Journal of Rural and Community Development

COVID-19 and Internet Access: The Pandemic Experience in Rural Canada

Authors: Helen Hambly, David Worden, & William Gillam

Citation:
Hambly, H., Worden, D., & Gillam, W. (2021). COVID-19 and Internet access: The pandemic experience in rural Canada. *The Journal of Rural and Community Development*, *16*(4), 225–245.

Publisher:
Rural Development Institute, Brandon University.

Editor:
Dr. Doug Ramsey

ISSN: 1712-8277 © Authors
www.jrcd.ca

COVID-19 and Internet Access: The Pandemic Experience in Rural Canada

Helen Hambly
University of Guelph
Guelph, Ontario, Canada
hhambly@uoguelph.ca

David Worden
University of Guelph
Guelph, Ontario, Canada
wordend@uoguelph.ca

William Gillam
University of Guelph
Guelph, Ontario, Canada
wgillam@uoguelph.ca

Abstract

During the COVID-19 pandemic, access to and use of broadband Internet proved challenging for many people in rural Canada. Rural households experienced a new depth of frustration, and Internet non-users encountered socio-economic vulnerability. The pandemic literally brought home the extent of human dependence on modern telecommunications. Extensive periods of online work from home; home-based businesses facing rapid digital transformation; schools creating virtual classrooms and ramping up technology use by students and teachers; medical experts switching to online consults and services of all types from business operations to e-government relying on cloud-based information systems, many of these livelihood and household behaviour changes are expected to continue post-pandemic. Based on a review of national datasets, literature, and news media, as well as recent studies at the household level, we examine and discuss COVID-19 rural broadband Internet access issues. Whereas the wider picture is one of national broadband gaps adversely affecting rural households, the household user experience data from two studies in Ontario point to Internet access issues affecting work from home, children and seniors in underserved premises, including farm households. The topics of online students and work from home dominated news media, but institutional issues were identified, including the acceleration of public funding programs, and to a lesser extent, ISP corporate social responsibility and investment in rural areas. The paper concludes that no matter where you live, COVID-19 has made everyone in Canada more aware of the importance of broadband access. Internet access in underserved areas that supports life and livelihoods that will help the entire country move beyond the pandemic.

Keywords: broadband, Internet, rural, COVID-19, digital divide

ISSN: 1712-8277

La COVID-19 et l'accès à Internet : l'expérience de la pandémie dans les régions rurales du Canada

Helen Hambly
University of Guelph
Guelph, Ontario, Canada
hhambly@uoguelph.ca

David Worden
University of Guelph
Guelph, Ontario, Canada
wordend@uoguelph.ca

William Gillam
University of Guelph
Guelph, Ontario, Canada
wgillam@uoguelph.ca

Résumé

Pendant la pandémie de COVID-19, l'accès et l'utilisation d'Internet à large bande ont représenté un défi pour de nombreuses personnes dans les régions rurales du Canada. Les ménages ruraux ont connu une nouvelle dimension de frustration et les non-utilisateurs d'Internet ont été confrontés à une vulnérabilité socio-économique. La pandémie a littéralement apporté dans les foyers une compréhension de l'ampleur de la dépendance humaine envers les télécommunications modernes. Les longues périodes de travail en ligne à domicile; les entreprises à domicile confrontées à une transformation numérique rapide; les écoles créant des salles de classe virtuelles et intensifiant l'utilisation de la technologie par les élèves et les enseignants; les experts médicaux passant aux consultations en ligne et aux services de tous types; des opérations commerciales à l'administration en ligne reposant sur des systèmes d'information basés sur le cloud, bon nombre de ces changements de moyens de subsistance et de comportement des ménages devraient se poursuivre après la pandémie. Sur la base d'un examen des ensembles de données nationales, de la littérature, des médias d'information, ainsi que d'études récentes au niveau des ménages, nous examinons et discutons des problèmes d'accès à Internet avec large bande en milieu rural, en période de COVID-19. Alors que l'image globale est celle des lacunes nationales en matière de large bande qui affectent négativement les ménages ruraux, les données sur l'expérience des utilisateurs des ménages de deux études en Ontario indiquent des problèmes d'accès à Internet affectant le travail à domicile, les enfants et les personnes âgées dans des locaux mal desservis, y compris les ménages agricoles. Les sujets des étudiants en ligne et du travail à domicile ont dominé les médias, mais des problèmes institutionnels ont été identifiés, notamment l'accélération des programmes de financement public et, dans une moindre mesure, la responsabilité sociale des entreprises de fournisseur de service Internet et l'investissement dans les zones rurales. L'article conclut que, peu importe où vous vivez, la COVID-19 a sensibilisé tout le monde au Canada à l'importance de l'accès à large bande. L'accès à Internet dans les zones mal desservies qui soutient la vie et les moyens de subsistance qui aideront l'ensemble du pays à dépasser la pandémie.

Mots-clés : large bande, Internet, rural, COVID-19, fracture numérique

ISSN: 1712-8277

1.0 Introduction

In North America, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic (henceforth, COVID-19) did not "break the Internet," but it significantly increased the need to get individuals, households, and communities connected to the information superhighway that is the Internet. Lai & Widmar (2020) and Katz et al. (2020) suggest that, in the United States, digitization provided national and community economic resilience to COVID-19. The need for Internet access to support entrepreneurship during COVID-19 is featured in papers in this special issue of the Journal of Rural and Community Development, including Perez et al. (2021).

This paper sets out to examine broadband Internet access during the period just prior to COVID-19 (2018–2019) and during the pandemic from March 2020-January 2022, beginning with a "wide-angle" picture of connectivity in Canada. We use Ontario-specific user survey datasets to look at household-level Internet access associated with broadband service challenges during the pandemic, explaining why they remain relevant beyond the context of COVID-19. In the last section of the paper, we highlight the need for further research, policy, and action on improved rural connectivity. The mechanism of strategic public investments in privately owned and operated infrastructure proves challenging; but action, we argue, must go further to meet the needs of people living in small communities and rural areas not only as they exit the pandemic, but prepare for the next one.

1.1 Relevant Literature and the Concept of Broadband Internet Access

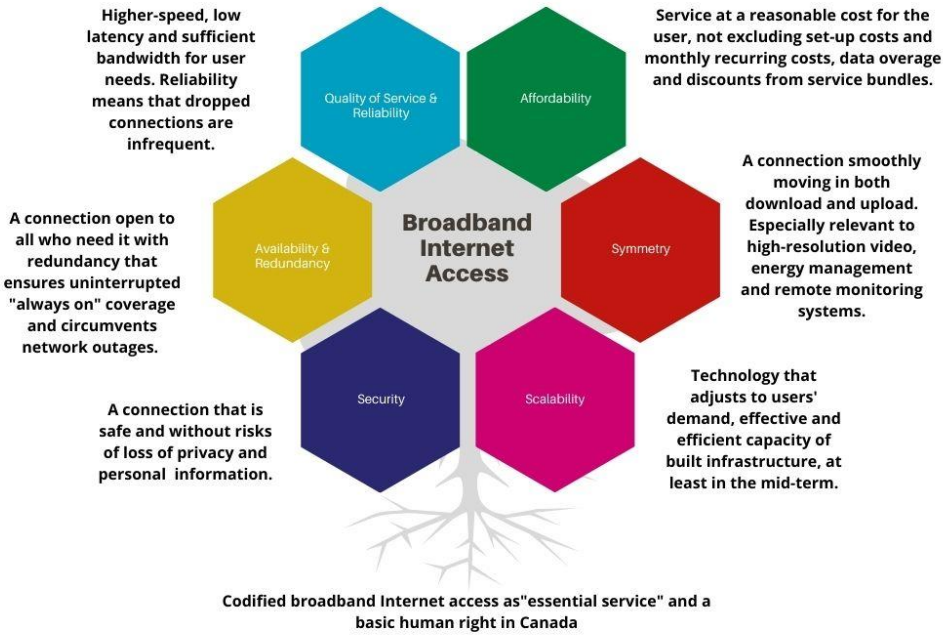
There is little doubt that COVID-19 shone a light where the digital divide, or those people and communities with reliable Internet access, in contrast to those without, are concerned (Wheeler, 2020). Broadband, also known as high or higher-speed Internet, underpins controlling, managing, and preventing COVID-19, including government rapid or real-time data tracking, public alerts, and vaccine information sites (Castiglione et al., 2021). Recent studies in Canada emphasize the importance of shared video communication for mental health and social connectedness needed to manage through challenging economic upheaval and household-level adjustments during the pandemic (Gadermann et al., 2021; Herron et al., 2021). Pre-pandemic, however, a lack of reliable broadband and the rapidly evolving Internet of everything' was already leaving some Canadians behind (Standing Committee on Industry, Science, and Technology [SCIST], 2018). Researchers in Canada document the difficulty of supporting rural students (Frenette et al, 2020), ensuring rural seniors or people with disabilities get the services they need (Davidson & Schimmele, 2019), the lack of workplace policy to support employees or entrepreneurship from an underserved rural premise including homes and cottages (Hambly & Lee, 2018), and poor connectivity in farming areas (Hambly & Chowdury, 2018) as well as in northern and First Nation communities (McMahon, 2020; McMahon et al., 2021).

