EVERGREEN

COMMUNITY
Solutions Network

CLIMATE RESILIENCE FOR MUNICIPALITIES IN CANADA

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CONTENTS

ACKNOWLEDGEMENT OF INDIGENOUS LANDS AND TREATIES ACROSS CANADA

The sacred lands and waterways upon which Evergreen operates, and the built communities and cities across the country, are the traditional territories, homelands and nunangat of the respective First Nations, Métis Nations and Inuit who are the long-time stewards of these lands. These lands are occupied lands and subject to inherent rights, covenants, treaties, and self-government agreements to peaceably share and care for the lands and resources across Turtle Island. These regions are still home to diverse Indigenous peoples, who are still fighting for their sovereign rights and tirelessly protecting their traditional territories. As uninvited guests who live and work on these lands, we have a responsibility to know the treaties that tie us together, advocate for Indigenous rights and commit to learning our responsibilities to each other.

ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

This introductory research brief is intended for leaders in communities in Canada who are interested in building strategies and processes for improved climate resilience through technological innovations. Smart tools and innovations can be leveraged by municipalities to build local climate resilience. Drawing from international and national research and initiatives, this brief presents an overview of Canadian efforts toward climate-resilience including the Sustainable Development Goals (SDGs). Using internationally recognized definitions from the Intergovernmental Panel on Climate Change (IPCC), the brief also showcases practical and local-level case studies in Canada that highlight the role of data and technology in climate resilience and concludes with a roadmap to guide the process of incorporating resilience in municipal planning in Canada.

PREFACE

Climate change is a global phenomenon affecting communities across Canada. The impacts of climate change are vast and complex from rising sea levels increasing the risk of flooding to intensifying extreme weather events that pose a risk to food production and human safety. "Emissions of greenhouse gases from human activities are responsible for approximately 1.1°C of warming since 1850-1900."[1] Temperature rises from greenhouse gases (such as carbon dioxide and methane from driving cars or using coal for heating) intensify weather events, droughts, flooding, storms and the decline of biodiversity which have rippling effects in the interconnected Earth system.

In Canada, the effects of climate change include extreme heat (contributing to drought and wildfire risks – as seen in Canada in 2023 with the worst wildfire season on record[2]), shorter snow and ice cover seasons, thinning glaciers and thawing permafrost, rising sea levels (contributing to coastal flooding), increased precipitation, warmer winters (with higher winter streamflows) and a host of other changes[3] that threaten existing structures and policies. Further, climate change can disproportionally affect vulnerable or at-risk populations exacerbating existing inequities. While climate change is a global challenge, collective action is needed at all levels to effectively address and reduce its impacts. Regions and municipalities have a role in reducing emissions to contribute to an intergovernmental approach to climate change[4] and can leverage smart data and technological innovations to create more climate-resilient communities.

The Community Solutions Network is a program led by Evergreen in partnership with Open North. Our team works with communities to build capacity and improve the lives of residents using data and connected technology approaches. We deliver advisory services, workshops, and online resources that focus on key areas such as climate resilience, data governance, inclusive public space, technology procurement, and public engagement. The Community Solutions Network is supported by funding from the Government of Canada.

1 "Climate Change Widespread, Rapid, and Intensifying – IPCC — IPCC." 2021. IPCC. August 9, 2021. *https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/*

2 Tasker, John Paul. 2023. "Canada Reports Worst Wildfire Season on Record — and There's More to Come This Fall." CBC, August 11, 2023. *https://www.cbc.ca/news/politics/canada-wildfire-season-worst-ever-more-to-come-1.6934284#:~:text=Canadian%20wildfire%20officials%20said%20Friday,the%20late%20summer%20and%20fall*.

3 "Canada's Changing Climate Report." 2019. Government of Canada. *https://changingclimate.ca/site/assets/uploads/sites/2/2020/06/CCCR_FULLREPORT-EN-FINAL.pdf*.

4 "The Municipal Role in Climate Policy." 2021. Institute on Municipal Finance and Governance. *https://imfg.munkschool.utoronto.ca/wp-content/uploads/2022/08/imfgwdw_no3_climatepolicy_august_25_2022.pdf*.

BUILDING STRATEGIES AND PROCESSES FOR IMPROVED CLIMATE RESILIENCE

Drawing from international and national research and initiatives, this brief presents an overview of international and Canadian climate-related targets including the Paris Agreement, Sustainable Development Goals (SDGs), net-zero emission targets and conservation and biodiversity targets.

UNDERSTANDING CLIMATE RESILIENCE

Climate resilience

Climate change is one of today's most critical challenges and affects the natural environment, food, safety, health and other concerns. While climate change is a global phenomenon, Canada's climate has warmed at more than double the global rate[5] and communities across Canada are taking local action to address the impacts of climate change in their regions.[6]

From mitigation to adaptation to resilience, discussions of climate change come with a myriad of intertwining terminology, which can be confusing and overwhelming. Solutions to climate change can range from simple to complex and interdisciplinary, involving strategies and actions to reduce exposure and vulnerability to the effects of climate change, as well as reduce greenhouse gas emissions. In this context, the following definitions from the United Nation's Intergovernmental Panel on Climate Change apply:

Climate mitigation is "the human intervention to reduce the sources or enhance the sinks of greenhouse gases"[7] and describes actions to reduce or prevent the effects of climate change. An example of climate mitigation is retrofitting existing infrastructure with solar panels to help reduce carbon emissions.

Climate adaptation is "the process of adjustment to actual or expected climate and its effects [...] to moderate or avoid harm"[8] and describes the changes that can be made to thrive in a changing climate. An example of climate adaptation efforts includes investing in nature-based solutions to better manage and prepare for risks from natural hazards.

Climate resilience is "the capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, and learning and transformation."[9] An example of climate resilience is integrating climate risk assessments or vulnerability assessments to identify the likelihood of climate hazards and assess their impact on cities and communities.

