Intelligent Cities

Kelowna, Canada

AI for Good

FOUNDATION

Final Report • December 2021

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Introduction

Facing drastic changes from the workforce to climate change, municipalities around the world have sought to create Smart Cities, using data-enabled sciences to improve the livelihood of their constituents sustainably and innovatively. We seek to take this concept a step further to look at how AI can reimagine urban centers globally, with sustainability and equity as defining principles. **It is our mission to make cities not only smart, but Intelligent.**

This report was completed through a multi-stage process, with the central philosophy of providing recommendations that are rooted in local concerns and infrastructure. To accomplish this, we began with an initial intake survey in which we learned from the City of Kelowna, namely the Intelligent Cities Director Andreas Boehm, in which we learned the central issues that were of primary concern for the city. We then held a series of meetings with the Intelligent Cities team in the City of Kelowna, honing our recommendations to cater to their interests and needs.

For each recommendation, we focussed our initial research on the sentiments and previous work done within the city to meet their goals. While the AI for Good Foundation is an international nonprofit, we believe that effective policy is only possible with a developed understanding of the local environment. **The resulting document provides the most feasible, efficient, and necessary technological solutions for the City of Kelowna.**

Wildfire Mitigation

Recommendation

Expand and improve upon wildfire mitigation efforts, specifically prescribed burns, through the use of drones and Artificial Intelligence. Drones should be utilized for prescribed burn mapping and deployment, as well as in-crisis mapping for the safety of firefighters and residents.

Current State of Wildfires in Kelowna

The City of Kelowna has concentrated its efforts to become a climate change resilient city after a series of major weather events in 2017. Wildfires, flooding, and drought have impacted the local infrastructure in the entire Okanagan Region. These major events have caused economic losses and posed health risks to communities and natural ecosystems. As stated in Climate Projections for the Okanagan Region report, extreme weather events are projected to increase in frequency in the coming decades.[1] This makes it necessary for the city of Kelowna to elaborate plans to adapt and protect communities, ecosystems, and infrastructure.

Major climate change-driven vulnerabilities for the city and surrounding communities, namely droughts and increasing frequency and duration of heatwaves, have set up ideal conditions for forest fires. As this document was being written in early September 2021, 162 wildfires[2] were active in British

Damage Caused by Wildfires in British Columbia

2017 saw the most destructive wildfire season in recent history.

1.2 million hectares burned

$649 million spent in fire suppression

65,000 people evacuated

[1] "Climate Projections for the Okanagan Region | RDOS." 2021. Rdos.bc.ca. https://www.rdos.bc.ca/development-services/planning/strategic-projects/climate-projs/.
[2] "B.C. Wildfire Dashboard." 2021. Arcgis.com. https://governmentofbc.maps.arcgis.com/apps/dashboards/f0ac328d88c74d07aa2ee385abe2a41b.

Columbia, and over 3,900 properties were under evacuation orders.[3] Climate change is causing the city of Kelowna to become hotter and drier, extending the wildfire season by 2.5 months over the last 30 years and almost certainly into the future.[4] Not only does this increase health and safety risks for Kelowna residents, but it is extremely costly as well. The wildfires of 2017, for example, cost British Columbia $649 million to contain, destroyed 1.2M hectares of land and caused the evacuation of 65,000 people. In 2018, this record was surpassed by the burning of over 1.3 million hectares.[5]

> As stated in Climate Projections for the Okanagan Region 2020 report, extreme weather events are projected to increase in frequency in the coming decades.

Current State of Kelowna Fire Protection

According to the Community Wildfire Protection Plan (CWPP, 2016 Update), the city of Kelowna has implemented a multi-step planning process, focussing on the usage of geospatial analysis (GIS) as its primary data collection source coupled with fieldwork. GIS has been used to update fuel typing, create threat polygons (essentially map areas) for study, and to assign initial and secondary threat assessments.[6] This plan was created as a successor to the CWPP of 2011, and since that point, the fire department has completed fuel treatment of 95% of the polygons identified as a moderate threat or greater in the 2011 CWPP.[7] Fuel treatment is a holistic approach to fire prevention that reduces the potential sources of fuel available to a wildfire, through methods such as pruning trees, removing woody surface debris, and prescribed burns (the act of intentionally setting small, controlled fires to prevent larger uncontrollable wildfires.) **In summary, the City of Kelowna has used geospatial analysis (GIS) to determine where fuel management should be implemented.**

Kelowna Wildfire Threat Polygon Map

[3]"Number of B.C. Evacuation Orders and Wildfires Ticks Down." 2021. CBC. August 31. https://www.cbc.ca/news/canada/british-columbia/bc-wildfire-august30-1.6158451.
[4] A CHANGING CLIMATE SPECIAL EDITION COMMUNITY TRENDS REPORT" 2021. City of Kelowna. https://www.kelowna.ca/sites/files/1/docs/business/2017_community_trends_report_.pdf
[5]"Wildfire Season Summary - Province of British Columbia." 2021. Gov.bc.ca. https://www2.gov.bc.ca/gov/content/safety/wildfire-status/about-bcws/wildfire-history/wildfire-season-summary.
[6]"City of Kelowna Community Wildfire Protection Plan 2016 Update" February 2017. B.A. Blackwell & Associates Ltd. https://www.kelowna.ca/sites/files/1/docs/city-services/Fire-Department/kelowna_cwppupdate_2016_final.pdf
[7] Ibid

Kelowna is now poised and ready to implement further wildfire mitigation innovations. The GIS mapping for fuel management has limitations, most notably that the threat assessments cannot be fully applied to the GIS model, causing the WUI (Wildfire Urban Interface) Threat Score to be greatly simplified.[8] In short, current imaging and GIS maps for wildfire mitigation are not meeting the need for diagnosing specific locations for wildfire mitigation. The need for improved wildfire mitigation technologies has been stated by the larger province of British Columbia in their independent review of wildfire and flooding events. The report recommended that the province "Increase use of technology by frontline workers during response by incorporating the use of drones… to assess and assist with planning in all phases of emergency management."[9] First Nations' voices cited in the report also stated the need for "improved technology to predict fire locations and collect data."[10] Not only have there been calls for improvements in technology, but mitigation strategies as well. According to the Government of British Columbia,

> "Its history of aggressive and highly effective wildfire suppression in the Province has resulted in a significant build-up of forest fuels; greater tree encroachment on grasslands; and, 'in-filling' of once open, dry forests of the southern Interior and other areas. This has both increased the risk of devastating wildfires and negatively impacted biodiversity and forest health."

Our recommendations seek to improve upon existing remote sensing infrastructure with drones and artificial intelligence towards correcting historical errors in wildfire mitigation.

First Nations Knowledge, Powered by Artificial Intelligence


Penticton Indian Band Councillor Tim Lezard

First Nations have been stewards of their land for thousands of years, and there is so much to be learned from their ability to mitigate fires. One of the principal fuel management tactics of First Nations is prescribed burning. Tim Lezard[11] is a councilor of the Penticton Indian Band, a First Nations government in the Okanagan region. He spoke of how his grandmother "knew effective methods for burning patches of

[8]City of Kelowna Community Wildfire Protection Plan 2016 Update" February 2017. B.A. Blackwell & Associates Ltd. https://www.kelowna.ca/sites/files/1/docs/city-services/Fire-Department/kelowna_cwppupdate_2016_final.pdf
[9]"Addressing the New Normal: 21st Century Disaster Management in British Columbia Report and Findings of the BC Flood and Wildfire Review: An Independent Review Examining the 2017 Flood and Wildfire Seasons." n.d. https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/emergency-preparedness-response-recovery/embc/bc-flood-and-wildfire-review-addressing-the-new-normal-21st-century-disaster-management-in-bc-web.pdf.
[10]Ibid
[11] Photo: DAN WALTON / iNFOnews.ca

their land on rotation each year," and shared her wisdom with her community before she passed. He learned the importance of never burning in summer months due to ground temperature, how to install and protect guard lines, and to know when weather is favorable.[12] Most importantly is the sentiment that the environment is to be respected.

Similarly, Mic Werstuik, an indigenous logger, learned much of his stewardship as a member of the Westbank First Nation. He remembers "helping his family steward the land" through traditional burns.[13] He now works for Ntityix Resources, a logging company in the Westbank First Nation that manages the forests held by the nation. 90% of those contracted to log in the region for Ntityix Resources are Westbank First Nation members.[14] The fuel mitigation efforts of Ntityix Resources helped prevent the Mt. Law fire near West Kelowna from becoming more severe this year.[15] Prescribed burning is empirically proven to reduce the damages of wildfires. According to Fernandez and Botelho (2003), a 1996 study on the efficacy of prescribed burns in Sierra Nevada, California found that the treatment reduced the average wildfire intensity by 76% and its burned area by 37%.[16] The province of British Columbia has affirmed the usefulness of controlled burning, specifically "because it helps decrease fuel loads… and reduce the intensity of future wildfires by removing understory vegetation.[17] Moreover, implementing prescribed burns is a large part of the province's efforts to reconcile with First Nations and their rights to environmental protection.

> "There are a lot of changes going on right now in regards to reconciliation with First Nations, and First Nations being more involved in the management of natural resources in British Columbia. I think that's going to result in more traditional practices coming into play."

Werstuik stated, "There are a lot of changes going on right now in regards to reconciliation with First Nations, and First Nations being more involved in the management of natural resources in British Columbia. I think that's going to result in more traditional practices coming into play."[18]

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[12]"Prescribed Burns Aren't Just for Fire Protection, Penticton Indian Band Councillor Says." 2021. INFOnews. August 30. https://infotel.ca/newsitem/prescribed-burns-arent-just-for-fire-protection-penticton-indian-band-councillor-says/it85373.

[13]"Indigenous Logger Hopeful Traditional Burning Practices Will Return to Westbank First Nation." 2021. INFOnews. September 6. https://infotel.ca/newsitem/indigenous-logger-hopeful-traditional-burning-practices-will-return-to-westbank-first-nation/it85511.

[14]Ntityix Resources LP. 2021. "Ntityix Resources LP." Ntityix Resources LP. November 15. https://www.ntityixresources.com/.

[15]Indigenous Logger Hopeful Traditional Burning Practices Will Return to Westbank First Nation." 2021. INFOnews. September 6. https://infotel.ca/newsitem/indigenous-logger-hopeful-traditional-burning-practices-will-return-to-westbank-first-nation/it85511.

[16]Fernandes, Paulo M., and Hermínio S. Botelho. 2003. "A Review of Prescribed Burning Effectiveness in Fire Hazard Reduction." International Journal of Wildland Fire 12 (2): 117. doi:10.1071/wf02042.

[17]"Wildland Fire Management Strategy." 2010. https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/wildfire-status/governance/bcws_wildland_fire_mngmt_strategy.pdf.

[18]Indigenous Logger Hopeful Traditional Burning Practices Will Return to Westbank First Nation." 2021. INFOnews. September 6. https://infotel.ca/newsitem/indigenous-logger-hopeful-traditional-burning-practices-will-return-to-westbank-first-nation/it85511.

Prescribed burns are efficacious in reducing wildfires, but are hazardous to implement. Workers must travel along firebreaks, lookout for spot fires, and set ignitions in targeted areas. The work exposes them to smoke "too dense to see through," causing irritated eyes, runny noses, and dry coughs, in addition to exposure to particulate matter.[19] Manual prescribed burning currently holds a few other disadvantages, including labor costs, risk of the fires becoming uncontrolled (escaping), and restrictions due to unpredictable warm or rainy weather.[20] Due to the possible risks and restrictions, planning of prescribed burns in British Columbia can take six months to multiple years.[21]

Drones for Wildfire Mitigation


Drone for Remote Sensing

The latest technologies can bring thousands of years of knowledge of First Nations Peoples to the forefront of climate change mitigation. Coupled with traditional methods, drones can make prescribed burning more effective, safer, cheaper, and faster to implement. UAVs can be operated remotely, allowing a pilot to see a spot fire or an escape as soon as it occurs, and then notify nearby workers to put out the fire.[22] Moreover, the UAV can survey over larger distances than individuals and limit their exposure to hazardous smoke. Finally, drones can also be used to remotely set prescribed burns without human labor or health risk, such as through incendiary payload attachments like Drone Amplified's IGNIS innovation.[23] **Drones can be utilized and optimized in tandem with artificial intelligence through real-time remote sensing and mapping of controlled burns and wildfires, prediction of optimized location to set prescribed burns through spatial and weather data, and real-time progress monitoring to ensure the safety of frontline workers.** Further applications such as ignition payloads are possible; however, it is within Kelowna's discretion to determine implementation steps and scope.

"The latest technologies can bring thousands of years of knowledge of First Nations Peoples to the forefront of climate change mitigation.

[19]"Using Drones with Infrared Capabilities to Monitor Fire Behavior - Oklahoma State University." 2021. March. https://extension.okstate.edu/fact-sheets/using-drones-with-infrared-capabilities-to-monitor-fire-behavior.html.
[20]"Prescribed Burning." 2021. BC Ministry of Forests. https://www.for.gov.bc.ca/hfp/publications/00099/siteprep/3-Fire.htm.
[21]"Prescribed Burns Reduce Wildfire Risks | BC Gov News." 2019. Gov.bc.ca. August 12. https://news.gov.bc.ca/factsheets/prescribed-burns-reduce-wildfire-risks.
[22]Indigenous Logger Hopeful Traditional Burning Practices Will Return to Westbank First Nation." 2021. INFOnews. September 6. https://infotel.ca/newsitem/indigenous-logger-hopeful-traditional-burning-practices-will-return-to-westbank-first-nation/it85511.
[23]"Innovation in Fire Management Technology." 2019. Ignis by Drone Amplified. March 14. https://droneamplified.com/proven-technology/.

Research and real-world applications have shown that drones are efficacious in aiding prescribed burns, as well as in immediate wildfire crises. According to Akhloufi et. al (2021)., drones have proven effective in their "implementation of remote sensing, allocation strategies, and task planning" and provide a "low-cost" alternative for the prevention and detection of wildfires, as well as to support firefighters in real-time during wildfire events.[24]

The nearby government of Alberta provides a successful example of the implementation of drones and artificial intelligence. Partnered with Pegasus Imagery, Alberta has acquired drones that "are equipped with radar and infrared sensors" to produce AI-created maps and video in real-time.[25] Alberta uses drones to plan and monitor prescribed burns, detect areas of high risk, and investigate the cause of wildfires after they occur, and will expand their use to replace manned aircraft when visibility is poor.[26] The Pegasus project has been considered a success with local fire leaders, including Parkland Fire Chief Brian Cornforth, who stated that "The information saves us resources — personnel-wise on the ground — and time, so we're effectively targeting the areas we need to and we know what's happening in that fire zone."[27]

"The information saves us resources — personnel-wise on the ground — and time, so we're effectively targeting the areas we need to and we know what's happening in that fire zone."

The Department of Defense in the United States has also begun to rely heavily on drones to address wildfires in California. The MQ-9 Reaper drone has become a "key asset" in fighting fires, flying 350 hours to support fire agencies handling the County, Klamathon, Ferguson, Carr, Mendocino Complex, and Eel fires. The technology is credited with "helping to protect thousands of structures" by providing video and fire-line updates to leaders, determining where to build future fire lines.[28]

Institutions local to Kelowna, Canada are also working towards utilizing drones for wildfires. Researchers at the University of British Columbia Okanagan (UBCO) have

[24]Akhloufi, Moulay A., Andy Couturier, and Nicolás A. Castro. 2021. "Unmanned Aerial Vehicles for Wildland Fires: Sensing, Perception, Cooperation and Assistance." Drones 5 (1): 15. doi:10.3390/drones5010015. https://www.mdpi.com/2504-446X/5/1/15/htm

[25]Riebe, Natasha. 2021. "Eye in the Sky: Alberta Startup Touts Drones as Wildfire Fighting Game Changer." CBC. July 31. https://www.cbc.ca/news/canada/edmonton/pegasus-imagery-1.6123463.

[26]"Alberta Implementing New Technology to Detect and Manage Wildfires" 2021. Canadian Forest Industries. May 20. https://www.woodbusiness.ca/alberta-implementing-new-technology-to-detect-and-manage-wildfires/.

[27]Chacon, Chris. 2021. "High-Tech Drones Being Used to Combat Wildfires in Alberta." Global News. Global News. August 12. https://globalnews.ca/news/8105792/high-tech-drones-alberta-wildfires/.