Recent literature suggests the pandemic intensified adverse situations within households where the Internet was unreliable, further worsened by "stay-at-home" orders (Ali, 2020; Weeden & Kelly, 2020; Taylor et al., 2021). There is a concern about the lack of Internet access in relation to personal security and gender-based violence, as highlighted by federal policymakers during deliberations of the Standing Committee on Industry, Science and Technology (INDU) by the Minister

of Women and Gender Quality and Rural Economic Development (Government of Canada, 2020) and again, in February 2021 in the Standing Committee on the Status of Women (House of Commons Canada, 2021). Further research is needed to examine the impact of a lack of Internet access for households with school-age children and seniors, as well as those not able to work during the pandemic. Based on an ever-expanding literature in Canada, the 'digital divide' most often discussed in the literature is geographic, that is, urban/rural and remote (Ramirez, 2001; Taylor, 2018; Freeman et al., 2019; McMahon et al., 2020). Once pandemic conditions mandated everyone home, at no other point in recent history did the topic of Internet access and the lack of reliable telecommunications outside Canadian cities seem to receive such widespread attention.

By definition, we conceptualize broadband Internet access as multi-dimensional and dynamic because technology and society change constantly, responding to socio-technical system dynamics (Borgman, 2000; Gorejena et al., 2016). Internet access has overlapping or interacting technical and institutional elements, as illustrated in Figure 1. Even with an available connection and affordable subscription, there are elements that determine the effectiveness of connected devices and their security. It lies outside the scope of this paper to discuss each of these elements, but the recent report by the Expert Panel on High-Throughput Networks for Rural and Remote Communities in Canada entitled "Waiting to Connect" (Canadian Council of Academies [CCA], 2021) defines broadband technologies and the many challenges facing rural and remote broadband networks.

Figure 1: "Flower Diagram" of broadband internet access.



As Figure 1 suggests, at the "root" of the problem is a longstanding effort to have a thriving national commitment to broadband Internet access as an essential service (Frieden, 2005; Rajabiun, 2020). To date, broadband Internet is not "deeply rooted" or institutionalized as a human right in Canada, nor is it directly integrated with basic

needs such as food, water and housing[1]. Substantiating user interests or adoption of digital technologies are not at issue because as the most recent (2020-2021) Canadian Internet Use Survey (CIUS) confirmed Internet use has increased across all groups in Canadian society over the past decade, with an upswing in Internet-related activities during the pandemic (Statistics Canada, 2021). What remains is a 'digital divide' because some Canadians cannot achieve a basic level of Internet access even if they have the fundamental need to do so.

The institutional elements of Internet access, including multiple stakeholders in policy and governance, has been discussed in the literature (Rajabiun & Middleton, 2013). Presently in Canada, broadband infrastructure is subject to market mechanisms, with 91% of the backhaul owned by a few large companies and strong regional variation in the number of network operators and Internet Service Providers (ISPs). Researchers have found that in rural areas, distance may (but not always) implicate investments that some ISPs reject in terms of timely capital cost recovery and shareholder dividends generated (Hambly & Rajabiun, 2021). Strategic procurement and subsidies may be used by federal, provincial/territorial, and municipal governments to incentivize new and upgraded rural broadband infrastructure and services (Rajabiun & Middleton, 2013; Organization of Economic Cooperation and Development [OECD], 2018). Under multi-government public investments in partnership with the ISPs, cost-sharing may involve extending fibre backhaul networks or building fibre to the (cell) towers as possible solutions to serve a greater number of premises or many smaller, rural communities (e.g., SWIFT, n.d.). Some rural communities or municipalities may "go it alone" to optimize access for local businesses and households, obtaining licenses from Canadian Radio-television and Telecommunication Commission (CRTC) to own and operate as an ISP (Mouly, 2021). Various other options for improved rural connectivity have been used in Canada (Rajabiun & Middleton, 2013; Taylor, 2018; McMahon et al., 2020).

Broadband Internet access (Internet access) is not available to all Canadians or available at comparable levels of service quality. It is necessary at this point of the paper to explain how households or communities in Canada most in need of improved service have been identified. At face value, the situation of Canadians' access to Internet looks good. The Canadian Radio-Television Commission's [CRTC] website states that "by the end of 2021, we expect 90 per cent of Canadian homes and businesses will have access to broadband speeds of at least 50 Mbps for downloads and 10 Mbps for uploads" (CRTC, 2021, para. 7). This 50/10 Mbps

[1] Canadians have constitutionally protected rights associated with information access and privacy, even under Article 19 of the Universal Declaration of Human Rights and its twin Article 19 of the International Covenant on Civil and Political Rights. However, the means to communicate and access information is not codified in Canadian law. Article 19 of the Universal Declaration and its twin Article 19 of the International Covenant on Civil and Political Rights (ICCPR) guarantee explicitly: an unfettered right to hold opinions; a right to express and disseminate 'any information or ideas'; a right to have access to media; and a right to seek and receive information and ideas. Not only does Article 19 prohibit states from interfering with the enjoyment of these rights, international law requires states not to interfere in these rights and take regulatory steps to protect them for everyone as well as 'practical' positive legislative actions, for example through the establishment of public telecommunication services such as free Wi-Fi in libraries or public buildings. In 2019, the "Order Issuing a Direction to the CRTC on Implementing the Canadian Policy Objectives to Promote Competition, Affordability, Consumers Interests and Innovation" indicating broadband access in Canada is, in fact, required for social and economic participation under the *Telecommunications Act* . See Rajabiun (2020) for a discussion of the recent regulatory challenges.

