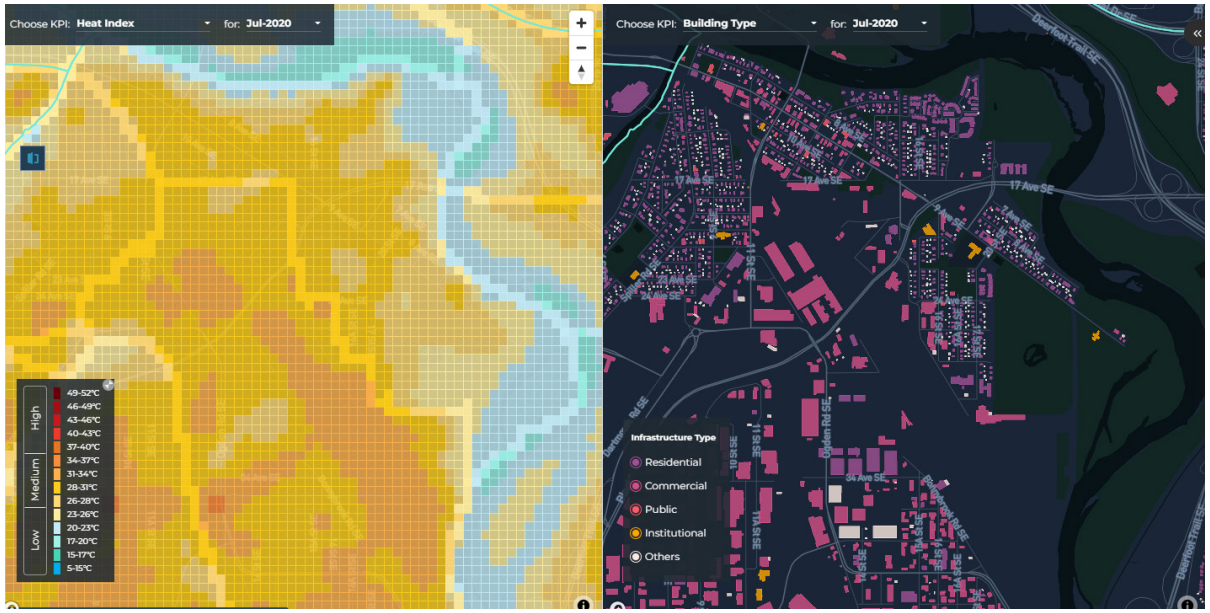


Figure 2: A visual demonstration of the AI for Resilient City tool

[3] An urban heat island occurs when a city experiences much warmer temperatures than nearby surrounding areas. The difference in temperature between urban and less-(intensely) developed rural/ nearby areas has to do with how well the surfaces in each environment absorb and hold heat.