[28]"Remotely Piloted Aircraft Become Mainstay of Wildland Firefighting." 2018. U.S. Department of Defense. https://www.defense.gov/News/News-Stories/Article/Article/1595204/remotely-piloted-aircraft-become-mainstay-of-wildland-firefighting/.

conceptualized "Arrow," a wildfire early detection and communication system that uses UAVs to detect wildfires in minutes after it has started, as opposed to days.[29]

Finally, the City of Kelowna can improve technologies for implementing prescribed burns without drones through the usage of artificial intelligence exclusively. For example, BurnPro 3D is a computer vision product that provides images of vegetation down to a granular level, allowing fire managers to decide where to set prescribed burns.[30] While this technology is specific to GIS and is currently in its nascent stages, BurnPro allows the city to see an application of artificial intelligence in prescribed burning currently in use.

Implementation

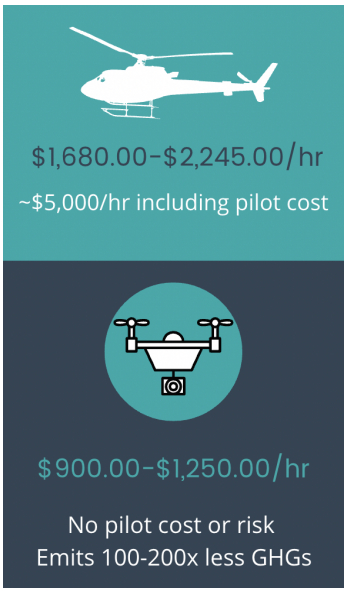
The AI for Good Foundation recommends that the City of Kelowna collaborate with local university professors, namely the UBCO Engineering team leading Arrow, as well as the local business Ntityix Resources to launch a pilot program of drone usage for wildfire prediction, mitigation, and targeted prescribed burning. Should resources prove to be insufficient or a constraint, we recommend that the City of Kelowna partner with Pegasus Imagery to meet capacity needs, emulating their work in Alberta within the City of Kelowna. **We believe that it is best to collaborate with local leaders and organizations before seeking external resources, especially in the pilot stage, as it will be lower in cost and more readily accepted by the community.** However, as the project grows we encourage larger collaborations to meet the needs of the City. We recommend that the success of such a program be measured by cost-benefit analysis, the input of the community and First Nations Leaders, and accuracy of results of wildfire prediction and prescribed burning implementation. Academic literature does not currently provide a comprehensive metric for evaluating drone technology's value in wildfire mitigation, but should such a framework arise we encourage its usage. Some metrics we recommend would be a gathering of qualitative review of front-line workers and indigenous stakeholders, continued tracking of the relationship between hectares burned each year in wildfires versus prescribed fires, and accuracy of drones and machine learning

[29]"ARROW – Atmospheric Reconnaissance & Reporting of Wildfires | Our Blue Planet." 2021. Our-Blue-Planet.com. https://our-blue-planet.com/industrial-innovations/arrow/.
[30]The New York Times. 2021. "How Artificial Intelligence Is Fighting Wildfires." https://www.nytimes.com/2021/07/15/us/wildfires-artificial-intelligence.html.

algorithms in limiting escape fires in prescribed burn scenarios. Machine Learning programs are trackable and educatable by nature, and this will allow for long-term analysis of the effectiveness of the project.

While we believe that targeted prescribed burning is of utmost importance for wildfire mitigation, drones and artificial intelligence can be utilized in several methods to improve climate resilience from wildfires. For example, aerial imagery can be combined with demographic data to understand the differential risk of wildfires on the population. As shown in Alberta and California, drones can be a powerful tool in disaster response once a wildfire has begun. The primary pilot project of drone usage by the City of Kelowna should have a focused scope on prescribed burns, but there are limitless applications to be built upon in the future.

Operational Considerations



Any partnership with outside companies will likely require financial investment. We recommend the city ask for a comparative cost analysis with any company they work with to ensure acceptability with constituents. We have been in contact with Pegasus Imagery to obtain a relative cost-benefit analysis. **Typically, the need being met by drones would be met by helicopters, which cost $1,680.00-$2,245.00 per hour.** This is a conservative estimate, as according to the fire chief of Parkland County in Alberta, the true cost of helicopters including pilots is closer to $5,000/hour.[31] **By comparison, Pegasus drones cost $900.00 - $1,250.00 per hour and emit 100-200x less greenhouse gas emissions (GHGs).** Therefore, drones cost considerably less in terms of city financial investment and environmental toll. In partnering with Pegasus, the City of Kelowna could also potentially receive funding through their application to Sustainable Development Technology Canada (SDTC).[32] **Constituents may also have concerns regarding privacy should drones and/or cameras be utilized. To address these concerns, the city can either provide resources explaining that no personal information will be gathered, or opt to utilize strictly**

[31] Riebe, Natasha. 2021. "Eye in the Sky: Alberta Startup Touts Drones as Wildfire Fighting Game Changer." *CBC*. July 31. https://www.cbc.ca/news/canada/edmonton/pegasus-imagery-1.6123463.

[32] "Home ~ Sustainable Development Technology Canada." 2021. Sustainable Development Technology Canada. November 24. https://www.sdtc.ca/en/.

remote sensing data that does not include visual imagery of property. In addition, partnerships with local companies and researchers are crucial because, according to research from UBC Okanagan, "studies in the US on successful fire resilience and adaptation efforts have shown that complex solutions are best accepted and initiated when originating locally from trusted sources."[33] As with other areas of this report where data privacy concerns are noted, we suggest an AI Ethics FAQ accompanied by infographics for full transparency and for sensitivity to community concerns regarding their privacy.

[33]"CLIMATE CHANGE, WILDFIRES AND THE COSTS OF LIMITED ACTION" Irving K. Barber Faculty of Science. The University of British Columbia Okanagan. https://eegs.cms.ok.ubc.ca/wp-content/uploads/sites/134/2021/07/Bourbonnais_White-Paper_wildfires-and-climate-change.pdf.

Flood Mitigation

Recommendation

We recommend that the City of Kelowna capture LiDAR imagery by drone to support and expand current flood risk mapping (Phase 1). Drone or Airborne LiDAR data should be inputted to create necessary ML prediction models, namely a Digital Twin of the Okanagan Lake Dam to simulate flood scenarios, model reservoir performance, and most importantly optimize the size and location of new spillway projects. Additionally, LiDAR imagery and ML models should also be used to map the greater downtown area to optimize catchments and select areas that could offer more permeability (Phase 2). Modeling of flooding scenarios should be used for citizen awareness at each stage, specifically in disaster flooding events, risk management, and in government oversight of new developments (Phase 3).

Current State of Kelowna Flood Mitigation

Since the 2017 flooding events, the City of Kelowna as well as the greater Okanagan region has taken steps to improve their technologies and mapping for flood mitigation. One manifestation of their improvements was the LiDAR mapping project of Okanagan Lake that began in 2018.[34] LiDAR, which stands for Light Detection and Ranging, is a remote sensing method that uses light in the form of a pulsed laser to measure distances to the Earth to generate accurate 3-D information of the focused area.[35] This technology was performed in Kelowna by airplane in 2018 and is currently being processed.

Okanagan Lake is of focus for this project due to the events that unfolded in the 2017 flooding scenario. **In short, the Okanagan region experienced the 2017 event due to snowmelt, high lake levels, and unseasonal precipitation culminating in the flooding of Mill Creek.**[36] While snowmelt and precipitation are largely out of human control,

[34] SEYMOUR, RON. 2021. "New Maps Give High-Res Peek into Okanagan Lake." *Daily Courier*. September 30. https://www.kelownadailycourier.ca/news/article_96c07f66-223f-11ec-9eb4-cb64b36c1254.html

[35] US Department of Commerce, National Oceanic and Atmospheric Administration. 2021. "What Is Lidar?" Noaa.gov. https://oceanservice.noaa.gov/facts/lidar.html.

[36] KelownaNow. 2017. "Flood 2017: A Visual Timeline." KelownaNow. May 5. https://www.kelownanow.com/watercooler/news/news/Kelowna/Flood_2017_a_photographic_timeline/#fs_103755.

> **While snowmelt and precipitation are largely out of human control, managing lake levels through the Okanagan Lake dam is not.**

managing lake levels through the Okanagan Lake dam is not. The city's current LiDAR project intends to combat these consequences in the future as they provide a clear view of the depth of the lake along the shoreline.[37]

The maps and photos garnered will "help with seasonal flood-protection efforts" by identifying areas most at risk during "heavy rainfall and quick snowmelt."[38] Officials find this project to be a step in the right direction towards fixing mistakes of the past. Shaun Reimer, the provincial official who manages Okanagan, stated that If LiDAR-generated flood maps were available in 2017, the damage might not have been as severe.[39] **The value of this project is that it provides the city and region with a better understanding of the lake, and one that is very much overdue. Before this project, floodplain maps covered only parts of the lake and were about 25 years old.**[40]

While this project has proven to be effective, it is not without great cost. The project was halted in 2018 due to a tragic plane crash of one of the LiDAR planes, resulting in the death of the technician and pilot on board.[41] The hard drive from this crash was recovered, allowing for current analysis.

Outside of this project, the City of Kelowna has sought alternative solutions to flooding. As part of the restoration efforts in 2017, the city removed high-hazard trees, accumulated gravel, and fallen debris. Additionally, the city replanted vegetation and trees in affected areas. This was done to ensure the watershed has the natural capacity to hold future floods.[42] Perhaps more importantly, in 2020 the City of Kelowna announced its interest in building out further flood mitigation strategies, including a three-kilometre spillway that would connect Mill Creek to Brandt's Creek.[43]

A Delicate Ecosystem, Perfected with Artificial Intelligence

The principal focus of flooding mitigation in Kelowna is Okanagan Lake; not only because of the direct impact it has on flooding, but also because it is rife with complexities from climate change unpredictability, biodiversity considerations, and limitations in long-term

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[37]SEYMOUR, RON. 2021. "New Maps Give High-Res Peek into Okanagan Lake." Daily Courier. September 30. https://www.kelownadailycourier.ca/news/article_96c07f66-223f-11ec-9eb4-cb64b36c1254.html.
[38] Ibid
[39] Ibid
[40] Ibid
[41]Gerding, Berry. 2018. "Airplane crash delays Okanagan Valley aerial mapping project." *Vernon Morning Star.* October 17. https://www.obwb.ca/newsite/wp-content/uploads/2018-10-18_clip_airplane_crash_delays_okanagan_valley_aerial_mapping_kcn_vernamstar_saobs_keremeosrvw.pdf
[42]"Flooding." 2018. City of Kelowna. March 9. https://www.kelowna.ca/city-services/safety-emergency-services/flooding.
[43]SEYMOUR, RON. 2020. "Soggy Mill Creek Target of City's New Flood-Control Projects." Daily Courier. June 19. https://www.kelownadailycourier.ca/news/article_bbeb280e-b256-11ea-93bd-1362589c4fc3.html.

and unpopular rezoning needs. Many factors must be considered in the delicate balance of this issue, and it cannot be solved in a day. **Our recommendation will provide the City of Kelowna with the knowledge necessary to reduce the impacts of flooding in their city in the future and empower its citizens with knowledge and understanding of the risks today.**

The first issue that must be considered in the issue of Okanagan Lake is the seasonal precipitation patterns. Snowfall builds up in the winter and melts into the lake as weather warms in the spring. The spring also tends to have "radical weather changes" in precipitation, a factor that is only worsening as climate change strengthens in the region.[44] Later in the summer, drought becomes of principal concern, which has dangerous ramifications as the area is prone to wildfires.[45] Solely from the perspective of unpredictable weather, officials have to critically consider water release timing from the dam. Holding the water level high in the spring increases the risk of flooding, though they must be conservative in releasing water from the dam as too much could worsen drought in the summer.

"Holding the water level high in the spring increases the risk of flooding, though they must be conservative in releasing water from the dam as too much could worsen drought in the summer.

The water timing considerations are made even more volatile by climate change and limitations in current infrastructure. **The Penticton dam on Okanagan Lake can only lower the lake level by approximately 1.75 centimeters a day, while "climate change-induced spring runoff" can raise the lake by 7 or 8 centimeters.[46]** Risks of holding high water levels in the spring are worsened as the lake levels cannot be managed daily with current infrastructure. Experts such as Jesse Zeman, the director of the fish and wildlife program for the BCWF, believe that British Columbia has not created the necessary modeling strategies to keep up with the effects of climate change on Okanagan Lake and spring runoff. The weighing of climate conditions is complicated and nuanced.[47]

"Overall, Kelowna must acquire knowledge to better understand the risks facing the region, and take steps to build synergies between the built environment, people's livelihoods, and ecological realities.

Aside from weather patterns, there are also challenges to the lake water level from biodiversity needs and human-induced impact. Not only is it precarious to release large amounts of water from the dam because it could worsen drought conditions in the

[44]Gerding, Barry. 2020. "Addressing Conflicts in Okanagan Lake Management." Kelowna Capital News. Kelowna Capital News. December 12. https://www.kelownacapnews.com/news/addressing-conflicts-in-okanagan-lake-management/.
[45] Ibid
[46]Gerding, Barry. 2021. "Okanagan Kokanee Spawning Initiative Suffers Setback." Vernon Morning Star. Vernon Morning Star. September 4. https://www.vernonmorningstar.com/news/okanagan-kokanee-spawning-initiative-suffers-setback/.
[47]Gerding, Barry. 2021. "Okanagan Kokanee Spawning Initiative Suffers Setback." Vernon Morning Star. Vernon Morning Star. September 4. https://www.vernonmorningstar.com/news/okanagan-kokanee-spawning-initiative-suffers-setback/.

summer, but the release can also negatively impact the yearly sockeye salmon run in the Okanagan River.[48] Finally, development surrounding the lake and in high flood-risk areas is an unsustainable human factor that must be mitigated. On Lake Okanagan, the natural shoreline faces extinction due to human-caused changes to the shoreline's natural state, including the removal of native vegetation, construction of 165 retaining walls that altered 1.45 km of shoreline, 164 new docks, nine new marinas, increased road access, and general landscaping.[49] These developments not only affect lake levels, but also put the properties at risk in flooding scenarios.

Leading experts and First Nations officials have proposed short-term and long-term solutions to this multifaceted problem. According to Jesse Zeman, B.C. and municipalities must strategize to deal with earlier and more intense spring runoff, followed by drier summers, due to climate change. **In the long-term, Zeman states, Okanagan Valley homes and infrastructure must be moved further from shorelines to decrease flood damages to property. While he is aware that his long-term proposal is likely to be unpopular, he states, "the climate is changing and we have to adapt to a new reality."[50]** These sentiments are echoed by holders of Indigenous knowledge in the region. The Syilx Okanagan Nation Alliance released a Flood and Debris Flow Risk Assessment in 2019, which states that the region "needs to improve flood mapping approaches," such as the LiDAR project, to understand disaster risk and "include them within land use plans." The SONA also calls to "identify and prioritize knowledge gaps" as well as to "address data gaps." Finally, the Alliance recommends "supporting local governments to enhance early warning" of flooding events.[51] Overall, Kelowna must acquire knowledge to better understand the risks facing the region, and take steps to build synergies between the built environment, people's livelihoods, and ecological realities.

Phase 1: Gathering Necessary LiDAR Data Through Drones

While the City of Kelowna has previously taken steps to begin LiDAR mapping of Lake Okanagan, the project was halted with only some of the data acquired and analyzed. We recommend that Kelowna continue to capture the necessary LiDAR imagery of Lake

> **Drones are ideal for this data source because they fly closer to the ground than planes, carry no human risks in pilots, are cheaper than man-operated aircraft, and provide the best and most granular data at any time, day or night.**

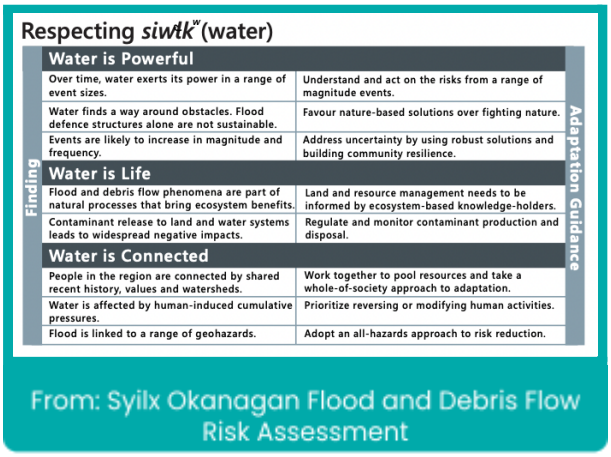
[48]Ibid
[49]Gerding, Barry. 2017. "Protecting Okanagan Lake's Shoreline." Kelowna Capital News. Kelowna Capital News. July 13. https://www.kelownacapnews.com/news/protecting-okanagan-lakes-shoreline/.
[50]Gerding, Barry. 2021. "Okanagan Kokanee Spawning Initiative Suffers Setback." Vernon Morning Star. Vernon Morning Star. September 4. https://www.vernonmorningstar.com/news/okanagan-kokanee-spawning-initiative-suffers-setback/.
[51] "Tikt (Flood) Adaptation – Syilx Okanagan Nation Alliance." 2014. Syilx.org. https://www.syilx.org/natural-resources/water/flood-risk-assessment/.