Internet speed threshold is also known as the "basic service objective" (BSO) established under Canadian Radio-Telecommunications Council (CRTC) Telecom Regulatory Policy 2016-496. Prior to 2016, the earlier aspirational speed target of 5/1 Mbps was increased to 50/10 Mbps with a qualification that they are actual speeds delivered, not "up to" speeds or those advertised by providers (Rajabiun, 2020). In 2018, CRTC also established, for the first time, a process to specify minimum universal quality of service (QoS) standards for fixed broadband Internet access service, defined as a "high-quality service if it provides the subscriber with a smooth experience when using real-time QoS-critical applications" (Telecom Decision CRTC 2018-241). This implicates not only download and upload speeds but also other targets such as the availability of unlimited data plans, latency defined at 50 milliseconds, and a packet loss threshold of 0.25%, measured during peak times (i.e., from 7 p.m. to 11 p.m. local time on weekdays). Subsequently, CRTC adopted a jitter threshold of five milliseconds, also measured during peak times (Telecom Decision CRTC 2019-42). Below the BSO thresholds (simply referred to as 50/10 Mbps), users cannot reasonably operate more than one or two Wi-Fi connected devices or stream video over the Internet without buffering.

In effect, the BSO serves as a measuring stick for broadband Internet access in Canada at the community and household levels. Although it is widely used in policy and public investment decision-making, the BSO does not address all elements of Internet access identified in Figure 1, and therefore, it does not necessarily assess rural Internet household or premise-level user experience, including understanding what a lack of Internet access has meant to life and livelihoods during the pandemic. This must be gained through other methods such as household and user surveys and data generated by, for example, news stories and media coverage. Therefore, we set out to explore the context of rural Canadians' need for improved connectivity during COVID-19. What are the issues associated with broadband Internet access during the pandemic, and will they remain relevant for policy action and institutional interventions beyond the context of COVID-19?

2.0 Methods and Data

Access to the Internet is geographically variable and experienced at individual, household, and community levels. First, we examined publicly available aggregate or mapped data reported "as of" the time covered by COVID-19 and the writing of this paper (March 2020 to December 2021). In Canada, the National Broadband Internet Service Availability Map (NBISAM) provides the public-facing view of the urban/rural and rural/remote (northern) broadband gaps (Industry, Science and Economic Development Canada [ISED], 2021)[2]. We also refer to public data from the Measurement Lab (M-Lab) Network Diagnostics Tool (NDT) Internet Performance Test (IPT) cited in other papers on COVID-19 and the digital divide (Lai & Widmar, 2020). M-Lab NDT datasets are publicly available, but they are also available by subscription on the proprietary dashboard of the Canadian Internet Registration Authority (CIRA, 2020).

[2] ISED and CRTC contract additional telecom datasets that are not publicly accessible, for example, the UK company SamKnows/TestMyISP (October 2019) reported in CRTC & SamKnows (2020). This report did not mention "rural" or define how many of the 3,266 Whiteboxes were deployed in rural areas. In 2021, a pilot project by the federal government awarded to start-up Canadian company Ecopia was announced in January 2021 but without exact specification of the project. The authors believe this would involve remote sensing imagery reported in a US ISP case study by Ecopia (2021).

Aside from these two large national datasets, some regional and municipal broadband initiatives administer broadband Internet use surveys to generate local data on connectivity needs, infrastructure availability, and variables pertaining to residential and business Internet access (e.g., cost of service, type of connection, use at premise, etc.). These surveys typically inform and update discussions within local councils (e.g., a gap analysis or feasibility study) (McNally et al., 2017; Rural Ontario Municipalities Association [ROMA], 2020). To examine the user experience data during COVID-19, we refer to data from two recent Ontario regional broadband studies (2020–2021). Aggregate quantitative data from the surveys include Internet performance data and residential/farm and home-based business use statistics.

The focus of this paper is pandemic-era Internet access in rural Canada. COVID-19 has been an evolving situation, and the opportunity that arose was to explore the extent to which COVID-19 had further affected those people and communities without higher-speed Internet access. Our research pursued this idea by juxtaposing Ontario's national datasets and user survey results with increased news coverage on rural broadband issues during the pandemic. Finding and analyzing relevant media coverage involved searches for articles from national or regional newspapers, magazines, and major news wire feeds retrieved from the main academic indexes for Canadian news periodicals (Candian Newsstream; Canadian News Online) as well as major commercial search indexes of news media such as ProQuest. We purposively included the Canadian Business and Current Affairs Database to include corporate or trade magazine articles that announced special COVID-19 broadband Internet access initiatives in the private sector, or public-private partnerships. The search process was date-defined (March 15, 2020, to June 31, 2021) and conducted in English with a boolean search string of rural (and) broadband (and) Internet (and) Canada. After cleaning the 517 results to remove repetitions of the same news item re-purposed in different Canadian news outlets, 219 items were of relevance to the research. The content of each item was read and rapidly evaluated using a structured observation guide that coded items by topic, date and source (Vindrola-Padros & Johnson, 2020). Sub-codes tagged the region of Canada, ISP name, and government funding program.

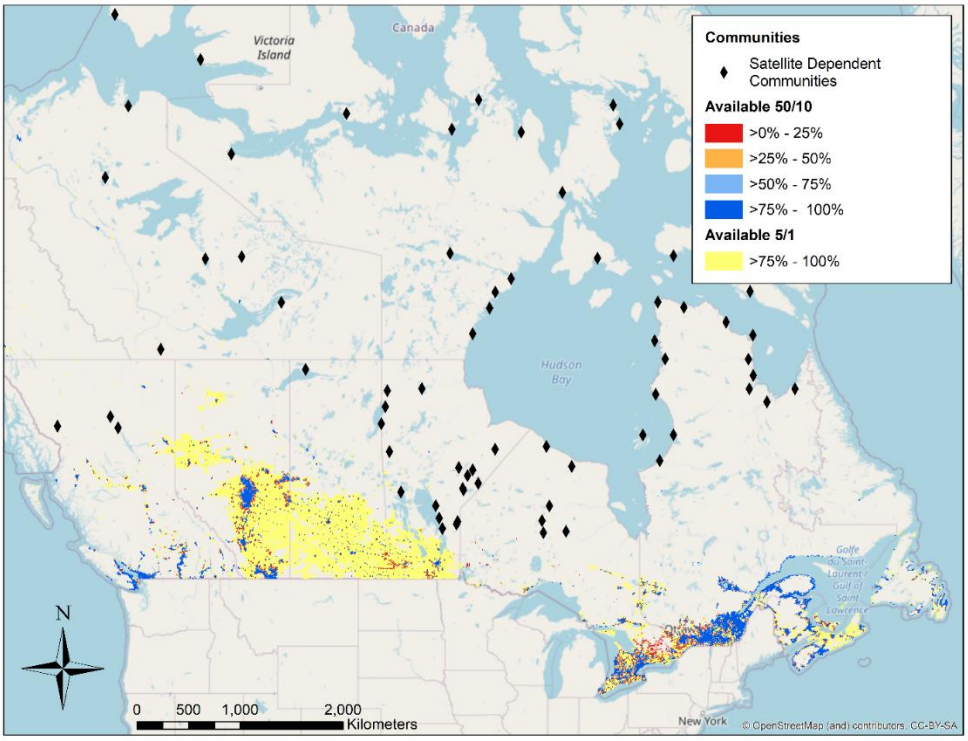
Some news coverage referred to recent reports from not-for-profit organizations or municipal associations on the relevance of COVID-19 and the need for improved connectivity and digital equity in Canada (Weeden & Kelly, 2020; Canadian Internet Registration Authority [CIRA], 2020; CYBERA, 2020; FNTC, 2021; Internet Society, 2020; ROMA, 2020; Institute for Fiscal Studies and Democracy [IFSD], 2021). We decided to include these reports in our analysis since they were publicly distributed and some generated news media coverage. The same deductive process of reading and coding (topic, date, source) and sub-coded (region, ISPs, government programs) was used.

