

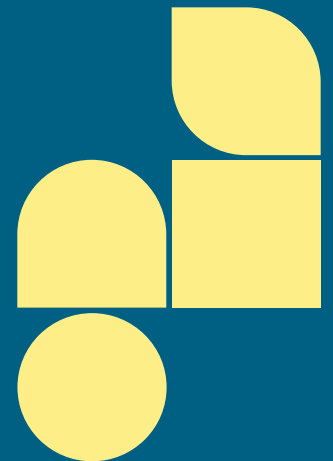


COMMUNITY  
Solutions Network

# SMART RESILIENCE FOR CANADIAN MUNICIPALITIES

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## Acknowledgement of Indigenous Lands and Treaties Across Canada

The 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 land. 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 an understanding of smart cities and its role in creating more climate-resilient communities. Using an inclusive and holistic definition of a smart city, this brief provides an overview of different smart city concepts and smart tools that can be leveraged by municipalities to improve climate resilience. The brief also showcases practical and local-level case studies in Canada that highlight the role of data and technology in climate resilience alongside tips for implementing successful smart solutions.

## Preface

Smart cities leverage data and technological innovations to improve the quality and efficiency of municipal services.<sup>1</sup> From smart transportation to smart energy, communities are deploying smart solutions to create more sustainable and vibrant places to live. Smart cities aim to create productive, sustainable and livable communities and foster a “dynamic platform that can lead to technological and social innovation.”<sup>2</sup> Promoting smart city tools (such as remote sensors, digital models and automatic lighting) can provide innovative solutions to complex and interdisciplinary challenges including community-level efforts to address climate change. While climate resilience does not always require a high-tech smart

solution (such as nature-based infrastructure<sup>3</sup> or other low-tech innovations), data and technology can be used to directly contribute to climate resilience or support climate-resilient initiatives. Regions and municipalities should use the opportunities of data and technology innovations to better promote and encourage 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.

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1 Canadian Security Intelligence Service. 2022. “Smart Cities and National Security.” Canada.Ca. February 16, 2022. <https://www.canada.ca/en/security-intelligence-service/corporate/publications/smart-cities-national-security/smart-cities-national-security.html>.

2 Kim, Hyung Min, Soheil Sabri, and Anthony Kent. 2021. “Smart Cities as a Platform for Technological and Social Innovation in Productivity, Sustainability, and Livability: A Conceptual Framework.” In Elsevier EBooks, 9–28. <https://doi.org/10.1016/b978-0-12-818886-6.00002-2>.

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3 United Nations Environment Programme. 2021. “Smart, Sustainable and Resilient Cities: The Power of Nature-Based Solutions.” 2021. <https://wedocs.unep.org/bitstream/handle/20.500.11822/36586/SSRC.pdf?sequence=1&isAllowed=y>.

# FOR LEADERS IN COMMUNITIES IN CANADA WHO ARE INTERESTED IN BUILDING AN UNDERSTANDING OF SMART CITIES

This brief provides an overview of different smart city concepts and smart tools that can be leveraged by municipalities to improve climate resilience.



## Understanding smart cities

There are many different perspectives in understanding a “smart city” and its use. Here, a smart city refers to “a resilient, inclusive and collaboratively built [community] that uses technology and data to better the quality of life for all people.”<sup>4</sup> The term “smart city” throughout this research brief refers to all communities of all sizes regardless of the city, town, village, region or other community scale.

Smart cities tend to be rooted in technology or skilled processes that have a colonial bias and are often associated with Western narratives of progress. As such, it’s important to approach smart cities and smart city planning and design through a decolonial framework.<sup>5</sup> Likewise, Indigenization or the process of meaningfully incorporating Indigenous knowledge approaches<sup>6</sup> is a vital element in how communities

engage and plan within smart cities.<sup>7</sup> When applied early in the design process of a project, decolonization approaches can enable the creation of more equitable cities for all.<sup>8</sup> The research brief, *Applying a Decolonized Approach as the Foundation to Creating Accessible Smart City Design*, explores how decolonized approaches can promote equitable, accessible processes and smart city designs for everyone.

A smart city often uses the Internet of Things (IoT) devices and other information and communication technologies (ICTs) to improve the efficiency and quality of municipal services and projects. A smart city may include technology-based infrastructure (such as smart sensors for streetlights, smart grid technology, smart transportation and other data and technological innovations) as well as data collection and analysis (such as smart sensors to collect data in real-time) for more informed decision-making processes.

4 “Smart Cities Glossary - Community Solutions Portal.” 2023. Community Solutions Portal. February 3, 2023. <https://futurecitiescanada.ca/portal/resources/smart-cities-glossary/>.

5 McPhie, Laura, Alicia Denoon, and Ismail Alimovski. 2022. “Applying a Decolonized Approach as the Foundation to Creating Accessible Smart City Design.” Community Solutions Portal. Evergreen. October 14, 2022. <https://futurecitiescanada.ca/portal/wp-content/uploads/sites/2/2022/10/eg-fcc-csn-decolonized-approach-research-brief-oct-2022.pdf>.

6 “What Is Decolonization? What Is Indigenization? | Centre for Teaching and Learning.” n.d. <https://www.queensu.ca/ctl/resources/decolonizing-and-indigenizing/what-decolonization-what-indigenization>.

7 McPhie, Laura, Alicia Denoon, and Ismail Alimovski. 2022. “Applying a Decolonized Approach as the Foundation to Creating Accessible Smart City Design.” Community Solutions Portal. Evergreen. October 14, 2022. <https://futurecitiescanada.ca/portal/wp-content/uploads/sites/2/2022/10/eg-fcc-csn-decolonized-approach-research-brief-oct-2022.pdf>.

8 Ibid.

## Smart cities and climate resilience

Smart technologies can also be leveraged to improve the climate resiliency of a community.<sup>9</sup> The emergence of new technologies can help communities develop new solutions to climate issues, as well as increase their understanding of environmental obstacles. Countries all over the world have set targets for decreasing greenhouse gas and carbon emissions,<sup>10</sup> but to achieve these targets communities have to significantly reduce their consumption of energy and natural resources. The concept of smart cities can play a role in accomplishing these environmental goals, as it can interweave technology-based solutions to improve climate change resilience and can be applied to diverse communities of all sizes.

Canada's National Adaptation Strategy looks 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."<sup>11</sup> Data and technological tools and innovations can be employed to support the strategy and its goals. For example, the *Canadian Centre for Climate Services* 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.<sup>12</sup>

9 "The UN Says Climate-Smart Cities Are the Future – These 3 Projects Show Their Potential." 2020. World Economic Forum. September 11, 2020. <https://www.weforum.org/agenda/2020/09/climate-change-resilience-urban-infrastructure/>.

10 "Countries." n.d. Climate Action Tracker. <https://climateactiontracker.org/countries/>.

11 "Plan, Prepare, Act: Government of Canada Launches First National Adaptation Strategy." Canada.Ca, June 17, 2023. <https://www.canada.ca/en/environment-climate-change/news/2023/06/plan-prepare-act-government-of-canada-launches-first-national-adaptation-strategy.html>.

12 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/about.html>.



Technological innovations are also key in meeting Canada's commitment to the *Sustainable Development Goals (SDGs)* including leveraging smart city concepts to support more sustainable cities and communities (Goal 11) and utilizing digital technologies and infrastructure to increase resource efficiency (Goal 12) and support climate action (Goal 13).<sup>13</sup> A smart city aims to improve the efficient use of resources and create a more resilient community that better meets the needs of society. SDGs such as Goal 11 and 12 rely on the improved access to infrastructure that smart cities can provide.<sup>14</sup> Likewise, Goal 13 can benefit from smart city innovations in the improved design and operation of infrastructure.<sup>15</sup>

Successful smart cities can provide data and technological solutions to sustainability and biodiversity issues. For example, the *Freshwater Ecosystems Explorer* is a data platform that provides up-to-date, detailed visualizations of the state of the world's freshwater ecosystems throughout time using geospatial maps.<sup>16</sup> The data extracted from these maps can be used by countries to inform the restoration freshwater bodies and monitor their progress towards achieving the Sustainable Development Goals.<sup>17</sup> Leveraging the role of technology can aid communities in the detection and assessment of climate

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13 Sachs, Jeffrey D., Guido Schmidt-Traub, Mariana Mazzucato, Drik Messner, Nabojša Nakicenović, 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](https://irp-cdn.multiscreensite.com/be6d1d56/files/uploaded/190830-Six-Transformations_working-paper.pdf).

14 Ibid.

15 Rosenzweig, C., W. Solecki, P. Romero-Lankao, S. Mehrotra, S. Dhakal, and S. Ali Ibrahim. 2018. "Climate Change and Cities: Second Assessment Report of the Urban Climate Change Research Network." Urban Climate Change Research Network. Cambridge University Press. <https://uccrn.ei.columbia.edu/arc3.2>.

