



The State of Safety in British Columbia's Remote Off-Grid Communities

Current knowledge, risk assessments, and engagement strategies to mitigate technical systems risk in remote areas.

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Who are we?

The GMCA Graduate Consulting Program is a unique opportunity for graduate students and postdoctoral fellows to apply their critical thinking and communication skills by solving real-life business problems for companies, government agencies and nonprofit organizations in British Columbia. In every project, a selected team of 5 graduate students will be exposed to a real-life business environment with a business client and will receive a series of training sessions and mentorship from local advisors, leaders in industry and consultants. Projects typically run for 3 months ending with a client report and presentation.

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List of Abbreviations

AANDC	Aboriginal Affairs and Northern Development Canada <i>now Indigenous and Aboriginals Canada, INAC</i>
BCSA	British Columbia Safety Authority <i>Now Technical Safety BC</i>
Census	Census Canada
NRCan	Natural Resources Canada
RCCBC	Rural Coordination Centre of British Columbia

Executive summary

Keeping people safe at home, especially in remote off-grid communities, is an ongoing challenge for the BC Safety Authority (BCSA). Residents in off-grid communities often install equipment in their homes such as propane tanks, diesel generators, electrical wiring and gas stoves without proper training, guidance or help from licensed contractors. While this can be a convenient and cost-saving option, unregulated equipment often ends up in a state of disrepair or are missing the proper safety features.

The recent deaths of a family of 4 in an off-grid community in Ashcroft, BC, highlights this deep-rooted problem of safety awareness and compliance in off-grid communities. In this particular case, the owners of the home installed a water heater in their home without proper ventilation and a carbon monoxide detector, which led to a fatal buildup of carbon monoxide inside the home.

Our first meeting with the Research & Analytics department of BCSA revealed that there is a lack of data internally with regards to the state of remote communities in BC; particularly those living off-grid. Our challenge was thus to collect information about these communities that could be used to improve communication with the communities and to prioritize communities based on their safety risks.

During the span of 3 months, we traversed numerous public databases and reports to collect a list of 280 remote communities in BC, 54 of which have been identified as off-grid communities. From those communities, we collected additional information from each community including topics such as community location, transportation access, communications, housing, energy use, socioeconomic info and health networks. During this search, we identified 4 key organizations, Census Canada, NRCan, RCCBC and INAC that provide the majority of data on remote communities in BC.

Next, our analysis of communication channels revealed that many remote communities have an online presence in the form of community websites and Facebook groups alongside more traditional channels such as radio and TV. We also designed and conducted an internal interview with a BCSA Safety officer in the Kamloops region and an external interview with an off-grid community technical expert. Both interviews resulted in new insights into energy use, safety awareness, safety issues and key contacts in those communities.

Lastly, we looked into existing risk prediction models to predict the relative risk of safety incidents for communities. We found that in BC, there were a number of risk prediction models in healthcare literature that tapped into socioeconomic and geographical features to identify communities with higher risk of injury. As of the time of writing, we are still testing these models on our data but preliminary data (not shown in this report) identified certain off-grid communities including Ashcroft BC as communities at higher safety risk.

Given the potential applications of the data highlighted in this report, we recommend that BCSA pursue the creation of a remote community database using the data sources and communication channels described in this report and to apply the information gained into improving safety outcomes in our province's remote communities.

Introduction

What are Remote Off-Grid Communities?

The term “Off-Grid communities” and “Remote communities” are often used interchangeably and are defined by Natural Resources Canada (NRCan) as communities that are not connected to the North American electric grid nor to the piped natural gas network, are permanent or long-term (> 5 years) and have at least 10 permanent dwellings.

In reality, many of these communities also drill their own wells, build their own roads and sheds, hook up electrical generators, electrical wiring and sewage plumbing, and install other equipment that insulate them all year round from the natural elements. On top of that, these utilities require their own safety checks such as smoke and gas detectors, electrical fuses and fire sprinklers in addition to routine maintenance and proper installation.

In the city, these safety checks are well integrated into every home, strictly enforced by local government and routinely checked by licensed contractors. In off-grid communities however, these safety checks are almost non-existent and there is a lack of awareness and urgency about safety at home. There is also a general resistance from the community towards relatively expensive and inaccessible licensed contractors and towards regulations in general.

Why Study Remote Off-Grid Communities in BC?

This consulting project was initiated in response to unresolved home accidents in remote off-grid homes, one of which made headlines as a family of four in Ashcroft, BC passed away from carbon monoxide poisoning due to an unregulated, self-installed water heater. Although the causes of the poisoning were identified and safety recommendations were made, this incident highlighted the lack of safety regulation and awareness in remote off-grid communities in BC. The key task now for the province and other stakeholders is to prevent further safety accidents at home.

Our client, the BC Safety Authority (BCSA), plays an important role in that regard as they are the organization mandated to oversee the safe installation and operation of technical systems and equipment including utilities at home. As BCSA has limited data on off-grid communities, our task was to collect information about these communities that could help them understand safety risks and improve two-way communication with off-grid communities.

Objectives

What is the goal of this project?

Our goal for this project is to build a data collection framework that allows BCSA to collect information on BC's remote off-grid communities that can be used to 1) identify off-grid communities 2) identify effective channels of communication and 3) predict residential safety risks of communities.

Timeline

What did we do?

We used the first month of June to assign team roles and objectives, bring in two consulting and data science mentors and to define the scope of the problem with Soyeon Kim, who is the Leader of the Research & Analytics department of BCSA. We spent the second month of July collecting data on off-grid communities via literature and database searching, information requests and interviews with remote community experts. In the third month of August, we analyzed the information we collected and came up with recommendations that would improve long term data collection and communication with off-grid communities.

Throughout the three-month project, the project team met at least once a week for 2 hours. We also met with our BCSA client (~2 meetings/month) and mentors (~2 mentors/month) to update them regularly on our progress and to get their feedback on the direction of our work.

Module 1: Finding Off-Grid Communities

Abstract

To understand the state of safety in off-grid communities, the first task is to locate these communities. In urban areas, this task is easier as there are relatively clear and consistent records of homes and homeowners. In remote areas however, tracking communities presents many challenges including a lack of official home addresses and records, frequent movement and changes in communities and often, a desire by communities to be “free from the prying eye of the (government and social) system”.

In this module, we tap into publicly-available information to collect existing information about remote off-grid communities in BC. Our research over the past months have shown that there are key organizations such as the Canadian Census (Census), Natural Resources Canada (NRCAN), Aboriginal Affairs and Northern Development Canada (AANDC; now INAC) and the Rural Coordination Centre of BC (RCCBC) that have and are still collecting data on remote communities. The data across these organizations can sometimes be inconsistent and inaccurate as communities and priorities change over time. However, we have found that they contribute a significant breadth of information including topics such as energy use, housing, education, welfare and health that strongly influence residential safety outcomes in remote communities.

In summary, here we have:

1. Compiled a list of approximately 280 remote communities in BC; 54 of which we have identified as off-grid
2. Identified key organizations that contribute data on remote off-grid communities
3. Collected a range of socioeconomical, geographical and energy-related community data
4. Provided recommendations to build on the data collected during this project
5. Described our approach in collecting the data

Overall, we found that the value of the data was worth the effort that was put into its collection and preparation. Combined with the increasing supply of Open Data and support for data-driven decision-making in our province, we believe that this is the right step forward for BCSA.