3.0 Broadband Internet Access in Canada—a Wide Angle View during COVID-19

Based on publicly available data visualization in the NBISAM, Canada's "wide angle" broadband Internet coverage is presented in Figure 2 (ISED, 2021). Many areas of Canada fall well below the BSO or "basic service objective" of 50 Mbps download and 10 Mbps upload. The yellow areas of 5/1 Mbps cannot support higher bandwidth applications such as streamed videos. At a regional level, uneven service

levels are evident because higher bandwidth areas (in dark or medium blue) border on the red and yellow areas indicating lower average bandwidth. For example, in densely populated southern Ontario, which has approximately 12.7 million people or one-third of the nation's population (Government of Ontario, 2020), Internet service levels vary substantially. A disparity in the achievement of the federal BSO is also evident in the higher Earth orbit satellite-dependent communities, most of which are well below BSO service levels. Data points on recent technologies such as the low Earth orbit satellite Internet service from Starlink is not yet incorporated into national mapping, although community surveys and social media communities are sharing service level.

Figure 2: Wide-angle view of broadband internet access in Canada.



Source: National Broadband Internet Service Availability Map (NBISAM) data from Industry, Science and Economic Development (ISED) Canada, as of June 10, 2021, with data visualization by the authors).

National broadband mapping in Canada made improvements after the strong critique presented by the 2018 Office of the Auditor General of Canada's report (OAGC, 2018). NBISAM aggregates Internet Service Provider (ISP) data submitted to the CRTC, making it available to the Federal Ministry of Industry, Science and Economic Development (ISED), the designer/manager of NBISAM. Redesigned in 2019, the national maps display average aggregate Internet service data visualized, where it is available, to a 250 km road segment. An important functionality incorporated into NBISAM allows viewers to "zoom in" on various layers of data. Program-supported areas and "communities without fibre backbone" are viewable online. By 'zooming out' the data aggregates to average speed thresholds spread across a 25 km^2 hexagonal area, which is fairly granular, although variations across communities may be observed. Without dates and sample sizes on the data presented

within the hexagons, the accuracy of the data due to areas lacking a sufficient number of observations or out-of-date information are plausible (Hambly & Rajabiun, 2021).

National broadband mapping struggles with more accurate determination of broadband Internet access that reflects performance at the household or premise level. Two other datasets are typically used: directly administered Internet use surveys and network diagnostics platforms such as Measurement Lab (M-Lab) which collects speed test data from a variety of common speed test platforms.[3] Table 1 presents the summary of national data from M-Lab's global dashboard. The summary indicates the high number of speed tests run in provinces such as Ontario, but limited data for premises in other regions of Canada. For this reason, Hambly & Rajabiun (2021) advised examining broadband data within provinces or territories, and with attention to urban/rural distribution of data.

Table 1: *Median Download/Upload Internet Speeds and Number of Tests by Province/Territory (Dec. 30, 2019-Oct. 25, 2020)*

Region	**Median Download (Mbps)**	**Median Upload (Mbps)**	**Number of Download Tests**	**Number of Upload Test**
CA-AB	24.56	8.00	1,628,318.00	1,637,058.00
CA-BC	37.93	12.03	1,889,891.00	1,834,309.00
CA-MB	18.38	4.30	379,881.00	374,211.00
CA-NB	16.70	7.46	172,944.00	175,892.00
CA-NL	20.40	8.40	100,003.00	103,421.00
CA-NS	20.81	8.42	266,946.00	268,129.00
CA-NT	14.37	3.72	8,472.00	8,952.00
CA-NU	7.90	1.41	1,248.00	3,268.00
CA-ON	25.20	8.53	8,305,971.00	8,153,117.00
CA-PE	8.10	1.74	57,517.00	57,169.00
CA-QC	26.97	9.77	2,050,399.00	1,989,301.00
CA-SK	12.28	3.42	252,643.00	247,744.00
CA-YT	10.55	1.96	4,979.00	4,962.00

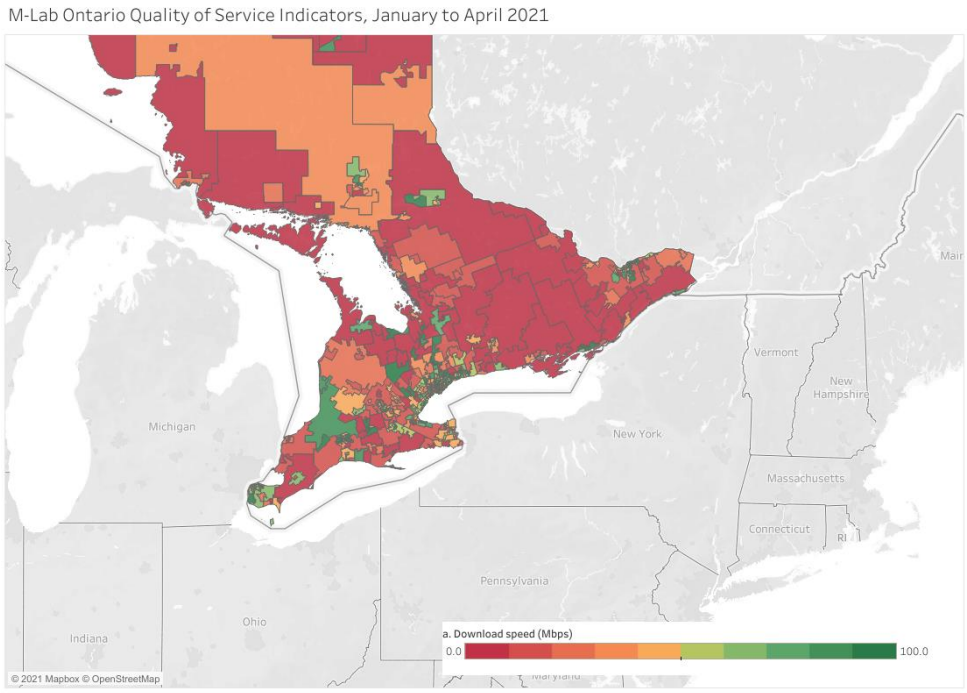
Note: Blue indicates higher Internet speed metrics and higher number of observations, red is lower Internet speed metrics and lower number of observations.
Visualization: Authors.
Data: Measurement Lab's (M-Lab) Network Diagnostic Tool (NDT)
https://www.measurementlab.net/data/

During COVID-19, Internet performance test results from the M-Lab dataset for Ontario were visualized. An open access, interactive map of pandemic-era M-Lab data (1st quarter of 2021) is available for Ontario (see Figure 3). The aggregate data (by postal code) highlights areas below the basic service objective of 50/10 Mbps.

[3] See: https://www.measurementlab.net/tests/ndt/

These areas occur even within the more relatively densely populated areas of southern Ontario (see Figure 3). Zooming in on the M-Lab test results includes additional Internet performance variables such as latency, packet loss, as well as the number of observations and their date.

Figure 3: January to April 2021, Quality of Service Indicators (Ontario).[4]



Note: See https://www.r2b2project.ca/publications/interactive-maps-and-data-visualizations/. In this figure, Ontario is partitioned by the Forward Sortation Area or CFSAUID (the first three alphanumeric characters of a postal code). Data in this visualization is retrieved from Measurement Lab's (M-Lab) Network Diagnostic Tool (NDT) https://www.measurementlab.net/data/

The national datasets of NBISAM and M-Lab provide "wide angle" views of connectivity in Canada, and neither alone presents a convincing case that basic service objective levels of 50/10 Mbps are achieved in rural Canada. Internet access must be assessed at a more granular level, specifically at the household or premise level within communities. For such further analysis and the extent to which the macro data of NBISAM and M-Lab are qualified by user experience during the pandemic (2020-2021), we draw on the results of two recent studies from Ontario.