16 "Freshwater Ecosystems Explore." n.d. United Nations Environment Programme. <https://www.sdg661.app/>.

17 "Freshwater Ecosystems Explore." n.d. United Nations Environment Programme. <https://www.sdg661.app/>.

risks and how to respond to them effectively. The toolkit, *Technology-Based Solutions for Resilience*, includes tools that are easily applicable and can be used to take action towards climate adaptation through improved climate resilience planning.

Through the use of digital sensors to measure and collect data and the distribution of data and information, smart city innovations can be leveraged to better understand and build toward climate resilience.<sup>18</sup> Further, innovations such as Artificial intelligence (AI), machine learning and digital modelling can support the planning and analysis of climate data and scenarios to better inform planning for climate risks and hazards which are explored in subsequent sections of this brief.

## Smart city concepts

- **Open data and data governance**

Open data, or data sets that are available to the public, are often used to operate smart technologies and innovations and require governance arrangements to be effectively managed.<sup>19</sup> Data governance refers to the principles, processes, policies, structures and other parameters and metrics that regulate data to ensure collaborative and balanced involvement by all relevant parties with a clear scope and purpose that builds on a relationship of trust and transparency.<sup>20</sup>

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18 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." *Critical Infrastructure Risk Management* 35. <http://dx.doi.org/10.1016/j.cirm.2021.100387>.

19 "Model Policy: Open Data." 2022. World Economic Forum. <https://weforum.ent.box.com/v/open-data-model-policy>.

20 Johnson, Jennifer, et al. 2022. "Data Governance Frameworks for Smart Cities: Key Considerations for Data Management and Use." *Journal of Law and Mobility*, May. <https://futurist.law.umich.edu/data-governance-frameworks-for-smart-cities-key-considerations-for-data-management-and-use%EF%BF%BC/>.

A smart city approach to data governance should reflect the type of data and its level of sensitivity and draw on the strengths of the involved parties.<sup>21</sup> Data governance in a smart city should include the meaningful involvement of the public and all partners in how smart and technological infrastructure and innovations operate<sup>22</sup> and be guided by public data sovereignty.<sup>23</sup> As such, data collection should include a human rights lens in how its collected, stored and shared.<sup>24</sup> For example, the importance of First Nations data sovereignty is an essential element in smart city data governance. First Nations data sovereignty “means First Nations data is governed by First Nations laws” and acknowledges “their inherent, Treaty and constitutional rights to self-determination and self-government,”<sup>25</sup> which parallels Indigenous data sovereignty and the rights of Indigenous peoples to “control data from and about their communities and lands.”<sup>26</sup>

21 Compute Ontario and ORION. 2019. “Building Ontario’s Next Generation Smart Cities Through Data Governance - Part 4: The Future of Ontario’s Data.” ORION. 2019. [https://www.orion.on.ca/wp-content/uploads/2019/11/Smart-Cities\\_The-future-of-Ontarios-data.pdf](https://www.orion.on.ca/wp-content/uploads/2019/11/Smart-Cities_The-future-of-Ontarios-data.pdf).

22 Morozov, Evgeny, and Francesca Brià. 2018. “Rethinking the Smart City: Democratizing Urban Technology.” Rosa Luxemburg Stiftung. 2018. [https://sachsen.rosalux.de/fileadmin/rls\\_uploads/pdfs/sonst\\_publicationen/rethinking\\_the\\_smart\\_city.pdf](https://sachsen.rosalux.de/fileadmin/rls_uploads/pdfs/sonst_publicationen/rethinking_the_smart_city.pdf).

23 Franke, Johannes, and Peter Gailhofer. 2021. “Data Governance and Regulation for Sustainable Smart Cities.” *Frontiers in Sustainable Cities* 3 (December). <https://doi.org/10.3389/frsc.2021.763788>.

24 Office of the United Nations High Commissioner for Human Rights. 2018. “A Human Rights-Based Approach to Data.” United Nations. 2018. <https://www.ohchr.org/sites/default/files/Documents/Issues/HRIndicators/GuidanceNoteonApproachtoData.pdf>.

25 First Nation Information Governance Centre. 2022. “Exploration of the Impact of Canada’s Information Management Regime of First Nations Data Sovereignty.” August 2022. [https://fnigc.ca/wp-content/uploads/2022/09/FNIGC\\_Discussion\\_Paper\\_IM\\_Regime\\_Data\\_Sovereignty\\_EN.pdf](https://fnigc.ca/wp-content/uploads/2022/09/FNIGC_Discussion_Paper_IM_Regime_Data_Sovereignty_EN.pdf).

26 Rainie, S., Kukutai, T., Walter, M., Figueroa-Rodriguez, O., Walker, J., & Axelsson, P. (2019) Issues in Open Data - Indigenous Data Sovereignty. In T. Davies, S. Walker, M. Rubinstein, & F. Perini (Eds.), *The State of Open Data: Histories and Horizons*. Cape Town and Ottawa: African Minds and International Development Research Centre. <https://www.stateofopendata.od4d.net/chapters/issues/indigenous-data.html>

Supporting data governance with Indigenous communities and sovereignty at the forefront ensures traditional knowledge and Indigenous leadership are meaningfully involved in the planning and implementation of smart city projects and innovations.<sup>27</sup> The inclusion of Indigenous perspectives can help advance technological reconciliation by closing systemic gaps in data and digital infrastructure within Indigenous communities.<sup>28</sup>

## ● Internet of Things

The Internet of Things (IoT) refers to “the network of physical objects, or things, which are connected to other devices and systems over the Internet.”<sup>29</sup> Smart buildings operate using IoT devices which “enable efficient and economical use of resources

### SMART CITIES

Countries all over the world have set targets for decreasing greenhouse gas and carbon emissions, but to achieve these targets communities have to significantly reduce their consumption of energy and natural resources. The concept of smart cities can play a role in accomplishing these environmental goals

27 The Firelight Group. 2021. “Open Smart City Initiatives as Tools for Indigenous Data Sovereignty.” Community Solutions Portal. Community Solutions Network. December 2021. <https://futurecitiescanada.ca/portal/wp-content/uploads/sites/2/2021/12/csn-indigenous-data-sovereignty-dec-2021-compliant.pdf>.

28 “Indigenous Engagement Approach to Open Smart Cities - Community Solutions Portal.” 2021. Community Solutions Network. November 3, 2021. <https://futurecitiescanada.ca/portal/resources/indigenous-engagement-approach-to-open-smart-cities/>.

29 “Smart Cities Glossary - Community Solutions Portal.” 2023. Community Solutions Portal. February 3, 2023. <https://futurecitiescanada.ca/portal/resources/smart-cities-glossary/>.

while providing a safe, comfortable environment to occupants.”<sup>30</sup> IoT devices can be used for environmental monitoring by collecting and interpreting data from a physical environment through sensors, lights and other devices.<sup>31</sup> As an example, IoT can promote climate resiliency by using sensors to track air quality and air pollution levels and using IoT leak detection sensors in plants or buildings to detect water leaks and monitor water quality.<sup>32</sup> Furthermore, IoT devices and technologies that require broadband, which is “expanded or improved high speed internet,”<sup>33</sup> can aid in the expansion and connectivity of a local community, allowing communities to make more informed decisions on climate resilience.<sup>34</sup> The toolkit, *Getting Started with Community Broadband*, provides step-by-step guidelines and tools for communities to implement community broadband.

### ● Artificial intelligence and machine learning

Artificial intelligence (AI) is the “simulation of human intelligence in programmed machines.”<sup>35</sup> AI can play a major role in climate adaptation and resilience efforts by collecting and interpreting large

30 Onomondo. 2023. “How IoT Is Influencing Smart Buildings | Onomondo.” Onomondo, June 9, 2023. <https://onomondo.com/blog/how-iot-is-influencing-smart-buildings/>.

31 Jones, Quinn. 2022. “IoT-Based Environmental Monitoring: Types and Use Cases.” Digi (blog). April 15, 2022. <https://www.digi.com/blog/post/iot-based-environmental-monitoring>.

32 Conure. 2022. “Top 7 Applications of IoT for Environmental Sustainability.” Conure, March. <https://www.conurets.com/top-7-applications-of-iot-for-environmental-sustainability/>.

33 Community Solutions Network. 2021. “Getting Started with Community Broadband.” Community Solutions Portal. Community Solutions Network. 2021. <https://futurecitiescanada.ca/portal/wp-content/uploads/sites/2/2020/12/evg-getting-started-broadband-2021.pdf>.

34 Community Solutions Network. 2021. “Getting Started with Community Broadband.” Community Solutions Portal. Community Solutions Network. 2021. <https://futurecitiescanada.ca/portal/wp-content/uploads/sites/2/2020/12/evg-getting-started-broadband-2021.pdf>.