Okanagan and the greater Kelowna region to facilitate Phase 2 and 3 of this recommendation.

LiDAR through drone capture is the recommended data source, over other sources such as satellite imagery, because satellites do not offer the necessary detail for accurate simulations. While satellites such as Sentinel-1 acquire radar, it likely does not have the necessary resolution to profile relief with enough detail. **Drones are ideal for this data source because they fly closer to the ground than planes, carry no human risks in pilots, are cheaper than man-operated aircraft, and provide the best and most granular data at any time, day or night.**

It is possible to achieve many of the simulations listed in the following phases using satellite imagery; however, it is at the expense of accuracy. The City of Kelowna could also consider using drones for photogrammetry of the necessary areas, being 3-D surface profiling via the capture of multiple photos, should it seek alternate data methods to LiDAR.

Phase 2: AI Models for Flood Mapping and Mitigation



From: Syilx Okanagan Flood and Debris Flow Risk Assessment

Drone imagery and artificial intelligence can provide the necessary information to understand and manage the complexities of Okanagan Lake water releases, provide accurate risk assessments for surrounding communities, and assess damage should flooding occur in the future. This recommendation is informed by the Syilx perspective as shown in the Syilx Okanagan Nation Alliance Flood and Debris Flow Risk Assessment, specifically its summary of recommendations for *Respecting Siwlk* (water).[52]

According to the Sylix Okanagan Nation Alliance, as climate change worsens, it is necessary to understand the range of severity possible in flood scenarios. Drones can accomplish this by providing the same LiDAR analysis that the City of Kelowna has already begun to undertake. However, the previous work can be improved in that the drones can travel any time of day or night, and poses no risk to an onboard pilot as planes do. **The LiDAR data can be coupled with artificial intelligence to create a "Digital**

[52] Photo: "Tikt (Flood) Adaptation – Syilx Okanagan Nation Alliance." 2014. Syilx.org. https://www.syilx.org/natural-resources/water/flood-risk-assessment/.

Twin"-- a virtual representation of an object or system created through real-time data[53]-- of Okanagan Lake and the greater Kelowna area, allowing city and water officials to model reservoir performance and simulate flooding scenarios to understand risks. Inputs for this model would include the "Digital Twin" of the dam, reservoir height, precipitation data, thermal conditions, and land use.[54]

Visualization of Digital Twin

Similar projects have been completed abroad. In Lisbon, Portugal, the city worked with private industry to create a Digital Twin of their city for urban flood simulations. From the information gathered, it developed and began implementing flood protection measures based on its simulations.[55] Lisbon created their Digital Twin using drones and ground-level imagery, as well as 3-D mapping software, to create a 3-D virtual reality. Using inputs such as meteorological data, sewer and stormwater networks, and Bentley's OpenFlows WaterOPS service, the city created a unique flood resilience model. This model is estimated to avoid 20 floods in the next 200 years, and save more than EUR 100 million in damages.[56] While this project was a massive undertaking, it shows the power that informed governance can provide.

We recommend that first manifestations of Digital Twins in flood mitigation in Kelowna should be oriented towards understanding and modeling Okanagan Lake for future flood scenarios, and optimizing the pathways of new spillways to prevent the flooding of Mill Creek as seen in 2017. Given recent interest in the City of Kelowna to construct new spillways,[57] AI modeling should be implemented to decide where and how large new spillway projects should be to optimize the projects.

Additionally, we recommend that the City use LiDAR imagery, coupled with machine learning for land use monitoring. Mapping downtown areas will allow experts to map runoff, and simulate changes to the watershed. This simulation capability could allow policymakers to find the optimal catchment areas in highly urbanized and

[53]Jakob Trauer, Sebastian Schweigert-Recksiek, C. Engel, and Markus Zimmermann. 2020. "WHAT IS a DIGITAL TWIN? – DEFINITIONS and INSIGHTS from an INDUSTRIAL CASE STUDY in TECHNICAL PRODUCT…" ResearchGate. unknown. May. https://www.researchgate.net/publication/342115737_WHAT_IS_A_DIGITAL_TWIN_-_DEFINITIONS_AND_INSIGHTS_FROM_AN_INDUSTRIAL_CASE_STUDY_IN_TECHNICAL_PRODUCT_DEVELOPMENT.

54 Photo: "Digital Twin Technology & GIS | What Is a Digital Twin?" 2017. Esri.com. https://www.esri.com/en-us/digital-twin/overview.

[55]Bühler, Michael Max, Christoph Sebald, Diana Rechid, Eberhard Baier, Alexander Michalski, Benno Rothstein, Konrad Nübel, et al. 2021. "Application of Copernicus Data for Climate-Relevant Urban Planning Using the Example of Water, Heat, and Vegetation." Remote Sensing 13 (18): 3634. doi:10.3390/rs13183634.

[56]"Lisbon's City Scale Digital Twins for Flood Resilience." 2020. GWPrime. July 15. https://www.gwprime.geospatialworld.net/prime/lisbons-city-scale-digital-twins-for-flood-resilience/.

[57] SEYMOUR, RON. 2020. "Soggy Mill Creek Target of City's New Flood-Control Projects." Daily Courier. June 19. https://www.kelownadailycourier.ca/news/article_bbeb280e-b256-11ea-93bd-1362589c4fc3.html.

non-permeable areas, mitigating the effect of increasing urbanization in Kelowna. Simulations could also be used to optimize inputting of green spaces and roofs in new development projects. **While it may be impossible to stop growth and urbanization in Kelowna as the city becomes more popular, LiDAR and AI models can ensure the growth is undertaken responsibly.**

Phase 3: Dissemination of Information and Governmental Oversight

Because flooding is only expected to increase as climate change worsens, the SONA report recommends addressing uncertainty and building community resilience. We recommend achieving this by disseminating the knowledge and risk assessments garnered by drones and AI to allow citizens to be prepared for and aware of flood risk. Researchers from the University of New South Wales completed a study analyzing the accuracy of UAVs in detecting flood damage in a flood-prone region of the Indus River in Pakistan. Using a Convolutional Neural Network (CNN)**, the UAVs and their analysis via machine learning were 91% accurate in positive flood detection.**[58] The study recommended that city governments implement these technologies for emerging disasters. While the City may choose alternate data sources and AI models for their flood mapping, the sentiment of the study to disseminate the information provided by models is of utmost importance. **AI should be used in the City of Kelowna to prevent the same lack of awareness of the incoming flooding seen in 2017. Moreover, as data is gathered over time through drone imagery and AI modeling, information on the habits of floods should be used to warn citizens in high-risk areas.**

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Additionally to warning citizens of incoming floods through AI-prediction, LiDAR imagery and AI-analysis should be used as a mechanism for government oversight to monitor development, specifically surrounding Lake Okanagan, to manage habitat loss and increased flooding risk. **As of 2017, almost 70 percent of the shoreline has been disturbed.**[59][60] Regular and

Development Along Lake Okanagan Shoreline

[58]Rivas Casado, Monica, Tracy Irvine, Sarah Johnson, Marco Palma, and Paul Leinster. 2018. "The Use of Unmanned Aerial Vehicles to Estimate Direct Tangible Losses to Residential Properties from Flood Events: A Case Study of Cockermouth Following the Desmond Storm." Remote Sensing 10 (10): 1548. doi:10.3390/rs10101548.

[59]Gerding, Barry. 2017. "Protecting Okanagan Lake's Shoreline." Kelowna Capital News. Kelowna Capital News. July 13. https://www.kelownacapnews.com/news/protecting-okanagan-lakes-shoreline/.

60 Photo: Ibid

thorough data gathering on further development is necessary to monitor changes to the lake. With this knowledge acquired, the City of Kelowna could catch and report infractions of shoreline disturbance and disincentive further harmful development in flood-prone areas.

Alternate Solutions

Should Kelowna find drone usage to not be immediately feasible, or the city simply wants to implement other AI interventions for flood mitigation, **we recommend alternate solutions that do not use drone-captured LiDAR.** York University in Toronto, Ontario has created AI models using data from the Don and Bow Rivers in Toronto and Calgary, respectively, that can predict water levels multiple days in advance of floods.[61] Using information from upstream hydrological and meteorological stations, researchers made a 4-input AI decision-making algorithm, or neural network, that uses data such as rainfall and temperature. The algorithm learns over time to find the biggest indicators for predicting water levels, reducing prediction uncertainty. The research project is considered effective as it can predict floods 3 days in advance in the Bow River, and 6 hours in advance for the Don River. Researcher Usman Khan cited the importance of this project, stating that **"early warning systems are considered the most effective way to mitigate flood induced scenarios."**[62] A more local enterprise to Kelowna working on similar projects is Minerva Intelligence, a Vancouver-based company that uses AI to map flood risk as well as other climate scenarios.[63] **With whichever technologies Kelowna chooses to develop, it is of the utmost importance that the city ensures open communication with those who may be impacted by increased flooding.**

> **With whichever technologies Kelowna chooses to develop, it is of the utmost importance that the city ensures open communication with those who may be impacted by increased flooding.**

Implementation

This recommendation is highly synergistic with our implementation tactics for Wildfire Mitigation and Sustainable Agriculture. For Phase 1 of this recommendation, we recommend that the City of Kelowna pursue local and regional partnerships to acquire the necessary drones and technological capacity. One such partnership is that of Pegasus Imagery, the Canadian company that is providing drones for wildfire mitigation

[61]2019. "York U Engineering Research Uses AI to Predict Flood Risk in Real-Time | York Media Relations." York Media Relations. November 11. https://news.yorku.ca/2019/11/11/york-u-engineering-research-uses-ai-to-predict-flood-risk-in-real-time/.
[62] 2019. "York U Engineering Research Uses AI to Predict Flood Risk in Real-Time | York Media Relations." York Media Relations. November 11. https://news.yorku.ca/2019/11/11/york-u-engineering-research-uses-ai-to-predict-flood-risk-in-real-time/.
[63]"GAIA FLOOD." 2021. Minerva Intelligence. May 24. https://minervaintelligence.com/gaia-flood/#casestudy.

in Alberta. Pegasus Imagery offers services in flood mitigation; by coupling these goals, the City of Kelowna could expedite implementation and reduce costs. Should Kelowna seek a more localized approach, we recommend partnering with UBC Okanagan, specifically the Arrow Program. For Phase 2 of our recommendation, we suggest partnering with private companies such as Lynker Analytics.[64] While a private partnership will certainly provide the necessary expertise to create the necessary models, it is worth considering the cost, estimated at $30-40k for projects of this magnitude. Should the City of Kelowna seek less expensive solutions, we recommend partnering with local machine learning engineers and students at UBC Okanagan. Phase 3 of the project, specifically the mapping and optimization of downtown areas, would entail a land cover appraisal. This too is available from Lynker Analytics, at the cost of $10-15k. For the government oversight portion of the recommendation, we suggest Clarity Value as a partner, which uses technology for improved government management.[65]

For solutions that do not require LiDAR or drone usage, the City of Kelowna can partner with the local Minerva Intelligence. An additional option is True Elements, a company that can map the watershed of Kelowna and then determine water quantity and quality using satellite imagery and sensors.[66]

Regardless of the partner, we believe it to be of utmost importance that the City of Kelowna partners with the Sylix Okanagan Nation Alliance and integrate Syilx perspective throughout its implementation. Similar to our recommendation for wildfire mitigation, there is not expansive literature on measuring the efficacy of these tactics. Looking at previous pilot projects, we recommend that metrics for efficacy include qualitative feedback from First Nations and Kelowna residents, accuracy of flood prediction modeling, and assessment of models.

[64] "Lynker Technologies." 2021. Lynker.com. August 17. https://www.lynker.com/.
[65] 2021. Clarityvalue.co. https://clarityvalue.co/.
[66] "True Elements - Water Quality Data & Forecasting." 2021. True Elements. October 6. https://trueelements.com/.

Operational Concerns

Residents of Kelowna may be concerned with the use of drones (UAVs) for privacy reasons. However, we believe that these concerns will be minimal as the surveyed areas for flooding and wildfires will only be analyzed surrounding Okanagan Lake, an area that has already been studied using LiDAR technologies. However, the City of Kelowna should still provide resources that address the privacy protection guaranteed in these analyses. Similar to wildfire mitigation, there could be startup costs associated with these technologies. However, as shown previously, drones are a much cheaper and safer alternative to human-piloted aircraft. Finally, if the City of Kelowna chooses alternative flood mitigation strategies, such as those provided by Minerva Intelligence and True Elements, possible issues may arise in acquiring the necessary data for flood mitigation. Should this be a problem, we recommend that Kelowna partner with UBC Okanagan to provide data sources for flood prediction.

Tourism Enhancement

Recommendation

The City of Kelowna should invest in a vehicle-to-infrastructure (V2I) mobile intervention that retrofits LiDAR sensors to vehicles which collect surrounding environment data. Translated to three-dimensional maps for geo-referencing, this technology can be leveraged to efficiently identify asset damages and elevate asset management to remote condition monitoring in Kelowna.

While we understand that infrastructure improvements may not be the most intuitive choice for tourism enhancement, our conversations with local leaders lead us to recommend a path for sustainable tourism that benefits citizens and visitors alike for decades to come.

Current State of Tourism in Kelowna

Kelowna's tourism sector is a vibrant and thriving industry that welcomes more than 1.9 million visitors, directly contributing to one of the city's most critical economic drivers and a 1.25 billion dollar industry.[67]

Aside from serving as a major fiscal channel, the value propositions Tourism offers to the community include the generation of 13,000 jobs, $204 million in tax revenue, and $443

67Shauf, Chris. 2017. "Kelowna's Tourism Industry Continues to Grow." Tourismkelowna.com. Kelowna Visitor Centre. December 7. https://www.tourismkelowna.com/industry/industry-news-centre/post/kelownas-tourism-industry-continues-to-grow/.

million in visitor spending at local businesses.[68] Kelowna can continue to augment their tourism sector, which is already in progress.

In a similar fashion to most other industries, Tourism faced extensive operational disruptions due to the pandemic. As the spread of COVID-19 continues to ebb away and tourism flows pick up once more, Tourism Kelowna, a nonprofit made up of the City's stakeholders, has disclosed a strategic response to COVID-19 titled '*The Way Forward*'.[69] This recovery action plan entails a timelined three phase approach to revive the tourism industry. Within this framework, the steps include:

1. **Preserve** - before allocating resources to recovering from the consequences of restricted mobility, the initial response was to ideally safeguard Kelowna's pre-existing tourism ecosystem. Key metrics of this first step included the development of e-commerce in order to shoulder proximity gathering constraints as well as the continuation of ongoing affairs presumably through virtual means.

2. **Push** - the second phase was set into motion when travel restrictions were slightly eased. Marketing was centric to this phase where the strategy of heavy-up marketing was primarily leveraged.

3. **Promote** - this step of the COVID-19 response is currently in process at the time of writing as it was designated to commence once travel restrictions were sufficiently lifted. The crux of this phase lies within destination marketing to amplify promotions and rekindle a desire within visitors to travel to Kelowna.

Through *The Way Forward,* key deliverables included: the creation and successful integration of a COVID-19 Safety plan within designated visitor centers; enhancement of the visitor guide to incorporate digital tools that aid value to tourists and local businesses; methods of sustaining and reviving tourism post-pandemic.

Concerns of the Local Community

In addition to the benefits of tourism, citizens and local organizations have also expressed an array of concerns associated with this form of economic growth. For members of the Kelowna community, an immediate concern is COVID-19. These

68"Report to the Community | Tourism Kelowna." 2019. Tourismkelowna.com. https://www.tourismkelowna.com/community/report-to-the-community/.

69Ibid

sentiments were clearly expressed in a resident survey[70] conducted by Tourism Kelowna which had a primary intention of gauging resident comfort levels in welcoming tourists.