4.0 "Zooming In" on Rural Broadband Internet Access during COVID-19

Analysis of data collected during the pandemic (2020–2021) was possible due to coincidental studies conducted by the Region of Durham and City of Hamilton. Both regions have recognized urban/rural broadband gaps, and these are apparent from aggregated data presented in the larger datasets such as NBISAM and R2B2/M-Lab "zoomed in" visualizations. Just as the COVID-19 pandemic hit, both of these

[4] For the interactive version of the map see: https://www.r2b2project.ca/publications/interactive-maps-and-data-visualizations/

regional governments had started to collect more granular data to assess broadband Internet access for strategic planning and public investment purposes.

Durham Region is an area of 2,523 km^2 bordering the north shore of Lake Ontario and located to the east of the Greater Toronto-Hamilton Area (GTHA). Durham's population as of December 2019 was just less than 700,000 residents. The vast majority (91.7% as of 2016) live in an urban area as designated by the Regional Official Plan. There are 1,323 farms in Durham Region. There were 2,394 surveys and approximately 500,000 M-Lab test results analyzed.

Hamilton is the ninth largest regional economy in Canada covering an area of 1,138 km^2, bordering the western tip of Lake Ontario, and lying southwest of the Greater Toronto-Hamilton Area (GTHA). Hamilton has just less than 540,000 residents with an average annual growth rate of 3.3% (16,970) since 2011. Nearly two-thirds (63.84%) of land use in Hamilton is agricultural, and agriculture generates $1.26 billion annually. There were 2,941 surveys and approximately 600,000 M-Lab test results analyzed.

Urban/rural disparity in broadband Internet access was evident in the two studies (see Table 2). Most notable are the significantly lower speeds for rural residents as compared to urban residents, with a slight difference for rural residents comparing Durham and Hamilton.

In terms of affordability, rural users pay more both in monthly costs and "all in" costs that include equipment setup costs and data overages due to the lack of unlimited data plans in rural areas. In the case of rural Durham, in 2020, a primary use plan with a data cap and overages incurred, on average, approximately the cost of another Internet subscription.

At the premise level, affordability issues adversely affected rural Internet users in both Durham and Hamilton.

Table 2: *Findings from Two Ontario Studies on Rural Broadband Internet Access (2020-2021)*

Dimension of Broadband Internet Access	**Durham (Jan-Aug 2020) n=2394**	**Hamilton (2020-2021) n=2941**
QoS, AVAILABILITY & SYMMETRY		
M-Lab NDT median Internet performance data	16.5/8.2 Mbps & 52 ms	36/9 Mbps & 28 ms
Median urban residential Internet service (M-Lab/CIRA)	35.5/10 Mbps & 21.5 ms	49/10 Mbps & 15 ms
Median rural residential Internet service (M-Lab/CIRA)	6.2/1.1 Mbps & 39 ms	7/1 Mbps & 33 ms
Percent of residential premises without internet access	3%	2%
Percent of residential premises with fixed broadband services below 5/1 Mbps	36%	11%
Percent of residential premises with fixed broadband below 25/3 Mbps	49%	29%

Dimension of Broadband Internet Access	**Durham (Jan-Aug 2020) n=2394**	**Hamilton (2020-2021) n=2941**
QoS, AVAILABILITY & SYMMETRY		
Percent of rural respondents with BSO (50/10 Mbps & 50 ms)	2%	9%
Percent of residential premises with mobile wireless as primary connection type	2% (urban) 17% (rural)	1% (urban) 13% (rural)
Percent of residential premises with fibre	8%	9%
AFFORDABILITY		
Percent of residential premises with data cap on primary connection	34%	19%
Percent of households with data overages over $100/month within past 12 months	89%	66%
Average cost of data overage for rural residents	$46 (low) - $117 (high)	$57 (low) - $125 (high)
Highest monthly cost of data overages	$510-$2000	$600-$900
Average monthly cost without & with data cap	$90 / $109	$105 / $112

Source: Durham Region (2020); City of Hamilton (2021)

For the purposes of this paper, we examined the Durham and Hamilton datasets in relation to three COVID-19 related issues reported in the news media coverage. These are residential use habits involving (1) unprecedented work from home, (2) access to basic Internet service for households with children or seniors, and (3) broadband Internet access at agri-business or farm premises.

4.1 Livelihood Internet Use

Residential Internet use habits shifted during COVID-19. Stay-at-home orders meant that residents were required to work from home. In Hamilton, nearly 70% (n=1,915) of respondents had a job that allows for telecommuting. Just over 36% had a job that allows telecommuting, but they could not due to a weak Internet connection. In Durham, the figures were 61% (n=839) of respondents that could telecommute but 49% encountered a lack of Internet performance. Households may also had more than one telecommuter. Symmetry and speed matter when workers are required to use a VPN (a secure virtual private network connection). For the first telecommuter in Durham, 81% (n=378) required access to work through a VPN (a secure virtual private network connection) and in Hamilton the figure was 80% (n=753). Furthermore, relevant to COVID-19 livelihoods, the surveys had asked respondents if they operated a home-based business. Of concern was the percentage of residential premises with speeds below the BSO (50/10 Mbps) that run a home-based business, which were 87% and 84% for Durham and Hamilton, respectively.

The Durham and Hamilton broadband studies shed light on being able to telecommute during public health requirements or during “stay-at-home” orders, but

also the economic resilience of being able to telecommute. Using a model by Hambly & Lee (2018) for assessing the net private benefit of telecommuting based on working two or more days from home, Durham Region reported a telecommuter surplus of $12,645 for the first telecommuter, and $7,559 for the second telecommuter in the household. Hamilton realized $13,072 and $9,334 for the first and second telecommuter, respectively. These findings are slightly higher (Hamilton) but consistent (Durham) with pre-pandemic telecommuting reported for southwestern Ontario by Hambly & Lee (2018). The pandemic difference observed was an increase in the number of telecommuting workers at the premise, but the challenge of having sufficient Internet performance to work from a rural premise. Not computed, due to lack of data, were the additional costs to the household during COVID-19 due to the adjustment to work from home.

4.2 Children and Seniors at Home

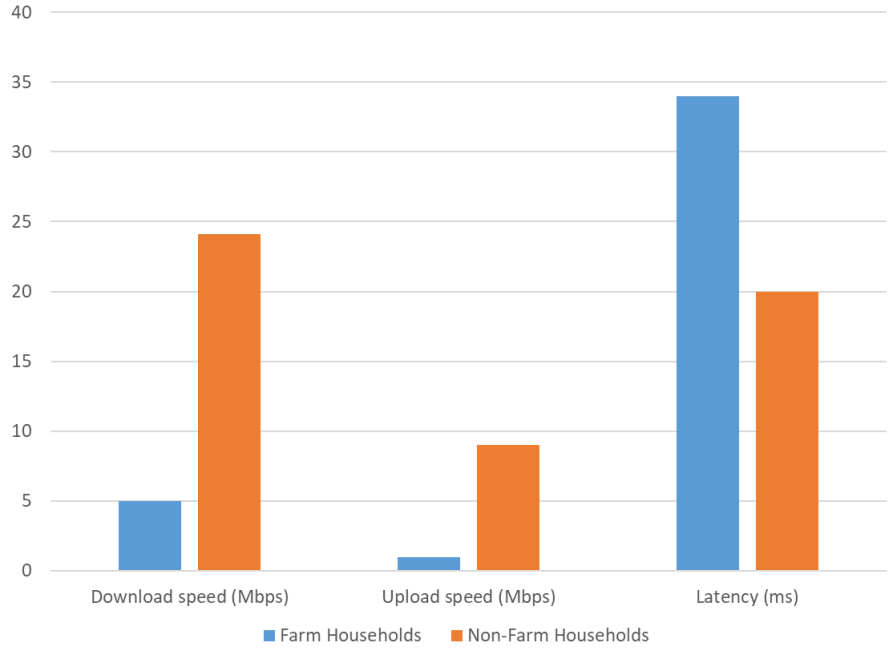
Significant results were not found in correlations between a primary residential type of Internet connection and children or seniors living at the premise. Of concern was the finding that 71% of households in Hamilton with children at home reported speeds below 50/10 Mbps, and in Durham the figure was 82%. As another indicator of urban/rural broadband gaps, in Hamilton, statistical significance was observed between the quality of service metrics and the school board where students are enrolled. The (English) public school board (with more schools located in smaller, rural communities, and therefore rural students enrolled) had lower download/upload speeds compared to the separated (Catholic) school board, with no differences in the French language schools.