35 “Smart Cities Glossary - Community Solutions Portal.” 2023. Community Solutions Portal. February 3, 2023. <https://futurecitiescanada.ca/portal/resources/smart-cities-glossary/>.





datasets in real time, which can help detect early warnings for severe weather occurrences and implement prevention efforts earlier.<sup>36</sup> The application of AI can be used to model climate feedback loops, enabling policy-makers and decision-makers to investigate both the intended and unintended effects of policies related to climate change.<sup>37</sup> The *AI for the Resilient City* program uses AI to create a data visualization and analytics tool to detect the impacts of climate change, including local heat data and infrastructure data, to help municipalities within Canada adapt to climate change risks.<sup>38</sup>

Likewise, machine learning uses data and algorithms for a machine to learn how to perform a task<sup>39</sup> often using large datasets to train and test the models. The data analytical functions of machine learning techniques can help identify climate-related patterns and trends and draw conclusions or insights with real-life implications. Machine learning can also improve the efficiency of existing systems (such as automated electrical grids that monitor and predict energy supply and demand to optimize energy production).<sup>40</sup> Machine learning can also be used for climate change risk assessments and in supporting disaster risk management<sup>41</sup> such as through predictive modelling to monitor different scenarios.

36 "Fighting Climate Change with the AI for the Planet Alliance." 2023. UNESCO. April 20, 2023. <https://www.unesco.org/en/articles/fighting-climate-change-ai-planet-alliance>.

37 "Fighting Climate Change with the AI for the Planet Alliance." 2023. UNESCO. April 20, 2023. <https://www.unesco.org/en/articles/fighting-climate-change-ai-planet-alliance>.

38 Evergreen. n.d. "AI for the Resilient City." <https://www.evergreen.ca/impacts/ai-for-the-resilient-city/#:~:text=AI%20for%20the%20Resilient%20City%20was%20made%20possible%20by%20an,climate%20change%20in%20their%20communities>.

39 "What Is Machine Learning?" 2018. United Nations Office of Information and Communications Technology. December 2018. <https://unite.un.org/sites/unite.un.org/files/emerging-tech-series-machine-learning.pdf>.

40 Beardmore, Adele. 2022. "Can Machine Learning Help Tackle Climate Change?" Earth. Org, August. <https://earth.org/machine-learning-climate-change/>.

41 Zennaro, Federica, Elisa Furlan, Christian Simeoni, Silvia Torresan, Sinem Aslan, Andrea Critto, and Antonio Marcomini. 2021. "Exploring Machine Learning Potential for Climate Change Risk Assessment." *Earth-Science Reviews* 220 (September): 103752. <https://doi.org/10.1016/j.earscirev.2021.103752>.

## ● Blockchain technology

Blockchain describes the process of recording and tracking transactions and assets in a network.<sup>42</sup> Two key features of blockchains are that all the data, information or blocks created on the network (blockchain) are publicly accessible to all and are permanently integrated into the blockchain so that data is not deleted, altered or destroyed by any entity. Blockchain is an emerging technology that promotes decentralization, openness and transparency which can be paired with other digital tools (such as remote sensors and AI) to uncover the effectiveness of certain climate-related initiatives such as emission reduction and carbon sequestration efforts.<sup>43</sup> Blockchains are also being explored to help identify lower carbon footprint options, monitor and report carbon emissions, support the management of carbon credits and promote renewable energy sources.<sup>44</sup>

## Cybersecurity risks of smart cities

Cybersecurity is the protection of systems, networks and programs from digital attacks.<sup>45</sup> Smart cities leverage the use of data and technology to create more efficient and beneficial communities. While data and technology can create more interactive and responsive communities, IoT and ICTs intrinsic to smart cities expose a risk of exploitation and cybersecurity vulnerabilities. For example, smart cities collect large datasets related to smart infrastructure and

42 "What Is Blockchain Technology?" n.d. IBM. <https://www.ibm.com/topics/blockchain>.

43 Hoopes IV, John, Anna Lerner, and Michael Mezzatesta. 2023. "Blockchain for Scaling Climate Action - White Paper." World Economic Forum, April. [https://www3.weforum.org/docs/WEF\\_Blockchain\\_for\\_Scaling\\_Climate\\_Action\\_2023.pdf](https://www3.weforum.org/docs/WEF_Blockchain_for_Scaling_Climate_Action_2023.pdf).

44 "Can blockchain help combat climate change?" 2023. CoIntelegraph. March 5, 2023. <https://cointelegraph.com/news/can-blockchain-help-combat-climate-change>

45 Michigan Technological University. 2023. "What Is Cybersecurity?" May 26, 2023. <https://www.mtu.edu/computing/cybersecurity/#:~:text=Cybersecurity%20is%20the%20practice%20of,or%20interrupting%20normal%20business%20processes>.

may contain personal and corporate information<sup>46</sup> which can be manipulated if a cybercriminal gains unrestricted access risking the privacy and security of Canadians and Canadian infrastructure.<sup>47</sup> Cybercriminals can also hijack smart devices and initiate ransomware attacks that could affect, for example, the performance of an energy management system within a building.<sup>48</sup> The negative impacts of a smart city breach can be large and disrupt public infrastructure and services including access to public transit and emergency utilities, such as electricity and water.<sup>49</sup> With these risks in mind, it is important “to balance efficiency and innovation with cybersecurity, privacy protections and national security”<sup>50</sup> and incorporate data governance and security throughout all phases of smart city planning processes.<sup>51</sup>

46 Canadian Intelligence Security. 2022. “Smart Cities and National Security.” Canada.Ca. February 16, 2022. <https://www.canada.ca/en/security-intelligence-service/corporate/publications/smart-cities-national-security/smart-cities-national-security.html#toc3>.

47 Ibid.

48 Institute for Defense & Business. 2023. “What Are the Cybersecurity Risks for Smart Cities?” Institute for Defense and Business. July 7, 2023. <https://www.idb.org/what-are-the-cybersecurity-risks-for-smart-cities/>.

49 Canadian Intelligence Security. 2022. “Smart Cities and National Security.” Canada.Ca. February 16, 2022. <https://www.canada.ca/en/security-intelligence-service/corporate/publications/smart-cities-national-security/smart-cities-national-security.html#toc3>.

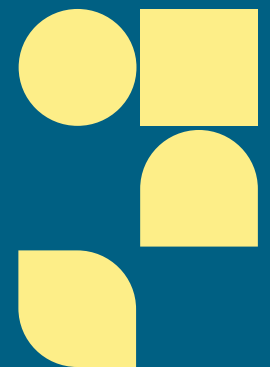
50 “Cybersecurity Best Practices for Smart Cities.” 2023. United States Cybersecurity and Infrastructure Security Agency. April 19, 2023. [https://www.cisa.gov/sites/default/files/2023-04/cybersecurity-best-practices-for-smart-cities\\_508.pdf](https://www.cisa.gov/sites/default/files/2023-04/cybersecurity-best-practices-for-smart-cities_508.pdf).

51 Canadian Intelligence Security. 2022. “Smart Cities and National Security.” Canada.Ca. February 16, 2022. <https://www.canada.ca/en/security-intelligence-service/corporate/publications/smart-cities-national-security/smart-cities-national-security.html#toc3>.

## Smart resilience in-action

The use of data and technology can be an opportunity for the creation of more climate-resilient communities and address the challenges posed by a warming world. By harnessing the power of data-driven insights, real-time monitoring, intelligent automation and more, smart technology empowers communities to adapt swiftly, fortify infrastructure and develop sustainable practices, creating a more resilient and sustainable future.

Below is a selection of case studies that showcase smart, climate resilience efforts in Canada that leverage data and technology to optimize resource use and climate-adaptive practices including agriculture and vertical farming to ensure food security (LED Smart Farm in Opaskwayak Cree Nation, MB) amidst changing environmental conditions and in reducing the impacts of sea level rise and coastal erosion (flood management plan in Hamlet of Tuktoyaktuk, NT) to safeguard vulnerable communities and preserve valuable ecosystems. The case studies demonstrate locally led and implemented initiatives that successfully prepare a region from the impacts of climate change.