Climate resilience integrates adaptation measures with mitigation to advance sustainable development. "Building climate resilience involves all actors (governments, communities and businesses) having the capacity to anticipate climate risks and hazards, absorb shocks and stresses, and reshape and transform development pathways

5 "Canada's Changing Climate Report." 2019. Government of Canada. *https://changingclimate.ca/site/assets/uploads/sites/2/2020/06/CCCR_FULLREPORT-EN-FINAL.pdf*.

6 Government of Canada. 2023. "Canada's National Adaptation Strategy." 2023. *https://publications.gc.ca/collections/collection_2023/eccc/en4/En4-544-2023-eng.pdf*.

7 Intergovernmental Panel on Climate Change. 2022. "Annex II - Glossary - Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." *https://archive.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-AnnexII_FINAL.pdf*.

8 Ibid.

9 Ibid.

in the longer term."[10] Effective climate resilience includes efforts by governments at all levels, Indigenous communities, civil society including youths, businesses and other groups to act in partnership toward shared goals. Climate resilience is an integrated approach that encompasses high-tech, low-tech and Indigenous knowledge solutions to successfully and sustainably address the impacts of climate change.

CLIMATE RESILIENCE AND TECHNOLOGY

Data and technology are integral to building climate resilience in Canadian communities.[11] Electronic and digital sensors can be used to measure levels (for air, water and soil) and collect data to identify climate hazards and risks. This data collection and distribution through the Internet of Things (IoT) and other information and communication technologies can then be used on a regional scale to support regional collaboration and information sharing. Data collection technologies can help automate the collection of information to support climate resilience targets such as the Sustainable Development Goals.[12]

Artificial Intelligence (AI) and machine learning can help collect and interpret datasets to detect early warnings for extreme weather or model climate feedback loops.[13] Likewise, digital modelling and digital twins can help plan and analyze climate data and scenarios to inform planning for climate risks and hazards. Further, digital technology can support public education and engagement through visual interpretations of climate data (such as through *Climate Data for a Resilient Canada* and *Climate Atlas*).

10 "Climate Action Pathway: Climate Resilience - Executive Summary." 2020. United Nations Framework Convention on Climate Change. *https://unfccc.int/sites/default/files/resource/ExecSumm_Resilience_0.pdf*.

11 Argyroudis, Sotirios A., Stergios Aristoteles Mitoulis, Eleni Chatzi, Jack W. Baker, Ioannis Brilakis, Konstantinos Gkoumas, Michael Ioannis Vousdoukas, et al. 2022. "Digital Technologies Can Enhance Climate Resilience of Critical Infrastructure." Climate Risk Management 35. *http://dx.doi.org/10.1016/j.crm.2021.100387*.

12 Canada Beyond 150. n.d. "Sustainable Development Goals: Final Report." *http://canadabeyond150.ca/assets/reports/SDG%20-%20EN.pdf*.

13 "Fighting Climate Change with the AI for the Planet Alliance." 2023. UNESCO, April. *https://www.unesco.org/en/articles/fighting-climate-change-ai-planet-alliance*.

Canada's National Adaptation Strategy looks at five interconnected systems, which are to "reduce the risks of climate-related disasters, improve health outcomes, protect nature and biodiversity, build and maintain resilient infrastructure, and support a strong economy and workers."

CLIMATE RESILIENCE AND CANADA

National Adaptation Strategy

"Canada's first National Adaptation Strategy is a shared vision of what we want our future to look like."[14] It boosts a framework towards a more climate-resilient Canada and achieving net-zero emissions. The Strategy looks at five interconnected systems, which are to "reduce the risks of climate-related disasters, improve health outcomes, protect nature and biodiversity, build and maintain resilient infrastructure, and support a strong economy and workers."[15] It includes a shared path on what the future should look like and outlines a set of guiding principles, long-term goals and a monitoring and evaluation framework to implement adaptation measures.[16] The goals outlined in the Strategy include ensuring all communities and people are "better prepared to prevent, mitigate, respond to and recover from the hazards, risks and consequences of disasters" from climate change, safeguarding the health of all people supported by a climate-resilient and adaptive health sector, halting and reversing biodiversity loss, improving climate-resilient infrastructure systems and supporting an economy that better anticipates, manages, adapts and responds to climate change impacts.[17]

To support these goals, the Strategy includes a number of specific targets such as the creation of 15 new national urban parks by 2030 to preserve nature and advance Indigenous reconciliation.[18] A wholistic participatory approach is needed to reach the goals of the Strategy, and a variety of federal, intergovernmental and Indigenous-led action plans will be put into place to efficiently coordinate and advance adaptation efforts.[19]

The federal government has also been accelerating its programs and spending on climate adaptation. For example, the *Disaster Mitigation and Adaptation Fund* to support public infrastructure projects to help communities better manage the climate-related risks and related disasters[20] and the *Canadian Centre for Climate Services* that provides locally relevant data, information and tools which supports *Climate Data for a Resilient Canada*, a collaborative climate information portal for Canadians to access and analyze climate data.[21]

Sustainable Development Goals

In 2015, all Member States of the United Nations (*including Canada*) adopted the *2030 Agenda for Sustainable Development*,

14 "Canada's National Adaptation Strategy: Building Resilient Communities and a Strong Economy." *https://www.canada.ca/en/services/environment/weather/climate-change/climate-plan/national-adaptation-strategy.html*.

15 "Plan, Prepare, Act: Government of Canada Launches First National Adaptation Strategy." Canada.Ca, July 18, 2023. *https://www.canada.ca/en/environment-climate-change/news/2023/06/plan-prepare-act-government-of-canada-launches-first-national-adaptation-strategy.html*.

16 Government of Canada. 2023. "Canada's National Adaptation Strategy." 2023. *https://publications.gc.ca/collections/collection_2023/eccc/en4/En4-544-2023-eng.pdf*.