In Durham and Hamilton, negative correlations for download speed and upload speed and the number of students and seniors living at the premise were observed. These correlations were weak but significant. The results suggest that Internet performance tends to be lower for households with more students and/or more seniors, as compared to households without students and seniors. Figures for seniors at home with connectivity at or below 50/10 Mbps are 87% and 78% for Hamilton and Durham Region, respectively. Surveys indicated “seniors living at the premise” list “telehealth” and “information search” high in the list of the question on “use of Internet,” whereas surveys indicating “school-age children living at the premise” indicate “homework” and “gaming,” as top uses of Internet access.

4.3 Farm Households

In Durham and Hamilton, agriculture is a key enterprise, and productivity is substantial; for example, in Durham gross annual farm receipts top $300 million annually. Farming is one area of rural livelihood that is highly underserved and lacking faster and reliable broadband Internet access. All farms (100%) surveyed in Durham (n=76) reported performance below BSO 50/10 Mbps. In Hamilton, the figure is 96%. On closer look, socio-demographic dynamics among rural households indicate important intra-rural differences in broadband Internet access. An example from Hamilton (see Figure 4), indicates students in farm households experience performance levels approximately five times lower than non-farm residences.

Figure 4: Internet Service Levels for Farm vs. Non-farm Households in Hamilton, Ontario.



These two Ontario studies completed during the pandemic point to some of the household challenges of limited access to broadband Internet and the continuing need for improved connectivity. There are individual-specific Internet access issues within the household level, such as the need for Internet access by seniors, school-age children, or adults who telecommute or run a business from home. The surveys used here are household or premise-level surveys encompassing all individuals, but it is apparent that individual user experience is the most granular level of understanding Internet access. We now turn to news media coverage during COVID-19 of rural Canadians struggling with Internet access.

4.4 News Media Coverage of Rural Internet Access during COVID-19

Prior to COVID-19, popular attention in Canada to rural broadband access often proved difficult to sustain. Several major not-for-profit organizations and municipal associations drew attention to Canada's digital divide, particularly in the first year of the pandemic (Weeden & Kelly, 2020; CIRA, 2020; CYBERA, 2020; FNTC, 2021; Internet Society, 2020; ROMA, 2020; IFSD, 2021). The news media pushed forward the point that urban dwellers in Canada had taken ubiquitous Internet connectivity for granted, and their eyes were opened when they visited areas outside the city (Visvizi et al., 2019). We found that the crisis of COVID-19 provided a "wake-up call" in terms of public awareness about Canada's digital divide and the need for policy action. From 219 articles analyzed, 65% of the news media stories were released in the first six months of the pandemic. Over one hundred items referenced action in relation to the federal government's Universal Broadband Fund (UBF), which announced its acceleration of $1.75 billion in the 2020 September Throne Speech and added $1 billion to the federal budget of April 19, 2021 (ISED, n.d.). Under the UBF's, "Rapid Response Stream" ($150 million), the approval of

multiple projects of up to $5 million each has provided a "slow release" of ongoing media attention to rural broadband.

Coding of the COVID-19 rural broadband media coverage frequently featured individual and household user experiences. The top focus was online learning, followed by work from home. Seniors and people with disabilities was the third most common topic. Media coverage featured personal stories about the lack of individual Internet access and a concern about rising prices of Internet access in rural areas. These stories were juxtaposed against spring 2021, annual financial reports of major telecommunications companies that achieved increased COVID-19 revenue; for example, Rogers and Cogeco realizing profits from a 50% and 60% increase in home Internet use, respectively. One-third of the news items drew a link to telecommunications companies on two aspects of their COVID-19 action agenda: corporate social responsibility actions for vulnerable households, and increased capital investments in rural broadband, mostly in the context of partnership with the federal and provincial government programs. Canadian news media called attention to the growing demand for telecommunications and communication during the pandemic. For example, Rogers was cited for its 40% increase in wireless calls and 300% increase in 1-800 calls in the first months of the pandemic. Some reports recognized that Canadian households were adversely affected by economic upheaval (e.g., job loss) or social vulnerability (e.g., increased reports of domestic violence and concerns for personal security). In response, the news coverage drew attention to COVID-19 corporate social responsibility initiatives. These were rapid-response Internet access improvements, most of which were short-lived. For example, Rogers offered #ForwardTogether to support customers with a brief period (April-June 30, 2020) of free long-distance calling, removal of data usage caps on home internet plans, and no accounts suspended/disconnected. Bell temporarily waived some customer fees for home internet and mobility and contributed an additional $5 million to its Bell "Let's Talk" mental health campaign. Xplornet, a larger rural provider, acted similarly and dropped data overage costs in May and June 2020. Complimentary devices and six months of free voice and data plans were provided by Rogers and Telus to women's shelters and other social support groups, according to a news story from southwestern Ontario. What was missing from the findings of our analysis of news coverage was clarity on the extent to which COVID-19 corporate social responsibility efforts assisted rural households, farms, or rural premises with school-age children and seniors.

Finally, news coverage during the pandemic also opened up some institutional dimensions of Internet access. In February 2021, Canada's big three telecom companies Bell, Rogers, and Telus, were called out for collecting more than $240 million from Canada's wage-subsidy program while paying out high dividends in the 2020 financial year to their shareholders. In the case of Bell, dividends increased by 5.1% in 2020. Some news stories featured a few Members of Parliament calling for wage-subsidy funds from these companies to be returned. Media coverage reported telecommunication companies accelerating their rural broadband capital investments. Most of these investments, however, will be required in successful applications to the federal Universal Broadband Fund, and similarly, provincial rural broadband programs.

5.0 Discussion

Our findings indicate that large "wide angle" views on connectivity in Canada offer a generalized understanding of COVID-19 broadband Internet access and the evolving needs of rural individuals, households, and communities. This is consistent with the findings of other studies (Taylor, 2018; Hambly & Rajabiun, 2021). For more granular analysis and the results of studies conducted by regional governments such as the Durham Region and the City of Hamilton during the pandemic (2020-2021) were informative. Such studies indicate the differences in broadband Internet access and key issues being discussed in the news. There is, for example, an apparent need to support rural households with multiple telecommuters who struggle with affordability and low quality of service for available Internet access. These findings point to the integrated elements of Internet access. Institutional and technological dimensions influence Internet access from the national level down to the local level, and households.

National and regional datasets, as well as news media coverage, suggest that new strategies for improved connectivity for all Canadians are needed. Addressing Internet access could integrate with the well-being of children, seniors, and the livelihoods of adults providing for their households. The COVID-19 pandemic has made it urgently clear that all Canadians need Internet access, and some more than others need attention. For example, how existing broadband infrastructure can better support farms and rural businesses is recognized in the Government of Ontario (2019) action plan entitled "Up to Speed," but the impact will have to be measured at the household and community level. This is why our findings support similar results in the literature (Rajabiun & Middleton, 2013) that municipalities such as Durham Region and the City of Hamilton will need to continue to study broadband Internet access and develop strategies to fit local needs, while partnering with ISPs and other levels of government.