# CASE STUDIES



# CASE STUDY 1: Opaskwayak LED Smart Farm



- **Location:** Opaskwayak Cree Nation, Manitoba
- **Number of persons affected:** 6,587 people (Across three communities)
- **Case Study Related Climate Impact:** Food Security, Climate Resilience, Health & Wellbeing, Changing Environment, Extreme Weather
- **Funding Source:** Canadian Federal Government,
- **Key Partners:** University of Manitoba, Opaskwayak Health Authority
- **Phase of Completion:** Completed & Operational
- **Website:** <https://opaskwayak.com>

In a remote Indigenous community in Northern Manitoba, the Opaskwayak Cree Nation is using smart technology to combat the effects of climate change, improve food security in the coldest months of the year and build resilience with year-round food production and providing fresh produce at no cost to community members. The Opaskwayak Cree Nation's Smart LED Vertical Farming program (which started as a pilot) is run out of the Nation's community centre and hosts a sophisticated computer-controlled farm run through AI, sensors, automatic LED lighting, hydroponics and several computer systems to oversee all aspects of the farming operation at all life cycles of the produce it is sustaining.<sup>52</sup> This program partners with the University of Manitoba, University of Guelph and McGill University and in 2021 received federal

52 Laychuk, Riley. 2018. "Year-Round Garden Provides Free Fresh Vegetables to Hundreds on Manitoba's Opaskwayak Cree Nation." CBC, April 3, 2018. <https://www.cbc.ca/news/canada/manitoba/manitoba-first-nation-indoor-farm-1.4600746>.

funding from the Government of Canada under the smart cities training program.<sup>53</sup>

The program is increasing climate resilience through smart innovation technology of AI, remote monitoring, Hydroponics, LEDs and sophisticated computer systems to ensure a non-stop sustainable vertical farming practice that is providing farm fresh produce to the community in an area of the country where fresh produce costs have and continue to soar due to transportation and growing costs.<sup>54</sup> The use of these smart technologies has allowed for the considerable consolidation of resources, agricultural space and economic requirements to run a fully functioning farm from the inside of a local community centre's spare room. In cold winter months, the vertical farm operates through any weather to ensure residents have access to healthy produce that would otherwise be priced out of the market or near spoiled by the time it arrives to the community. A potential co-benefit of this pilot is increased wellbeing and health through improved access to healthy food.<sup>55</sup> Opaskwayak Health Authorities note that this region of Manitoba has the highest rate of diabetes-related illness in the country, at around 50 per cent, and researchers at the Health Authority

53 University of Manitoba. n.d. "Smart Vertical Farming to Expand in Northern Manitoba." <https://news.umanitoba.ca/smart-vertical-farming-to-expand-in-northern-manitoba/#:~:text=The%20%244.95%20million%20in%20funding,%2C%20and%20seven%20additional%20institutions>.

54 Dyck, Iris. 2023. "Rising Food Costs Affecting Ability to Purchase Nutritious Food in Remote Manitoba Communities." Global News, February 14, 2023. <https://globalnews.ca/news/9487116/rising-food-costs-nutritious-food-manitoba-north/>.

55 Lilley, Renée. 2021. "Northern Manitoba First Nation Aims to Help Feed Community, Fight Diabetes with Expanded Vertical Farm Project." CBC, July 9, 2021. <https://www.cbc.ca/news/canada/manitoba/smart-vertical-farm-opaskwayak-nation-u-of-manitoba-1.6091894>.

and University of Manitoba are studying the effect that healthy vegetables and produce consumed during pregnancy in this community will decrease the rates of gestational diabetes.<sup>56</sup>

The LED Smart Farm promotes food security to ensure “all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preference.”<sup>57</sup> Further, the program supports the right to food security by promoting food sovereignty which is “the right of peoples to health and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agricultural systems.”<sup>58</sup> The use of smart vertical farming plays a key role in fighting food insecurity in northern regions of Canada but also has a significantly smaller carbon footprint. Vertical farms have the ability to run on a full year schedule compared to traditional farming operations that would be growing the same produce but limited to shorter growing seasons based on seasonality. The program has been an astounding success with immediate uptake in the community as well as giving the individuals who work at the vertical farm an immense feeling of gratification in playing a role in feeding their community.<sup>59</sup>

As the world warms and the effects of climate change become more pronounced, it is important for communities of all sizes across the country to ensure that critical systems are resilient to this change. The ability for a community to produce their own

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56 Ibid.

57 FAO, IFAD, UNICEF, WFP and WHO. 2023. The State of Food Security and Nutrition in the World 2023. Urbanization, agrifood systems transformation and healthy diets across the rural–urban continuum. Rome, FAO. <https://doi.org/10.4060/cc3017en>

58 La Via Campesina. 2019. “Food Sovereignty. a Manifesto for the Future of Our Planet.” La Via Campesina. 2019. [https://viacampesina.org/en/wp-content/uploads/sites/2/2021/10/EN\\_25-Years-FS-Statement-For-Web-3.pdf](https://viacampesina.org/en/wp-content/uploads/sites/2/2021/10/EN_25-Years-FS-Statement-For-Web-3.pdf).

59 Laychuk, Riley. 2018. “Year-Round Garden Provides Free Fresh Vegetables to Hundreds on Manitoba’s Opaskwayak Cree Nation.” CBC, April 3, 2018. <https://www.cbc.ca/news/canada/manitoba/manitoba-first-nation-indoor-farm-1.4600746>.



food, reliably and when they require it, reduce the reliance on other producers nationally or globally and helps protect their food supply from the effects of weather (and extreme weather) and other changes in the environment as the agricultural and food sector are shifted in the coming years and decades as a result of a warming world and changing environment. The use of smart technology in this program allows for the seamless operation of the farm, ensuring the perfect conditions are met to grow the healthiest produce possible in tight vertical conditions while also not requiring a large number of employees to maintain the farm.

As the impacts of climate change expand in their velocity and frequency it will be important to utilize smart city ideas that intersect with climate resilience to ensure that we can continue to feed the most vulnerable in a volatile world.

In addition to this program, the Opaskwayak Cree Nation have also recently purchased a large parcel of land that is designated as prime agricultural land. This acquisition in tandem with the Smart LED Vertical Farm, has the capability to feed the entire local community at any given time of the year. This farmland will be used to expand its agriculture capability, employ local Indigenous residents to become skilled in the field and continue to use smart technology to enhance the area. Included in the property's master plan, is the use of solar PV panel arrays to separate crop growing areas to aid in providing clean green energy through smart technology to the property.<sup>60</sup> To learn more about the project, *Evergreen's Future Fix podcast* showcases the LED Smart Farm in an episode on *Smart Farms in Northern Communities*.

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60 Opaskwayak. 2022. "Agricultural & Environmental Education." Opaskwayak -. May 24, 2022. <https://opaskwayak.com/community-master-plan/agricultural-environmental-education/>.

## CASE STUDY 2: Coastal Erosion and Rising Sea Levels in the Hamlet of Tuktoyaktuk



- **Location:** Hamlet of Tuktoyaktuk, Northwest Territories
- **Number of persons affected:** 965 people
- **Case Study Related Climate Impact:** Rising Sea Level, Changing Environment, Sea Ice Loss, Erosion
- **Funding Source(s):** Canadian Federal Government, Government of Northwest Territories
- **Key Partners:** Canadian Federal Government, Government of Northwest Territories,
- **Phase of Completion:** Implementation (ongoing)
- **Website:** <https://tuktoyaktuk.ca>

The Arctic Hamlet of Tuktoyaktuk located in the Northwest Territories has been severely impacted by climate change in the past few decades, including coastal erosion. Although erosion protection protocols were administered between the years 1998 to 2001, coastal erosion continues to be an ongoing and relevant problem for the community, with rising sea levels increasing erosion rates.<sup>61</sup>

The Government of Northwest Territories was granted federal funding of \$240,000 through the National Disaster Mitigation Program to design a coastal erosion mitigation plan.<sup>62</sup> The

61 Canada, Crown-Indigenous Relations and Northern Affairs. 2020. "Hamlet of Tuktoyaktuk: Climate Change and Coastal Erosion." Canada.Ca. July 10, 2020. <https://www.canada.ca/en/crown-indigenous-relations-northern-affairs/news/2020/07/hamlet-of-tuktoyaktuk-climate-change-and-coastal-erosion.html>.

62 Ibid.

mitigation plan included pinpointing coastal erosion hazards and prioritizing mitigation efforts in more vulnerable areas to help decrease future erosion damage, as well as the enhancement of public safety efforts.<sup>63</sup> Various contributors were involved in the monitoring of coastal erosion caused by melting sea ice, including Indigenous governments, the territorial government as well as local authorities and residents living in the area.<sup>64</sup>

Through *Crown-Indigenous Relations and Northern Affairs Canada's (CIRNAC) Climate Change Directorate*, the Government of Canada collaborated with the Hamlet of Tuktoyaktuk and the Government of Northwest Territories to aid the community's coastal erosion reduction efforts.<sup>65</sup> The *Climate Change Preparedness in the North Program* granted \$3.655 million to assist with implementing a variety of adaptation measures within the hamlet, such as helping relocate residents living on the peninsula to another division that is located at a higher elevation within the community and planning future actions towards the hamlet's preferred adaptation method to reduce current and future climate impacts.<sup>66</sup> In 2021, Tuktoyaktuk received *Arctic Inspiration Prize* funding to help create the Community Climate Resiliency Project, a community-based climate

63 Ibid.

64 Canada, Crown-Indigenous Relations and Northern Affairs. 2020. "Hamlet of Tuktoyaktuk: Climate Change and Coastal Erosion." Canada.Ca. July 10, 2020. <https://www.canada.ca/en/crown-indigenous-relations-northern-affairs/news/2020/07/hamlet-of-tuktoyaktuk-climate-change-and-coastal-erosion.html>.