17 Ibid.

18 Ibid.

19 Ibid.

20 Infrastructure Canada. 2023. "Infrastructure Canada - Disaster Mitigation and Adaptation Fund: Program Details." July 20, 2023. *https://www.infrastructure.gc.ca/dmaf-faac/details-eng.html*.

21 Environment and Climate Change Canada. 2021. "About the Canadian Centre for Climate Services." Canada.Ca. December 17, 2021. *https://www.canada.ca/en/environment-climate-change/services/climate-change/canadian-centre-climate-services/display-download/climate-data.html*.

a 15-year plan of action for people, planet and prosperity around the world.[22] The plan revolves around a set of *17 Sustainable Development Goals (SDGs)* which acknowledge that poverty, climate change and other social and economic challenges affect one another, and therefore must go hand-in-hand with strategies that improve education, health, economic growth and also help conserve the planet's terrestrial and marine ecosystems.[23]

All of the SDGs contribute to a more climate-resilient world and many can be supported through leveraging digital technologies. For example, smart cities can support SDG 11 on sustainability cities and communities; digital technologies and infrastructure can help increase resource efficiency to support SDG 12 on responsible consumption and production; and digital technologies and data play a critical role in SDG 13 on taking climate action.[24] To address Goal 13 on climate action, the Government of Canada is supporting the reduction of greenhouse gas emissions through capping emissions from the oil and gas sector and a requirement that they "decline at the pace and scale needed to get to net zero by 2050."[25] Many provinces and cities throughout Canada have made net-zero-by-2050 commitments or plan to implement net-zero-by-2050 legislation.[26] Engagement, involvement and support across all societies are needed, including provinces and territories, cities, Indigenous peoples, youth and businesses.[27]

22 "Transforming Our World: The 2030 Agenda for Sustainable Development." n.d. United Nations Sustainable Development Goals. *https://sdgs.un.org/2030agenda*.

23 "The 17 Goals." n.d. United Nations Sustainable Development Goals. *https://sdgs.un.org/goals*.

24 Sachs, Jeffrey D., Guido Schmidt-Traub, Mariana Mazzucato, Drik Messner, Nabojsa Nakicenovic, and Jonah Rockström. 2019. "Six Transformations to Achieve the Sustainable Development Goals (SDGs)." Sustainable Development Solutions Network, August. *https://irp-cdn.multiscreensite.com/be6d1d56/files/uploaded/190830-Six-Transformations_working-paper.pdf*.

25 "Sustainable Development Goal 13: Climate Action." January 4, 2023. *https://www.canada.ca/en/employment-social-development/programs/agenda-2030/climate-action.html*.

26 Ibid.

27 "Net-Zero Emissions by 2050." Canada.Ca. July 11, 2023. *https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/net-zero-emissions-2050.html*.

The Government of Canada is working to develop concrete measures and actions for the 17 Sustainable Development Goals through the *2030 Agenda National Strategy* which embeds Indigenous knowledge and leadership in its success.[28] Canada's *Pan-Canadian Framework on Clean Growth and Climate Change*, which was developed to create a pan-Canadian approach to building resilience to climate change, encourages the use of technology to support climate resilience efforts.[29] Likewise, Canada's 2030 Agenda National Strategy highlights the role of technological innovations in indicators to meet the SDGs and the need for technology in achieving all the SDGs.[30]

Incorporating environmental goals and targets is important in accomplishing both short-term and long-term environmental achievements. However, climate resilience is an ongoing process and climate action must continue even after these targets are reached. Even though the effects of human-induced climate change on Earth are not reversible, the prevention of future temperature increases will lead to less global warming.[31] Climate change is an enduring challenge and continual climate action efforts are necessary to sustain the planet we live on for future generations to come.

28 Government of Canada. 2023. "Canada's National Adaptation Strategy." 2023. *https://publications.gc.ca/collections/collection_2023/eccc/en4/En4-544-2023-eng.pdf*.

29 Government of Canada. 2016. "Pan-Canadian Framework on Clean Growth and Climate Change." 2016. *https://publications.gc.ca/collections/collection_2017/eccc/En4-294-2016-eng.pdf*.