National data during COVID-19 point to strategies needed for the most underserved rural and remote areas of nations such as Canada (Beaunoyer et al., 2020; McMahon et al., 2021). The pandemic, we conclude, made engaging actively in telecommuting from home and online learning impossible below 5/1 Mbps, but also, problematic for sustaining the livelihoods of rural areas below the BSO of 50/10 Mbps. Concerns for online school performance identified by Statistics Canada in Frenette et al. (2020) and family mental health support (Gadermann et al., 2021) will continue even after the pandemic is over. A future policy is needed by governments to address Internet access in households with more than one telecommuter and in households with children and seniors.

Internet access in rural areas makes other digital transformation for socio-economic impact possible (Katz et al., 2020). This might mean realizing new economic resilience or closing gaps within the socio-technical system whereby, for example, a business adopts new technology (e.g., precision technology devices or applications) that affect the "bottom line" or results in social benefit (e.g., reduced emergency service to the premise calls or reduced carbon emissions) (Gorejena et al., 2016). News coverage during COVID-19 had an impact on drawing the attention of all Canadians (policymakers and telecommunication companies) to rural broadband. National and local media must continue to play a key role in telling more stories about the urban/rural digital divide and improving broadband Internet access that realizes social, economic, and environmental opportunities.

The institutional side of Internet access is complex, as evidenced by the issues covered by the news media during COVID-19 and the volume of announcements about public investments in rural broadband. Coming out of the pandemic, Canadians may wonder, "Didn't we fix the digital divide?" The answer will be found in national and regional datasets and user-level surveys. We recognize the limitations of this study, including the need for additional regional data from across Canada. Our superficial analysis of news coverage of COVID-19 on rural broadband issues suggests that there is a need for revising the method and addressing institutional dimensions of Internet access, even following up on interventions such as corporate social responsibility interventions and post-pandemic benefits for Internet access and bridging digital divides. Data was not available to determine if rural users surveyed during COVID-19 made use of these temporary interventions. Nevertheless, the root causes of Internet access for all Canadians are institutional, as well as technical.

6.0 Conclusion

This paper highlights some of the complex political, economic, and social issues associated with rural connectivity during COVID-19, based on an analysis of data at the national and regional levels and news media coverage to inform policy interventions that are likely to continue after the pandemic. Rural Canada would benefit from codifying broadband Internet access as "essential service." Focused on COVID-19 experiences, our findings suggest that data collection, measurement, and mapping provide a good wide-angle look at rural broadband in Canada, but more granular analysis of issues at the household level is important, particularly for farm households and residential premises with school-age children, seniors, and telecommuters. The "return to pre-pandemic normal" is not a good option where rural broadband is concerned. Popular awareness about rural broadband Internet access grew during COVID-19, and if it is lost, rural residential and business needs will go unfulfilled and continue to limit Canada's overall pandemic recovery.

References

Ali, C. (2020). The presumption of the connected: Why assuming broadband connectivity is disastrous in a time of crisis. *Digital Beat*. Washington, DC: Benton Institute. https://www.benton.org/blog/presumption-connected

Beaunoyer, E., Dupéré, S., & Guitton, M. (2020). COVID-19 and digital inequalities: Reciprocal impacts and mitigation strategies. *Computers in Human Behavior, 111*(2020), e1-e9. https://doi.org/10.1016/j.chb.2020.106424

Borgman, C. (2000). From Gutenberg to the global information infrastructure: Access to information in the networked world. Cambridge, MA: MIT Press.

Canadian Council of Academies [CCA]. (2021). *Waiting to Connect: The Expert Panel on High-Throughput Networks for Rural and Remote Communities in Canada*. Council of Canadian Academies.

Castiglione, A., Umer, M., Sadiq, S., Obaidat, M. S., & Vijayakumar, P. (2021). The Role of Internet of Things to Control the Outbreak of COVID-19 Pandemic. *IEEE Internet of Things Journal, 8*(21), 16072–16082. https://doi.org/10.1109/JIOT.2021.3070306

Canadian Internet Registration Authority (CIRA), & The Strategic Counsel. (2020). *COVID-19 Online Behaviours and Attitudes* [PowerPoint slides]. https://www.cira.ca/sites/default/files/2020-04/CIRA%20Covid-19%20Report%20--%20Online%20Behaviours%20and%20Attitudes.pdf

City of Hamilton. (2021). *Hamilton residential, rural, farm and business broadband surveys.* Author. https://www.hamilton.ca/city-initiatives/strategies-actions/hamilton-residential-rural-farm-and-business-broadband-surveys

Canadian Radio-Television Commission (CRTC), & SamKnows. (2020). *Measuring Broadband Canada.* Report. https://crtc.gc.ca/eng/publications/reports/rp200601/rp200601.PDF

Canadian Radio-Television Commission (CRTC). (2021). *What you should know about Internet speeds.* https://crtc.gc.ca/eng/internet/performance.htm

CYBERA. (2020). *Alberta rural connectivity coalition*. https://www.cybera.ca/arcc/

Davidson, J., & Schimmele, C. (2019). *Evolving Internet use among Canadian seniors.* Ottawa, Ontario, Canada: Statistics Canada.

Durham Region. (2020). Durham Region recognizes the importance of adequate broadband infrastructure. *Broadband* https://www.durham.ca/en/economic-development/invest-and-grow/telecommunications.aspx

Ecopia. (2021, June). *How Bloosurf used Ecopia's building-based geocoding solution to identify broadband serviceable locations remotely*. Case study. https://uploads-ssl.webflow.com/5b42ca4220a14a3f61aeff1f/60c0ca80d717d6943b887d5a_Bloosurf%20Case%20Study%202021June%20(1).pdf

First Nations Technology Council (FNTC) (2021), *First Nations Technology Council Co-Creating Strategy to Achieve Digital Equity for Indigenous Peoples*. https://technologycouncil.ca/2021/11/03/co-creating-strategy-to-achieve-digital-equity-for-indigenous-peoples/

Freeman, J., Park, S., & Middleton, C. (2019). Intersections between connectivity and digital inclusion in rural communities. *Communication Research and Practice, 5*(2), 139–155.

Frieden, R. (2005). Lessons from broadband development in Canada, Japan, Korea and the United States. *Telecommunications Policy, 29,* 595–613. https://doi.org/10.1016/j.telpol.2005.06.002

Frenette, M., Frank, K., & Deng, Z. (2020). *School closures and the online preparedness of children during the COVID-19 pandemic*. Ottawa, Ontario, Canada: Statistics Canada.

Gadermann, A., Thomson, K. C., Richardson, C. G., Gagné, M., McAuliffe, C., Hirani, S., & Jenkins, E. (2021). Examining the impacts of the COVID-19 pandemic on family mental health in Canada: findings from a national cross-sectional study. *BMJ Open, 11*(1), e042871–e042871. https://doi.org/10.1136/bmjopen-2020-042871

Gorejena, K., Mavetera, N., & Velempini, M. (2016). A critique and potency of socio-technical systems theory: a quest for broadband growth and penetration. *Public and Municipal Finance, 5*(2), 7–19. http://dx.doi.org/10.21511/pmf.5(2).2016.01

Government of Canada. (2020, November 19). *Appearance before the Standing Committee on Industry, Science and Technology (INDU) by the Minister for Women and Gender Equality and Rural Economic Development.* https://ised-isde.canada.ca/site/transparency/en/appearance-standing-committee-industry-science-and-technology-indu-minister-women-and-gender-0

Government of Ontario. (2019). Up to Speed: Ontario's Broadband and Cellular Action Plan. https:// www.ontario.ca/page/speed-ontarios-broadband-and-cellular-action-plan?share=ab06ad30-a729-11e9-b1d7-536843a29b1d

Government of Ontario. (2020). *Ontario population projections.* https://www.ontario.ca/page/ontario-population-projections#:~:text=The%20population%20of%20Southwestern%20Ontario%20is%20projected%20to,in%202046%2C%20an%20increase%20of%2029.2%20per%20cent

Hambly, H., & Chowdury, M. (2018). *A gap analysis of broadband connectivity and precision agriculture adoption in Southwestern Ontario, Canada*. Montreal, Canada: e-Proceedings of the 14th International Conference on Precision Agriculture.

