SCIENCE SPOTLIGHT

TEMPERATURE INCREASE: REDUCING THE HEAT

GEN ACTION

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Canada

SCIENCE WORLD

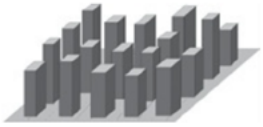
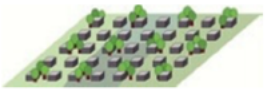
Temperature Increase: Reducing the Heat

Origin Story: WHAT IS A LOCAL CLIMATE ZONE?

Climate is more than just temperature. It is the long-term weather pattern in a particular area, typically measured across a thirty year period. A scientist who studies the climate in and around cities is an urban climatologist. They research how atmospheric conditions and patterns impact urban areas and vice versa. Urban climatologists can classify neighbourhoods into their **local climate zone (LCZ)**. A local climate zone is an area that has consistent surface properties and land cover, and each LCZ can have unique air temperature patterns. To get a sense of the types of properties scientists measure, stand outside. What colour are the structures around you? How dense are the buildings? Are there any trees around you? If you look up, do you see buildings or sky? If you look down, do you see pavement or grass?

The local climate zone you are in can affect how comfortable you feel outside. If you are on a city sidewalk or urban area surrounded by roads or other infrastructure, those structures absorb and re-emit the sun's heat more than other things like trees or grass. **Mean radiant temperature** serves as a measure of this exchange of heat between our surroundings and ourselves, and it is a big factor in how comfortable we feel outside. People are generally more comfortable in environments with lower mean radiant temperatures. This is one reason why a green park feels cooler than a grey concrete sidewalk.

EXAMPLES OF LOCAL CLIMATE ZONES

Built types	Definition
1. Compact high-rise 	Dense mix of tall buildings to tens of stories. Few or no trees. Land cover mostly paved. Concrete, steel, stone, and glass construction materials.
4. Open high-rise 	Open arrangement of tall buildings to tens of stories. Abundance of pervious land cover (low plants, scattered trees). Concrete, steel, stone, and glass construction materials.
5. Open midrise 	Open arrangement of midrise buildings (3–9 stories). Abundance of pervious land cover (low plants, scattered trees). Concrete, steel, stone, and glass construction materials.
6. Open low-rise 	Open arrangement of low-rise buildings (1–3 stories). Abundance of pervious land cover (low plants, scattered trees). Wood, brick, stone, tile, and concrete construction materials.
8. Large low-rise 	Open arrangement of large low-rise buildings (1–3 stories). Few or no trees. Land cover mostly paved. Steel, concrete, metal, and stone construction materials.

Iain Stewart and Tim Oke, Local climate zones for urban temperature studies (Bulletin of the American Meteorological Society, 2012), 1885, modified version of table 2.

1. Stewart, I. D., and T. R. Oke. "Local Climate Zones for Urban Temperature Studies", Bulletin of the American Meteorological Society 93, 12 (2012): 1879-1900, accessed Oct 21, 2022, https://doi.org/10.1175/BAMS-D-11-00019.1

Planting for the Future:
CAN STREET TREES REDUCE OUR CITIES' RISING TEMPERATURES?

Temperature, or how hot or cold it is, varies all the time. Temperatures change from day to night, with the seasons, during extreme weather like heat waves, and even from year to year. Measuring global temperatures for decades, climate scientists have observed that global air surface temperatures are rising over time. More intense, long-lasting, and frequent heat waves, and extreme temperatures, are predicted because of climate change.

Global climate scientists have created climate models, like the Representative Concentration Pathway (RCP) 4.5 and 8.5 scenarios, to visualize different potential futures. These use various levels of greenhouse gas concentrations in the atmosphere to predict different degrees of global changes. The first, RCP 4.5, models a future where climate change stabilizes because climate strategies and technologies are used to reduce greenhouse gas emissions. The second scenario, RCP 8.5, represents one of the worst-case climate futures, with continued and increased intensive use of fossil fuels. Between these two scenarios, many climate scientists predict that RCP 4.5 is the more likely future scenario[1], but many cities are preparing for the worst outcome and using the RCP 8.5 to plan for the future.[2]

But, how do current and future rising global temperatures impact the temperatures we will feel in our neighbourhoods? Urban climatologists, like Dr. Aminipouri and his colleagues, are researching how different future scenarios of climate change impact local urban temperature changes and if solutions are able to help reduce the future heat we will experience in our cities.