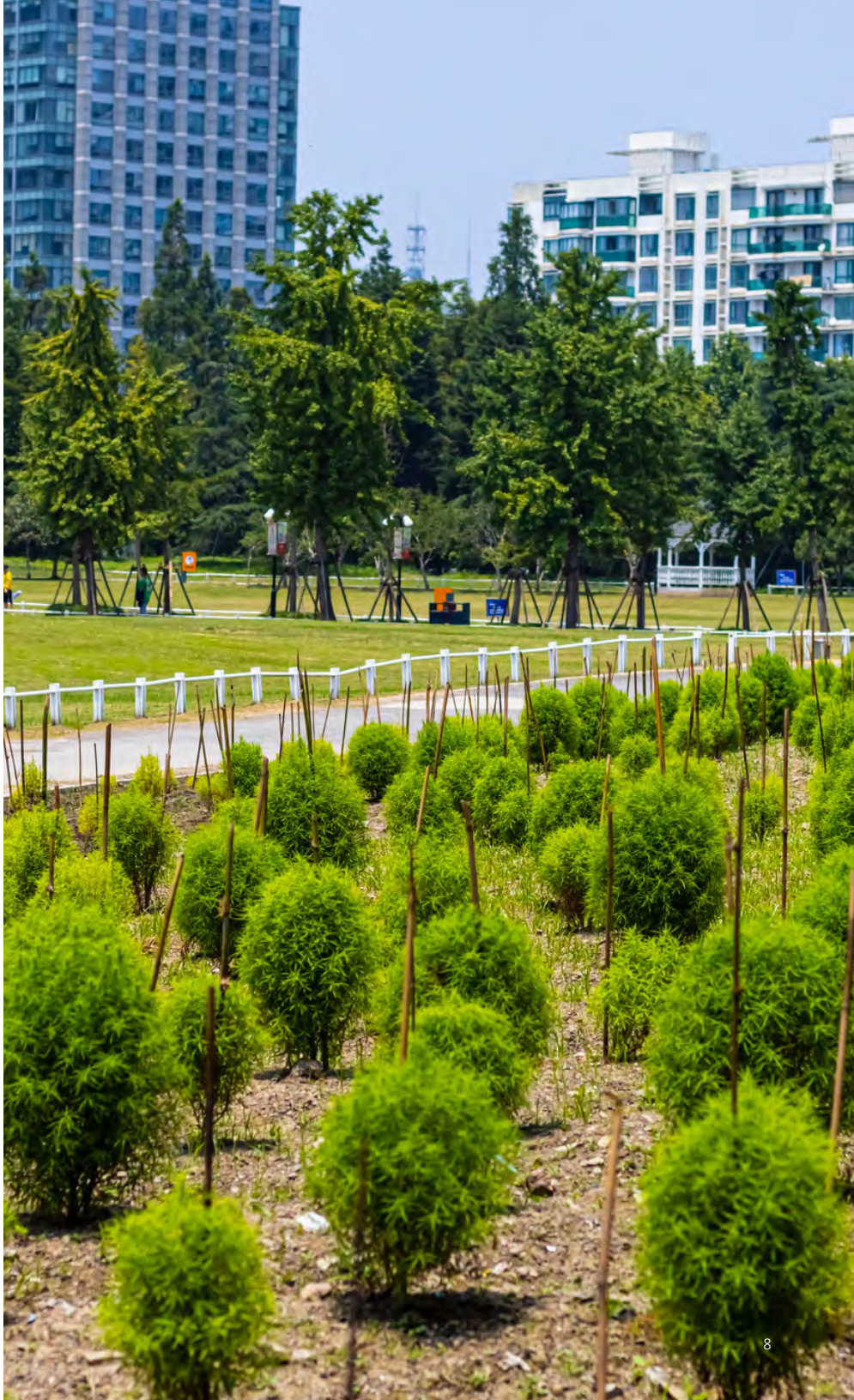
30 "Canada's 2030 Agenda National Strategy." 2019. Government of Canada. 2019. *https://www.canada.ca/content/dam/esdc-edsc/documents/programs/agenda-2030/7781_EmploymentSocialDevelopment_2030-ENv5.pdf*.

31 The National Aeronautics and Space Administration. n.d. "Is It Too Late to Prevent Climate Change?" Global Climate Change: Vital Signs of the Planet. *https://climate.nasa.gov/faq/16/is-it-too-late-to-prevent-climate-change/*.

CLIMATE RESILIENCE IN-ACTION

Local municipalities and regions across Canada are implementing climate adaptation projects[32] to prepare for a more resilient future. Municipal-level climate resilience can be a mix of simple and complex efforts based on the willingness and capacity of the municipality and its local climate risks. There are many common municipal services (like tree planting programs or composting programs) that already promote sustainability and climate resiliency within efforts toward beautification, tourism, waste management or other priorities. While climate resiliency should be embedded amongst all programs, climate-specific programs can directly meet climate-related targets and goals with more impactful outcomes.

This research brief presents two case studies that showcase climate resilience efforts in Canada that directly work to improve infrastructure and systems to withstand, learn and adapt to the impacts of climate change. The projects are ongoing resilience efforts that leverage data and technological innovations to support the climate resiliency of homes and buildings to cope with flood management risks and safeguard the community while supporting the Sustainable Development Goals. The case studies demonstrate locally led and implemented initiatives that successfully prepare a region for the impacts of climate change.



32 Government of Canada. 2023. "Canada's National Adaptation Strategy." 2023. *https://publications.gc.ca/collections/collection_2023/eccc/en4/En4-544-2023-eng.pdf*.

CASE STUDIES

CASE STUDY 1: CLIMATE RESILIENT HOME TOOL

- **Location:** Edmonton Metropolitan Region
- **Number of persons effected:** 1.4 million people
- **Case Study Related Climate Impact:** Wildfire, Flooding, Extreme Weather & Changing Environment
- **Funding Source:** Federation of Canadian Municipalities, Municipal Governments, Federal Government
- **Key Partners:** Federation of Canadian Municipalities, Municipal Governments, All One Sky Foundation
- **Phase of Completion:** Completed & Implemented
- **Website:** *https://www.climateresilienthome.ca/*

The Climate Resilient Home (CRH) is an online tool created by a group of municipalities in the Greater Edmonton Area (Edmonton Metropolitan Region) and funded by the Federation of Canadian Municipalities (FCM). The tool is a virtual and visual guide for homeowners, builders, municipal staff and elected officials to improve the climate resiliency of homes, specifically targeting single detached houses in urban and rural settings.[33] However, many of the insights provided by the tool both on the exterior and interior on how to make homes more resilient can be used in nearly all types of homes whether detached or otherwise, specifically the retrofits and changes one can make to their homes.

A climate-resilient home is one that is better able to cope with climate change related events such as storms, floods, heatwaves, wildfires and extreme cold, and saves homeowners money, reduces future climate related damages and provides homeowners with the information to stay comfortable in their home during heat waves, safer during extreme weather and better prepared for a changing environment. The tool allows a homeowner to input some basic information about their home, such as general area (urban vs rural), new construction or existing home and what climate impacts they would like to understand how their home can be resilient to (Wildfire, Extreme Weather, Flooding, Changing Environment). This exercise then provides the user with a list (and printable report) of changes and retrofit options, both externally and internally, that could be taken to make their home more resilient to the identified climate impacts while saving the user money on both energy costs and future climate impact related costs, like basement flooding. The report lets users know the relative initial cost of the retrofit (based on an icon scale) and the amount of work required to make the change.

The CRH tool's smart technology delivers outreach and education on climate resiliency for homeowners, policymakers and developers who are preparing for a changing world, save money in the near and long term and learn more about what they can do to take control of their homes in a changing environment.