65 "Hamlet of Tuktoyaktuk: Climate Change and Coastal Erosion — Canada in a Changing Climate." n.d. <https://changingclimate.ca/case-study/hamlet-of-tuktoyaktuk-climate-change-and-coastal-erosion/>.

66 Ibid.

monitoring program to track water, air, erosion and landscape changes.<sup>67</sup> The program engages and involves members of the community to learn and develop the skills to monitor climate change within the area in which they live.<sup>68</sup> Currently, there are six trained climate monitors that are able to identify areas experiencing erosion.<sup>69</sup> Through this project, the hamlet is able to enhance its capacity to use geospatial tools to monitor climate data.<sup>70</sup> The implementation of adaptation measures is ongoing, with the Hamlet of Tuktoyaktuk continuing to receive support and assistance from CIRNAC as well as through other partnerships involved in these reduction efforts.<sup>71</sup>

In addition, the *Tuktoyaktuk Community Corporation* received funding to initiate the operation of *SmartICE* technology, a climate change adaptation program tool that incorporates Indigenous traditional knowledge of ice travel with advanced data acquisition and remote monitoring technology.<sup>72</sup> SmartICE technology enables trained climate monitors in Tuktoyaktuk to retrieve and distribute information on sea ice characteristics,

67 Williams, Ollie. 2023. "Fiercer Storms and Bigger Waves Hasten Tuk's Erosion Crisis." Cabin Radio, January 3, 2023. <https://cabinradio.ca/113364/news/environment/climate/fiercer-storms-and-bigger-waves-hasten-tuks-erosion-crisis/>.

68 Scott, Mackenzie. 2018. "Tuktoyaktuk Residents Will Learn How to Monitor Impacts of Climate Change." CBC, December 2, 2018. <https://www.cbc.ca/news/canada/north/tuktoyaktuk-climate-change-program-1.4929164>.

69 Williams, Ollie. 2023. "Fiercer Storms and Bigger Waves Hasten Tuk's Erosion Crisis." Cabin Radio, January 3, 2023. <https://cabinradio.ca/113364/news/environment/climate/fiercer-storms-and-bigger-waves-hasten-tuks-erosion-crisis/>. <https://cabinradio.ca/113364/news/environment/climate/fiercer-storms-and-bigger-waves-hasten-tuks-erosion-crisis/>.

70 "Community Based Climate Monitoring." n.d. Future Tuktoyaktuk. <https://futuretuktoyaktuk.org/community-based-climate-monitoring>.

71 "Hamlet of Tuktoyaktuk: Climate Change and Coastal Erosion — Canada in a Changing Climate." n.d. <https://changingclimate.ca/case-study/hamlet-of-tuktoyaktuk-climate-change-and-coastal-erosion/>.

72 Government of Northwest Territories. n.d. "Responding to Climate Change in the NWT: Annual Report 2021-2022." Government of Northwest Territories. <https://www.gov.nt.ca/ecc/sites/ecc/files/resources/climatechange-annualreport-2021-2022-web.pdf>.



Photo by Andrew MacNeill



including sea ice thickness and ice surface conditions in real-time, to initiate safe travel decision-making.<sup>73</sup> Identifying these characteristics through SmartICE can also indicate how the warming of oceans is causing the erosion and thinning of sea ice.<sup>74</sup> Ice monitoring data and any related maps are immediately viewable by community members through *SIKU*, an Indigenous knowledge web platform for Inuit that provides resources, services and tools for weather, ice safety and language preservation.<sup>75</sup> This platform holds a variety of information related to sea ice and weather safety, such as ice and weather hazard reports and satellite imagery sea ice in near-real time.<sup>76</sup> SmartICE equipment acquisition was completed in 2021-2022 and the SmartICE system is fully operational.<sup>77</sup>

However, there are still challenges for Tuktoyaktuk and its residents. The hamlet is on its way to becoming the first community in Canada to be completely relocated due to rising sea levels and coastal erosion.<sup>78</sup> Losing up to 1 metre of coastline each year,<sup>79</sup> community members are at a critical point to protect their

homeland and way of life before it is completely washed out by the ocean. Several homes that were along the shoreline have been relocated further inland.<sup>80</sup> In July 2023, it was announced that \$53.7 million from the federal government's Disaster Mitigation and Adaptation Fund will be spent throughout the next three years towards protecting Tuktoyaktuk from climate change impacts and building new climate-resilient infrastructure.<sup>81</sup> Tuktoyaktuk also hopes to hold a conference with the six communities located in the *Inuvialuit Settlement Region* sometime in late 2023 to discuss next steps regarding these climate impacts.<sup>82</sup>

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73 "SMART Ice Canada." n.d. United Nations Framework Convention on Climate Change. <https://unfccc.int/climate-action/momentum-for-change/ict-solutions/smartice>.

74 "SmartICE: Supporting Inuit Knowledge of the Landscape with Technology | CBC Radio." 2020. CBC. March 13, 2020. <https://www.cbc.ca/radio/quirks/mar-14-coronavirus-epidemiology-greenland-glaciers-melt-and-more-1.5495007/smartice-supporting-inuit-knowledge-of-the-landscape-with-technology-1.5495008>.

75 "SIKU - the Indigenous Knowledge Social Network." n.d. SIKU. <https://siku.org/>.

76 Ibid.

77 Government of Northwest Territories. n.d. "Responding to Climate Change in the NWT: Annual Report 2021-2022." Government of Northwest Territories. [https://www.gov.nt.ca/ecc/sites/ecc/files/resources/climatechange-annualreport-2021-2022\\_web.pdf](https://www.gov.nt.ca/ecc/sites/ecc/files/resources/climatechange-annualreport-2021-2022_web.pdf).

78 Taylor, Juanita, and Kate Kyle. 2022. "Washing Away." CBC News, November 19, 2022. <https://www.cbc.ca/newsinteractives/features/washing-away-tuktoyaktuk-shoreline-erosion>.

79 Ibid.

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80 Ibid.

81 CBC News. 2023. "Feds Promise \$53M to Help Protect Tuktoyaktuk, N.W.T., from Shoreline Erosion, Climate Change," July 28, 2023. <https://www.cbc.ca/news/canada/north/tuktoyaktuk-erosion-infrastructure-funding-1.6920622>.

82 Williams, Ollie. 2023. "Fiercer Storms and Bigger Waves Hasten Tuk's Erosion Crisis." Cabin Radio, January 3, 2023. <https://cabinradio.ca/113364/news/environment/climate/fiercer-storms-and-bigger-waves-hasten-tuks-erosion-crisis/>.

A smart city encourages the responsible and transparent use and sharing of data to facilitate greater levels of collaboration while avoiding the misuse of data. Smart technology and other smart city elements can also be used as an educational tool for the public to better understand local climate-related risks.



## Building smart resilience

### Tips for successful smart solutions

- **Fill a gap and leverage technology where it is most useful**

Data and technological solutions should support the efficiency and effectiveness of a project. Not all solutions require a technological fix and may be addressed through low-tech or no-tech innovations (such as nature-based solutions including wetland restoration or rain gardens) or through the exchange of Indigenous knowledge to bridge networks in support of changing environmental commons.<sup>83</sup> Ensure that the objective of the project and the issues that need to be resolved would benefit from data and technological solutions. Some low-tech or no-tech innovations can be supplemented by smart technologies to help monitor and manage the project over time. For example, nature-based solutions such as restoring marshes or wetlands for flood management can be supported by water management sensors to collect and track water levels or salinity to monitor changes over time.<sup>84</sup>

83 Rathwell, Kaitlyn, Derek Armitage, and Fikret Berkes. 2015. "Bridging Knowledge Systems to Enhance Governance of Environmental Commons: A Typology of Settings." *The International Journal of the Commons* 9 (2): 851. <https://doi.org/10.18352/ijc.584>.

84 Quinn, Nigel W.T., Ricardo Ortega, Patrick J. A. Rahilly, and Caleb W. Royer. 2010. "Use of Environmental Sensors and Sensor Networks to Develop Water and Salinity Budgets for Seasonal Wetland Real-Time Water Quality Management." *Environmental Modelling and Software* 25 (9): 1045–58. <https://doi.org/10.1016/j.envsoft.2009.10.011>.

- **Leverage smart connections**

From smart phones to social media, people and communities across the country are extraordinarily connected regardless of proximity or time zone. IoT has created a smart network using sensors and devices to increase interconnection across sectors.<sup>85</sup> Many communities have untethered access to the Internet and technology with the means to stay connected through smart technologies. Mobile and personal smart devices can leverage IoT to connect complex smart systems together such as through smart thermostats, lighting, heating and cooling in homes and buildings or using web-based applications to connect people with ride sharing, on-demand transit and transportation networks in communities and regions. These connections can be leveraged for municipal and regional planning and project implementation efforts to share IoT and other data for improved collaboration<sup>86</sup> (such as the Okanagan Valley digital dashboard on regional flooding<sup>87</sup>). These interconnected systems can improve the monitoring of environmental variables across entire watersheds and regional

85 Adams Jr, W. Charlton. n.d. "The Internet of Things and the Connected Person." *Wired*. <https://www.wired.com/insights/2014/12/iot-connected-person/>.