While COVID-19 presents itself as a pressing but current cause of concern, a long-term matter of interest for 96% of Tourism Kelowna stakeholders and the 86% of the local community of Kelowna at large is ensuring the practice of responsible and sustainable tourism.[71] The concept of sustainable tourism is a framework that values the maximization of benefits that tourism presents to the local community, while mitigating the adverse impacts that tourism inflicts on the locality's environment and social life.[72] The often difficult to identify but severe damage tourism has the potential to impose on local ecosystems has led to the coinage of the term 'the invisible burden'. This includes not only the social and environmental strain imparted upon destinations, but as well as hidden financial burdens that residents are often obliged to cover.[73]

What is the impact of shifting from destination marketing to destination management?

One of the most important mechanisms to ensure sustainable tourism is to create infrastructure changes that will make Kelowna appealing to citizens and tourists alike, repositioning priorities to destination management. Destination marketing and destination management are distinctive strategies to ameliorate tourism within a specific destination. The former is front-facing and centered around attracting visitors to

[70]Tourism Kelowna. 2020. "Second Resident Sentiment Survey Collected." Tourismkelowna.com. Kelowna Visitor Centre. August 26. https://www.tourismkelowna.com/industry/industry-news-centre/post/second-resident-sentiment-survey-collected/.

[71] Horsnell, Jennifer. 2020. "An Impactful Conference." Tourismkelowna.com. Kelowna Visitor Centre. January 23. https://www.tourismkelowna.com/industry/industry-news-centre/post/an-impactful-conference/.

[72]"Who We Are - Center for Responsible Travel." 2021. Center for Responsible Travel. April 13. https://www.responsibletravel.org/who-we-are/.

[73]"Destinations at Risk: The Invisible Burden of Tourism - Travel Foundation." 2019. Travel Foundation. http://www.thetravelfoundation.org.uk/invisible-burden/.

the destination through promoting the location. The main functionalities of destination marketing include advertising highlights of the location, crafting and amplifying an ideal tourism narrative surrounding the area, and ensuring that the customer experience with marketing channels are user-friendly and convenient.[74] The role of destination marketing is typically associated with destination marketing organizations (DMO) or a tourist board who superintend operations.[75]

In a similar fashion to destination marketing, destination management is meant to bolster tourism but deviates from the marketing focus and instead is more concerned with overseeing all aspects of the operations of the destination holistically. This entails activities, the environment, attractions, events, public assets and resources, and accommodations to ensure that the tourism experience meets or exceeds the expectations of visitors. Destination management is aligned with the best interests of the locality and its residents as well as the environment by mitigating consequences of tourism such as damages, pollution, demand on resources, and congestion.[76]

> While COVID-19 presents itself as a pressing but current cause of concern, a long-term matter of interest for 96% of Tourism Kelowna stakeholders and the 86% of the local community of Kelowna at large is ensuring the practice of responsible and sustainable tourism.

Due to the wide-reaching presence of social media platforms, tourists are often sufficiently fulfilling the role of destination marketing through sharing their travelling experiences to their audiences. As a result, destination marketing has lessened in need. Cities have begun to realize and acknowledge this paradigm shift and respond accordingly.[77]

[74]"What Is Destination Marketing?" 2018. Promodo Online Marketing Company - SEM, SEO Services, PPC, Usability & CRO. July 12. https://www.promodo.com/blog/what-is-destination-marketing/.
[75]Revfine.com. 2020. "14 Destination Marketing Strategies to Attract More Visitors | Revfine.com." Revfine.com. November 4. https://www.revfine.com/destination-marketing/.
[76]Revfine.com. 2021. "Destination Management: How Tourism Adds Value to Your Destination." Revfine.com. March 4. https://www.revfine.com/destination-management/.
[77]Greco, Gianna. 2019. "Behind the Shift from Destination Marketing to Destination Management." Skift. Skift. January 24. https://skift.com/2019/01/24/behind-the-shift-from-destination-marketing-to-destination-management/.

How can Kelowna leverage AI and Intelligent City Principles to elevate city asset maintenance?

Artificial intelligence is already playing an active role in facilitating the streamlining of city asset infrastructure maintenance and operation on a global scale.

a. Optimizing road maintenance costs

Roads serve as the backbone of a city's transportation and mobility networks thus it is imperative for cities to optimize workflows for the maintenance and renewal of road infrastructure.[78] Impediments to ensuring these processes are as efficient as possible include time inefficiencies, intensive strain on human resources, as well as high costs to assess damage. Therefore, in order to circumvent the aforementioned challenges, it's critical to identify road damage such as imperfections, cracks, potholes and other symptoms of infrastructure distress as early as possible.[79]

"The results and conclusive findings of this initiative are promising for future applications that meld artificial intelligence and public asset maintenance and management.

Kokomo, Indiana acknowledged the potential for Artificial Intelligence to augment and streamline their road damage identification process through a joint initiative with Picterra, a geospatial intelligence company.[80] To illustrate their pipeline, the process is initialized with data acquisition from the drone pilot. Through the subsequent amounts of data that was collected, orthophotos, an aerial photo that has been corrected to be orthographic, are then generated. This step is closely followed by assessment and detection of road damage by a human personnel which then guides decision making in the deployment of resources according to priorities of maintenance.[10]

The results and conclusive findings of this initiative are promising for future applications that meld artificial intelligence and public asset maintenance and management. Relative to conventional operations ($64,000), the Picterra intervention ($2,400) was able to outperform in terms of total cost, human resource requirements, and speed.[10]

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[78]AJ Abdallat. 2021. "Council Post: The Future of Smart Cities' Utilities: Powering Progress with AI." Forbes, April 12. https://www.forbes.com/sites/forbestechcouncil/2021/04/12/the-future-of-smart-cities-utilities-powering-progress-with-ai/?sh=7086899564c7.

[79]"Artificial Intelligence for More Efficient Haul Road Maintenance - KAGARA Corp." 2020. KAGARA Corp. December 11. https://kagaracorp.com/haul-road-maintenance/.

[80]"How Smart Cities Are Using Artificial Intelligence? | Picterra." 2020. Picterra. April 14. https://picterra.ch/blog/smart-cities-using-artificial-intelligence/.

b. Video Analytics to enhance public services

Solutions that leverage tools like Internet of Things (IoT) are becoming increasingly commonplace in smart cities; and further implementation of IoT can move cities like Kelowna toward becoming Intelligent Cities. The hardware component of IoT has become a primary prerequisite for larger-scale Artificial Intelligence projects. NVIDIA has built out a sustainability-centric platform that coalesces intelligent video analytics and sensors in order to drive actionable insights in the maintenance of public assets and infrastructure. The overarching goal is with this heightened acumen to support cities with navigating which areas of the city take precedence for enhancement.[81]

c. Smarter traffic management with Miovision

Miovision is developing a traffic system of the future that encompasses tools such as cameras as well as historical big city infrastructure data to alleviate traffic congestion issues in cities where constrictions in traffic flow are a pertinent issue. This application already has been deployed in Quincy, Massachusetts who incorporated the technology into their traffic system. Residents of Quincy have mobility through two main channels of transportation, local and regional but their networks were often congested. This state was especially notable in their downtown core region due to heightened economic activity as well as increased access to a major highway route and public transit. The key objectives of Quincy to attenuate congestion were reducing commute times, bolster predictability of traffic patterns, and minimize congestion time frames.[82]

With these targets in mind, the team identified the capacity for a decentralized adaptive signalling system to alleviate their traffic issue. However, while in development, they also recognized and acknowledged the need for other distinctive features to be incorporated into the system such as mediums of traffic data collection, detection abilities, and remote communication from intersection to intersection.[12]

[81]AJ Abdallat. 2021. "Council Post: The Future of Smart Cities' Utilities: Powering Progress with AI." Forbes, April 12. https://www.forbes.com/sites/forbestechcouncil/2021/04/12/the-future-of-smart-cities-utilities-powering-progress-with-ai/?sh=7086899564c7.

[82]"Case Study: Building a Future-Proof Traffic System, Quincy, MA | Miovision." 2021. Miovision.com. https://miovision.com/case-studies/quincy/.

Following the deployment of Miovision Video Detection and Performance Measures, paired with Rapid Flow Technologies Surtrac adaptive system[83] (essentially a system that adapts in real time to changing traffic by optimizing traffic flows every second), Quincy raked in the benefits of 10-15% reduction in congestion, improved foot and vehicular traffic within the metropolitan region, and the eradication of previous traffic issues.[12]

Detailed Recommendation for Improving Kelowna's Infrastructure

Kelowna's current infrastructure management is an unenhanced system that solely relies on local community participation. Residents must visit the City of Kelowna's website, locate the report/request under services and requests and then identify the issue that they would like to report. From there, they're subjected to a lengthy survey that requires them to detail the type of structure, the location of their problem, a description and attach images. Once they've provided that information, they then must share their own private information as the city does not accept anonymous requests.

It's imperative that the city of Kelowna moves towards a solution to resolve infrastructure damages remotely in order to make condition monitoring as sustained and methodical as possible to expedite the city's response to damaged public assets. It's also critical to map out how to suspend delays as much as possible in the timeframe between when infrastructure needs maintenance to when city personnel are deployed to repair the area of concern.

City infrastructure has been consistently acknowledged as a civic issue by the city. A 2018 community trends report underlined the significance of Kelowna's infrastructure challenge, and noted how interwoven infrastructure is with the quality of life for residents and the economic competitiveness of the city.[84] Through the 10-Year Capital Plan, Kelowna's infrastructure deficit was forecasted to rely on an investment of $1.05 billion to be allocated across twelve capital cost centers.[85] Although a segment (a predicted $573 million) of that overhead will be funded by the general fund, the shortfall of $477 million remains unresolved.[86]

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[83]Rapid Flow Technologies. 2021. "Surtrac: Intelligent Traffic Signal Control System." Rapidflowtech.com. https://www.rapidflowtech.com/surtrac.

[84]"15 Things to Know About Canadian Infrastructure." BCG Center for Canada's Future. https://static1.squarespace.com/static/59c96387268b96752ffd6100/t/59d3ee32d7bdcef89793aee4/1507061319999/15_things_to_know.pdf

[85]"10-Year Capital Plan." 2018. City of Kelowna. https://www.kelowna.ca/sites/files/1/docs/10-year_capital_plan_2018_-2027.pdf

[86] "Community Trends 2018." 2018. City of Kelowna. https://www.kelowna.ca/sites/files/1/docs/2018_community_trends_report_-_responding_to_the_infrastructure_challenge.pdf

Cities are only beginning to realize the vast potential of integrating smart city technologies into their infrastructure ecosystems. Urban infrastructure is at the basis of the economic and social experiences of residents and quality of life at large for the local community. As cities scale and additional demand is exerted on assets, it's essential to recalibrate how actors approach enhancing and maintaining city infrastructure with environmental mindfulness and on financial constraints.

With aging infrastructure and growing populations, investment allocated to the renewal of assets in need of maintenance is a necessity. Intelligent and robust asset management systems that effectively monitor and streamline the lifecycle process of city infrastructure generate value for residents and the city.

A vehicle-to-infrastructure (V2I) solution that coalesces emerging technologies that *Intelligent City* stakeholders are becoming increasingly acquainted with such as Artificial Intelligence (AI) and Internet of Things (IoT), can fill the gaps in Kelowna's current asset management pipeline's identification phase which is currently heavily reliant on human intervention. By eliminating the operational prerequisite of residents or a workforce to pinpoint assets in need of repairs, the implementation of a vehicle-to-infrastructure solution would enable reduced labor costs, quicker response times to damages, and heightened safety.

> Through eliminating the operational prerequisite of residents or a workforce to pinpoint assets in need of repairs, the implementation of a vehicle-to-infrastructure solution would enable reduced labour costs, quicker response times to damages, and heightened safety.

The framework for this vehicle-to-infrastructure intervention is composed of three main processes:

Data Collection - Vehicles that follow a routine route such as public transportation, garbage trucks, etc would be retrofitted with camera systems and LiDAR sensors, instruments that emit pulses of light that hit surroundings to determine distances between real-world objects, which would capture a snapshot of the conditions of assets. This data would translate to 3D point cloud visualizations of the city environment/surroundings as the vehicle navigates through the streets.

Analysis of assets - Once the point cloud data has been captured, this information will be processed and then curated into a detailed map of the city environment. Asset damages such as pot-holes, cracks or imperfections in road surfaces, etc will then be identified and pinpointed.

Deployment of Infrastructure Repair Resources - This data will then be transmitted to infrastructure management teams who can leverage the insights garnered from the data to power decision making and recalibrate resource allocation accordingly enabling more efficient operations and quicker identification of asset damages.

Case Studies

While the technologies behind vehicle to infrastructure solutions are still maturing, some cities have forged ahead in finding applications where V2I can be used to solve civic issues. In the particular case of asset management, a notable example is a joint collaboration between Cepton Technologies, a LiDAR-based solutions provider and Vortex IOT, a smart city technologies vendor. These companies have undertaken a pilot project to transfigure UK buses into a remote and mobile condition monitoring system, capable of observing surroundings in an effort to reimagine urban asset management.[87]

Vortex IoT brings its Continuous Urban Scanner System (CURBS) to the table. CURBS retrofits LiDAR powered cameras to vehicles enabling the collection of 3D point cloud visualization data, which is the cornerstone to creating 3D mapping of city streets. The role of AI comes into play in tandem with Cepton's Vista®-P60 high-resolution lidar sensors which create the 3D map visualizations. Courtesy of CURBS, asset management becomes more targeted as causes for concern such as potholes, fallen road signs and road surface damages are quickly detected and using 5G networks, that data is relayed back to infrastructure management teams to enable more efficient operations and quicker identification of asset damages. Furthermore, it is expected that Cepton's and Vortex IoT's intervention will likely influence the safety of city roads as well as carbon emissions.[88]

Cepton and Vortex IoT are in the midst of deploying this solution in the West Midlands under a 5G scheme sponsored by the UK government called "WM5G" alongside National Express and BT. "The mission of the WM5G Transport team is to support 5G innovation within the region to make transport networks safer, more sustainable and more intuitive to users," said David Conner, Project manager at WM5GTransport.[18]

[87]"Vortex and Cepton Partner to Enable V2I Solutions with Smart Lidar and AI." 2021. Cepton.com. https://www.cepton.com/announcements/vortex-and-cepton-partner-to-enable-v2i-solutions-with-smart-lidar-and-ai.
88"Vortex and Cepton Partner to Enable V2I Solutions with Smart Lidar and AI." 2021. Businesswire.com. October 5. https://www.businesswire.com/news/home/20211005005421/en/.

Potential Partners

VortexIoT - develops Internet of Things technologies such as smart sensors, networks, and AI based systems.[89] Vortex IoT's Continuous Urban Scanner (CURBS) which lies at the intersection of three emerging smart city technologies, AI, LiDAR, and 5G, is the mainstay product enabling this real-time mapping system.[90]

Cepton Technologies - this potential partner is suggested in conjunction with VortexIoT. Cepton, a provider of liDAR based solutions, in this application would be supplying their Vista®-P60 high-resolution lidar sensors to supplement Vortex IoT's Continuous Urban Scanner, completing the intervention.

Cyclomedia - designs, builds, and operates advanced geo-imaging technologies and mapping systems. They offer a suite of solutions and interventions but all have the common denominator of using mapping as a tool to drive desired outcomes. Should the city partner with Cyclomedia, Cyclomedia's data capture, data visualization, and data insights products are at the backbone of this recommendation. [91]

Operational Considerations

Should the City of Kelowna choose to partner with a private company such as Cyclomedia- base cost estimates circulate at $150 per mile; however, these costs are dependent on the assets that the city would like captured, if they would like to pursue a yearly contract or a one-time use case, and other factors.

Due to the solution's dependence on collecting environmental information in order to create the 3D maps, citizens may experience unease at the prospect of being captured within the data as retrofitted vehicles roam the streets of Kelowna. Though there may be initial reservations, LiDAR is renowned for its data anonymization. This feature of LiDAR serves the best interests of residents in terms of data privacy due to the fact that it does not capture biometric data, keeping the faces of residents unidentifiable if captured.[18]

89"Making the Invisible, Visible." 2021. Vortex. https://vortexiot.com/.

90"Transport Competition Winner: CURBS - West Midlands 5G." 2020. West Midlands 5G. October 5. https://www.wm5g.org.uk/news/transport-competition-winner-curbs/.

91"About Cyclomedia | Cyclomedia." 2021. Cyclomedia.com. https://www.cyclomedia.com/us/company/about-cyclomedia.