This virtual home tool helps users plan a new home or retrofit an existing structure by showcasing the climate resiliency of different home features that can protect against flooding, wildfire, extreme weather and increasing temperatures. The online tool also estimates the effort and expense of installing these resilient features, making it useful to both homeowners and developers. The virtual Climate Resilient Home demonstrates design features which address key climate change impacts facing the Edmonton Metropolitan Region. It serves as both an education and outreach tool for users and an important climate resilience tool for municipal staff, elected officials and developers.[34]

33 "Climate Resiliency Home Edmonton." 2022. Climate Resiliency Home Edmonton. December 22, 2022. *https://www.climateresilienthome.ca/*.

34 City of Edmonton. 2022. "Climate Resilient Home Guide." *https://www.edmonton.ca/sites/default/files/public-files/ClimateResilientHomeGuide-web.pdf*.

From a home desktop, a work computer, tablet or smart phone the CRH tool gives infrastructure, landscape design, technology and more information and reporting to everyday homeowners in a consolidated, easy to navigate and smart tool - saving users time from researching, phone calls and searching for information that otherwise is not concisely connected and displayed. In addition, these resources provided on the CRH tool website are chosen specifically for the Edmonton Metropolitan Region so that the recommendations are based on the unique local circumstances of the user.

The program works with 8 municipalities, funded by FCM under the Municipalities for Climate Innovation Program's Climate Adaptation Partner Grants[35] and was successfully developed and implemented by the *All One Sky Foundation*. This program and virtual tool are currently active and have been successfully launched. Based on the nature of the climate resilience and adaptation program, no ongoing additions or changes would be required to the tool unless the program or tool scope expanded.

35 Federation of Canadian Municipalities. n.d. "Tool and Case Study: Climate Resilient Home Adaptation Tool." *https://fcm.ca/en/case-study/mcip/tool-and-case-study-climate-resilient-home-adaptation-tool*.

CASE STUDY 2: RESILIENCE TO RIVERINE FLOODING

- **Location:** Grand Forks, BC
- **Number of persons effected:** 4,000 people
- **Case Study Related Climate Impact:** Flooding, Extreme Weather & Changing Environment
- **Funding Source:** Government of Canada, Government of British Columbia, Municipal Government
- **Key Partners:** Government of Canada, Government of British Columbia
- **Phase of Completion:** Ongoing
- **Website:** *https://www.grandforks.ca/fmp/*

The City of Grand Forks' Flood Mitigation Project is the result of ongoing climate impacts of severe flooding, rain flows, extreme heat and drought which prompted back-to-back flooding events in 2017 and 2018, with the latter flood costing more than 48 million dollars in damage to the City and surrounding rural area. The results of these events led the City to create a Flood Mitigation Program, which included working with a wide array of stakeholders including, but not limited to, representatives from all levels of the Canadian government, Grand Forks residents, First Nations members and City Council.

The program started by conducting an engineering study to provide a high-level overview of regional flood risks and impacts and disaster mitigation (adaptation) options for the municipality's rural and urban neighbourhoods.[36] Hydrological data modeling was used to inform the flood mitigation and community dyke plan. "Four options were evaluated: (1) update floodplain bylaws and raise buildings, (2) enhance minimal flood and erosion protection, (3) develop flood protection infrastructure and (4) initiate home buyout and restoration of the functional floodplain."[37]

Building resilience into physical infrastructure, natural asset protection, ecosystem services, and municipal bylaws and policies is key to ensuring a strong climate-resilient community. The use of the hydrological data modeling allowed the City staff and engineers to understand the future cost flooding events of different magnitudes would have on the region, with estimations from the Grand Forks Engineering Study showing 100-150 million in future damages without flood resilience built into the city.[38] Based on the outcome of the studies and modeling with action plans, the City of Grand Forks partnered with the Osoyoos Indian Band to provide housing through the relocation of houses currently located within the floodplain restoration area. Up to 10 houses will be moved and another 10 modular houses constructed in three potential areas of Grand Forks (outside of the flood restoration zone), providing much-needed housing for Grand Forks residents. The Osoyoos Indian Band has agreed to lead the house moving and land development for the three potential building sites.[39]

The project is currently being implemented but under a number of different sub-projects (work packages) such as flood mitigation and adaptation construction projects, revolving around flood plains mitigation, earth berms, pumping stations, erosion control, priority

36 City of Grand Forks. 2020. "Flood Mitigation Program: Summer 2021 Update." *http://www.grandforks.ca/wp-content/uploads/210817DMAF_8PageSimple-1.pdf*.

37 "Using Climate Information to Drive Adaptation: Resilience to Riverine Flooding." n.d. Canada in a Changing Climate: Advancing Our Knowledge for Action. *https://changingclimate.ca/case-study/using-climate-information-to-drive-adaptation-resilience-to-riverine-flooding/*.

38 Federation of Canadian Municipalities. 2021. "Grand Forks, British Columbia: Resilience to Riverine Flooding." *https://changingclimate.ca/site/assets/uploads/2021/11/Grand-Forks-BC-case-study-Oct-22-2021-EN.pdf*.

39 "Media Release: Partnership with Osoyoos Indian Band." Press release. November 10, 2021. *https://www.grandforks.ca/wp-content/uploads/2021-11-10-MediaRelease-CityOfGrandForksOIBPartnership.pdf.*

road raising and riverside riprap to protect the residents of the region from climate impacted related flooding. Quarterly updates are provided by the Grand Forks region[40] which includes, updated timelines, new-changing or updated flood adaptation planning projects and a budget to-date which stands at 46 million dollars of implementation actions which includes a total of around 51 million dollars from provincial and federal[41] funding sources (Climate adaptation and disaster funding).[42] Implementation of physical infrastructure and construction is expected to be completed by late 2023 and continue to update and materialize climate resilience policies to protect and adapt to a changing climate.