1.1 Objectives

In order to plan for any projects catering to off-grid communities, BCSA needs to first find and understand the state of off-grid communities in BC. Our work in this first module addresses the “who and where?” questions: Who are the off-grid communities in British Columbia and where are they? To do this, BCSA requires:

- a reliable list of off-grid communities and their community features and
- a data collection strategy to update or re-create that list

1.2 Results

1.2.1 There are approximately 280 remote communities in BC, 54 of which are identified as off-grid communities

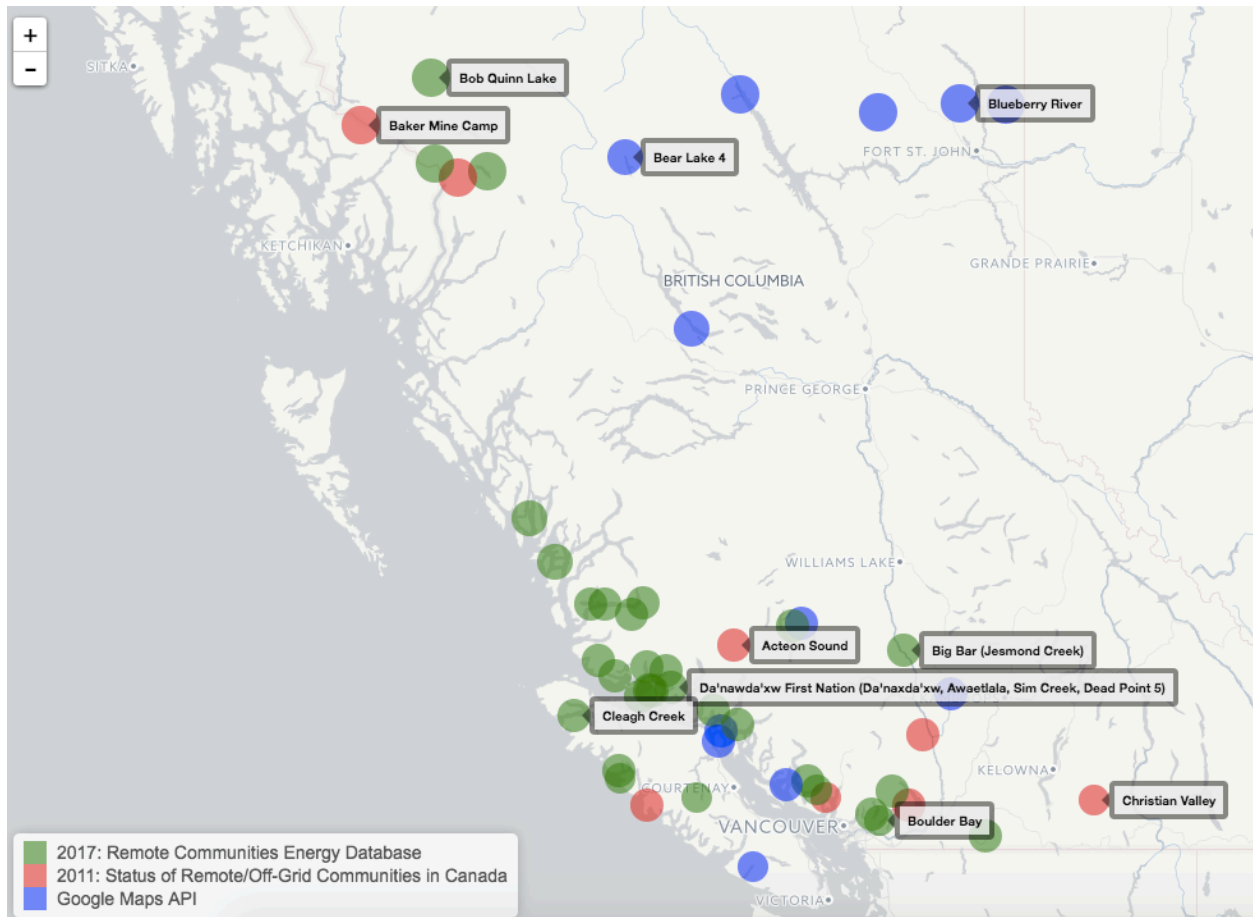


Figure 1. Map of 54 remote off-grid communities (out of 280 remote communities)

Our data collection efforts showed there are approximately 280 remote communities in BC that are listed on publicly-available datasets. From these 280 communities, we have identified 54 off-grid communities (Appendix A) that rely on alternative energy sources to power their homes and have mapped them on Figure 1. As BCSA is interested in improving residential safety in off-grid communities, we recommend using this set of 54 communities as a starting point for further work.

1.2.2 AANDC (INAC), NRCAN and RCCBC are the main sources to obtain lists of remote off-grid communities in BC.

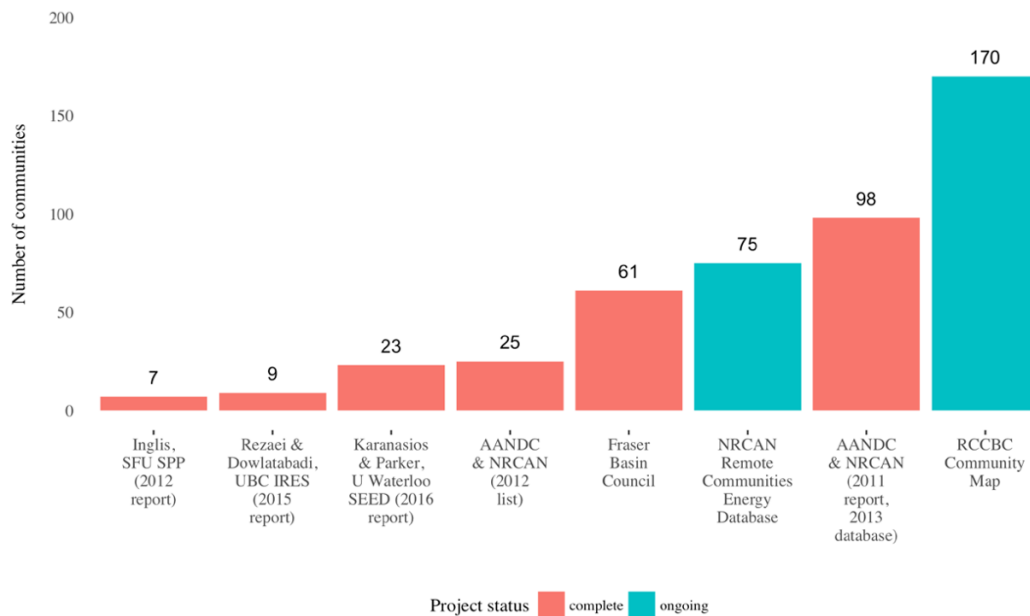


Figure 2. Number of communities from each dataset

Our community data was sourced purely from publicly-available information and during our search, we traversed numerous websites and database portals, finally settling with a few (Appendix B). With that experience, we found that AANDC, NRCAN and RCCBC were the most reliable and comprehensive sources to obtain lists of remote off-grid communities.

The reliability of these data sources come from:

- their nature as government authorities or government-affiliated organizations
- their significant number of years of research into remote areas in BC
- AANDC, NRCAN and RCCBC have ongoing data collection on remote communities that are used to power two interactive data portals called:
 - 'Atlas of Canada: Remote Communities Energy Database' and
 - 'RCCBC Community Map'

These data sources are also deemed comprehensive because:

- They have the largest list of remote communities (Figure 2)
- Their data specifically includes energy usage and community energy projects; two factors that influence residential safety outcomes (Appendix C)

Thus, we recommend using the datasets from these organizations as a starting point for the creation or validation of any remote community database at BCSA.

1.2.3 Public databases provide a diverse selection of community information

Feature	Examples	Potential use case
Community name	Venables Valley, Chenahkint	Allows BCSA to identify communities accurately
Lat,Lng coordinates	52.46667(lat) ,-125.3167(lng)	Allows BCSA to find communities and allocate manpower
Main Power Source	Diesel, Hydro, Solar	Allows BCSA to determine the possible hazards
Major fuel source	Diesel, Propane, Wood	Allows BCSA to determine the possible hazards
Age distribution (0-14, 15-64 and 64+)	11.8%, 29.4%, 7.7%	Allows BCSA to determine communication and education strategies
Land area	25,000 (sqft)	Allows BCSA to allocate manpower and resources
Population	10, 100, 3400	Allows BCSA to allocate manpower and resources
Types of dwelling	Single detached, mobile	Allows BCSA to determine the possible hazards
Average income	\$10,432 - \$25,797	Allows BCSA to determine the possible hazards
Aboriginal status	Aboriginal, Non-aboriginal	Allows BCSA to determine communication strategies
Education	Trades, High school, Diploma, Degree	Allows BCSA to determine communication strategies
Community websites	https://www.heiltsuknation.ca/	Allows BCSA to contact community representatives

Table 1: Possible use cases of community features.