Together, the researchers asked two big questions:

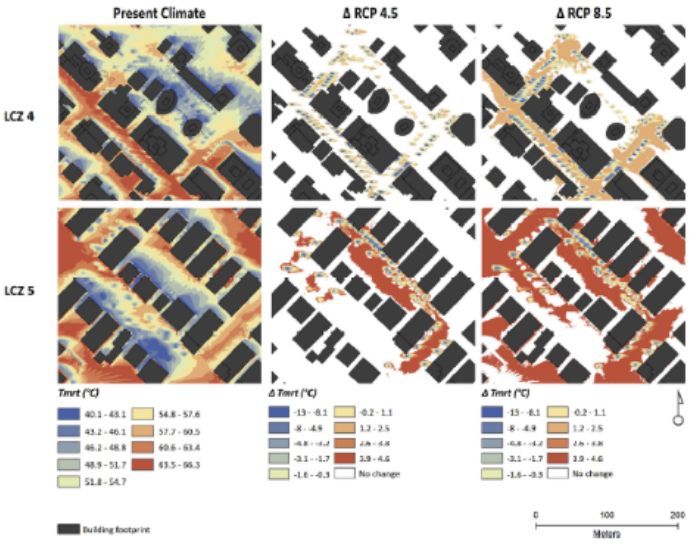
1. In these two RCP climate scenarios, what changes in temperatures will we observe for different Vancouver, B.C. neighbourhoods and local climate zones?
2. Can urban planners reduce or maintain current mean radiant temperatures, an important measure for human comfort and health, in the future by increasing the number of street trees along our city sidewalks?

PREDICTING FUTURE TEMPERATURES

The research team selected six different local climate zones that were spread across the city. These were representative of typical Vancouver neighbourhoods. Using global and local climate modelling and data sampling techniques, the team compared temperatures predicted by the models to current observed temperatures in these climate zones.

They discovered that both future climate scenarios saw an increase in mean radiant temperature as well as monthly maximum and minimum air surface temperatures across all climate zones. However, these increases were not at the same intensity for each scenario or even by local climate zone. In the RCP 8.5 scenario, there were more days with extreme heat – the kind that could harm human health. In both scenarios, city neighbourhoods that were compact high-rises, or LCZ 1, had larger changes in temperatures observed.

MAPPING IF TREES REDUCE THE HEAT



Aminipouri, Mehdi, David Rayner, Fredrik Lindberg, Sofia Thorsson, Anders Jensen Knudby, Kirsten Zickfeld, Ariane Middel, and E. Scott Krayenhoff, Urban tree planting to maintain outdoor thermal comfort under climate change: The case of Vancouver's local climate zones (Building and Environment, 2019) 233, fig. 6.

For each of the climate zones, scientists added street trees to their model and visualized the temperature changes that would occur on one of the hottest days of the year. For some LCZs, they could add hundreds of new trees, while in others, there was only space for dozens. They found that tree cover and added street trees helped maintain or reduce the predicted extreme heat under the RCP 4.5 scenario for all local climate zones. However, trees were unable to solve the temperature problems under the RCP 8.5 scenario as local temperatures still increased.

PLANTING OUR WAY FORWARD

These types of studies provide new, local knowledge for city planners and decision-makers. Dr. Aminipouri and his team shared that there are lots of ways to protect our cities from global temperature increases. Reducing the radiant heat with street trees can help cool things down, but other greenery like green roofs or city parks help too! By cooling our cities with plants, we can save lives from heat-related illnesses, help fight climate change, and improve our communities.

1. Zeke Hausfather and Daniel Raimi, "Which Climate Path Are We On?, with Zeke Hausfather," February 25, 2020, in ***Resources Radio***, produced by Elizabeth Wason, podcast, MP3 audio, 12:18, https://www.resources.org/resources-radio/which-climate-path-are-we-zeke-hausfather
2. City of Vancouver's Sustainability Group, ***Climate Change Adaptation Strategy, 2018 Update and Action Plan***. Vancouver, British Columbia: City of Vancouver, October 2019. Accessed October 13, 2022, https://vancouver.ca/files/cov/climate-change-adaptation-strategy.pdf

Time for GENACTION!

Try This at Home:
NEIGHBOURHOOD TEMPERATURE INVESTIGATION

We can investigate where the temperature might be too hot or just right in our neighbourhoods! First, you need to have a thermometer to measure the temperatures around you. If you do not have one, you can buy one at the store or build your own! Next, print out a map of your street, just a block or two, from the internet. Finally, identify if your neighbourhood matches one of the local climate zones in the table above.

Once you have your thermometer, your neighbourhood map, and have identified your climate zone, walk along your block and record the temperatures you observe. Where are they higher? Where are they cooler? What is around you? Your temperature readings will change depending on the weather, the time of day, the time of year, if there is shade, and if there are different amounts of buildings, infrastructure, or trees around you. Try making a temperature map on another day and see what changes. If you find a consistently hot spot, you can see if it is possible to plant a tree there.

See full details for this activity and others at scienceworld.ca/resource/neighbourhood-temperature-investigation and scienceworld.ca/resources.