Other flood adaptation and resilience initiatives in Grand Forks are the reinforcement of 1300 metres of riverbank, creating a more secure floodplain and the relocation of the most vulnerable neighbourhoods to flood risks away from the floodplain and repurposing the land. The acquisition of 73 single-family dwellings, 20 vacant properties and a mobile-home park to enable floodplain restoration and flood mitigation structures in one high risk location of Grand Forks was one of the first steps in protecting the most vulnerable.[43] With properties vacated and physical barriers in place, a re-connected and transformed stormwater management system was implemented to pump excess flood water trapped behind infrastructure out of the community. Grand Forks is prepared to remain resilient against flooding events to come.

The success of the Flood Mitigation Project will work to protect over 800 residents, their homes and the community from future flooding and other extreme weather events. In addition, it will improve the resiliency of the community from increased flooding, drought, heat

and snowmelt events by expecting to reduce the number of residents who go without essential city services (communication, power, health, and emergency services) during flooding by 45%, by raising priority roads, pumping flood waters out of the City and protecting residents from riverine flooding. These resilience projects through the use of modeling techniques will provide long-term savings and offset recovery and replacement costs associated with wide-scale flooding events due to extreme weather and climate change.[44]

40 "Flood Mitigation Program - Documents." August 22, 2023. *https://www.grandforks.ca/fmp/*.

41 Federation of Canadian Municipalities. 2021. "Grand Forks, British Columbia: Resilience to Riverine Flooding." *https://changingclimate.ca/site/assets/uploads/2021/11/Grand-Forks-BC-case-study-Oct-22-2021-EN.pdf*.

42 Ibid.

43 Ibid.

44 "Canada and BC Work in Partnership to Help Protect Residents and Businesses of Grand Forks from Disastrous Impacts of Flooding." 2019. BC Gov News. June 26, 2019. *https://news.gov.bc.ca/stories/canada-and-bc-work-in-partnership-to-help-protect-residents-and-businesses-of-grand-forks-from-disas*.

SMART CLIMATE RESILIENCE PLANNING

Climate change is a threat multiplier

Climate change is an environmental and social crisis that intersects between every sector and region. Climate change disproportionately affects vulnerable or at-risk populations based partly on their geographical location, financial or socio-economic status, access to resources and services and other barriers to influencing decision-making processes.[45] It's important for decision-makers to be inclusive and proactive to vulnerable and at-risk populations who are already experiencing crises that can be further exacerbated by the impacts of climate change and measures to address climate change.

The effects of climate change have a direct impact on the environment and on humans but also aggravate other issues such as the food crisis, the housing crisis, immigration and other risks.[46] Climate change is a threat multiplier[47] that exacerbates existing risks which adds to the complexity of the issues. Because of the overlapping and vast impacts of climate change, solutions to address the effects or reduce the impacts should be interdisciplinary and protect the rights of the most vulnerable.

Plan to be resilient

Climate change impacts all areas of life requiring an interdisciplinary and intersectional approach to adapt and be resilient to its effects. Resilience isn't only applicable to infrastructure and planning projects but should be considered in all types of projects from climate action to social programming to future-proofing communities. Embedding climate resilience within the decision-making and planning processes of all projects and programming (also known as mainstreaming resilience[48]) ensures its durability and longevity from climate-related risks. A single municipal project can address multiple gaps or issues (as showcased in the case studies above) such as implementing multi-use pathways which encourages and provides safer active transportation routes, more inclusive routes for individuals with mobility challenges and supports outdoor physical activity to improve public health while also supporting the reduction of greenhouse gas emissions from reduced vehicle use (see the *Bowen Island Transportation Plan* in British Columbia for an example). Considering how the environment impacts a project and how a project impacts the environment highlights the integral role of nature in everyday life.

Good resilience planning accounts for all climate events – direct effects like extreme weather but also chronic events like population migration and air quality. Further, when creating climate resilient projects, vulnerable and at-risk communities should be meaningfully included throughout the process of planning, implementing and maintenance of the project.

Smart innovations can help to better understand and monitor regional climate risks to inform municipal decisions. Electronic sensors (for example, electronic water level controllers that use sensors with LED lights to signal high or low water levels for flood management) and drones (such as those used during wildfire management to map the fire perimeter) can monitor the status of climate risk factors or collect data and information to plan for climate events. Satellite and aerial imaging and sensing,

45 Newell, Peter. 2023. "Towards Transformative Climate Justice: An Emerging Research Agenda." Figshare. June 10, 2023. *https://sussex.figshare.com/articles/journal_contribution/Towards_transformative_climate_justice_an_emerging_research_agenda/23482907*.

46 Werrell, Caitlin E., and Francesco Femia. 2015. "Climate Change as Threat Multiplier: Understanding the Broader Nature of the Risk." *https://climateandsecurity.org/wp-content/uploads/2012/04/climate-change-as-threat-multiplier_understanding-the-broader-nature-of-the-risk_briefer-252.pdf*.

47 "Climate change recognized as 'threat multiplier', UN Security Council debates its impact on peace." n.d. United Nations News. *https://www.un.org/peacebuilding/news/climate-change-recognized-%E2%80%98threat-multiplier%E2%80%99-un-security-council-debates-its-impact-peace*.

48 Henstra, Daniel. n.d. "A Whole-of-Government Approach to Climate Adaptation." Canadian Climate Institute. *https://climateinstitute.ca/wp-content/uploads/2022/07/A-whole-of-government-approach-to-climate-adaptation.pdf*.

Geographic Information System (GIS) mapping or visualization tools are more comprehensive tools that provide visual, digital maps for better planning and an improved understanding of the local landscape. In addition to planning tools, smart innovations can support warning systems for public alerts and emergency response in the event of a climate emergency such as a wildfire or air quality concerns. Furthermore, smart innovations can also be deployed for easy-to-understand informational tools for engaging with and educating the community about climate change and its local risks.