Hambly, H., & Lee, J. D. (2018). The rural telecommuter surplus in Southwestern Ontario, Canada. *Telecommunications Policy, 43*(3), 278–286. https://doi.org/10.1016/j.telpol.2018.07.009

Hambly, H., & Rajabiun, R. (2021). Rural broadband: Gaps, maps and challenges. *Telematics and Informatics, 60*(July), 101565. https://doi.org/10.1016/j.tele.2021.101565

Herron, R. V., Newall, N. E. G., Lawrence, B. C., Ramsey, D., Waddell, C. M., & Dauphinais, J. (2021). Conversations in times of isolation: Exploring rural-dwelling older adults' experiences of isolation and loneliness during the COVID-19 pandemic in Manitoba, Canada. *International Journal of Environmental Research and Public Health, 18*(6). https://doi.org/10.3390/ijerph18063028

House of Commons Canada. (2021, February 23). *Meeting No. 17 FEWO - Standing Committee on the Status of Women* [Video file]. https://parlvu.parl.gc.ca/Harmony/en/PowerBrowser/PowerBrowserV2/20210223/-1/34806?Language=English&Stream=Video

Institute for Fiscal Studies and Democracy (IFSD). (2021). *Assessing the efficacy of instruments for the delivery of rural broadband.* [Report]. Ottawa, Ontario: University of Ottawa. https://www.ifsd.ca/web/default/files/Blog/Reports/2021-04-21_Final%20report_Assessing%20the%20efficacy%20of%20instruments%20for%20the%20delivery%20of%20rural%20broadband%20.pdf

Industry, Science and Economic Development Canada (ISED). (2021). *National broadband Internet service availability map*. Government of Canada. https://www.ic.gc.ca/app/sitt/bbmap/hm.html?lang=eng

Internet Society. (2020). *Ensuring Every Canadian Has Access to the Internet*. Ottawa (ON): Internet Society.

ISED (Industry, Science and Economic Development Canada). (n.d.) *High-speed Internet for all of Canada*. https://ised-isde.canada.ca/site/high-speed-internet-canada/en

Katz, R., Jung, J., & Callorda, F. (2020). Can digitization mitigate the economic damage of a pandemic? Evidence from SARS. *Telecommunications Policy, 44* (10), 102044. https://doi.org/10.1016/j.telpol.2020.102044

Lai, J., & Widmar, N. O. (2020). Revisiting the digital divide in the COVID-19 era. *Applied Economic Perspectives and Policy, 43*(1), 458–464. https://doi.org/10.1002/aepp.13104

McNally, M., Rathi, D., Evaniew, J., & Wu, Y. (2017). Thematic analysis of eight Canadian federal broadband programs from 1994 to 2016. *Journal of Information Policy, 7*, 38–85. https://doi.org/10.5325/jinfopoli.7.2017.0038

McMahon, R., McNally, M., & Joseph, K. (2020). Shaping "Digital Futures" in Alberta: Community engagement for Rural Broadband Development. *Canadian Journal of Communication, 45*(1), 25–51. https://doi.org/10.22230/cjc.2020v45n1a3527

McMahon, R. (2020). Co-developing digital inclusion policy and programming with Indigenous partners: Interventions from Canada. *Internet Policy Review, 9*(2), 1–26. http://dx.doi.org/10.14763/2020.2.1478

McMahon, R., Akçayir, M., McNally, M. B., & Okheena, S. (2021). Making sense of digital inequalities in remote contexts: Conceptions of and responses to connectivity challenges in the Northwest Territories, Canada. *International Journal of Communication, 15*, 5229–5251.

Mouly, A. (2021, March 26). Vermilion mayor talks broadband at Alberta Rural Connectivity Forum. *Lakeland Connect.* https://lakelandconnect.net/2021/03/26/vermilion-mayor-talks-broadband-at-alberta-rural-connectivity-forum/

Office of the Auditor General of Canada (OAGC). (2018). *Independent auditor's report, 2018 Fall Reports. Connectivity in Rural and Remote Communities.* http://www.oag-bvg.gc.ca/internet/English/parl_oag_201811_01_e_43199.html#hd4a

Organization of Economic Cooperation and Development (OECD). (2018). *Bridging the digital rural divide*. Paris, France: Author.

Perez, M. A., Mendis, R., & Newell, W. (2021). Enterprise hubs: A path to reignite collaboration networks in rural Newfoundland. *The Journal of Rural and Community Development, 16*(4), 178–207.

Rajabiun, R. (2020). Technological change, civic engagement and policy legitimization: Perspectives from the rise of broadband Internet as an essential utility in Canada. *Government Information Quarterly, 37*(1), 101403. https://doi.org/10.1016/j.giq.2019.101403

Rajabiun, & Middleton, C. A. (2013). Multilevel governance and broadband infrastructure development: Evidence from Canada. *Telecommunications Policy, 37*(9), 702–714. https://doi.org/10.1016/j.telpol.2013.05.001

Ramírez, R. (2001). A model for rural and remote information and communication technologies: A Canadian exploration. *Telecommunications Policy, 25*(5), 315–330. https://doi.org/10.1016/S0308-5961(01)00007-6

Rural Ontario Municipalities Association (ROMA). (2020). *Broadband connectivity: A municipal primer.* Toronto: Author.

Standing Committee on Industry, Science and Technology (SCIST). (2018). Broadband connectivity in rural Canada: Overcoming the digital divide. [Report Presented to the 1st Session, 42nd Parliament of the House of Commons, Ottawa, Canada]. https://www.ourcommons.ca/Committees/en/INDU/StudyActivity?studyActivityId=9604427

Taylor, G. (2018). Remote rural broadband systems in Canada. *Telecommunications Policy, 42*(9), 744–756. http://dx.doi.org/10.2139/ssrn.3357266

Taylor, G., Anderson, K., & Cramer, D. (2021). Municipal digital infrastructure and the COVID-19 pandemic: A case study of Calgary, Canada. *Journal of Digital Media & Policy, 12*(1), 137–157. https://doi.org/10.1386/jdmp_00052_1

Vindrola-Padros, C., & Johnson, G. (2020). The use of rapid qualitative research in time-sensitive contexts: Challenges and opportunities. In B. Clift (Eds.), *Temporality in Qualitative Inquiry: Theories, Methods and Practices* (pp. 172–190). Routledge.

Visvizi, A., Lytras, M. D., & Mudri, G. (2019), Smart villages: Relevance, approaches, policymaking implications. In A. Visvizi, M.D Lytras, & G. Mudri (Eds.), *Smart villages in the EU and beyond* (pp. 1–12). Emerald Publishing Limited. https://doi.org/10.1108/978-1-78769-845-120191002

Weeden. A., & Kelly, W. (2020, June 18). *Addressing the digital divide: COVID-19 and the importance of connecting rural Canada*. [Report]. Rural Insight Series. Canadian Rural Revitalization Foundation. Retrieved from http://crrf.ca/ri-digital-divide/

Wheeler. T. (2020, April 2). Why the Internet didn't break. [Blog]. *Brookings.* https://www.brookings.edu/blog/techtank/2020/04/02/why-the-internet-didnt-break/