86 Sims, Kalyn. 2021. "Smart Cities Are Built On Collaboration." *Forbes*, December 2, 2021. <https://www.forbes.com/sites/forbestechcouncil/2021/12/02/smart-cities-are-built-on-collaboration/?sh=61b3ddf06b85>.

87 Carroll, Lisa. 2022. "Using Data for Real-Time Flood Response." *Municipal World*. April 2022. <https://www.municipalworld.com/feature-story/real-time-flood-response/>.

environmental areas<sup>88</sup> giving more power to planners, policy and decision makers and community members to have reliable and regional information.

- **Ensure the accessibility of smart solutions**

Many smart innovations rely on the availability of broadband Internet or other broadband communications using a smart device. While these innovations can be effective tools, they can also be exclusionary to communities and populations without widespread access and who are often already disproportionately impacted by the impacts of climate change.<sup>89</sup> Barriers to smart solutions include the equitable access of technology (including smart phones and the Internet or other broadband communications) and the lack of technological or digital literacy to effectively use smart phones or other smart devices.<sup>90</sup> Including educational resources and in-person support to improve technological literacy can increase the use of smart technologies and improve the overall success of a smart program.<sup>91</sup> *Accessible Public Spaces for All: A Practitioner's Toolkit* provides further insights into creating more inclusive spaces and the importance of engaging with the community for the successful implementation of accessible and effective smart innovation projects.

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88 "Water Quality Dashboard." n.d. Government of British Columbia. <https://elkvalleywaterquality.gov.bc.ca/pages/water-quality-dashboard>.

89 "Indigenous Knowledges and Climate Change." n.d. Climate Atlas of Canada. <https://climateatlas.ca/indigenous-knowledges-and-climate-change>.

90 Nikpeyma, Nasrin, Mehdi Zolfaghari, and Aeen Mohammadi. 2021. "Barriers and Facilitators of Using Mobile Devices as an Educational Tool by Nursing Students: A Qualitative Research." *BMC Nursing* 20 (1). <https://doi.org/10.1186/s12912-021-00750-9>.

91 Hadziristic, Tea. 2017. "The State of Digital Literacy In Canada: A Literature Review." Brookfield Institute. April 2017. [https://brookfieldinstitute.ca/wp-content/uploads/BrookfieldInstitute\\_State-of-Digital-Literacy-in-Canada\\_Literature\\_WorkingPaper.pdf](https://brookfieldinstitute.ca/wp-content/uploads/BrookfieldInstitute_State-of-Digital-Literacy-in-Canada_Literature_WorkingPaper.pdf).

- **Safeguard data to protect against security breaches**

The IoT and smart city innovations rely on increased connectivity and digital infrastructure which require specific security measures to ensure information and data remains safe from cybercriminals and privacy breaches.<sup>92</sup> Improper data use, unauthorized access to sensitive data, poor quality data, and other issues can easily cause harm to people and communities. As a result, it is essential to follow the appropriate fair information principles and policy requirements as determined in Canadian privacy regulations. This includes having an established and public privacy policy that outlines who is accountable, the purposes of data collection, what is collected and how it is stored, and what safeguards are in place. In addition, it is strongly recommended to have an internal data governance framework that institutes clear roles and responsibilities for the management of the data to ensure your organization is adhering to the required practices.

Municipalities and other authoring organizations should include strategic and proactive cybersecurity risk management processes in the planning and design of projects and systems. The implementation of any data governance strategy should be respectful and safeguard First Nations data sovereignty and Indigenous data sovereignty. All smart technologies should include security infrastructure to ensure the resilience and security of the connected networks and systems. While smart cities include open data that is available and freely used and redistributed, open data and information should also be protected and secure from cybersecurity breaches.<sup>93</sup>

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92 "Cybersecurity Best Practices for Smart Cities." 2023. United States Cybersecurity and Infrastructure Security Agency. April 19, 2023. [https://www.cisa.gov/sites/default/files/2023-04/cybersecurity-best-practices-for-smart-cities\\_508.pdf](https://www.cisa.gov/sites/default/files/2023-04/cybersecurity-best-practices-for-smart-cities_508.pdf).

93 "The Agility Effect." 2017. The Agility Effect Magazine. 2017. [https://www.theagilityeffect.com/app/uploads/2022/09/The-Agility-Effect-Magazine\\_N%C2%B03\\_WINTER-2017\\_version-EN.pdf](https://www.theagilityeffect.com/app/uploads/2022/09/The-Agility-Effect-Magazine_N%C2%B03_WINTER-2017_version-EN.pdf).

## Smart tools for climate resilience

- **Public alerts and learning**

During a climate emergency, the IoT provides an opportunity for technology to alert the public of suggested or required safety actions. Municipalities or emergency services can use social media, traditional websites or smart applications (such as Quebec’s SUPREME system which provides real-time information for extreme weather hazards<sup>94</sup>) to provide status updates of impending and occurring disasters and recovery efforts. Immediate alert systems are also in effect across the country that disseminate alert messages directly to the public in the affected regions (such as the national emergency alert system Alert Ready which can send messages to all TVs, radio stations and wireless devices<sup>95</sup>). A smart city encourages the responsible and transparent use and sharing of data to facilitate greater levels of collaboration while avoiding the misuse of data. Smart technology and other smart city elements can also be used as an educational tool for the public to better understand local climate-related risks. Resources like *Climate Data for a Resilient Canada* that uses maps and other visuals to summarize climate data and *Climate Atlas* which is a user-friendly and interactive tool to learn about and simplify the complexity of climate change for a more informed public. Smart devices and tools can also be used to access information such as adding QR codes in public spaces directing users to educational webpages or informational snippets about the benefits of solar panels in the area or the recommended plan for restoring a shoreline.

94 World Health Organization. 2018. “Early Warning Systems: SUPREME: An Integrated Heat Health Warning System for Quebec.” Global Health Heat Information Network. 2018. [https://ghhin.org/wp-content/uploads/WHO-WMO\\_Case\\_Phase\\_3\\_Ch5k.pdf](https://ghhin.org/wp-content/uploads/WHO-WMO_Case_Phase_3_Ch5k.pdf).

95 D’Cunha, Patricia. 2023. “National Emergency Alert System Tested Wednesday in Much of Canada.” City News, May 9, 2023. <https://toronto.citynews.ca/2023/05/09/alert-ready-emergency-test/>.



## ● Data collection and monitoring

The IoT and smart technologies can optimize data collection and monitoring using remote sensors, cloud-based applications, automated tools and other IoT efficiencies that can reduce manual processes. The remote collection of information and metrics can then be summarized and analyzed as needed through smart technologies using AI or machine learning. Data collection and monitoring tools can provide benefits for local municipalities but can also be used to improve regional awareness and integration. Digital dashboards that analyze and report metrics and information can collect data from across a region to create more comprehensive interpretations of regional climate information. For example, the *Okanagan Valley digital dashboard* uses 24 sources of data that is presented in an easy-to-understand dashboard<sup>96</sup> and *PEI's Water Registry* which includes a variety of dashboards to interpret water data for the province. Digital dashboards used by municipal and regional governments can also be made publicly available for public education and information. Likewise, climate mapping and modelling using smart data collection can also be leveraged for public awareness of local climate risks and decision-making solutions. IoT solutions, such as digital dashboards, connect sensors and devices to build more efficient networks.

## ● Smart engagement and consultation

Meaningful engagement and consultation with the community is an essential process of most municipal planning and decision-making activities and a foundational characteristic of a smart city.<sup>97</sup> Climate-related planning and decision-making immediately impacts community members requiring regular information-sharing and meaningful involvement. Smart technology and the

wide availability of broadband Internet and communications, and other IoT elements, has improved the ways in which engagement and consultations can be conducted.

In addition to in-person engagement and consultations, municipal leaders can lean on smart devices to gather information and feedback from the community through traditional websites (such as *Let's Chat Moncton* in New Brunswick and *EngageNL* in Newfoundland), QR codes in public locations as well as in the delivery of meetings and town halls. Recording and live-streaming council meetings with closed-captioning and uploading the recording and meeting notes to a publicly accessible website ensures those that cannot attend in-person still have an opportunity for engagement. When scheduling in-person consultation meetings with the local community and council meetings that are open to the public, the time of day and location of these in-person meetings should be reflective of the availability of the community but having options for community members to virtually join the sessions creates a more inclusive environment for those with mobility challenges, vision or hearing impairments or other barriers to in-person attendance. Smart cities rely on participatory, collaborative and responsive governance to foster inclusive and fair communities.<sup>98</sup>

### CLIMATE-RELATED PLANNING

and decision-making immediately impacts community members requiring regular information-sharing and meaningful involvement.