Resilience planning

Resilience planning can include incorporating climate change and its impacts into existing regional or community master plans, prioritizing climate resilience in all municipal projects and programs or more comprehensive planning such as implementing a vulnerability assessment to inform zoning changes. Regardless of the strategy, planning for climate resilience is essential for robust systems that mitigate and protect against the long-term impacts of climate change. The *Technology-Based Solutions for Resilience: A Practitioner's Toolkit* includes a climate resilience planning canvas with more comprehensive step-by-step guides and tools to help navigate the sometimes complex planning processes. Municipal planning, like climate change, intersects with a myriad of sectors and priorities which can be challenging to effectively manage. This brief highlights a roadmap to guide the process of incorporating resilience in municipal planning.

Assess existing capacities and information systems

- Understanding the capacity of the institution or organization, human resources and other assets helps frame the planning process to draw on the strengths of what exists and helps identify gaps that need to be filled. Capacity assessments can include a review of strategic plans and goals, organizational structure and knowledge management, staffing knowledge and expertise, financial operations management, partnerships and networks

and other potential assets. Creating a list of internal and external stakeholders can also be an integral part of capacity assessments to ensure the necessary departments and community groups are utilized, informed and meaningfully engaged in the project's process. Further, a thorough understanding of the capabilities of existing information systems can inform the feasibility of data and technological options. Some systems may not have the capacity and ability to expand in the way needed for the plan adding costs and time to the project's timeline.

Identify climate hazards and risks and local vulnerabilities

- The impacts of climate change exhibit uniquely based on the local region. While some regions are more prone to flooding due to expansive shorelines or impermeable urban infrastructure, others are more vulnerable to wildfires and air quality concerns. Further, the population demographics of the region can be a determining factor in the level of risk to the population. Identifying the local vulnerabilities of the impacts of climate change provides an understanding of what actions should be taken to reduce exposure to risks and hazards as well as build capacity and reduce sensitivity to climate events. There are several free online resources with climate data available for localities to use and explore. The Government of Canada's *Canadian Centre for Climate Services* provides access to Environment and Climate Change Canada's climate data and includes a Climate Services Support Desk with climate experts to help users understand and use the climate information. *Climate Data for a Resilient Canada* is a tool to access, visualize and analyze climate data with accessible data summaries based on a city or town search. Further, regional-based climate data may also be available or feasible to collect and monitor through collaboration with neighbouring municipalities or other regional bodies and partnerships.

Engage the community

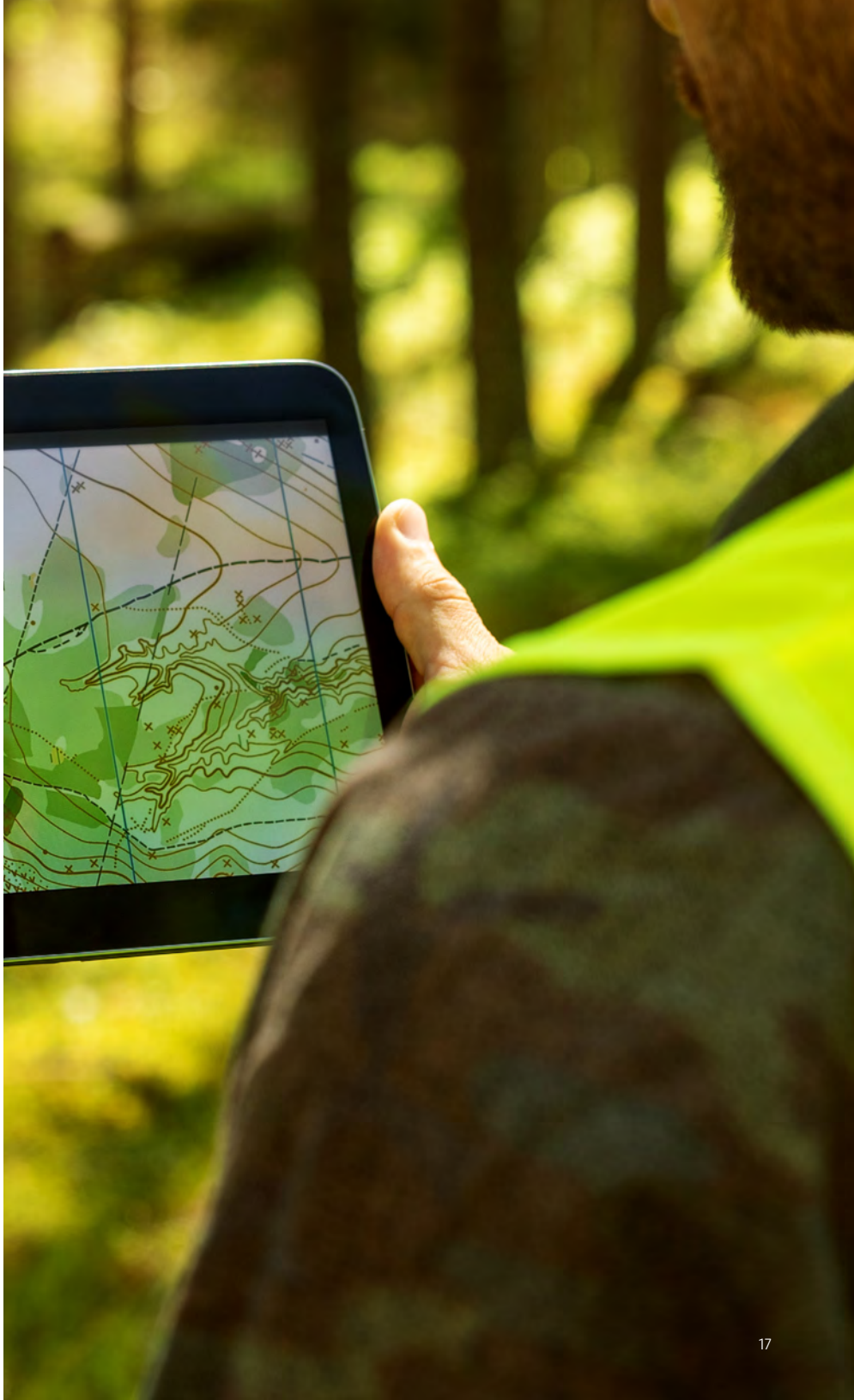
- Participatory planning with the community and all relevant parties should be an embedded process within all municipal decision-making. In addition to the municipal planning team, engagement with technical advisors and experts, organizations or individuals that may be significantly impacted by the project and all people who live, work or visit the area should be regularly informed and meaningfully consulted (with opportunities for feedback) throughout the planning and implementation process. Municipalities should prioritize engagement with Indigenous communities and vulnerable and at-risk populations most impacted by climate change to ensure the equity and success of the solutions.
- Consultation and engagement opportunities should consider the availability and needs of the community in choosing the timing and location of in-person meetings as well as the opportunity for virtual engagement through smart devices or websites. Climate literacy may be a barrier to public engagement but there are online educational tools and resources available to improve awareness and understanding of local climate risks. The *Climate Atlas of Canada* interactive tool is an easy-to-understand mapping and storytelling resource which is useful for educating communities about how climate change affects Canada.