Envisioned Impact

Infrastructure plays a critical role in the quality of life residents experience in their day to day lives. Assets serve a multitude of functions, among these, many are interconnected with public safety, with that in mind, ensuring that assets are maintained and serviceable is essential.

Creating a Catalyst

Recommendation

The City of Kelowna should build upon its Design Jam by creating an annually-recurring civic hackathon program, with a target audience of city workers and citizens of Kelowna. This program should be complete with individual learning and collaborative team engagement events leading up to a final learning-through-prototype event. The program should not measure success in effective projects resulting from the Design Jam, but rather in community involvement and collaboration.

Overview of Catalyst in Kelowna

In January 2020, the City of Kelowna released its Intelligent City Strategy Executive Summary, outlining the programs and goals to integrate technology into city infrastructure. Within this framework is a three-strategy approach, the first being "Intelligent Foundation", concerned with the implementation of automation, digitization, and data-driven decision-making in business and municipal spaces for increased efficiency. Strategy Two of the plan calls for "Intelligent Collaboration," through fostering networks that use technology to solve problems facing the city, as well as increasing digital equity and connectivity. Catalyst, or Strategy 3 of the Intelligent City Strategy, seeks to provide resources and guidance to foster innovation within the city.[92]

One way that the city has implemented Strategy 3 is through "Design Jams." In which, the city works in collaboration with citizens to solve issues facing the community.[93] In the October 2019 Design Jam, the goal was to reduce theft from vehicles. This resulted in 4 prototypes that are in consideration for buildout. This interactive session convened approximately 30 community members to consider solutions from the community. The methodology behind a Design Jam was to "come together as a community and

[92] "Intelligent City Strategy." 2020. City of Kelowna. https://www.kelowna.ca/sites/files/1/docs/related/intelligent_city_strategy_-_city_of_kelowna.pdf.
[93] Ibid

re-scope the problem" of vehicle theft. The event resulted in actionable prototypes through community innovation and collaboration.[94]

> One participant stated that this "is as close to a perfect academic, public sector, and private enterprise partnership as one can imagine."

Similar to Design Jams are "hackathons," which, too, have been utilized to find and create smart city solutions in Kelowna. In January 2020, Rogers Communications envisioned a collaboration with Microsoft and UBC to create an "ideation session" for solutions that could be created with the 5G bandwidth provided by Rogers and the Microsoft Azure Edge Compute platform. Microsoft Garage, an internal program with Microsoft, facilitated this conceptualization and eventually a hackathon within the City of Kelowna. Set for the last weekend of March 2020, the hackathon was made virtual due to the COVID-19 pandemic. The purpose of the hackathon was to both solve Kelowna city problems and teach participants new skills. Microsoft employees also participated as mentors and benefited from the event, providing a space to step out of their normal roles, hear student perspectives, and make connections.[95] This hackathon led directly to the implementation of a project dedicated to exploring how technology and wireless connectivity could be used to study downtown traffic. **As a result, LiDAR sensors, supplied by Blue City Technology, will be installed at crucial intersections.** One participant stated that this "is as close to a perfect academic, public sector, and private enterprise partnership as one can imagine."[96] Overall, this event was a success and led to direct collaboration and innovative solutions in Kelowna.

Rogers Virtual Hackathon in 2020

Hackathons: Changing Goals

> Becoming increasingly popular over the last decade, city governments have been drawn to these events as a way to make use of public data repositories and garner new ideas from the community of what software could be beneficial.

This recommendation seeks to create a "civic hackathon," which are events that seek to improve city service through new technologies such as software programming, data analysis, or graphic and web design.[97] **The primary difference between civic hackathons and traditional**

[94]"City of Kelowna Hosts Brainstorming Session to Combat Crime - Kelowna News." 2019. Castanet.net. October 30. https://www.castanet.net/news/Kelowna/269356/City-of-Kelowna-hosts-brainstorming-session-to-combat-crime.
[95] "Making Smart Cities: The Power of Hackathons Brings Together Rogers, UBC Students, City of Kelowna, and Microsoft to Advance 5G Smart City Applications - Microsoft Garage." 2021. Microsoft Garage. May 17. https://www.microsoft.com/en-us/garage/blog/2021/05/making-smart-cities-the-power-of-hackathons/.
[96] Potenteau, Doyle. 2020. "Pilot Project Featuring LiDAR Sensors, 5G Network, to Study Traffic Patterns in Downtown Kelowna." Global News. Global News. May 28. https://globalnews.ca/news/6999316/pilot-project-traffic-patterns-kelowna/.
[97]Turkel, Eli, Elizabeth Suchanic, and Randy Neil. n.d. "Civic Hackathons as Deliberative Democracy: Reflections from Participation in the 2018 Delaware Open Data Challenge." https://cpb-us-w2.wpmucdn.com/sites.udel.edu/dist/4/10696/files/2019/04/Turkel_Hackathon-2j9uu8g.pdf.

hackathons is that the participants are not students, but rather members of the community, for the community. Becoming increasingly popular over the last decade, city governments have been drawn to these events as a way to make use of public data repositories and garner new ideas from the community of what software could be beneficial. Perhaps more importantly, civic hackathons are designed to have citizen participation to allow them to acquire the knowledge to solve city problems, and in turn the capacity to include technologies in their own businesses and lives. **In short, civic hackathons are designed to foster innovation towards city problems while simultaneously encouraging collaboration and knowledge sharing of data-enabled solutions within the community, accomplishing Strategies 2 and 3 of Kelowna's Intelligent City Strategy.**

Our recommendation seeks to show Kelowna can "hack hackathons" and integrate the tenants and existing projects, such as "Design Jams," to create a sustainable and effective program for innovation and community engagement.

While there are many possible benefits to hackathons, they are not without criticism. Research in the efficacy of hackathons have supported colloquial understandings that solutions are unfinished or abandoned after the hackathons, with a correlation found between applications losing accolades and being abandoned.[98] Not only have single hackathons been largely found to be ineffective, but exclusionary. One survey of hackathons found that most participants are male, between the ages of 25 and 34, and attend largely to network. Considering such an insulated demographic, it is not surprising that 70% of hackathon attendees surveyed were not attending their first hackathon.[99]

Our recommendation seeks to show Kelowna can "hack hackathons" and integrate the tenants and existing projects, such as "Design Jams," to create a sustainable and effective program for innovation and community engagement. Overall, this recommendation necessitates a reorientation of what a hackathon's success looks like. **Instead of using a metric of numerous successful and implemented projects, research shows that civic hackathons should be measured for their community engagement and empowerment.** We offer research-backed implementation requirements to make this ideal a reality for Kelowna.

[98]Gama, Kiev. 2017. "Preliminary Findings on Software Engineering Practices in Civic Hackathons." 2017 IEEE/ACM 4th International Workshop on CrowdSourcing in Software Engineering (CSI-SE), May. doi:10.1109/csi-se.2017.5.
[99]Turkel, Eli, Elizabeth Suchanic, and Randy Neil. n.d. "Civic Hackathons as Deliberative Democracy: Reflections from Participation in the 2018 Delaware Open Data Challenge."
https://cpb-us-w2.wpmucdn.com/sites.udel.edu/dist/4/10696/files/2019/04/Turkel_Hackathon-2j9uu8g.pdf.

Reimagining the Hackathon

The first and arguably most important requirement to have an effective hackathon program is to ensure it will not be a singular event, but rather a multiple-month program that is repeated yearly. Research shows that a single hackathon cannot solve a city's problems, but a series of events creates the space to form stronger community bonds and more thoroughly-considered solutions.[100] This allows municipalities to reorient their expectations from "fixing community problems" to the "reinvigoration of civic life in local communities."[101] **Providing citizens with more time and yearly-repeating events can foster actual learning as opposed to short, frantic races to answers.**

Along with simple length, there are tangible strategies that can be implemented to ensure sustained "social learning ecosystems." Researchers Jaskiewicz et al. recommends that civic hackathons specifically orient themselves around:[102]

Supporting participants by providing necessary education and skills

Inspiring citizens with complementary abilities and backgrounds to create data-literate communities towards city improvement

Providing participants with a challenge to synthesize their knowledge and work as a team, creating community bonds and empowering citizens

Towards these points, we recommend that the city intentionally create teams for each hackathon, complete with citizens of diverse experiences, identities, and skill sets. This not only will combat the tendency towards near-exclusive white male participation, but allow for better collaboration and solution ideas. A typical citizen may not have adequate coding experience, but has a valuable base of lived experience in the context of local challenges. By collaborating with "laypeople citizens" data professionals can benefit from collaboration in understanding the necessary context of solutions. Simultaneously, "lay people" learn from data professionals through exposure to the possibilities and utilities of

"By collaborating with "laypeople citizens" data professionals can benefit from collaboration in understanding the necessary context of solutions.

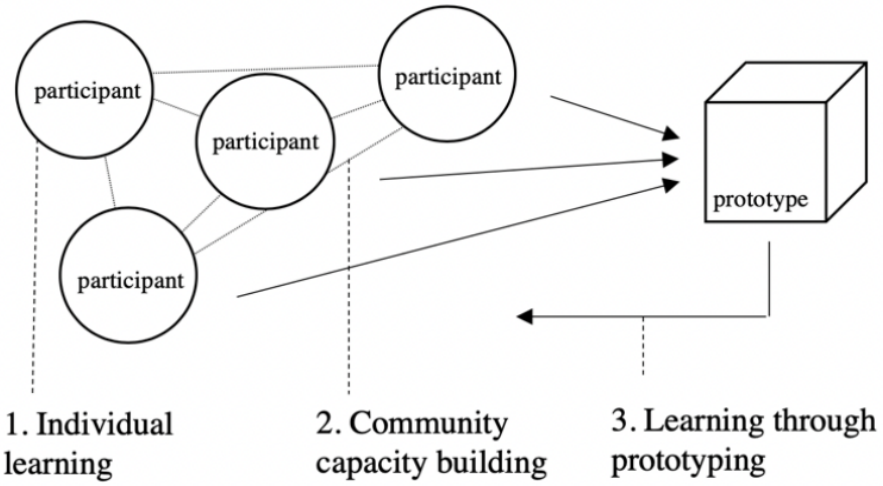
[100]Turkel, Eli, Elizabeth Suchanic, and Randy Neil. n.d. "Civic Hackathons as Deliberative Democracy: Reflections from Participation in the 2018 Delaware Open Data Challenge." https://cpb-us-w2.wpmucdn.com/sites.udel.edu/dist/4/10696/files/2019/04/Turkel_Hackathon-2j9uu8g.pdf.

[101] Ibid

[102]Tomasz Jaskiewicz, Ingrid Mulder, Nicola Morelli, and Janice Siboniso Pedersen. 2020. "Hacking the Hackathon Format to Empower Citizens in Outsmarting 'Smart' Cities." ResearchGate. unknown. July 4. https://www.researchgate.net/publication/342926526_Hacking_the_hackathon_format_to_empower_citizens_in_outsmarting_smart_cities.

open data and data-driven solutions. By intentionally connecting people holding lived experience with those who have technical expertise, the pursuit of hackathon ideas have created a symbiotic relationship of learning and sharing data literacy skills within communities.

Jaskiewicz et al. denotes the importance of not only diverse participants, but a structured and strategic "positive learning loop" through a **multi-stage process of individual learning, community capacity building, and learning through prototyping.**[103]



[104]

Individual Learning

Tied to the recommendation for Data Privacy and AI Ethics, we recommend that the City of Kelowna integrate community instruction on data privacy and ethics with a yearly hackathon. This dual purpose can have a multitude of benefits. A community series of lectures on data ethics and privacy can expose citizens to the possibilities and dangers within city data-enabled solutions. These lectures, a "kick-off" to the hackathon, can serve as a recruiting tool to attract curious or concerned members of the community. **We recommend that these lectures and broader hackathons are mandatory or highly encouraged for all city employees.** Towards the objective of Intelligent City Strategy 3a., "Engage and empower our staff, community, and stakeholders to collaborate on shared problems,"[105] members of city departments should

[103]Tomasz Jaskiewicz, Ingrid Mulder, Nicola Morelli, and Janice Siboniso Pedersen. 2020. "Hacking the Hackathon Format to Empower Citizens in Outsmarting 'Smart' Cities." ResearchGate. unknown. July 4. https://www.researchgate.net/publication/342926526_Hacking_the_hackathon_format_to_empower_citizens_in_outsmarting_smart_cities.
[104]Ibid
[105] "Intelligent City Strategy." 2020. City of Kelowna. https://www.kelowna.ca/sites/files/1/docs/related/intelligent_city_strategy_-_city_of_kelowna.pdf.

participate and invite relevant contacts and stakeholders in Kelowna to participate. In addition to lectures on data privacy and ethics, recommended lectures include overviews of previous successful hackathon projects, issues specific to Kelowna that could benefit from smart solutions, and resources and free courses available to provide citizens with opportunities for further digital literacy, as well as an overview of open data sources for hackathon implementation.

Community Capacity Building

The first necessary step for community capacity building, as mentioned above, is the intentional creation of teams with diverse backgrounds. In hackathon feedback, researchers Jaskiewicz et al. found that the most valuable impacts of participation in a civic hackathon were learning about their teammate's perspectives, improving their ability to work in a diverse team, and gaining new understandings of the city's problems.[106] The power of collaboration is visualized below. By creating teams consisting of both common ground and expertise, teams are better suited to learn from one another and have diverse perspectives on skills needed and solutions possible, resulting in a strong collaborative learning environment. To facilitate team collaboration, we recommend the city hold multiple events leading up to the final hackathon for teams to brainstorm. This would solely require the city to provide a physical space in which teams can work independently. Additionally, we greatly encourage the city to use the civic hackathon as a means for people to use the open data catalogue offered by Kelowna, Open Kelowna. A civic hackathon will not only expose citizens to the availability and utility of the resources of open datasets including information on land use, transportation, utilities and more, but also provide them with a space for ingenuity and application.[107]

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[106]Tomasz Jaskiewicz, Ingrid Mulder, Nicola Morelli, and Janice Siboniso Pedersen. 2020. "Hacking the Hackathon Format to Empower Citizens in Outsmarting 'Smart' Cities." ResearchGate. unknown. July 4. https://www.researchgate.net/publication/342926526_Hacking_the_hackathon_format_to_empower_citizens_in_outsmarting_smart_cities.

[107]"Open Kelowna." 2016. Kelowna.ca. https://opendata.kelowna.ca/.

[108]Tomasz Jaskiewicz, Ingrid Mulder, Nicola Morelli, and Janice Siboniso Pedersen. 2020. "Hacking the Hackathon Format to Empower Citizens in Outsmarting 'Smart' Cities." ResearchGate. unknown. July 4. https://www.researchgate.net/publication/342926526_Hacking_the_hackathon_format_to_empower_citizens_in_outsmarting_smart_cities.

Learning Through Prototyping

We recommend that the City of Kelowna continue its Design Jam program, with the aforementioned Individual Learning and Community Capacity Building events leading up to each Design Jam. While a prototype is technically the end result, in the practicality of fostering collaboration, it primarily serves as a tool rather than the objective. Research shows that talking and working through problems gives participants a medium to align their views and a space to apply their unique skills to reach a solution.[109] **While it is possible that stakeholders and the City of Kelowna might want to implement solutions, this should not be the primary metric of success.**

Looking Forward

There are plenty of opportunities to consider to encourage re-entry, but the most important philosophy is encouraging growth and resilience to establish the Design Jam and preceding events as fully integrated in the community.

The primary goal at the end of a Design Jam is to encourage re-entry and growth the following year. This will create the "positive feedback loop" that is necessary to sustain a yearly event. To accomplish this, the city may want to encourage successful or strong teams to serve as mentors the following year for new teams. Another option could be ranked experience hackathons, where new teams compete against each other, and seasoned teams compete separately. There are plenty of opportunities to consider to encourage re-entry, but the most important philosophy is encouraging growth and resilience to establish the Design Jam and preceding events as fully integrated in the community.

Proposed Partners

To fund a yearly hackathon, we highly recommend that the City of Kelowna reestablish contacts with Rogers Communications and Microsoft to create a yearly hackathon event. Because the previous event was highly successful, and used by both Rogers and Microsoft as an opportunity for publicity, we believe that supporting a civic hackathon is a highly realistic synergy and public-private partnership. We also recommend partnering

[109]Tomasz Jaskiewicz, Ingrid Mulder, Nicola Morelli, and Janice Siboniso Pedersen. 2020. "Hacking the Hackathon Format to Empower Citizens in Outsmarting 'Smart' Cities." ResearchGate. unknown. July 4. https://www.researchgate.net/publication/342926526_Hacking_the_hackathon_format_to_empower_citizens_in_outsmarting_smart_cities.

with UBC Okanagan to recruit students and help run the event. Finally, we recommend partnering with Accelerate Okanagan, which has successfully implemented 2 hackathons in the Okanagan region. Finally, we offer ourselves, AI for Good Foundation, as possible partners, specifically in the building of individual learning resources.