When the community features from the Canadian Census was combined with the data we extracted from AANDC, NRCan, RCCBC and other online data sources, we found a diverse selection of community features (Appendix C) broadly divided into 5 categories:

- Geographical info – *lat,lng coordinates, region, road access*
- Communications – *community websites*
- Housing info – *types of dwelling*
- Energy use – *energy supply/demand, fossil fuels, renewable energy*
- Socioeconomic info – *aboriginal status, education, age, income, population*
- Health info – *access to hospitals, doctors, medical outreach programs*

Table 1 shows a subset of these features and their possible use cases. The breadth and relevance of information makes the case that publicly-available community information is valuable data that can be used for decision-making at BCSA.

1.3 Module Conclusions & Future Recommendations

Collecting data on off-grid communities is only the first step in understanding residential safety. As communities and priorities change, there is a need to update and expand the breadth and depth of the community data collected. Thus, the aim of this module has been to first, provide a glimpse into the current state of knowledge regarding remote off-grid communities and secondly, to provide a framework for which to begin designing a robust data pipeline.

We have seen, in this module, that there are key organizations that perform the majority of research and outreach work in off-grid communities including the Census, AANDC, NRCan and RCCBC. The types of community features collected from these sources often reflect the focus of their work. For example, AANDC's focus on Indigenous community welfare, NRCan's focus on energy and resources and RCCBC's focus on rural BC health strongly influence the type of data they collect.

Depending on BCSA's research interest, there is the option of tapping into other sectors in BC including economic planning groups, wildfire prevention groups and environmental groups as valuable data sources. Following that line of thought, we also realized there is a potential to tap into the information held by local energy and telecom companies such as BC Hydro and Telus. As these companies are actively expanding into remote areas, they may uncover more information about the needs and concerns of remote communities in BC currently unavailable as Open Data.

We have also discovered that data across projects (even within the same organization) can be inconsistent both in terms of format and data values presented. Thus, there is a real need to communicate with these data-gathering organizations to understand how their data collection is performed and to collect data directly from these organizations with their guidance.

Finally, in terms of data access, we are seeing an increase in the volume and types of data from open data portals such as Data BC, the NRCan Remote Communities Energy Database and municipal open data portals that complement traditional data sources such as the Canadian Census. Data is also increasingly being delivered in a more consistent format with the adoption of Open Data Portal software such as the Comprehensive Kerbal Archive Network (CKAN) by governments across the world (BC Data Catalogue, City of Surrey Open Data Catalogue in BC).

In conclusion, we believe that the value of remote off-grid community data, our demonstration that it can be collected and the impeccable timing of the Open Data movement make a strong case for further development of this project in BCSA.

Module 2: Communicating with BC's Off-Grid Communities

Abstract

By definition, off-grid communities are situated in remote regions of BC¹. Consequently, BCSA's ability to communicate with and to disseminate information to these communities is limited, and makes (1) raising safety awareness and (2) implementing safety measures in these communities a challenging task. In this module, we report findings that were derived from direct relations with members of off-grid communities, BCSA Safety Officers, or third-parties.

The work presented here aims to enrich BCSA's understanding of the various communications channels that can be of use to the organization for communicating with (and obtaining information about) off-grid communities. We present data on channels such as radio, television and social media. We also provide insights from a survey administered to a BCSA safety officer, and explain in detail how BCSA can use our surveying method to gather other useful insights from its remaining safety officer employees. Our interactions with BCSA's safety officers and third-party experts working with off-grid communities in BC suggest that off-grid residents are reluctant to communicate with safety authorities. This adds a layer of complexity to the challenges face by BCSA when attempting to penetrate these communities to enforce provincial law. To this end, we have explored how BCSA is perceived by members of off-grid communities, and recommend that future resources be put into strategies that help facilitate cooperative interactions with these populations.

This module identifies the different resources that BCSA can utilize to engage off-grid residents in order to advance their goals of raising safety awareness and implementing safety measures.

Briefly, our findings indicate that:

1. There are multiple channels BCSA can use to communicate with their off-grid constituency, such as radio and television, social media, community centers, as well as through collegial relationships formed between its safety officers and off-grid residents.
2. Using surveying methods, BCSA can efficiently gather information specific to each community it wants to engage. This information can provide insights into the strategies BCSA can employ to bring about lasting change within that community.
3. BCSA and its mandate is often perceived incorrectly by off-grid residents, and efforts to correct these misconceptions would help BCSA with its public relations.
4. Third party organizations (such as contractors, etc.) are a useful resource from which to collect information relevant to the state of safety within an off-grid community.
5. Of the 39 communities that we evaluated in-depth (see Module 1), 100% of them have an online presence, consisting of social media (Facebook) pages and community websites. This can serve as a portal through which BCSA can engage these communities.

Overall, the work presented here describes the various channels BCSA can use to obtain valuable qualitative data on specific communities, and how this data can be used to drive action and affect sustainable change.

2.1 Objectives

In order to implement safety measures in BC's off-grid communities, BCSA needs to have an explicit means of communication with individuals from these areas. Our work in the previous modules addressed the "who?" question: Where are the off-grid communities in British Columbia situated, and which ones are at high risk of technical incidents? We identified all the communities by name and geographical region, and provided a risk analysis for each of those communities driven by demographic data. The next step is to answer the "how?" question: How can BCSA take actions to mitigate the technical systems risks associated with these communities? To do this, BCSA requires (1) a reliable line of communication with their off-grid constituency, and (2) a strategy to implement appropriate safety measures within this constituency.

Off-grid communities are heterogeneous in their culture and lifestyles, and hence, the strategy used to engage and implement each community will vary slightly. The purpose of this module is to address how these different off-grid communities, each with their own cultures, lifestyles, and with varying degrees of technical safety expertise and receptiveness to authority can be engaged to increase the safety of their technical systems.

2.2 Results

2.2.1 Radio and television communications channels are an effective means of disseminating information within both aboriginal and non-aboriginal remote communities in British Columbia.

Of all the modes used to communicate information, radio is perhaps the most well-established. Specifically, in rural communities, radio has been shown to be an effective means of relaying information. In their book titled "Radio for Education and Development", Jamison and McAnany state that "the advent of inexpensive radio receivers has opened up the use of radio for education and development by increasing quality, effectiveness and access, while reducing or containing costs of transmitting messages." Building on this, we hypothesized that residents of off-grid communities in Canada use the radio as a medium for consuming information. It is important to mention that we were unable to acquire data on the prevalence of radio use in BC's off-grid communities, as, to the best of our knowledge, this information is not readily available through any government statistics reports. However, we obtained data on the prevalence of radio use in off-grid communities in the Yukon Territories (Appendix H): 57.6% of off-grid survey respondents stated that they own a radio. While this data is not specific to BC, we presume that the adoption rate of household radio systems in off-grid BC will not vary greatly from this estimate, given that many of the off-grid communities in BC reside a relatively short distance from other larger towns or cities in comparison to the Yukon; it is likely that radio station coverage will encompass nearby off-grid communities. We have compiled a list of all the radio stations whose frequency encompasses regions occupied by off-grid residents in BC, and this information is provided in detail in Appendix D in the supplementary documents.