Prioritize actions and create a plan

- Developing a well-informed strategy to address climate risks and vulnerabilities embeds resiliency in the processes and actions of a community. All strategies and plans should include regular and meaningful consultation and engagement with the same parties identified earlier to ensure a thoughtful understanding of the project and its outcomes. Climate resilience planning should describe feasible actions related to local planning and regulations and economic tools and incentives with targets, timelines and funding options.

Implement actions including monitoring and evaluation processes

- Embedding indicators and metrics for monitoring the progress of a project is important for ensuring the intended outcomes and its longevity. Smart tools and approaches can assist the collection and analysis of data such as sensors or using digital dashboards on climate data. Ongoing monitoring is also important for the maintenance of a project to ensure it continues to adapt and adjust to the changing climate and changing context of the community's needs. Data collection over time can also inform future planning and decision-making processes with up-to-date information on the status of the project and risks over time.



RESOURCES FOR SMART RESILIENT PLANNING

- *Climate Atlas* is an interactive tool to learn about climate change in Canada
- *Climate Data for a Resilient Canada* provides high-resolutions climate data for Canada
- Evergreen's *Green Energy Solutions: A Practitioner's Toolkit* provides an overview of green energy solutions and principles to guide green energy solutions in public space projects
- Evergreen's *Technology-Based Solutions for Resilience: A Practitioner's Toolkit* provides a pathway to better leverage technology to improve an understanding of local climate risks and improve planning for climate-resilient public spaces
- Federation of Canadian Municipalities' webpage on the *building blocks of municipal climate resilience* guides municipal adaptation planning
- Government of Canada's webpage on *climate-related resources for local governments*
- ICLEI's *Equitable Climate Adaptation: Considerations for Local Governments* resource with actionable ideas and tools for local governments
- ICLEI's *Introducing Indicators* guide to measure adaptation progress
- *Municipal Climate Change Action Centre's capacity building library* that focuses on energy and climate change mitigation planning for Alberta's municipalities

GLOSSARY

Artificial Intelligence (AI) is the "simulation of human intelligence in programmed machines."[49] AI can play a major role in climate adaptation, mitigation and resilience efforts by collecting and interpreting large datasets in real time, which can help detect early warnings for severe weather occurrences and implement prevention efforts earlier.[50]

Climate adaptation are measures taken with the intent of reducing the negative effects of climate change and is "the process of adjustment to actual or expected climate and its effects [...] to moderate or avoid harm"[51]

Climate mitigation is any action or response intended to reduce or prevent greenhouse gas emissions, or to enhance sinks that capture or store carbon, usually towards long term benefits and is "the human intervention to reduce the sources or enhance the sinks of greenhouse gases"[52] and describes actions to reduce or prevent the effects of climate change.

Climate resilience describes the capacity to respond to and adapt to or cope with climate change impacts and is "the capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, and learning and transformation."[53]

Greenhouse gas emissions (GHGs) are gases in the atmosphere that trap energy from the sun and cause the Earth's temperature to rise. The burning of fossil fuels has accelerated this effect, through the emission of large amounts of carbon dioxide, methane and nitrous oxide to the Earth's atmosphere.

Internet of Things (IoT) refers to "the network of physical objects, or things, which are connected to other devices and systems over the Internet."[54]

Net-zero is used to describe strategies and targets aimed at eliminating the emissions of greenhouse gases in and refers to "a state in which the greenhouse gases going into the atmosphere are balanced by removal out of the atmosphere."[55]

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49 "Smart Cities Glossary - Community Solutions Portal." 2023. Community Solutions Portal. February 3, 2023. *https://futurecitiescanada.ca/portal/resources/smart-cities-glossary/*.

50 UNESCO, April 2023. *https://www.unesco.org/en/articles/fighting-climate-change-ai-planet-alliance*.

51 Intergovernmental Panel on Climate Change. 2022. "Annex II - Glossary - Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." *https://archive.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-AnnexII_FINAL.pdf*.

52 Intergovernmental Panel on Climate Change. 2022. "Annex II - Glossary - Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." *https://archive.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-AnnexII_FINAL.pdf*.

53 Intergovernmental Panel on Climate Change. 2022. "Annex II - Glossary - Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." *https://archive.ipcc.ch/pdf/assessment-report/ar5/wg2/WGIIAR5-AnnexII_FINAL.pdf*.

54 "Smart Cities Glossary - Community Solutions Portal." 2023. Community Solutions Portal. February 3, 2023. *https://futurecitiescanada.ca/portal/resources/smart-cities-glossary/*.

55 "What Is Net Zero?" 2023. Net Zero Climate. July 12, 2023. *https://netzeroclimate.org/what-is-net-zero/*.

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