Operational Considerations

One of the principal concerns of the city in creating a recurring hackathon event is cost. To mitigate this, we recommend that the city rely heavily on its previous partners, specifically Rogers Communications and Microsoft, to finance the events. Other issues, specifically those voiced by Accelerate Okanagan, were participant buy-in and a lack of business or solutions generated from the event. We believe both of these issues will be mitigated by the creation of intentional teams. Participants will be more likely to follow through if they are relied upon such as in a team dynamic. Moreover, in creating repeated, elongated programs, we believe that the likelihood of project implementation will only increase as the program grows.

Data Privacy & AI Ethics

Recommendation

The City of Kelowna should immediately implement the Government of Canada's Algorithmic Impact Assessment (AIA) to create accountability and transparency for new AI-centered projects. In addition, the City of Kelowna should create its own framework that expands outside of the scope of the AIA. Finally, Kelowna should integrate community feedback and knowledge sharing to ensure understanding and acceptance of new solutions.

Current State of Data Privacy and AI Ethics

The City of Kelowna's governance is driven by a citizen-first model that has been at the core of its digital transformation. The city and its partners use municipal and residential data to better understand the city's problems and provide targeted solutions. Voluntarily offered citizen input is the common denominator in ventures. When Kelowna had first begun laying the groundwork for their smart city plan, it pursued public opinion on the initiatives that residents wanted to subsume as part of their smart city approach. This was corroborated by organized initiatives such as workshops with industries, businesses, educators, and other sectors to elevate the city's understanding of what issues the cities should prioritize and what interventions would be most effective.[110]

Kelowna has already instituted principles that stress data ethics within the city's official community plan, Imagine Kelowna[111], and the city's Intelligent City Strategy[112]. Within these documents, great emphasis is placed on being collaborative, innovative, connected, and

[110]Lai, Sarah, Yu Chu. 2019.. "The Smart Cities Approach: The Opportunity and Possibility of Data Driven Communities the Smart Cities Approach: The Opportunity and Possibility of Data Driven Communities By." Accessed December 13. https://dspace.library.uvic.ca/bitstream/handle/1828/10976/Chu_Sarah_Lai_Yu_MPA_2019.pdf?sequence=1&isAllowed=y.
[111]"Imagine Kelowna." 2016. City of Kelowna. November 22. https://www.kelowna.ca/our-community/about-kelowna/imagine-kelowna.
[112] "Intelligent City Strategy." 2020. https://www.kelowna.ca/sites/files/1/docs/related/intelligent_city_strategy_-_city_of_kelowna.pdf.

responsible, calling for the responsible collection and management of data. This includes being responsible stewards of the data collected and shared, making sure that only data that is needed is collected, and protecting the privacy of those from whom data is collected. At a high level, there were three principal strategies put forward to realize Kelowna's intelligent city vision. The first strategy mentioned revolved around accelerating the city's shift to digitalized operations, the second strategy involved fostering a collaborative network, and the third on providing the guidance and tools city departments and the community need to fulfill requirements. The subgoal behind the first strategy focused on government operations specifically such as permitting and billing and ensuring that the digital transition maintained privacy protections.[3]

A key stepping stone to garnering civilian trust in data-related matters includes open governance. **Fostering a culture of open governance promotes transparency and invites public oversight, which is particularly salient when sensitive citizen data is collected.** The City of Kelowna has placed great emphasis on its commitment to nurturing an open government; the city makes municipal data and municipal information open and accessible free of charge for public and commercial use through its Open Data Portal[113]. It is through this portal that community members and stakeholders can access municipal information under a variety of areas of interest such as environmental, creation and culture, and land use. Civilians and other stakeholders are then permitted to put this data to use as they deem fit. The city suggests use cases such as analyzing datasets, building mobile applications, or helping solve important issues within the city.[4] The portal lends itself to a collaborative and innovative community by increasing transparency and access to information while adhering to the laws that govern the privacy of data in the city.

Fostering a culture of open governance promotes transparency and invites public oversight, which is particularly salient when sensitive citizen data is collected.

The province of British Columbia (BC) has in place access and privacy laws that apply to the City of Kelowna. These include the Freedom of Information and Protection of Privacy Act (FIPPA)[114] and the Personal Information Protection Act (PIPA)[115], which are overseen and enforced by the Office of the Information and Privacy Commissioner (OIPC)[116] of BC. The former legislates city governance principles such as making city information freely

[113]"Open Kelowna." 2016. Kelowna.ca. https://opendata.kelowna.ca/.

[114]"Freedom of Information and Protection of Privacy Act." 2021. Gov.bc.ca. https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/96165_00.
[115]"Personal Information Protection Act." 2021. Gov.bc.ca. https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/00_03063_01.
[116]"Office of the Information and Privacy Commissioner for B.C. | Home." 2021. Oipc.bc.ca. https://www.oipc.bc.ca/.

available to the public, safeguarding individual data privacy protections, prohibiting inappropriate collection or disclosure of personal data. The City of Kelowna has released an encapsulating statement that delineates how personal data is collected and the usages the city has for it — *"Personal information is any information that can be used (either on its own, or when combined with other information) to identify a specific person. For example, name, address, birthdate, medical, financial information and photographs or images of an individual. However, it does not apply to business contact information."* [117]

Data collection and usage details are also disclosed by Kelowna; the city informs residents that personally identifiable information, financial/payment information, digital images, utility use, and permitting & licensing information are all subject to collection in the interest of municipal operations namely, service delivery, security, and open data. Kelowna acknowledges that all of this data is acquired through means of city services, email communications, telephone calls, website visits, and public hearings. On the city's webpage that provides all of this information, it is also revealed that residents bear the right to solicit details as to how their data is collected and what use case the city has in mind for it, to refactor individual information, and to obtain a copy of personal information the city has collected. Furthermore, there are opportunities in certain instances provided to residents to opt-out of data collection; however, this comes at the cost of inaccessibility to certain services from the city.[8]

> **While the matter of controversy was resolved, it speaks to the need for open communication with citizens whenever any large project is undertaken by the city.**

Kelowna is familiar with smart city initiatives and features a portfolio of pilot projects involving emerging technologies that are frequently relied on such as LiDAR and 5G. A prominent example is a joint pilot project between Rogers Communications, the University of British Columbia, and Blue City technology that set out to analyze traffic patterns in downtown Kelowna. This initiative aims to demystify vehicular interactions and better understand how to heighten road safety. While some data and privacy concerns were raised, the city put them to rest, assuring that privacy was of utmost priority and that collected data was anonymized prior to being stored.[118]

News Article Following 5G Announcement

[117]"Information and Privacy." 2016. City of Kelowna. May 19. https://www.kelowna.ca/city-hall/city-government/information-and-privacy.
[118]Potenteau, Doyle. 2020. "Pilot Project Featuring LiDAR Sensors, 5G Network, to Study Traffic Patterns in Downtown Kelowna." Global News. Global News. May 28. https://globalnews.ca/news/6999316/pilot-project-traffic-patterns-kelowna/.

While the matter of controversy was resolved, it speaks to the need for open communication with citizens whenever any large project is undertaken by the city.

There are also initiatives across Canada that provide guidelines for the management of big data. One such example is the Tri-Agency Statement of Principles on Digital Data Management[119] by the Canadian Institutes of Health Research (CIHR), the Natural Sciences and Engineering Research Council of Canada (NSERC), and the Social Sciences and Humanities Research Council of Canada (SSHRC). The CIHR, NSERC, and SSHRC are federal granting agencies that promote and support research, research training, knowledge transfer, and innovation within Canada.

Gap Analysis and Expert Reviews

FIPPA and PIPA were enacted in 1993[120] and 2004[121] respectively in British Columbia. These laws predate some of the more recent developments in artificial intelligence and may not keep pace with its latest advances as its utilization continues to grow as Kelowna becomes an intelligent city. Privacy commissioners of multiple cities[122] have called for "urgent reform" of the current privacy laws to give cities the ability to respond to technological advancements such as artificial intelligence, as well as to enable cities to impose monetary penalties for bad actors.

Fortunately, reforms[123] to the privacy statutes are underway at the national level. On Nov. 17, 2020, the Canadian government introduced the Digital Charter Implementation Act, 2020 (DCIA, or Bill C-11) which aimed at overhauling the country's private sector data privacy legal regime, leading to the establishment of a Consumer Privacy Protection Act (CPPA) for the private sector. The proposed changes[124] include Federal Enforcement Power and Steep Fines. Presently, the Privacy Commissioner is unable to impose fines or penalties for violating laws such as the Personal Information Protection and Electronic Documents Act (PIPEDA) and algorithmic transparency. Instead, the proposed act would

[119]Communications and Marketing Branch. 2014. "Tri-Agency Statement of Principles on Digital Data Management - Science.gc.ca." Science.gc.ca. https://science.gc.ca/eic/site/063.nsf/eng/h_83F7624E.html?OpenDocument.
[120]"FIPPA-Freedom of Information and Protection of Privacy Act | SCARP | UBC School of Community and Regional Planning." 2021. Scarp.ubc.ca. https://scarp.ubc.ca/fippa-freedom-information-and-protection-privacy-act.
[121]Guide to Access and Privacy Protection under FIPPA. 2015. Office of the Information and Privacy Commissioner for British Columbia. https://www.oipc.bc.ca/guidance-documents/1466#:~:text=This%20legislation%20came%20into%20effect,use%20and%20disclose%20personal%20information.
[122]DeRosa, Katie. 2021. "Bad Actors Who Violate Privacy Rules Should Face Fines: B.C. Privacy Commissioner." Vancouversun. Vancouver Sun. February 24. https://vancouversun.com/news/bad-actors-who-violate-privacy-rules-should-face-fines-b-c-privacy-commissioner.
[123]"Updating Canada's Privacy Act for Artificial Intelligence – Policy Magazine." 2021. Policymagazine.ca. https://www.policymagazine.ca/updating-canadas-privacy-act-for-artificial-intelligence/.
[124]"Canada Proposes Federal Privacy Law Overhaul – Key Takeaways | Insights | Greenberg Traurig LLP." 2020. Gtlaw.com. https://www.gtlaw.com/en/insights/2020/11/canada-proposes-federal-privacy-law-overhaul-key-takeaways?__cf_chl_captcha_tk__=pmd_5014f2eee7c0308684d556f483613d753272bd61-1628251401-0-gqNtZGzNA02jcnBszQc6.

require businesses to disclose the use of an automated decision system for predictions that could have a significant impact on individuals. Individuals would also have the right to request explanations on the collection and use of their information for automated decision-making.

Robert Entwistle, an Information Services Manager, from the City of Kelowna has shed light upon what he believes are the top five challenges that the city faces in implementing a smart city approach. **One issue is with the municipal government lacking the deliberate intention in developing a collaborative culture with the local community.** Entwistle is a proponent of local involvement within smart cities, stating that a smart city approach is collaborative in nature and adduces to when the city relied on public opinion in the development of the smart city plan. Amongst other concerns, Entwistle also brings up the challenge of resource constraints, he also proposes a solution of taking advantage of human capital in which the theme of collaboration across stakeholders is once again brought up. Entwistle posits that under limited resource circumstances, engaging with different stakeholders can act as a cost-effective salve. The list of roadblocks put forward concludes with changing workforce cultures and the challenge of distinguishing between tech vendors that have a genuine intention to provide value to the community and which ones are profit-centric and lack focus on the Kelowna community.[125]

For Immediate Implementation: the Algorithmic Impact Assessment and the Directive on Automated Decision-Making

Canada's Algorithmic Impact Assessment (AIA) is a questionnaire that measures the predicted impact of an AI decision system. Composed of 48 risk-related and 33 mitigation-related questions, the AIA creates a score that analyzes system design, algorithm, decision type, impact and data risks, as well as measures of data quality, stakeholders, privacy, and fairness mitigations. A more detailed description of each of these areas can be found below:

[125] Lai, Sarah, Yu Chu. 2019.. "The Smart Cities Approach: The Opportunity and Possibility of Data Driven Communities the Smart Cities Approach: The Opportunity and Possibility of Data Driven Communities By." Accessed December 13. https://dspace.library.uvic.ca/bitstream/handle/1828/10976/Chu_Sarah_Lai_Yu_MPA_2019.pdf?sequence=1&isAllowed=y.

Risk Areas	Definition
1. Project	
Project Phase	Project owner, description and stage (design or implementation).
Business Drivers / Positive Impacts	Motivation for introducing automation into the decision-making process.
Risk Profile	High-level risk indicators for the project.
Project Authority	Need to seek new policy authority for the project.
2. System	
About the System	Capabilities of the system (e.g., image recognition, risk assessment).
3. Algorithm	
About the Algorithm	Transparency of the algorithm, whether it is easily explained.
4. Decision	
About the Decision	Classification of the decision being automated (e.g., health services, social assistance, licensing).
5. Impact	
Impact Assessment	Duration, reversibility and area impacted (freedom, health, economy or environment).
6. Data	
Source	Provenance and security classification of data used to automate decisions.
Type	Nature of the data used as structured or unstructured (audio, text, image or video).
7. Consultation	
Internal and External Stakeholders	Internal and external stakeholders consulted, such as privacy and legal experts.
8. De-Risking and Mitigation Measures	
Data Quality	Processes to ensure that data is representative and unbiased, as well as transparency measures related to those processes.
Procedural Fairness	Procedures to audit the system and its decisions, as well as the recourse process.
Privacy	Measures to safeguard personal information.

While it is a mandatory tool for the federal government to support the Treasury Board's Directive on Automated Decision-Making ("the Directive"), **the tool is available to the public for reuse under open license.**[126] Overall, the AIA is intended to help government agencies to understand and manage the potential impacts and hazards of automated decision-making in the public sphere. There are five central components to the AIA:[127]

1.) The institution (in this instance, the City of Kelowna) using automated decision systems needs to assess how their automated decision systems affect the communities in terms of justice, bias, fairness, or other socio-economic issues

2.) The institution needs to collaborate with external researchers to assess the life cycle of the automated decision systems

[126]"Algorithmic Impact Assessment Tool." 2021. Government of Canada. https://www.canada.ca/en/government/system/digital-government/digital-government-innovations/responsible-use-ai/algorithmic-impact-assessment.html.

[127]Lai, Sarah, Yu Chu. 2019.. "The Smart Cities Approach: The Opportunity and Possibility of Data Driven Communities the Smart Cities Approach: The Opportunity and Possibility of Data Driven Communities By." Accessed December 13. https://dspace.library.uvic.ca/bitstream/handle/1828/10976/Chu_Sarah_Lai_Yu_MPA_2019.pdf?sequence=1&isAllowed=y.

3.) The institution needs to publicly publish what is an automated decision system and include relative researchers' assessment of the system before implementing the system in the institution.

4.) The institution needs to answer or clarify any questions and comments from community members

5.) The institution needs to construct a plan to address communities that are affected by the automated decision systems due to biases or other issues not addressed by the institution's mitigation plan. (Reisman, Schultz, Crawford, and Whittaker, 2018, p.4)

Canada's AIA is largely praised for providing a usable framework for public administration that is navigating the new and complicated field of artificial intelligence. The Government of the United Kingdom has sought to create their own version of Canada's system, citing it as "an effective way... [of] managing the regulatory and ethical risks raised by these technologies, including fairness."[128] Jason Millar, a University of Ottowa Professor that specializes in Computer Science Ethics, states that for municipalities seeking to use AI and machine learning, "it would be wise to use Algorithmic Impact Assessment (AIA) and Canada's Directive on Automated DecisionMaking."[129] The Directive largely incorporates the AIA, but also includes parameters on Transparency, Quality Assurance, Recourse, and Reporting. These additional metrics are described specifically to the federal government; however, our recommendation covers and expands upon these areas.

The benefit of implementing Canada's AIA in the City of Kelowna is that it is a pre-made framework and scoring mechanism that the citizens of Kelowna can trust as verified by the federal government. In addition, it does not require much additional capacity from the City of Kelowna, as the framework is already complete. Capacity will therefore only exist in implementation and auditing, which could ideally be accomplished through the department of the Intelligent Cities Manager. However, the AIA is not an all-encompassing solution. According to the Open Government Partnership, Canada's AIA "does not provide a detailed descriptive account of the use of algorithmic systems, opting instead for a score-based system, where binary positive or negative answers to the questions indicate the 'impact level' of a particular system."[130] Therefore, should the AIA be implemented, the City will still need additional mechanisms such as peer review, human oversight, and perhaps more detailed scoring than binary mechanisms.