96 Carroll, Lisa. 2022. "Using Data for Real-Time Flood Response." *Municipal World*. April 2022. <https://www.municipalworld.com/feature-story/real-time-flood-response/>.

97 Lauriault, Tracey P., Rachel Bloom, and Jean-Noé Landry. 2018a. "Open Smart Cities Guide V1.0." *Open North*. [https://opennorth.ca/wp-content/uploads/legacy/OpenNorth\\_Open\\_Smart\\_Cities\\_Guide\\_v1.0.pdf](https://opennorth.ca/wp-content/uploads/legacy/OpenNorth_Open_Smart_Cities_Guide_v1.0.pdf).

98 Ibid.

## ● Climate analysis and planning

Digital technologies, such as digital twins and climate modelling, can help visualize, interpret and simulate climate scenarios for better planning for regional climate risks. Digital twins create virtual replicas of physical assets, processes and systems in a community. Climate models are used to study climate change and variability to project long-term climate change.<sup>99</sup> By using historic and real-time data with future climate conditions,<sup>100</sup> climate analysis technologies use algorithms, AI and machine learning to predict and analyze the climate impacts of a region at different times and based on different factors (such as visualizing the impact of naturalization compared to building development in a region after ten years). Digital twins and other virtual replicas that use machine learning and AI simulations allow a comparison of how anticipated projects can impact climate change and vulnerable communities for improved and more informed decision-making.<sup>101</sup>

## ● Smart mobility

The transportation sector is responsible for 23% of Canada's greenhouse gas emissions and only 12% of regular commuters use public transit as a primary mode of travel.<sup>102</sup> Public transportation systems provide an opportunity to reduce the number of carbon-emitting vehicles on the roads as well as create more connections

99 Environment and Climate Change Canada. 2017. "Climate Models." Canada.Ca. June 6, 2017. <https://www.canada.ca/en/environment-climate-change/services/climate-change/science-research-data/modeling-projections-analysis/centre-modelling-analysis/models.html>.

100 Richardson, G. 2010. "Adapting to Climate Change: An Introduction for Canadian Municipalities." Natural Resources Canada. 2010. [https://natural-resources.canada.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/mun/pdf/mun\\_e.pdf](https://natural-resources.canada.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/mun/pdf/mun_e.pdf).

101 Leffring, Folkert. 2023. "Accelerating Climate Action in Cities with Digital Twins." Cities Today - Connecting the World's Urban Leaders. July 4, 2023. <https://cities-today.com/industry/accelerating-climate-action-in-cities-with-digital-twins/>.

102 Clean Energy Canada, the David Suzuki Foundation, Environmental Defence, Équiterre, and the Pembina Institute. 2016. "Reducing GHG Emissions in Canada's Transportation Sector." June 2016. [https://legacy.equiterre.org/sites/fichiers/fmm\\_transportation\\_recs.pdf](https://legacy.equiterre.org/sites/fichiers/fmm_transportation_recs.pdf).

and access within a region. Public transportation utilizes data and technological innovations to create seamless user experiences through trip or journey planning applications (such as *TripLinx* or *SmartCommute*) and for transit updates. On-demand transit, micro-mobility transit (such as e-bikes and e-scooters) and many carsharing or ride-hailing services also rely on smart applications to reserve and pay for the transportation services. Smart parking systems can be used to identify available parking spaces for users and the use of smart applications are also increasingly popular for on-demand mobile payments for parking (such as *HonkMobile*). The *New Shared Mobility Solutions: A Practitioner's Toolkit* further explores shared mobility options and benefits with examples of different models and systems. In addition to shared mobility through public transportation, smart technology can also improve wayfinding through interactive displays, touch-responsive mapping and QR code signage (to supplement physical signs) that can improve the visual, mobility or cognitive accessibility of a space.<sup>103</sup>

## ● Automation and energy efficiency

Homes in Canada account for just over 18% of the national greenhouse gas (GHG) emissions in the country, largely due to the systems to heat and cool homes, the hot water used and the appliances and technology run<sup>104</sup>. Increasing the energy efficiency of homes through smart technology is one way that Canadians can reduce its carbon footprint and save individuals money through less energy consumption<sup>105</sup>. IoT innovations

103 "Support Navigation and Wayfinding." n.d. Digital Accessibility. <https://accessibility.huit.harvard.edu/support-navigation-and-wayfinding>.

104 Environment and Climate Change Canada. 2021. "Annex: Homes and Buildings." Canada.Ca. February 12, 2021. <https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/healthy-environment-healthy-economy/annex-homes-buildings.html>.

105 Sondergaard, Dawn. 2022. "Homeowners Embrace Smart Home Technology to Fight against Climate Change - Homebuilders Association Vancouver." Homebuilders Association Vancouver. June 4, 2022. <https://havan.ca/canadian-homeowners-eager-to-embrace-smart-home-technology-in-fight-against-climate-change/>.

such as home monitoring and energy automation systems as well as energy efficient smart technology like smart switches, electric heat pumps, LED lighting and Intelligent Thermostats can help improve the efficiency of a home<sup>106</sup>. For example, the Google Smart Nest allows a homeowner, through a smart device, to monitor the temperature and thermostat settings, adjust LED lighting in the home and a new service which allows thermostats to directly communicate with energy providers to allow for automatic shifting of heating and cooling time to when energy on the local power grid is cleaner.<sup>107</sup> Further, systems like Purple Air<sup>108</sup> allow individuals and communities<sup>109</sup> to monitor air quality automatically through the use of home based and outdoor sensors that measures the air quality and connects that data and information through Wi-Fi to a smart technology application dashboard that can be accessed through the web or a variety of mobile-based applications (such information has been leveraged by Canadian municipalities including Cowichan Valley Regional District<sup>110</sup> and the Province of Alberta<sup>111</sup>). By leveraging IoT innovations, smart technology and automation in the home is becoming easier and cheaper to reduce a home's carbon footprint and energy bills.

106 "How the Smart Home Can Help Halt Climate Change." 2021. Silicon Labs. December 28, 2021. <https://www.silabs.com/blog/how-the-smart-home-can-help-halt-climate-change>.

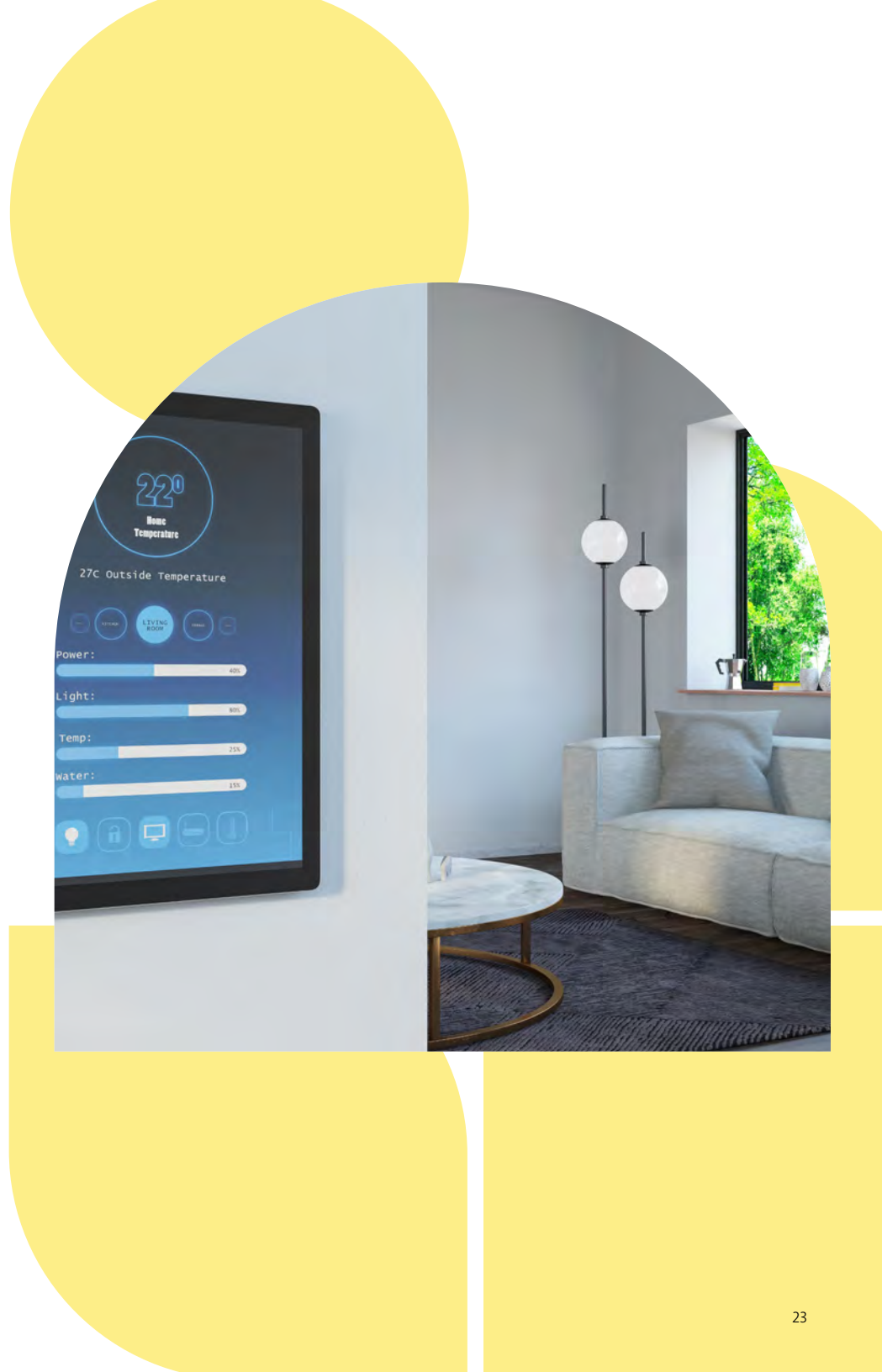
107 "How the Smart Home Can Help Halt Climate Change." 2021. Silicon Labs. December 28, 2021. <https://www.silabs.com/blog/how-the-smart-home-can-help-halt-climate-change>.