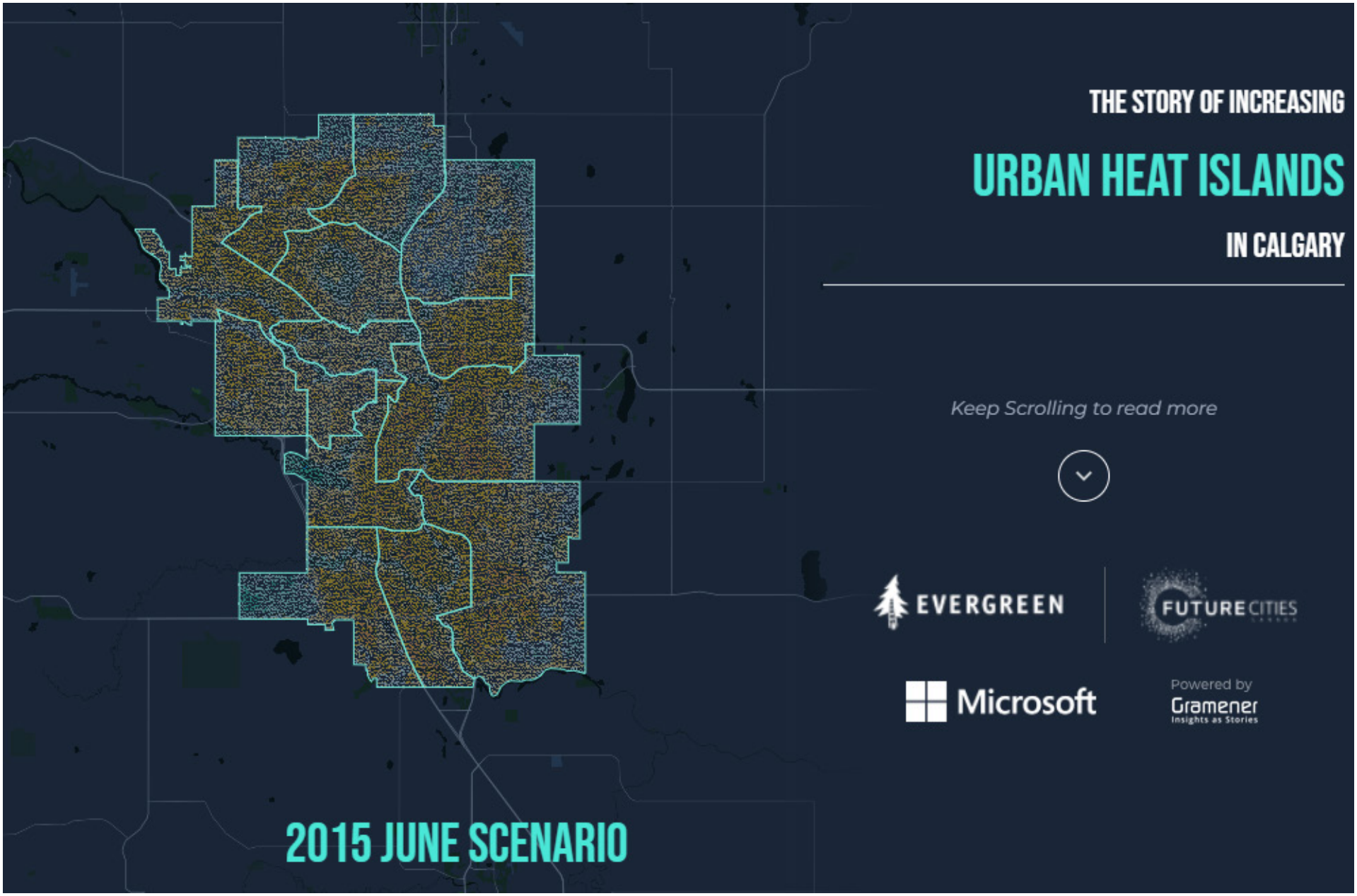


Figure 3: Default Story Mode view

PILOT PHASE 1: THE CITY OF CALGARY

City Overview

The city of Calgary is located in Southern Alberta, with a population of over 1.3 million and size of 820 square kilometres . Among the most significant climate change hazards Calgary is currently facing are higher average temperatures, which are the slow onset effects of heat on communities and the environment, and extreme heat, periods in which the maximum and minimum temperature are high enough to present significant risks to people, built, and natural environments. These climate risks are projected to become much more significant as climate change continues and intensifies. The average annual daily temperature is projected to rise from the historical average of 4.3 degrees Celsius to 7.4 degrees Celsius by the 2050s and to 9.5 degrees Celsius by the 2080s. Both the number of heatwaves and the duration of heatwaves are projected to rise dramatically.

These climate changes are and will continue to have destructive impacts in Calgary. Population health is worsened by higher instances of heat-related illnesses and even death, as well as lower air quality. Higher average temperatures can also result in increased damage to infrastructure and harm to natural areas and ecosystems. These climate hazards also bring economic damages, from increased costs of cooling buildings and reduced labour productivity.

Opportunity

The City of Calgary has a responsibility to enhance climate resiliency by understanding, preparing, and responding to climate change and its impacts, including extreme heat and higher average temperatures. Understanding what parts of our communities are consistently most exposed to high temperatures. can inform climate adaptation planning decisions, help prioritise City resources, and can inform decisions made by community planners, social services and emergency management groups to direct cooling interventions and foster climate resilience to heat induced impacts.

[5] *Data about Calgary's population*

[6] *Population and dwelling counts: Canada, provinces and territories, and census subdivisions (municipalities) (statcan.gc.ca)*

[7] *Climate Projection for Calgary- Download PDF*

Value Proposition

The tool will help to examine the impact of the UHI effect in relation to the city's infrastructure and population that will enable city planners and other decision makers better understand the vulnerable neighbourhoods that need interventions and evaluate potential development scenarios to create or mitigate UHI. This implies:

- Identifying hotspots that are most impacted through UHI within the city.
- Analyzing the impact of natural built assets in the heat variation across time in communities across Calgary.
- Supporting the development of climate risk profiles that can counter the effects of UHI.
- Identifying contributing factors and leverage decision-making and policy shifts.
- Applying data insights from the visualization tool in emerging initiatives at the city or local level.

Application of the UHI Tool

Evaluation Metrics to report on.