Frequency of Popular Radio Stations in Remote Communities of BC

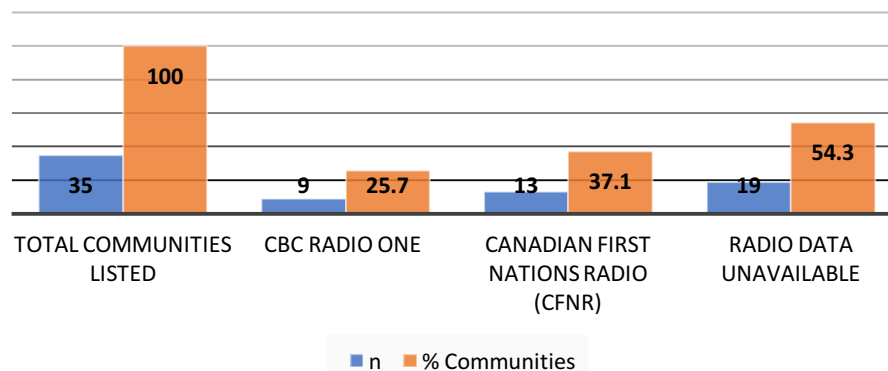


Figure 3: Popular radio stations in a subset of BC's remote communities.

We next quantified which of the radio stations were the most prevalent in aboriginal and non-aboriginal communities, and found that 'Canadian First Nations Radio' (CFNR) and 'CBC Radio One' are most prevalent in aboriginal and non-aboriginal communities, respectively (Figure 3). We therefore suggest that, should BCSA wish to purchase advertising space in any of the radio stations described in Appendix D, it would be most effective to transmit ads through CBC Radio One for non-aboriginal communities and through CFNR for aboriginal communities.

Television is also a widely-accepted platform for relaying information to the public. Similar to our radio data, we were unable to obtain data on the prevalence of television systems in off-grid communities in BC. However, the same report published by the Yukon Bureau of Statistics (Appendix H) shows that 78.8% of off-grid respondents in the Yukon Territories stated that they own a television in their home. While this data is not conclusive regarding BC's television adoption rate in off-grid communities, we presume that similar estimates apply.

By virtue of the ways television service providers do business, it is difficult to obtain data on which television channels are broadcast in off-grid communities; The contract between the television service provider and the individual will determine the bundle of channels provided. Therefore, we were unable to acquire a consistent data set for off-grid BC, as the channels may vary greatly for each household. We thus recommend, should BCSA wish to purchase television advertising space, that it do so in basic cable channels. This will maximize ad penetration in off-grid communities because basic cable television bundles are significantly cheaper than those with specialty channels. Owing to the socioeconomic status of many of these communities, it is highly probable that basic cable bundles are most prevalent in these areas. Moreover, with each upgrade on the television bundle, the basic cable channels always remain, regardless of the bundle.

2.2.2 Surveying safety officers is a valuable tool to uncover information on the state of safety of an off-grid community, the key points of contact for that community, and the potential engagement strategies for that community.

We administered a survey (Appendix E) to Gina McPherson, a BCSA safety officer in the Kamloops region who specializes in gas and electrical systems. The goal of this was to test whether the specific questions we designed are useful in gathering information on off-grid communities.

Survey Design and Rationale

This survey aims to help BCSA collect *anecdotal information* regarding the current state of safety in specific off-grid communities present under the jurisdictions of relevant Safety Officers. By virtue of this methodology, information on off-grid communities for which BCSA does not have a Safety Officer representative will not be gathered, and results should be interpreted accordingly; Any generalizations about the state of the off-grid ecosystem as a whole should be made with the appropriate caveats, as this survey will not exhibit 100% penetrance, and is qualitative by nature.

This survey is designed to be distributed by BCSA to its Safety Officers in order to:

1. gather specific anecdotal information (that is not legally binding) on the current state of safety of specific off-grid communities
2. identify points of contact (key individuals, community centers, bulletin boards, community leaders, etc) that BCSA can interact with
3. elucidate potential strategies for engagement (e.g. educational outreach) that can affect sustainable change within a specific community.

This survey relies on the assumption that BCSA Safety Officers have accumulated anecdotal observations on the off-grid communities they are assigned to. Although these anecdotal observations may be incomplete BCSA would nonetheless find this information useful when deciding how best to allocate its resources towards each community.

The following key insights were gathered from the survey:

1. Off-grid residents *don't understand what they don't know* – educational strategies can help mitigate this.
2. It is valuable to explain to off-grid residents why complying with the rules and regulations is in their best interest, and that their vision of self-actualization does, in fact, align with BCSA's missions.
3. Off-grid communities have community/public buildings where many residents gather for a variety of functions. This can serve as a medium through which to disseminate information to those communities
4. Interviewing safety officers regarding key personnel they have interacted with in a community can identify specific individuals (residents, third-parties, etc) through which BCSA can relay information to that community or gather information about that community.

We show that safety officers possess highly specific knowledge with respect to the communities that each of them oversees. Consequently, we recommend that this survey be used to gather information from other safety officers who are in direct contact with off-grid communities. The data gathered from safety officers via surveys will allow BCSCA to tap into a large pool of information that it can use to tailor its actions in a community-specific manner. Please turn to Appendix E for key insights and a summarized transcript of the safety officer survey.

2.2.3 Of the 39 communities we assessed, 100% of them have an online presence and this can be used as an effective way to contact remote communities.

Today, the internet represents an invaluable platform for people to share information and engage in discussions. We therefore hypothesized that the subset of 39 remote communities described in Module 1 may have an online presence in the form of social media (Facebook) groups, community websites, or both. To test this, we:

1. performed a google search using the name of each community as the search term, and
2. performed a Facebook search using the name of each community as the search term.

We gathered at least one URL linking to either the name of a Facebook group, community website, or online forum for each of the 39 communities (Appendix F). This suggests that there is a robust presence of off-grid communities on the internet. Further searches need to be done to investigate whether this finding holds true for the rest of BC's off-grid communities.

Next, we hypothesize that Facebook groups could serve as an effective portal through which BCSCA can communicate with off-grid residents or other third-parties associated with the off-grid ecosystem. To test this, we began a case-study in which we attempted to contact an administrator of the Facebook group "BC Off-Grid Living" by way of initiating a Facebook message thread. The purpose of this conversation was to make contact with a member of this online community and to ask questions regarding the state of safety of the off-grid communities associated with this online forum. Mr. Graig Pearen, administrator of this Facebook group, replied to the message and we engaged in a discussion about the technical installations present in these communities that violate safety legislation. To quote Mr. Pearen:

"A lot of off-grid people think the electrical code only applies to grid (BC Hydro) customers. Others don't want to have anything to do with permits or inspections of any kind and are "do it yourself" people who never hire a tradesman. Every time I get the chance, I explain that the electrical code is a safety code and that it is the minimum required, not something to strive for."

To complement this discussion, Mr. Pearen sent us 12 photos, each of them showing exactly how and where safety norms were being violated (Appendix G). We believe this data to be useful for BCSCA because we able to identify via this method important data regarding the prominent technical safety risks within communities in the Prince George area and the different methods they use to generate energy – just some of the many potential data points that can be gathered through online outreach.

Taken together, the Google and Facebook search data, as well as the case-study we employed show that:

- Off-grid communities are active online, and that it is possible to contact them and collect valuable information.
- This information can be used to estimate the major technical safety risks associated with an off-grid community.

2.2.4 Insights from the Project “Off-grid living in the Yukon”

We identified a government census report published by the Yukon Bureau of Statistics on the state of off-grid living in the Yukon Territories. To the best of our knowledge, this report is the first of its kind to gather in-depth data on the state of off-grid living in Canada. The Yukon Bureau of Statistics report was used to make assumptions on the state of remote living in BC and has been referenced throughout our report. We have provided a detailed summary of the report in Appendix H. For the full report, please consult the supplementary documents. Because this report helped facilitate careful decision making by the Yukon government, we recommend that a similar census be conducted on the state of off-grid living in BC. Whether this is under the purview of BCSA or other authorities is outside the scope of this document.

2.3 Conclusions & Future Recommendations

This report has highlighted some of the tools and resources BCSA can utilize to communicate with its off-grid constituency:

1. Radio and television networks;
2. Internal surveying of safety officers;
3. Social media and community websites.

We report that radio and television are an effective means of disseminating information to the off-grid sector, though future studies into the prevalence of these systems in remote households needs to be performed. Our lack of definitive knowledge on the prevalence of radio communications channels in off-grid communities is a limitation of this portion of the study. However, because it is evident that call signs for the channels CBC Radio One and CFNR localize to remote areas, it is logical to presume that they are widely listened to in remote areas of BC.