108 "PurpleAir | Real-Time Air Quality Monitoring." n.d. <https://www2.purpleair.com/>.

109 "PurpleAir PA-II Air Quality Sensor." 2022. Government of Alberta. August 24, 2022. <https://open.alberta.ca/dataset/f59d9607-df82-4af9-a337-97b1dedec212/resource/2be08aa3-c62e-48a7-bb73-53f6391c03c8/download/aep-purpleair-air-quality-sensor-fact-sheet.pdf>.

110 "FAQ." n.d. Cowichan Valley Regional District. <https://www.cvr.d.ca/3077/FAQ>.

111 "PurpleAir PA-II Air Quality Sensor." 2022. Government of Alberta. August 24, 2022. <https://open.alberta.ca/dataset/f59d9607-df82-4af9-a337-97b1dedec212/resource/2be08aa3-c62e-48a7-bb73-53f6391c03c8/download/aep-purpleair-air-quality-sensor-fact-sheet.pdf>.



## ● Green and clean smart energy

Green and clean energy supports the transition from the reliance of fossil fuels to better meet international and national climate targets. Green and clean smart technologies vary widely in their energy source including solar photovoltaic (PV) panels and arrays to capture sunlight, wind turbines using the wind's power, geothermal energy using the Earth's high temperatures and pressure, tidal action systems powered using the oceans and tides<sup>112</sup> and clean, smart nuclear power<sup>113</sup> (the toolkit *Green Energy Solutions* provides a more detailed overview of renewable, green and clean smart technologies with tools to better understand the energy solution that best suits local needs). Technologies like geothermal heating can be integrated into the construction of homes and buildings and do not necessarily require extensive or connected systems in the power grid. With geothermal energy, home and building owners can use the heat and temperate difference trapped in the Earth to both heat and cool throughout the year while increasing resilience and decreasing reliance on the traditional grid and use smart monitoring technology to monitor the entire system.<sup>114</sup>

The use of solar panels and arrays on homes, buildings and parcels of land is continuing to become more and more popular as prices for these energy sources decline<sup>115</sup> and sunlight is abundant. The use of solar energy is available to most regions of Canada (and the world) and provides an excellent source of power. The use of smart, green technology can reduce energy bills<sup>116</sup> and some communities in Canada have programs that enable community members to feed excess energy generated back to the traditional grid.<sup>117</sup>

### GEOTHERMAL HEATING

With geothermal energy, home and building owners can use the heat and temperate difference trapped in the Earth to both heat and cool throughout the year while increasing resilience and decreasing reliance on the traditional grid and use smart monitoring technology to monitor the entire system.

112 United Nations. n.d. "What Is Renewable Energy?" <https://www.un.org/en/climatechange/what-is-renewable-energy>.

113 "Nuclear Power in a Clean Energy System." 2019. IEA. IEA. <https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system>.

114 Read, Mary. 2020. "Geothermal Energy for Homes in Canada | Green Building Canada." Green Building Canada. May 20, 2020. <https://greenbuildingcanada.ca/2020/geothermal-energy-homes-canada/>.

115 Canada Energy Regulator. 2021. "Market Snapshot: Declining Solar Panel Costs Result in Record Capacity Additions." January 29, 2021. <https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2015/market-snapshot-declining-solar-panel-costs-result-in-record-capacity-additions.html>.

116 "Solar Energy." n.d. Canadian Renewable Energy Association. <https://renewablesassociation.ca/solar-energy/#:~:text=In%20Canada%2C%20there%20are%20currently,Increased%20energy%20independence%20for%20individuals>.

117 "Generate Your Own Electricity." n.d. BC Hydro. [https://app.bchydro.com/accounts-billing/electrical-connections/net-metering.html?utm\\_source=direct&utm\\_medium=redirect&utm\\_content=netmetering](https://app.bchydro.com/accounts-billing/electrical-connections/net-metering.html?utm_source=direct&utm_medium=redirect&utm_content=netmetering).



## Smart city resources

- Evergreen's *Accessible Public Spaces for All: A Practitioner's Toolkit* introduces elements of inclusive public spaces and opportunities to improve engagement with people with disabilities
- Evergreen's *Advancing Community Resilience through Smart Approaches* toolkit that provides guidance and resources to communities interested in building resilience through data and connected technology approaches
- Evergreen's *Applying a Decolonized Approach as the Foundation to Creating Accessible Smart City Design* research brief explores decolonized and Indigenized approaches in the smart city designs
- Evergreen's *Future Fix Podcast* series explores how data and tech are transforming communities across Canada and includes episodes on *smart cities*, *digital placemaking* and other episodes exploring specific smart city innovations across Canada
- Evergreen's *From Consultation to Co-creation in the Open Smart City* toolkit that provides guidance and resources to communities interested in co-creation as a foundation for an open smart community
- Evergreen's *Reimagining Public Spaces* suite of toolkits on *New Shared Mobility Solutions*, *Accessible Public Spaces for All*, *Technology-Based Solutions for Resilience* and *Green Energy Solutions* explores different smart city concepts that can be applied in public spaces
- Solar rebates in Canada: <https://www.solacity.com/solar-rebates-and-incentives-in-canada/>



## Glossary

**Artificial intelligence** (AI) is the “simulation of human intelligence in programmed machines.”<sup>118</sup> 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.<sup>119</sup>

**Blockchain** is the decentralized ledger of all transactions across a peer-to-peer network.

**Cybersecurity** is the protection of systems, networks and programs from digital attacks.<sup>120</sup>

**Data governance** refers to the principles, processes, policies, structures and other parameters and metrics that regulate data collection to ensure collaborative and balanced involvement by all relevant parties with a clear scope and purpose that builds on a relationship of trust and transparency.<sup>121</sup>

**Digital twin** is a virtual replica of physical assets, processes and systems in a community.

**First Nations Data Sovereignty** means First Nations data is governed by First Nations laws<sup>122</sup>

**Hydroponics** is a technique that uses water-based nutrient solutions instead of soil to grow plants.<sup>123</sup>

**Indigenous data sovereignty** refers to the rights of Indigenous peoples to “control data from and about their communities and lands.”<sup>124</sup>

**Internet of Things** (IoT), which refers to “the network of physical objects, or things, which are connected to other devices and systems over the Internet.”<sup>125</sup>

**Machine learning** is a form of artificial intelligence where computers use data and algorithms to “learn” over time, improving the performance of tasks over time and mimicking how humans learn.

**Smart city** refers to “a resilient, inclusive and collaboratively-built city that uses technology and data to better the quality of life for all people.”<sup>126</sup>

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120 Michigan Technological University. 2023. “What Is Cybersecurity?” May 26, 2023. <https://www.mtu.edu/computing/cybersecurity/#::~:~:text=Cybersecurity%20is%20the%20practice%20of,%20interrupting%20normal%20business%20processes>.

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123 “Hydroponics.” n.d. National Agricultural Library. <https://www.nal.usda.gov/farms-and-agricultural-production-systems/hydroponics#::~:~:text=Hydroponics%20is%20the%20technique%20of,%20hobbyists%20and%20commercial%20enterprises>.

124 Rainie, S., Kukutai, T., Walter, M., Figueroa-Rodriguez, O., Walker, J., & Axelsson, P. (2019) Issues in Open Data - Indigenous Data Sovereignty. In T. Davies, S. Walker, M. Rubinstein, & F. Perini (Eds.), *The State of Open Data: Histories and Horizons*. Cape Town and Ottawa: African Minds and International Development Research Centre. <https://www.stateofopendata.od4d.net/chapters/issues/indigenous-data.html>

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126 Ibid.



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