The Climate Adaptation team and the Climate Governance and Strategic Planning Team at the City of Calgary uses the tool to inform and develop "Community Climate Risk Profiles", The Community Climate Risk Profiles are created for each community in Calgary and assist Community Planners in making evidence-based decisions related to climate risk reduction as they complete multi-community planning projects. These profiles provide insights into the geographic and community-specific indicators that drive climate risk, such as geographical features, demographics, and the condition of existing built and natural environments.

As a part of these climate risk profiles, the UHI tool helps to identify the warmest areas where residents are most exposed to the impacts of extreme heat and higher average temperatures, as well as the coolest areas that can provide relief during the warm days.

Through the UHI maps produced from the tool, the City can also provide evidence that supports and informs the following actions:

1. Utilizing the tool to inform 5 planning projects (currently in draft, non-approved form), and approximately 10 public infrastructure projects. It helped to inform a project that developed a value for the heat reduction effects of natural assets in the City of Calgary
2. Providing quantitative data that demonstrated the importance of natural assets for temperature reduction and the value of increasing and enhancing the natural assets from a climate risk perspective.
3. Demonstrating the effect of roads and paved spaces on heat, with the highest temperatures being around paved parking lots and rooftops. This information can affect how we design these spaces to be better equipped for climate change and become more climate resilient for the future
4. Demonstrating the cooling effect of park and natural assets, particularly of water bodies
5. Indicating that heat amplifying impact of paved spaces and reduction impacts of greenspaces extend beyond the geographic boundaries of the respective feature and affect parts of the community nearby

Docendo discimus – By teaching, we learn

With any new pilot program, the inherent risk of trying something new is failing. Whether that be a climate solution, new company or new technology there is always that risk. We would like to thank our funders and partners, in supporting the vision of Evergreen through this program and helping us build a tool that can help municipalities in their resiliency initiatives. There were many lessons learned from the pilot program with the Phase 1: City of Calgary but the ability to build in a predictive function was the most important one. This could help to predict as an example how a climate solution like planting street trees on one street would affect UHI and extreme heat years and decades down the road. But as we built the tool and, in the process, consulted with scientists from NASA and other data science experts, with the current scope and data inputs that existed in the current tool, it seemed inadequate to create a predictability function at that resolution of street level. With additional climate models, wider range and greater depth of data and wider mode resolution (Neighbourhood/ community level vs street level) the ability to create the predictive function is possible.

A scenario modelling example that would be feasible in future phases of the program could be climate solutions of visualizing the effect of transitioning 75% of flat rooves to green or white rooves and identifying the change in extreme heat and UHI trends for that community. This is one of many possible solutions and examples

What's Next and how Evergreen plans to succeed

Evergreen is moving full speed ahead since the completion of Phase 1 in early 2022. The program has further expanded its partnership and ambition into Phase 2 by bringing on board the Region of Peel (located in Ontario) and a local conservation authority. This partnership is important as the tool geographically expands to incorporate a regional government which within its boundaries has 3 cities- Mississauga, Brampton, and Caledon. This brings on new opportunities and challenges which Evergreen is running headfirst at innovation and growing this program to provide governments and cities with the resources to take climate action.

As for next steps within the tool itself we are actively working towards the implementation of scenario modelling within the application for the Region of Peel, which would allow municipal users to see how changes to the city, community and/or local environment would affect variables within the tool and identify the effects of UHI and extreme heat before a shovel ever hit the dirt. This mode if successful will be a massively advantageous step for the program, and partners in planning climate action solutions and better arming government staff and planners with a tool to make more informed decisions.

About Evergreen and Future Cities Canada

Evergreen is dedicated to making cities livable, green and prosperous. Since 1991, the national not-for-profit has been facilitating change in communities through connection, innovation and sustainable actions. We work with community builders across sectors to solve some of the most pressing issues cities face: climate change, housing affordability, and access to nature and public spaces.

evergreen.ca

Future Cities Canada is a national cross-sector initiative with the mission to accelerate innovation to transform cities for the benefit of all. Drawing on the expertise of its founding organizations - The McConnell Foundation, TD Bank Group, Evergreen, Maison de l'innovation sociale and Community Foundations of Canada - and together with a diverse and growing network of partners, Future Cities Canada collectively strives to address the challenges facing cities and citydwellers to reimagine cities that are equitable, regenerative and prosperous.

futurecitiescanada.ca

Contact Us

If you or you think your local government would be interested in the UHI tool as described, please feel free to reach out and contact the AI for The Resilient City Program team at Evergreen at:

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