[128]"Review into Bias in Algorithmic Decision-Making." 2020. GOV.UK. https://www.gov.uk/government/publications/cdei-publishes-review-into-bias-in-algorithmic-decision-making/main-report-cdei-review-into-bias-in-algorithmic-decision-making.

[129]Lai, Sarah, Yu Chu. 2019.. "The Smart Cities Approach: The Opportunity and Possibility of Data Driven Communities the Smart Cities Approach: The Opportunity and Possibility of Data Driven Communities By." Accessed December 13. https://dspace.library.uvic.ca/bitstream/handle/1828/10976/Chu_Sarah_Lai_Yu_MPA_2019.pdf?sequence=1&isAllowed=y.

[130]Ada Lovelace Institute, AI Now Institute and Open Government Partnership. 2021. "Algorithmic Accountability for the Public Sector." https:// www.opengovpartnership.org/documents/ algorithmic-accountability-public-sector/

Additionally, the AIA has been criticized "for the lack of established mechanisms for engaging affected communities, members of the public or experts to participate in how agencies should respond to identified impacts."[131] For this reason, it is imperative that an additional, multifaceted approach to Data Privacy and AI Ethics is adopted by the City of Kelowna. Many of the following recommendations are partially captured by the AIA, so the city can integrate the AIA whenever possible.

Looking Forward: A Data Privacy and AI Ethics Approach Made for Kelowna, By Kelowna

Data Privacy

To adequately respond to the rapid development of artificial intelligence and all of the corollaries of widening the scope of big data applications to the general public (especially under circumstances where data is garnered from residents), the city may wish to include the following in their data privacy bylaws/guidelines:

- Mandatory notification of breaches;
- Obligations in the event of a data breach;
- Extension of obligations to third-party contractors.
- Rights for residents to opt for data portability, the right to be forgotten, the right to object to automated processing of their information, etc.;
- Requirements for companies to set the highest levels of confidentiality as their default settings, without the intervention of any persons concerned (i.e., protection by design and by design and by default – offering proactive action instead of remedial action after privacy violations).

In addition to setting up policies to guide the governance of data from the city, it is recommended that the city encourage the use of privacy-preserving solutions wherever possible to safeguard data as well as build trust. The city may wish to consider using privacy-preserving approaches, such as:

- federated learning or secure multi-party computation – training AI models using local data but without sending the data out to the provider's cloud;

[131] Ibid

- differential privacy – injecting noise into computations on datasets in such a way that the output cannot be tied back to the presence or absence of any individual in the dataset;
- homomorphic encryption – keeping the data encrypted during computation;
- zero-knowledge proofs – verifying information without revealing the information itself;
- private information retrieval – retrieving an item from a database without revealing which item is retrieved.

Requirements from Providers

In addition to the establishment of a framework, means of incentivizing and/or enforcing responsible use should be put in place to ensure adherence to the framework, including possible disciplinary vehicles for abuse of data and violation of data privacy laws. **Furthermore, city partners and any organizations making use of data from the city of Kelowna should commit to the responsible use of AI including adhering to responsible AI frameworks set by the city to become a city partner and/or provide services and/or make use of city data.** This includes being transparent about informed consent as well as being transparent about the use of the data. The city may wish to consider a combination of requirements for solution providers, such as:

- transparency guidelines;
- certification and auditing standards (e.g., obtaining recommended certifications or submitting to auditing and testing standards);
- accountability measures (e.g., being liable for the damage caused by their technologies). Such measures could include fines, termination of projects, or banning further data usage.

Algorithmic Transparency

It's imperative to facilitate initiatives that are reliant on collecting data from the local community with full disclosure of operations and the impact outcomes will have on residents. Having measures in place to regulate activities is also essential in fortifying public trust. The city may wish to consider the following to aid in increasing transparency and accountability:

- The use of data protection impact assessments or algorithmic impact assessments, such as the AIA, to systematically and comprehensively analyze any processing so as to identify and minimize data protection or algorithmic risks.
- The use of tools to detect and eliminate bias in ML models.
- The use of an AI or algorithmic register that provides residents with information about where and how the city is making use of AI and algorithms. The register can provide details such as how they were built, which data and algorithms they use, as well as the decisions, assumptions, and ethical principles used to design them. Contact details can also be provided to elicit feedback and allow residents to seek further information.

Empowerment of Citizens and Expanding Digital Literacy

Both in the immediate utilization of Canada's Algorithmic Impact Assessment and the larger buildout of a Data Privacy and AI Ethics Framework for the City of Kelowna, the locality must be empowered with the necessary knowledge to make informed opinions and decisions regarding new projects. We recommend that the City of Kelowna engage willing residents in a Digital Literacy Program, with additional forums for new projects. As expert Jason Millar states, these trainings will allow "residents [to] have a better basic knowledge to challenge what data should be collected" and "how the data should be collected."

A Digital Literacy program is important both for passive residents and necessary for involved city officials. Robert Entwistle of Kelowna stated that some of the largest barriers to smart city solutions are:[132]

- 1.) Awareness in municipal government wanting to collaborate with the community
- 2.) Developing a collaborative culture beyond the municipality, but collaborating with the community more
- 3.) Limited resources – Prioritizing projects with multiple stakeholders and community members
- 4.) Changing culture of the workforce – Training

A Digital Literacy Program with forums for new projects would address the needs of community collaboration, the prioritization of the community needs in the creation of new solutions, and educate municipal and residential workers to be more adept in this

[132]Lai, Sarah, Yu Chu. 2019.. "The Smart Cities Approach: The Opportunity and Possibility of Data Driven Communities the Smart Cities Approach: The Opportunity and Possibility of Data Driven Communities By." Accessed December 13. https://dspace.library.uvic.ca/bitstream/handle/1828/10976/Chu_Sarah_Lai_Yu_MPA_2019.pdf?sequence=1&isAllowed=y.

technological age. This program should be included in the annual civic hackathon recommended by the AI for Good Foundation later in this report. A Digital Literacy Program, combined with an annual civic hackathon, will allow Kelowna to create a vibrant and resilient community geared towards becoming a smarter and more sustainable city.

Operational Considerations

There are few operational barriers to the implementation of an Algorithmic Impact Assessment on new projects; therefore, we recommend this solution for immediate use. A larger Data Privacy and AI Ethics Framework for the City of Kelowna would require much more additional resources or possible consultation fees. The AI for Good Foundation is capable of working with the city in a consultation capacity to work with the city to create this framework. Should the City of Kelowna seek a collaboration that is free of charge, we recommend working with MISA Canada, a platform for municipalities to share smart practices on information and communication technology (ICT) related issues, to create the framework. While this would be likely free or no charge, the city can face issues of a lack of expertise and extended timelines. Finally, a Digital Literacy Program carries potential costs in advertisement, recruitment, space, and expertise. This can be accomplished internally through the department of the Intelligent Cities Manager or could be contracted by the AI for Good Foundation to create the Digital Literacy Curriculum.

In the creation of privacy standards for the City of Kelowna, it is also worth considering the tradeoffs that healthy initiatives with high value, especially for those who need it most in society, could possibly be prevented from taking place due to it being too onerous to comply with stringent data privacy mandates. It is worth considering the capacity of smaller firms in compliance to ensure that it is not only large firms, such as Google, that are capable of taking on projects within the city.

Sustainable Agriculture

Recommendations

- The City of Kelowna should create a cooperative drone technology lending program that is dedicated towards advancing precision and regenerative agriculture on Kelowna's small farms. Part of this program is purchasing drones, with estimated costs enclosed.
- Alongside the lending program, the City should create an ongoing Agriculture Community Engagement Program designed towards educating farmers on the benefits of drones for precision and regenerative agriculture, integrating indigenous knowledge and sustainable farming techniques, and business sessions for succession planning for a prolonged local agricultural system.
- Recruiting young farmers is paramount to an aging farmer population. Several BC and Canada-wide organizations have resources for both building community and mentorship. In addition, the next generation can be trained to be drone pilots and contribute to the cooperative drone technology lending program established by the City of Kelowna.
- The City of Kelowna should create an AgTech pilot program to test water management innovations, such as smart meters and drip irrigation systems to find the most effective technologies to be deployed on small farms in the region. Partner with AgTech businesses by providing the space to test new technologies for sustainable agriculture. Should partnering with business be too costly, consider working with students at UBC Okanagan.
- Work with UBC Okanagan, or create a Design Jam event, to develop an app to create an "online farmers market" connecting local farmers to consumers in the Kelowna area, encouraging the purchase of local produce. This has the potential to couple well with the civic hackathon recommendation should the City choose for the project to be a Design Jam. Alternatively, work with We Heart Local BC to expand to create an online marketplace of produce.

Current State of Agriculture in Kelowna

British Columbia is known for its flourishing agricultural sector, and Kelowna especially derives much of its culture, tourism, and business from agribusiness. Approximately 40% of the city's land is zoned for agriculture, and of this zoned land, 41% is used to grow tree fruits.[133] Kelowna, as well as the greater province, specifically garner much of their profits from agritourism and wine production. **The British Columbia wine industry produces $2.8 billion annual revenue while employing 12,000 people. Kelowna itself has over 44 wineries, and overall the Okanagan valley has 84% of the total vineyard acreage of British Columbia.**[134] It is important to note that Kelowna's agricultural sector consists mostly of small farms; 63% of farm parcels are 4 hectares or smaller. Additionally, while much of the land is zoned for agriculture, only 45% of this land is in active farm use. Finally, the City of Kelowna is facing an aging farming population, as the average farmer age is 56.8 years old.[135]

In 2017, the City of Kelowna released its Agriculture Plan, which was predicated by a community survey of citizens of the city, non-farmers and farmers alike. This feedback was prolific and helped the city understand the views and concerns of constituents specifically relating to agriculture and food issues. **In their survey, the city found that 95% of Kelowna residents found policies to preserve farmland to be either important or very important.**[136] The survey also asked what the principal challenges were for the city in relation to agriculture. The top three challenges were difficulties accessing land for farming due to speculation, high costs, and capital inputs (73%), competing non-farm uses for farmland (urban-rural edge issues) (70%), and lack of succession planning (age of farmers, no new young farmers) (56%). While there were many other issues addressed, these top results capture the views of the majority of Kelowna residents. When asked what the city could do to

> **95% of Kelowna residents found policies to preserve farmland to be either important or very important.**

[133]"Agriculture Plan." 2017.City of Kelowna. https://www.kelowna.ca/sites/files/1/docs/related/agriculture_plan_final_august_2017.pdf.
[134]"2020 Facts and Figures." 2020. Tourism Kelowna. https://assets.simpleviewinc.com/simpleview/image/upload/v1/clients/kelowna/Key_Facts_Figures_2020_TK_bdb9cd84-e5b2-440f-aeaf-9029ba5c61e1.pdf
[135]"Agriculture Plan." 2017.City of Kelowna. https://www.kelowna.ca/sites/files/1/docs/related/agriculture_plan_final_august_2017.pdf.
[136]"Agriculture Plan Engagement Summary." 2017. City of Kelowna. https://www.kelowna.ca/sites/files/1/docs/related/agriculture_plan_engagement_summary_august_2017.pdf.

improve and support the local food system, the most popular responses were to support farmers and food processors with services such as value-added production and technical production skills, protect farmland and prevent urban sprawl, and provide more education around local food.[137]

The subsequent 2017 update of the Kelowna Agriculture Plan took into account the concerns of residents and provided a list of goals to be pursued by the city. The goals are as follows:[138]

- 1. Develop clear policies that serve to protect and promote agriculture
- 2. Identify opportunities to strengthen farming as an economic driver
- 3. Increase the amount of, and access to, locally grown and produced food
- 4. Promote and celebrate the agricultural character of Kelowna; and
- 5. Build resilience in communities against rising costs of food and risks from climate change

Further analysis of agriculture in the Okanagan region has become available as recently as this year, specifically the "Bringing Our Food System Home Report" from the Institute for Sustainable Food Systems within the Kwantlen Polytechnic University, endorsed by the City of Kelowna. **The report found that while Okanagan residents spend approximately $1.4 billion on food annually, most of this money does not stay in the local economy as it goes to imported and non-local businesses.**[139] This can be attributed to the growing trend towards a concentrated global food system. Another negative externality is the concentration and monopolization of farms. Over the last 50 years, Canada has experienced increased gross farm profits, but stagnant and even declining farmer livelihoods. These large farms often use unsustainable farming practices, even locally, leading to decreased ecological health.[140] In the Okanagan region, agriculture has been the primary driver of the 75% of wetlands lost in the Okanagan and Fraser River Delta.[141] The report calls for a robust, innovative regional food system. When functional, these systems can increase local economic benefits, increase transparency in the food system, promote more equitable supply chains, and encourage deeper public engagement and community relationships. To reach this goal of a regional food system, KPU recommends:

> **Over the last 50 years, Canada has experienced increased gross farm profits, but stagnant and even declining farmer livelihoods.**

1. Increasing local food infrastructure to ensure year-round local food access

[137]"Agriculture Plan Engagement Summary." 2017. City of Kelowna. https://www.kelowna.ca/sites/files/1/docs/related/agriculture_plan_engagement_summary_august_2017.pdf.
[138]"Agriculture Plan." 2017.City of Kelowna. https://www.kelowna.ca/sites/files/1/docs/related/agriculture_plan_final_august_2017.pdf.
[139]"BRINGING OUR FOOD SYSTEM HOME Report on the Okanagan Bioregion Food System Project." 2021. Accessed December 13. https://www.kpu.ca/sites/default/files/Bringing%20Our%20Food%20System%20Home_Okanagan_web%20version_final_May%2025_spreads_low%20res.pdf.
[140]Ibid
[141] Ibid

2. Emphasizing production of tree fruits for local consumption and export, supported by an expanded post-production
3. Mitigating the negative externalities of food production by ensuring habitat resilience and connectivity
4. Ensuring that local food is affordable to residents
5. Providing protected and financially available farmland
6. Working towards regenerative agriculture, complete with closed-loop nutrient cycling
7. Creating a regional education and research program dedicated to meeting local food needs and adapting to climate change
8. Honoring and supporting indigenous self-determination, food systems, and farming practices.

Little news has come in recent months regarding advancement towards these goals. The most contentious topic as of October 2021 is the City of Kelowna's move to request an exemption to use land zoned for agriculture use instead as a storage location for city public transit buses.[142] While this is a small move, and one that is arguably worthwhile to expand public transportation, we find that there have not been many large-scale efforts to meet the needs and goals denoted in the 2017 agriculture plan. Moreover, environmental degradation due to climate change has become increasingly precarious for the economic sector. As droughts become more frequent, agricultural water use is increasingly concerning, especially considering the crop makeup of the region. **Kelowna is currently going through shortages and predicting earlier and more frequent water shortages due to climate change, population growth, and expansion of the agricultural land base.**[143] Agriculture is a big consumer of water, with 120,000 million liters of water used per year, an average of 66 cm per hectare.[144] As climate change worsens, it is imperative to strengthen Kelowna's local agricultural resilience and ensure local food security for the region.

> **As climate change worsens, it is imperative to strengthen Kelowna's local agricultural resilience and ensure local food security for the region.**

[142]SEYMOUR, RON. 2021. "Loss of Farm for New Bus Barns Good for Agriculture - Kelowna Council." Daily Courier. September 14. https://www.kelownadailycourier.ca/news/article_e388c78c-1578-11ec-bb43-af0fc750edef.html.
[143]"Implications for the Future» Okanagan Water Supply & Demand Project." 2011. Obwb.ca. https://www.obwb.ca/wsd/implications-for-the-future.
[144] "Water Use» Okanagan Water Supply & Demand Project." 2011. Obwb.ca. https://www.obwb.ca/wsd/key-findings/water-use.

Recommendation:

The City of Kelowna should create a cooperative drone technology lending program that is dedicated towards advancing precision and regenerative agriculture on Kelowna's small farms. Drones are used by large and small agricultural businesses worldwide. In order to help Kelowna's economy and strengthen the stake of small farmers, we suggest establishing a cooperative drone technology lending program. Just as tractors and/or tractor services can be co-opted, new technology can be treated the same way to make the adoption of new and competitive techniques more sustainable.