Based on the breadth of information gathered from the safety officer survey we administered, we recommend that BCSA carry out an internal surveying initiative to gather more information about BC’s off-grid ecosystem by replicating our approach with its remaining safety officers. The data gathered from these surveys can be used to make informed decisions and drive action. A limitation of this approach is that it is qualitative by nature; Because only one safety officer is assigned to a single area in BC, it is impossible to generate an “average” image of a remote community with quantitative confidence. Additionally, the information gathered from safety officers is inherently subjective. However, it is also a fact that safety officers are trained individuals with domain-specific knowledge and the capacity to identify prominent issues affecting the off-grid communities they serve. As such, the anecdotal observations safety

officers make about their constituencies would still be valuable for BCSA's leaders, and can help drive actionable decision-making.

We also recommend that BCSA bolster its online efforts in the future. In this report, we show that 100% of the 39 communities we evaluated have a presence online (Facebook, websites, etc.). By manually contacting a third-party technical installations contractor who is an administrator of a Facebook group pertaining to the Prince George area, we were able to collect valuable information on the state of safety of communities in that area. This shows that online communications methods are valuable tools for engaging off-grid residents. One potential challenge to engaging residents via online channels is that some may not be receptive to interacting with authority. However, given the high numbers of individuals one can interact with online, it is likely that at least one or a few individuals will be receptive within each community. Further, by employing methods such as A/B-testing specific research questions and/or geo-fencing, BCSA can learn more about BC's off-grid ecosystem. This approach is relatively cheap, requiring only a computer and the purchase online surveying rights.

Module 3: Identifying Risk in Off-Grid Communities

Abstract

After recent off-grid community incidences in Kennedy Lake and Ashcroft, BCSA has voiced concern regarding the state of safety in rural off-grid communities. Off-grid communities are officially defined as communities that are not connected to the North American electric grid nor to the piped natural gas network. In reality, these communities drill their own wells, hook up electrical diesel generators, electrical wiring, sewage plumbing, build their own roads, build their own homes and insulate from the elements. On top of that, these utilities need to have their own safety equipment such as smoke and gas detectors, electrical fuses, fire sprinklers in addition to routine maintenance and proper installation.

In the city, these utilities are well integrated into every home, strictly enforced and routinely checked by licensed contractors. In off-grid communities, however, these systems are almost non-existent and there is a general resistance from the community towards relatively expensive and inaccessible licensed contractors and towards regulations.

Indeed, rural communities have been shown to have a higher chance of accidental injury and injury mortality than their urban counterpart.^{42,43} It is our goal then to determine which off-grid communities have the highest risk of injury. In order to do so, we present, in this module, both the factors that put a community at risk for injury and existing methods to model a community's risk for injury. We have identified a multitude of factors with the most common being a community's education level, income level, aboriginal status, socioeconomic status, employment/unemployment rates, degree of rurality, and the quality and access to trauma and health care services. We have additionally provided a list of 4 risk prediction models with which BCSA can use as a framework to design their own community risk assessment model.

3.1 Objectives

In order to construct a model to identify the risk of injury in off-grid communities, BCSA must first understand what factors are used to assess risk in off-grid communities. Our work in this first two modules addresses the "who, where, and how?" This module answers the question "What". What factors put an off-grid community at risk and what methods can be used to model this? To be able to answer these questions, BCSA requires established factors related to injury risk and methods, which have been validated, to model this.

To ensure that the factors and models have are both established and validated, this module aims to locate multiple quality papers that use factors established by research and have been validated by sources such as trauma records, primary care providers, and health insurance claims. This data can then be compiled and used to determine the risk of injury for each of the communities.

3.2 Results

3.2.1 There is a confirmed risk difference between rural and urban communities

We first sought to see if there was a difference in safety risk between rural versus urban communities and found a time series analysis that was performed from 1999 to 2006 of over one million injury deaths across over three thousand United States counties. Injury mortality was found to increase with increasing rurality and, after adjustment, had approximately a 1.22 times higher likelihood of injury death when comparing the most rural to the most urban community.

Although motor vehicle accidents are seen to contribute the most to the risk of injury and/or death in rural communities, factors within BCSA's purview are seen to have an increase in risk injury death in rural communities as well, including suffocation and machinery accidents (Appendix J).^{42,43} By identifying and understanding the increased mechanisms of risk within rural communities, BCSA will be able to determine which mechanisms to emphasize when disseminating safety information to the communities.

3.2.2 There are 33 community features and 9 socioeconomic status indices that have been previously used in risk prediction models in BC; mostly for healthcare

To understand what information could be used to predict the safety risk of a BC remote community, we examined past risk prediction work in BC. Interestingly, though not surprising, the majority of community risk studies were designed for the healthcare system in efforts to allocate medical resources and manpower across rural BC. From these studies, we found 33 community features and 9 socioeconomic status indices that have been previously used to identify communities that are at higher risk of injuries and have higher demand for medical resources.

The most commonly studied predictive community risk injury features include:

- Education level, income level, race, ethnicity, and/or Aboriginal status, socioeconomic status, employment and/or unemployment ratio and rates, rurality, and quality and access to trauma and health care services

A full list of features can be found in Appendix K. Additionally, socioeconomic status (SES) can be measured by a number of indices as shown in Appendix L^{37-40,44-46,48}. These community features and indices contain a predictive power for risk injury in off-grid communities' and may aid BCSA in constructing their own risk injury model.

3.2.2 Risk Injury Predictive Models

Remarkably, four quality papers were identified to model risk injury which were created and based on data found in British Columbia. Appendix N summarizes these papers and their possible use.

Each of the models will produce a relative risk injury score that can be used by BCSA to take into consideration when allocating resources for communities. Communities with a higher risk injury score will be more likely to have an injury occurring in that community. Each model has its own limitations and should be examined in detail before use; however, a description of each is provided in Appendix N to aid in understanding the parameters of all the model. No model is considered better than another and each has its own pros and cons.

Major considerations are with regards to what information is available from the communities. For example, the “RISC Research Project” paper only requires two parameters from the communities, their location and Aboriginal status. Therefore, communities in a similar location and with a similar Aboriginal status will be given the same risk injury likelihood without taking other factors, such as education, SES, etc. into consideration. However, if a community contains little information, this could be used as an estimate until more information is found and a more community specific model can be applied. Therefore, it is our recommendation that BCSA considers which and how much community relevant information is available when applying any of the models. This should additionally be taken into consideration if BCSA proceeds in the construction of their own risk injury model.

3.3 Module Conclusions & Future Recommendations

Identifying factors of risk injury is the first step in understanding why rural communities have a higher rate of risk injury compared to their urban counterpart. As communities' change, so too do their features and, therefore, their level of risk. Consequently, it is imperative to keep updated information on the communities found in module one. Therefore, the aim of this module is to first, identify community factors/features that put off-grid communities at risk for injury and secondly, to provide options to BCSA in ways to model the community's injury risk assessment.

In this module, it is recognized that there are a number of factors and graphical modeling methods that can be used to determine and display community injury risk. Each model has their advantages and disadvantages where many times simplicity may be used due to the lack of information on the communities. For example, the RISC research project bases its risk analysis according to the community's location within a health service delivery area (HSDA). These areas can span over large regions of land and may decrease the accuracy of the model for an individual community but also creates a model which is easy to use and requires little data regarding the actual community.²

There is the opportunity of drawing on sectors in BC including the primary healthcare system data, BC Trauma Registry, WorkSafe BC insurance claims, BC Coroner's office, and other valuable data sources if BCSA wishes to create their own risk injury model and validate it. However, we also recognize the difficulty of building one's own model and have **identified a health geographer professor** who has stated her willingness to help should a model wished to be pursued.^{1,11,5}

Lastly, we have also seen in this module that the ranking of features "deemed" to be the most/least important in determining risk injury varies across papers (even within papers published using health data in British Columbia) and can be inconsistent. Due to this discrepancy, there is a need to further research and understand how each factor impacts injury risk and their magnitude of impact with regards to off-grid communities in British Columbia. To conclude, this model has highlighted potential injury risk factors and methods to use them to predict communities at risk.