Climate Action:
URBAN TREES

Many of our cities and communities will be exposed to hotter and hotter temperatures due to climate change. Reducing global and local temperatures is as easy as planting a tree! Dr. Aminipouri reminded us that if we plant one tree at a time and reduce the extreme heat by one degree, we can save lives and improve human environmental well-being. If you have a front yard, see if you can plant a tree that will provide shade on the sidewalk in front of your house. Use the My Tree app or work with your neighbourhood garden centre or arborist to choose the right tree for where you will plant it. Want to plant trees with others? Join a community tree planting event during National Forest Week or for Arbour Day.

To make sure our cities are cooler for everyone, identify areas where there is a lack of trees. Write a letter to your MP advocating for planting more street trees in areas and communities of need. Talk to your friends and family about how trees can reduce heat in our cities and how we need to provide equitable access to trees and heat protection for all.

MEET OUR LOCAL SCIENCE HERO:

Dr. Mehdi Aminipouri is an urban climatologist.

How did your interest in urban trees and climate change come about?

"My home country is one of the hottest places on Earth and trees in urban areas are not common. We know that extreme heat is intensified by climate change. These factors can harm human health and well-being, so I got interested in the role urban trees could play to alleviate these negative effects of temperature increases."

What is your favourite part of being a scientist?

"Being a scientist is fun because I get to talk and work with others! At scientific conferences, scientists come together, create new ideas, and share the results of their work. Conferences can generate a lot of new ideas for solutions and research about climate change."

What has happened since this research?

"Since this research was published, many cities in British Columbia and Canada have implemented new strategies to increase tree coverage in urban areas to reduce extreme heat as well as carbon dioxide."

If you could share one call to action with Canadian youth, what would you say?

"Help plant one tree!"

This Science Spotlight was written based on Aminipouri, Mehdi, David Rayner, Fredrik Lindberg, Sofia Thorsson, Anders Jensen Knudby, Kirsten Zickfeld, Ariane Middel, and E. Scott Krayenhoff. "Urban tree planting to maintain outdoor thermal comfort under climate change: The case of Vancouver's local climate zones." Building and Environment 158 (2019): 226-236. https://doi.org/10.1016/j.buildenv.2019.05.022

Climate Change
Past, Present, and Future

Earth is the only planet in the solar system known to support life. What makes our home so special? Earth has an atmosphere, a layer of gases between our planet and space. Some of these gases, like carbon dioxide, are called **greenhouse gases**. They are crucial parts of our atmosphere; they trap in the heat of the sun, similar to how heat is trapped in a greenhouse, or in a car on a hot day. This process, called the **greenhouse effect**, keeps Earth's temperature warm enough for living things to thrive.

The sun's rays hit our round, tilted planet unevenly. This uneven heating of Earth's surface leads to differences in temperature, which drives weather patterns. We call the patterns in temperature and weather over long periods of time **climate**. Different parts of the world have vastly different climates; it depends on how much heat they receive, as well as what landscape features are nearby. Water, mountains, ocean currents, and forests all impact our climate. In turn, living things around the world have adapted to the climate they live in.

Something, though, is changing. Over the past two hundred years, humans have been burning fossil fuels, such as coal and oil, to make energy to power our daily lives. Fossil fuels are made from decomposed plant matter and microscopic life millions of years old. This matter is full of carbon, and, burning it releases, or emits, billions of tonnes of **carbon dioxide** gas into the atmosphere every year. When too much carbon dioxide is emitted, the delicate balance of greenhouse gases maintaining

Earth's climate is upset. More and more heat is trapped, causing the planet to warm. Weather patterns change, water levels rise, storms get worse.

Climate has changed many times throughout Earth's history, from ice ages to periods much hotter than today. So why is this time any different? Scientists agree on two things. One, temperatures are rising faster than they ever have in documented climate history. Two, this climate change is driven by human activities, due primarily to greenhouse gas emissions.
Climate change is already impacting people's ways of life all over the world. Powerful storms, droughts, forest fires, and floods are threatening people's access to food, water, and safe homes.

The most important step we can take to prevent serious climate change is to reduce greenhouse gas emissions. Incredibly brave and caring people around the world are finding new ways to reduce emissions and make our communities climate resilient every single day. And you can join them! These Science Spotlights are here to help us learn more about climate change and how you can take action.

Our Commitment to the Decolonization of Science

Institutions of GenAction initiative respect and affirm the inherent and Treaty Rights of all Indigenous Peoples across what we now know as Canada. We give thanks to the Indigenous Peoples who care for this land since time immemorial and pay respect to their traditions and ways of knowing. We acknowledge their many contributions to innovations in Science, Technology, Engineering, and Mathematics, past and present, and are committed to deepening engagement and collaborating with Indigenous Peoples as partners in order to advance truth and reconciliation and the decolonization of science.

Climate Change: Past, Present, and Future is based on...Delmotte, Masson, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, et al. 2021. "Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." Intergovernmental Panel on Climate Change. Cambridge University Press. In Press.