Methods toward implementation:

- The City can purchase agricultural drones and spearhead the implementation of drone technology into local precision agriculture practices. As Kelowna is already looking at ways to maximize the utilization of their private airport, this could be another way the City could maximize this valuable resource while creating a supportive program for local industry.
- Companies like The Sky Guys can rent their services, assuaging the entire cost of another tool purchase for the small farms.[145] The BC company, Candrone, rents their equipment but this would require the farmers to have an operating license. Candrone's rental kits range in price from $1,850 to $2,700. The average cost of just the drone is $1,500- $2,000.[146] If the City were to purchase the drones for a cooperative purchase, the cost would be much less for small farms and foster collaboration within the local agricultural community.
- Just as in our recommendation for collaboration with universities in utilizing drones for fire mitigation, we propose that the City of Kelowna or community organizations representing the small farmers, reach out to programs like Olds College Drone School where farmers can get 2-day certifications or possibly use their farms as learning facilities. The average cost of

[145]"Precision Agriculture Drone – Farming Technology | the Sky Guys." 2018. Theskyguys.ca. https://theskyguys.ca/drone-services/precision-agriculture-technology/.
[146]"Drone & Lidar Equipment Rentals – Candrone." 2018. Candrone.com. https://candrone.com/pages/rentals.

the certification is under $600, making that plus the cost of cooperative drones a viable investment.[147]

In addition to teaching farmers about new technologies that can be used for sustainable agriculture, it is equally important to integrate knowledge from historical stewards of the land. In 2018, the province of British Columbia created the B.C. Indigenous Agriculture Development Program, which has supported 48 communities in BC and distributed nearly $250,000 in funding.[148] The program has two streams: Indigenous governments, communities, and organizations as Stream 1 and Indigenous entrepreneurs as Stream 2. Stream 1 provides funding opportunities to integrate community engagement into their projects.[149] We recommend that the City of Kelowna provide a space for these Indigenous grant winners to teach local farmers about their practices and projects. Not only will this provide more funding to the indigenous communities accepted in the program, but provide an opportunity for non-indigenous farmers to learn about all methods of sustainable agriculture, old and new. To foster these connections, we recommend working with local First Nations, such as the Westbank First Nation and the Sylix Okanagan First Nation to facilitate collaboration in the Indigenous Agriculture Development Program. **Relationships should be established and maintained with First Nations groups' interests prioritized.**

> **We recommend working with local First Nations, such as the Westbank First Nation and the Sylix Okanagan First Nation to facilitate collaboration in the Indigenous Agriculture Development Program.**

Recommendation:

The City of Kelowna should examine resources for an aging local farmer population including: Digital Succession Planning and Micro Loan/Grant Programs. Making the difficult decision to retire and pass on land and a farm business to either identified or unidentified successors can be a daunting process. According to California Farmlink[150], which has been advising on the farm succession process for over 20 years, successful planning includes:

- Communication, intention setting, and team-building
- Business valuation, structure, and transition of management
- Retirement, estate, and tax planning
- Farmland conservation planning

[147]"Drone School for Farmers & Agronomists." 2021. Oldscollege.ca. https://www.oldscollege.ca/programs/continuing-education/agriculture/drone-school-for-farmers-agronomists/index.html.
[148]"Food Security, Agriculture in Indigenous Communities Grows | BC Gov News." 2021. Gov.bc.ca. July 5. https://news.gov.bc.ca/releases/2021AFF0042-001297.
[149]"B.C. Indigenous Agriculture Development Program - Province of British Columbia." 2021. Gov.bc.ca. https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/programs/indigenous-agriculture-development-program.
[150]"Succession - the Regenerator - California FarmLink." 2021. California FarmLink. November 10. https://www.californiafarmlink.org/succession/.

- Creative approaches and financing strategies for land and business transfers

Companies like BDO Canada offer these services.[151] However, we suggest that the City host experts from either a Canadian business or nonprofit to offer virtual or in-person sessions to the community. Nonprofits like BC's Young Agrarians offer online business sessions and mentorship.[152] By collaborating with nonprofits or national experts that can customize their services for the family farmers of Kelowna, economic security, smooth transition, and a sustainable path to growth are attainable for local small farms, vineyards, fishing operations, and ranches.

Additionally, with international focus more and more concentrated on supply chain challenges due to a world reliant on international import and export, supporting local agriculture can benefit food security for the greater BC population as well. **In order to address the many challenges the pandemic has dealt businesses as well as the increasing need to compete with large-scale agriculture, microgrants and microloans can be a useful resource.** In the United States, agricultural microgrants as little as $5,000 USD have helped small farmers overcome financial impediments that their larger counterparts do not need to consider. With small infusions of capital, not only is the individual business assisted, but the local economy also benefits.

Agricultural microloans can also be beneficial. However, anytime debt is considered, there are many risk factors, be it from private or government avenues. In Canada versus the US, there are fewer government agricultural subsidies. Canada's AgriStability Program--"the primary risk management program for producers facing severe income losses"[153]--is often criticized for being both overcomplicated and insufficient. **We recommend that the City of Kelowna offer seminars--either virtual or in-person--with the various Risk Management and government-driven agricultural support offices to bolster the general knowledge of local farmers and ideally prevent predatory lending practices by suggesting realistic tailored solutions.**

> **In the United States, agricultural microgrants as little as $5,000 USD have helped small farmers overcome financial impediments that their larger counterparts do not need to consider.**

Recommendation:

In response to an aging farmer population, the City of Kelowna should invest in resources targeting young and beginning farmers. Organizations like the National New Farmer

[151]"Farm Succession Planning | BDO Canada." 2021. BDO Canada. https://www.bdo.ca/en-ca/industries/agriculture/farm-succession-planning/.
[152]"Young Agrarians." 2021. Young Agrarians. https://youngagrarians.org/.
[153]"Business Risk Management Programs | CFA-FCA." 2021. Cfa-Fca.ca. https://www.cfa-fca.ca/issues/business-risk-management-programs/.

Coalition provide community and training for this growing segment of the population.[154] The NFU's Region 8 includes BC and offers emergency resources, agricultural leadership opportunities targeting women, and policy briefs.[155] In Nova Scotia and Ontario, Veterans of Iraq and Afghanistan are finding peace and purpose in farming. Like their counterparts in the United States, Veteran to Veteran peer efforts are helping Veterans heal from the mental health toll of war through farming, while also teaching young people a new career field.

By encouraging engagement with groups like NFU or Veteran collectives, and through organizing locally, small farms will become more sustainable and continue to grow and add to the local economy with the new generation. Investment through training and co-opted resources is an expense that will pay off for the City of Kelowna. Through awareness of supply chain challenges, diversification from large agribusinesses, and a vibrant tourism industry that thrives on local vineyards, Kelowna will be resilient to climate change obstacles. By investing in new and beginning farmers, a bridge can be built between the judicious use of new technology and the next generation who will be directly contributing to the economy and ecological sustainability of the region's resources.

> **Through awareness of supply chain challenges, diversification from large agribusinesses, and a vibrant tourism industry that thrives on local vineyards, Kelowna will be resilient to climate change obstacles.**

Recommendation:

The City of Kelowna should create a pilot "testbed" program by inviting AgTech businesses to test their technologies in the Okanagan region, specifically dedicated to smart solutions for water management and soil optimization**. Given a history of complex flooding and drought scenarios, ensuring resilience in agricultural water usage is of utmost importance.** There are a plethora of resources available to integrate technological mechanisms for water management, but in its current capacity, the city is not currently able to roll out and expand solutions. For example, there is a large availability of regular highly detailed satellite imagery via the GOES-West satellites (the primary satellite imagery source of western North America), as well as soil maps and related agricultural resources that can provide insights for crop management, water management, and other sustainable measures. A pilot testbed program will allow the City of Kelowna to partner with the most promising companies in the region, and provide an opportunity for farmers

> **A pilot test bed program will allow the City of Kelowna to partner with the most promising companies in the region, and provide an opportunity for farmers to see in real-time which solutions are available and viable.**

[154]"National New Farmer Coalition | National Farmers Union." 2021. National Farmers Union. https://www.nfu.ca/about/nfu-youth/national-new-farmer-coalition/.
[155]"Region 8 (British Columbia, Yukon and NWT) | National Farmers Union." 2020. National Farmers Union. November 16. https://www.nfu.ca/regions/region-8-bc-yukon-nwt/.

to see in real-time which solutions are available and viable. Given that less than half of the land zoned for agriculture use is currently actively used for this purpose, we recommend that the City of Kelowna use inactive ALR land for the testbed.[156] Possible AgTech companies to partner with include:

- Terramera, a Vancouver-based company that uses Actigate™ Targeted Performance technology to increase agricultural productivity and reduce pesticide use by sending nutrients directly to plant cells. ML and prediction models allow Terramera to predict high-performance yields. Terramera specifically works in government partnerships, including the larger province of British Columbia, to solve crop challenges due to climate change.[157]
- Vancouver-based Semios uses wireless IoT networks (Internet of Things, or physical sensors that connect and transfer data) to help farmers assess the yield and grade of crops, specializing in tree fruits, in near real-time. Sensors measure climate, soil moisture, and insect and disease activity.[158]
- BC-Based Skaha Labs uses land-surface modeling, climatology, meteorology, and remote sensor technology to provide soil moisture mapping for irrigated and dryland farming. Installation and removal of sensors, data transfer charges, soil moisture status reports, and critical irrigation alerts are all included in a per-year cost beginning at $3,490 in the first year, with lower costs each following year.[159]

Recommendation:

Create a Design Jam event, to develop an app to create an "online farmers market" connecting local farmers to consumers in the Kelowna area, encouraging the purchase of local produce. This is our primary recommendation, as it would serve as a tangible project for a first iteration of our civic hackathon recommendation. Alternatively, Kelowna could work with existing projects to expand to create an online marketplace of produce or involve UBC Okanagan students to create the app.

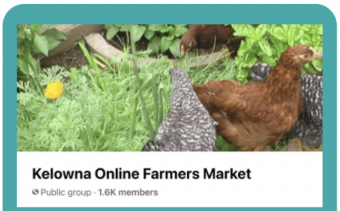
[156]Agriculture Plan." 2017.City of Kelowna. https://www.kelowna.ca/sites/files/1/docs/related/agriculture_plan_final_august_2017.pdf.
[157]"Partnerships & Collaboration." 2019. Terramera.com. https://www.terramera.com/partnerships-collaboration.
[158]"All-in-One Crop Management Solutions - Semios." 2021. Semios. June 29. https://semios.com/solutions/.
[159]"Pricing | Skaha Labs." 2015. Skaha Labs. https://www.skahasensing.ca/pricing.

The app should display the available products at each farm, the distance to each farm, and approximate prices of products. By eliminating middlemen in the selling of produce, local farmers that use the app can consider selling their crops at a reduced price to incentivize buying locally instead of in supermarkets. There are several verticals that such an app could take, such as a mechanism for in-app purchasing of products to be picked up later, public transportation routes to reach each farm, and even a "gamified" system in which people can compete with their peers to see who is buying locally the most frequently. **All of these mechanisms, or any others that are conceived of, should be oriented towards making the purchasing of local produce more accessible and enticing**. Should this app be created in the civic hackathon/Design Jam, we recommend creating groups comprised of consumers, farmers, developers, and business owners to get a variety of necessary perspectives.

Similar projects, namely the We Heart Local BC initiative, can be used either as a jumping-off point or pursued as a partner. The limitation of the project is that while it shares the mission of connecting local producers and consumers, there is not currently an established platform.[160] Should it be possible to expand We Heart Local to include local farmers in an online marketplace, it is worth considering building the online farmers market through this initiative as it is already established.

The BC Farmers' Market Trail provides a comprehensive list of farmers markets throughout British Columbia, and even provides the capability in some farmers markets to shop online.[161] While this is indeed a step in the right direction, it is incomplete as it relies on existing farmers markets. Additionally, there are few Kelowna farmers markets listed, and none have the capability of online shopping. Ideally, the app would allow any farmer to market their products immediately in the app in the Kelowna region. That said, it may benefit the City to meet with the creators of BC Farmers' Market Trail to discuss further inclusion of Kelowna.

The need for individual retailers to have access to an online marketplace is best showcased in Kelowna in that there is an active Kelowna Online Farmers Market on Facebook with approximately 1.6k members.[162] With the mission of "Helping locals connect with local farmers, crafters and artisans," This group acts with the exact purpose of the proposed app. An app that is specific to Kelowna would improve this idea by



Existing Online Farmers Market Facebook Group

[160]"About Us | We Heart Local BC." 2018. Weheartlocalbc.ca. https://www.weheartlocalbc.ca/about/.
[161]"BC Farmers' Market Trail." 2021. The BC Farmers' Market Trail. October 6. https://bcfarmersmarkettrail.com/.
[162]"Kelowna Online Farmers Market." 2017. Facebook.com. Facebook Groups. https://www.facebook.com/groups/2309162929309343/.

focusing primarily on farmers and local produce rather than crafts and baked goods and would provide additional services such as online purchasing. The need for a local food web is actively sought and being created by residents of Kelowna; the city simply has the opportunity to institutionalize this commodity and aid in its growth.

AI for Good

Summary of Recommendations

Wildfire Mitigaation

Expand and improve upon wildfire mitigation efforts, specifically prescribed burns, through the use of drones and Artificial Intelligence. Drones should be utilized for prescribed burn mapping and deployment, as well as in-crisis mapping for the safety of firefighters and residents.

Flood Mitigation

Capture LiDAR imagery by drone to support and expand current flood risk mapping (Phase 1). Drone or Airborne LiDAR data should be inputted to create necessary ML prediction models, namely a Digital Twin of the Okanagan Lake Dam to simulate flood scenarios, model reservoir performance, and most importantly optimize the size and location of new spillway projects. Additionally, LiDAR imagery and ML models should also be used to map the greater downtown area to optimize catchments and select areas that could offer more permeability (Phase 2). Modeling of flooding scenarios should be used for citizen awareness at each stage, specifically in disaster flooding events, risk management, and in government oversight of new developments.

Tourism Enhancement

Invest in a vehicle-to-infrastructure (V2I) mobile intervention that retrofits LiDAR sensors to vehicles that collect surrounding environment data. Translated to three-dimensional maps for geo-referencing, this technology can be leveraged to efficiently identify asset damages and elevate asset management to remote condition monitoring in Kelowna.

Creating a Catalyst

Build upon the Design Jam by creating an annually-recurring civic hackathon program, with a target audience of city workers and citizens of Kelowna. This program should be complete with individual learning and collaborative team engagement events leading up to a final learning-through prototype event. The program should not measure success in effective projects resulting from the Design Jam, but rather in community involvement and collaboration.

Data Privacy & AI Ethics

Immediately implement the Government of Canada's Algorithmic Impact Assessment (AIA) to create accountability and transparency for new AI-centered projects. In addition, the City of Kelowna should create its own framework that expands outside of the scope of the AIA. Finally, Kelowna should integrate community feedback and knowledge sharing to ensure understanding and acceptance of new solutions.

Sustainable Agriculture

- The City of Kelowna should create a cooperative drone technology lending program that is dedicated towards advancing precision and regenerative agriculture on Kelowna's small farms. In this program, recruiting young farmers is paramount to an aging farmer population
- Alongside the lending program, the City should create an ongoing Agriculture Community Engagement Program designed towards educating farmers on the benefits of drones for precision and regenerative agriculture, integrating indigenous knowledge and sustainable farming techniques, and business sessions for succession planning for a prolonged local agricultural system.
- The City of Kelowna should create an AgTech pilot program to test water management innovations, such as smart meters and drip irrigation systems to find the most effective technologies to be deployed on small farms in the region.
- Create a Design Jam event, to develop an app to create an "online farmers market" connecting local farmers to consumers in the Kelowna area, encouraging the purchase of local produce.

About the AI for Good Foundation

AI for Good pursues the creation of technical capabilities, infrastructure, research communities, policy frameworks, and implementation to ensure Artificial Intelligence is used in the right place at the right time to accelerate progress towards the United Nations' Sustainable Development Goals. The Foundation was created in 2015 and operates globally, with public charity registrations in the United States (501c3) and Europe. For further information, please visit https://ai4good.org or email info@ai4good.org.

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This work would not have been possible without the work of our Summer 2021 Fellows:

- Tenzin Migmar
- Alex Talbott
- Jose Garcia
- Christine Mwase
- Mario de Jesus

Special thanks to our dedicated Council for Good Members for sharing their expertise for this report:

- Alex Leader
- Aishwarya Srinivasan
- Matt Lythe
- Jared Sheehan
- Shweta Khushu