Report Conclusions

In this report, we have identified and extensively characterized BC's off-grid communities, providing multi-demographic data that can be used in risk-prediction applications. Next, we identified many of the relevant communications channels BCSA can use to relay information and engage with its off-grid constituency. Taken together, Modules 1 and 3 describe a framework that, when implemented, can be used to (1) identify and (2) predict risk, in off-grid communities. Once communities have been prioritized for risk, the various communication methods described in Module 2 can be used to (3) engage with those communities. While future work is warranted to perfect this framework, the work described herein provides BCSA with the current knowledge available on its off-grid constituency and the tools with which to refine its off-grid research efforts and engagements. We hope that the findings of this project will be of use to BCSA and we sincerely thank Soyeon Kim and the rest of BCSA for this incredible opportunity.

Modules at a glance

In Module 1, we identified approximately 280 remote communities in BC that are listed on publicly-available datasets. From these 280 communities, we mapped 54 off-grid communities that rely on alternative energy sources to power their homes. As BCSA is interested in improving residential safety in off-grid communities, we recommend using this set of 54 communities as a starting point for further work.

Next, we elucidated 3 methods of communicating with BC's remote communities. Radio and television communications present a useful medium through which to pass information on to remote communities. Furthermore, our hypotheses about the presence of remote communities on social media were supported by findings that indicate 100% of the 39 remote communities we analyzed have an online presence in the form of Facebook groups and/or websites. Furthermore, surveying safety officers proves to be an effective means of obtaining valuable information on the state of safety, key points of contact and engagement methods for specific communities. We recommend BCSA expand on these social media and surveying strategies to increase their knowledge of their remote constituency in order to make more informed decisions and affect lasting change.

In Module 3, we present a potential application for the demographic data collected from Module 1 (and potential data that can be collected by the methods described in Module 2). We found existing risk prediction models that were able to quantify the relative injury risk of specific communities using some of the demographical information we have collected. This allows BCSA to bin communities into relative risk groups so that it can prioritize its resource allocations, enabling it to engage the communities who will be most positively impacted.

Future Directions

In order to build on the work here, we recommend that BCSA continuously update the database we have generated in Module 1 using the methods described in both Modules 1 and 2. While the research methods outlined in Module 1 allow BCSA to gather public data on each community, the methods described in Module 2 allow it to gather tailored information on each community. These complementary research tools allow BCSA to gather both statistically significant and personalized data on each community, making for a comprehensive understanding of each remote community.

We also recommend that BCSA facilitate further research through social media and surveying efforts in order to acquire information on the specifics of each community. As mentioned in Module 2, remote communities are quite heterogeneous in their culture and demographics, and hence, acquiring 'personalized' data for each community will give BCSA a more granular picture of each community that is not represented by any 'macroscopic' government-led census. Specifically, we are referring to information about community centers, key contacts and leaders within each community, and which engagement strategies will be most efficacious in that community as is perceived by the relevant safety officer.

Methods

The following pages describe the method used to produce the results in Module 1, 2 and 3 respectively.

Module 1 methods

1.4.1 Summary of methods

In summary, we have identified data sources on off-grid communities from publicly-available sources using simple tools such as the google search engine. We have then extracted and cleaned the data with the help of data manipulation tools such as Excel, R, Tabula and Webscraper.io. While our methods here are far from an automated data pipeline, it describes the logic behind each step that could be automated in a future project. Finally, it is important to note that a lot of the work in identifying reliable data sources, identifying similar communities and data cleaning still requires human input.



Figure 4. Summary of data collection method

1.4.2 Finding lists of remote communities

To find lists of remote off-grid communities, we used the following keywords in various combinations in google search and google scholar search:

- “British Columbia”, “off-grid”, “communities”, “rural”, “remote”

The searches yielded a number of websites, which we further filtered for relevance manually and extracted the data as described below:

- For interactive websites with table download links, we downloaded the .csv or .xls files.
- For websites with PDF reports, we used Tabula to extract tables of communities.
- For websites without a table download link, we used webscraper.io or manual copying to collect community names and information.

1.4.3 Checking Off-grid status

Depending on the combination of the search terms in 1.2.1, not all datasets in our search results will clearly describe the off-grid status of their communities. To validate the on/off-grid status of these communities, we used the definition provided by NRCan that:

an off-grid community is:

- any community not currently connected to the North-American electrical grid nor to the piped natural gas network; and
- Is a permanent or long-term (5 years or more) settlement with at least 10 dwellings.

and looked at community features within each dataset that describe:

- Energy provider(s) – i.e. BC Hydro, Fortis BC, Independent providers
- Main energy source – i.e. Grid, Diesel, Alternative
- Renewable energy source(s) – i.e. Solar, Wind, Run-of-the-River, Waste heat
- Population size

to determine if a community is on/off-grid. Where the information is unavailable for a community, we specify the on/off-grid status as '*unknown*'.

1.4.4 Extracting other community features

Once we had community names and their on/off-grid status, we collected other community features that could assist in predicting residential safety risk (Module 3) and improving community outreach (Module 2). This information included:

- Geographical info – *lat, lng coordinates, region, road access*
- Communications – *community websites*
- Housing info – *types of dwelling*
- Energy use – *energy supply/demand, fossil fuels, renewable energy*
- Socioeconomic info – *aboriginal status, education, age, income, population*
- Health info – *access to hospitals, doctors, medical outreach programs*

In the case where latitude and longitude coordinates were unavailable, we used the Data BC geocoder app or the Google Maps Geocoding API to geocode the community.

1.4.5 Data cleaning and compiling

The final and most difficult task is to clean and compile all the heterogeneous datasets into a standardized format for simple analysis and visualization. The challenges included

- Inconsistent naming of communities and
- Conflicting community features between datasets

1.4.5.1 Fixing inconsistent community names

Due to the movement of communities and re-naming of communities by government authorities and the communities themselves, many communities have multiple names and/or have different spellings. Often times, the location names and first nation names are also used interchangeably to describe a community. This makes the process of identifying duplicate communities a challenge. To solve that problem, we used our own approach (in the following order):

- Merge exact (and almost exact) duplicates of communities using the R coding language and Levenshtein distance calculation
i.e. “Fort Ware”, “Fort Ware”, “Fort Ware 1” -> “Fort Ware (Fort Ware 1)”
- Merge inexact duplicates of communities using manual deduplication in Excel
i.e. “Gwawaenuk”, “Kwa-wa-aineuk” -> “Gwawaenuk, (Kwa-wa-aineuk)”
- Identifying interchangeable duplicates of communities by google searching communities and using the BC Geographical Names database.
i.e. “Bella Bella”, “Waglisla”, “Heiltsuk First Nation” -> “Bella Bella (Waglisla, Heiltsuk FN)”

1.4.5.2 Resolving conflicts in community features between datasets

Some community features were commonly found across datasets including ‘Population size’ and ‘Energy demand/supply’. In some cases, however, the same feature on the same community do not agree between two or more datasets. This can happen for a number of reasons:

- Some studies are older and thus, outdated (common)
- The community level being studied is different between studies (i.e. Block vs Village vs Census DA) (common)
- Some studies have different methods for measurement

If the conflict is caused by an older study, we resolved the conflict by keeping the value from the newer study. For other cases however, we did not merge the conflicting datasets. Instead, we kept the identical features separate by adding a suffix to the feature name denoting the data source’s abbreviated name. i.e. ‘Energy demand’ features from a NRCAN 2011 paper will be renamed to ‘Energy demand_NRCAN2011’. The rationale here is that we wanted to leave it to the user of our data to decide which feature to keep based on and the relevance of the data source to the scope and interests of their analysis.

Module 2 methods

2.4.1 Radio communications data

The following websites were accessed in order to identify those radio stations whose coverage encompasses geographical regions in BC where off-grid communities reside:

1. <http://www.canadianradiodirectory.com/>
2. <https://radio-locator.com/>

The communities outlined in Module 1 were entered by name into the search function. The names, call signs and frequencies of stations that cover off-grid regions were then tabulated (Appendix D).

2.4.2 Surveying the Safety Officers

The purpose of this survey was to design a set of questions that, when answered by safety officers, based on their anecdotal experiences would yield valuable information to BCSA on the state of safety of off-grid communities and would uncover key points of contact through which BCSA can engage each community.

The survey consisted of the following sections:

1. Safety Officer identification
2. Awareness
3. Community-specific technical systems information
4. Points of contact and community engagement
5. Other salient information

In the first section, the safety officer provided their name and jurisdiction, for documentation purposes. In the second, the safety officer was asked a series of questions to help identify how many off-grid communities they are aware of which exist in their jurisdiction, and where they are. (Note: for a complete list of the survey questions see Appendix E). In the third section, the safety officer was asked a series of questions regarding the current state of safety in the community of interest. In the fourth section, the respondent was asked a series of questions about any community leaders, key personnel, community bulletins, community buildings, public events, etc, that would be receptive to engagement from BCSA in order to improve the state of safety in their community. In the fifth and final section, the safety officer was prompted by the survey administrators to, in “free-form”, describe any other information they believe would be useful for BCSA to achieve their goal of improving the state of safety in off-grid communities.

In the case of the survey described in this module, Gina McPherson (Kamloops region) was the safety officer respondent, and the community of interest was the Venables Valley (Hare Krishna) community.

2.2.3 Social Media and Community Presence Data

For the 39 off-grid communities described in Module 1, many have an online presence in the form of social media (Facebook) groups, community websites, or both. To test this we:

3. performed a google search using the name of each community as the search term, and
4. performed a Facebook search using the name of each community as the search term.

2.2.4 Off-grid living in the Yukon

This portion of the module describes work done by the Yukon Bureau of Statistics in collaboration with Yukon Energy Solution Center (ESC) and Natural Resources Canada (NRCan). It was targeted towards improving the reliability, cost effectiveness and social and environmental advantages of the renewable energy technologies and systems so that renewable energies become the preferred energy option for the people who live off the electrical grid. We followed up with the researchers at ESC and Yukon Bureau of Statistics (YBS) which yielded interesting insights on how similar work could be conducted in British Columbia.

http://emrlibrary.gov.yk.ca/energy/living_offgrid.pdf

Module 3 methods

3.4.1 Summary of methods

Here, we have identified a number of features and models that could be used to assess off-grid communities risk injury in British Columbia. We then validated and confirmed the quality of the factors and models found within the papers to ensure that BCSA would be confident in utilizing models backed by evidence. From those papers, we extracted the injury risk features and identified community features that would help BCSA determine the risk injury of the communities. Lastly, we utilized one of the models using the 37 communities identified in module one to provide a snapshot visualization of risk injury in British Columbia's off-grid communities.



Figure 5. Summary of risk model searching process

3.4.1 Finding factors and models of injury risk

To find potential factors and models of injury risk, we used the following keywords in google scholar search engine:

- “British Columbia injury risk”, “off-grid injury risk”, “trauma and injury risk in British Columbia”, “rural and remote health service burden”

All search results yielded web pages which allowed us to download PDF academic papers, we used Tabula to extract tables within the PDF if needed. Papers were then read in totality.

3.4.2 Validation and quality confirmation

To validate if the factors and models accurately represents risk injury, the paper must have one of the following:

- Be validated through a reliable external source, such as trauma records, primary care providers, and health insurance claims
- Be based on a paper which has had their model validated though means mentioned above
- Have factors established through scientific research and/or with similar results found or cited in one or more papers

Any of the papers unable to meet these criteria were not used in this module.

3.4.3 Extracting injury risk features

Once we had compiled over five risk assessment papers, the papers were categorized for which communities they could be applied to. For example, some of the papers found only studied Aboriginal communities. The injury risk features were then extracted and included:

- Education Level – *no education, high school, university, etc.*
- Income Level – *above or below the national poverty line*
- Aboriginal Status – *Aboriginal or Non-Aboriginal*
- Socioeconomic Status – *aboriginal status, education, age, income, population*

The papers were then assessed for the size of the population tested, the number of feature overlap between papers, and the applicability of the paper to Canada's off-grid communities. Although the first two measures are easily gaged, the last measure of how well a paper reflects Canada's off-grid communities is more difficult to determine. Therefore, studies within Canada, and even more so within British Columbia, were regarded as better representatives of British Columbia's off-grid communities.

3.2.4 Data cleaning and compiling

Lastly, the data must be cleaned and compiled to combine the diverse risk injury methods into a standardized format to compose one or more model using the established risk injury factors. Some of the challenges that occurred when cleaning and compiling the data included:

- Information of the community features that were needed for the model could not be found
- Conflicting degrees of risk were identified depending on the model used

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Module 3

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Appendix

The following pages describe the appendices referred to in Module 1,2 and 3.

Appendix A: Off-Grid communities

Community	Aboriginal (Y/N)	Population (2016 Census)	Served by BC Hydro or Other Energy Provider (Y/N)	Energy Type
Shearwater	N	100	N	Hydro and Microgrid
Acteon Sound	N	25	N	Fossil Fuel
Bob Quinn Lake	N	17	N	Fossil Fuel
Christian Valley	N	1850	N	Fossil Fuel
Drury Inlet	N	45	N	Fossil Fuel
McNab Camp	N	24	N	Fossil Fuel
Meziadin Lake	N	193	N	Fossil Fuel
Nuchatlaht	N	122	N	Fossil Fuel
Sechelt Creek	N	45	N	Fossil Fuel
Tide Lake	N	125	N	Fossil Fuel
Baker Mine Camp	N	30	N	Fossil Fuel (Diesel)
Cleagh Creek	N	23	N	Fossil Fuel (Diesel)
Dead Point (Sim Creek)	Y	10	N	Fossil Fuel (Diesel)
Eastgate	N	50	N	Fossil Fuel (Diesel)
Erickson Gold Mine Village (Table Mountain Gold Project)	N	130	N	Fossil Fuel (Diesel)
Gilford Island	N	541	N	Fossil Fuel (Diesel)
Gwayasdums	Y	27	N	Fossil Fuel (Diesel)
Katit	Y	90	N	Fossil Fuel (Diesel)
Machmell	N	45	N	Fossil Fuel (Diesel)
Moses Inlet	N	70	N	Fossil Fuel (Diesel)
Pitt Lake	N	45	N	Fossil Fuel (Diesel)
Quaee (Quaee 7, Tsawataineuk)	Y	78	N	Fossil Fuel (Diesel)
Quatam River	N	45	N	Fossil Fuel (Diesel)
Scott Cove	N	45	N	Fossil Fuel (Diesel)
Seymour Inlet	N	45	N	Fossil Fuel (Diesel)
Sheemahant	N	47	N	Fossil Fuel (Diesel)
Timfor	N	45	N	Fossil Fuel (Diesel)

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Western Mines (Myra Falls)	N	30	N	Fossil Fuel (Diesel)
Chilco Lake 1	Y	5	N	Hybrid (Diesel & PV)
Lohbiee (Lohbiee 3)	Y	91	N	Hybrid (Diesel & PV)
Bear Lake 4	Y	151	N	unknown
Blueberry River	Y	197	N	unknown
Chilco Lake 1A	Y	25	N	unknown
Earl Creek	N	25	N	unknown
Garden 2A	Y	5	N	unknown
Greenwood Camp	N	64	N	unknown
Halfway River (Halfway River 168)	Y	172	N	unknown
Hornet	N	30	N	unknown
Ingenika Settlement (Ingenika Point)	Y	234	N	unknown
Nelson Island	N	< 2624 (Sunshine Coast A)	N	unknown
Nitinat (Ditidaht)	Y	< 1206 (Cowichan Valley I)	N	unknown
Owen Bay	unknown	< 2431 (Strathcona C)	N	unknown
Pendleton Bay	unknown	< 1,938 (Bulkley-Nechako B)	N	unknown
Quadra Island (Cape Mudge 10)	Y	147	N	unknown
Scotty Gold	N	80	N	unknown
Tanakut 4	Y	15	N	unknown
Venables Valley	N	25 families	N	unknown
Doig River	Y	118	N	Renewable Energy (Hydroelectric)
Kitasoo	Y	292	N	Renewable Energy (Hydroelectric) Backup Diesel
Dease Lake	N	335	N	Renewable Energy (Run-of River)
Big Bar (Jesmond Creek)	N	133	N	Fossil Fuel (Diesel)
Boulder Bay	N	45	N	Fossil Fuel (Diesel)
Narrows Inlet Logging Div	N	45	N	Fossil Fuel (Diesel)
Phillips Arm	N	45	N	Fossil Fuel (Diesel)
Stave Lake	N	55	N	Fossil Fuel (Diesel)
Queen's Cove	N	10	N	unknown

Appendix B: Community list data sources

Data source	Full reference
AANDC & NRCan (2012 list)	AANDC. (2012). ecoENERGY for Aboriginal and Northern Communities Program: Off-Grid Communities. https://www.aadnc-aandc.gc.ca/eng/1314295992771/1314296121126
AANDC & NRCan (2011 report, 2013 database)	NRCan. (2011). Status of Remote/Off-Grid Communities in Canada. Ottawa: Aboriginal Affairs and Northern Development Canada (AANDC) and Natural Resources Canada (NRCan). http://www.NRCan.gc.ca/energy/publications/sciences-technology/renewable/smart-grid/11916
Karanasios & Parker, U Waterloo SEED (2016 report)	Karanasios, K., and Parker, P. (2016). “Recent Developments in Renewable Energy in Remote Aboriginal Communities, British Columbia, Canada.” <i>Papers in Canadian Economic Development</i> 16 (0): 65-81. Doi: 10.15353/PCED.V1610.70.
Fraser Basin Council (undated)	Fraser Basin Council. Remote Communities in BC that are not connected to the major gas or electricity networks. http://www.fraserbasin.bc.ca/Library/CCAQ_RCI/rci_communities_list.pdf
RCCBC Community Map (ongoing)	Rural Coordination Centre of BC. (2017). Community Map. http://rccbc.ca/community-map/
Inglis, SFU SPP (2012 report)	Inglis, L. (2012). Barriers to Renewable Energy Development in British Columbia’s Remote Communities. Research project-Simon Fraser University.
Rezaei & Dowlatabadi, UBC IRES (2015 report)	Rezaei M., and Dowlatabadi H. (2015). “Off-grid: community energy and the pursuit of self-sufficiency in British Columbia’s remote and First Nations communities.” <i>Local Environment</i> , Doi: 10.1080/13549839.2015.1031730
NRCan Remote Communities Energy Database (ongoing)	NRCan. (2017). The Atlas of Canada – Remote Communities Energy Database. http://atlas.gc.ca/rced-bdece/en/index.html

Appendix C: Feature list data sources

Data Source	Feature categories
StatsCan. (2016). Census Program.	Housing, Population, Socioeconomic info (detailed)
AANDC. (2012). ecoENERGY for Aboriginal and Northern Communities Program: Off-Grid Communities.	Energy use, Off grid status
AANDC and NRCan. (2011). Status of Remote/Off-Grid Communities in Canada. Ottawa: Aboriginal Affairs and Northern Development Canada (AANDC) and Natural Resources Canada (NRCan).	Aboriginal status, Community energy projects, Energy provider, Energy use (detailed), Fossil fuel use, Geographical info, Population
Karanasios, K., and Parker, P. (2016). "Recent Developments in Renewable Energy in Remote Aboriginal Communities, British Columbia, Canada." <i>Papers in Canadian Economic Development</i> 16 (0): 65-81.	Aboriginal status, Community energy projects, Energy use, Population, Renewable energy
Fraser Basin Council. Remote Communities in BC that are not connected to the major gas or electricity networks.	Energy provider
Rural Coordination Centre of BC. (2017). Community Map.	Geographical info, Health network info (detailed), Socioeconomic info
Inglis, L. (2012). Barriers to Renewable Energy Development in British Columbia's Remote Communities. Research project-Simon Fraser University.	Energy use, Population, Renewable energy
Rezaei M., and Dowlatabadi H. (2015). "Off-grid: community energy and the pursuit of self-sufficiency in British Columbia's remote and First Nations communities." <i>Local Environment</i>	Off grid status, Population, Renewable energy
NRCan. (2017). The Atlas of Canada – Remote Communities Energy Database.	Aboriginal status, Community access (detailed), Community energy projects, Community website, Energy provider (detailed), Energy use (detailed), Fossil fuel use, Geographical info (detailed), Population

Appendix D: Radio and Television Channels

Too large to include here. Will be delivered as an external file by Ido Refaeli.

Appendix E: Safety Officer Survey: Design, Methodology, and Detailed Transcripts

A standardized copy of the survey was administered by phone by the Graduate Consulting Program to Gina McPherson (jurisdiction: Kamloops area, Venables Valley) in order to test the efficacy of the survey. Safety officers were prompted to answer all questions truthfully, drawing from any knowledge they have gathered by way of interacting with each community. Survey responses were retrieved and answers paraphrased in the results section below.

The goal of this exercise was to identify questions that were useful in gathering information from safety officers regarding the state of off-grid communities in their jurisdictions.

[Survey Transcript Below]

Section 1: Safety officer identification

Basic Information: Safety Officer Identification

Name of interviewee: Gina McPherson, electrical specialty (hereafter abbreviated as GM).

Section 2: Awareness

What off-grid communities do you oversee?

There are multiple off-grid communities per area. Goldbridge “center”; Some communities have a center. Venables valley is within GMs assigned region/jurisdiction. At this point of the interview, GM suggested that a valuable question to ask a safety officer would be something to the effect of “how many off-grid communities are you aware of exist in your area?”

How many safety officers are designated to oversee off-grid communities?

We inspect based on the requests that come to our list. Requests come in based on those working within the regulatory system. We only find out after an incident comes up for those that are not in the regulatory system – as is the case for most off-grid communities. Their inspection areas are designed geographically and are loosely based on population density.

Regulatory system: anybody who works within this system is on record. Due to this not being enough, safety officers are now assigned to remote communities.

To summarize: Some remote communities are under BCSA's regulatory system and are inspected only when the request comes. For other remote communities, inspection is done only when there is an incident.

Note: contact information for the communities that are in BCSA's regulatory system is available with BCSA. Surveying should be done with these residents for more information.

Section 3: Community-specific technical safety information

What are the major safety violations or safety incidents you usually see? What are the major technical systems associated with these incidents?

Carbon monoxide poisoning (as an aside, GM has an electrical specialty), as a result of incorrect installations of instant hot water gas supply.

Insights: GM mentioned that by asking safety officers what the most common causes of incidents are, BCSA can gain awareness of which engagement strategies (for example, educational) would be most useful for that community. In the case of the Venables Valley community, and other communities with similar risk factors, it would be important to implement safety measures aimed at reducing the risk for carbon monoxide poisoning.

This section of the proves useful in identifying which types of technical systems are most prominent in a specific community, and will help BCSA prioritize engagement strategies aimed at these specific technical appliances.

What are the most common causes of injury that you see? What are the major ones that first come to mind?

Very severe incidents are the only ones heard about; small non-fatal incidents are not contacted about. This is especially the case for those communities which are not registered with BCSA.

Are people aware of the fact that those specific practices cause specific safety related incidents? If yes, then what is the reason that they still continue? Are there any economical, logistical or any other reasons?

They don't know what they don't know---most people in remote communities are unaware of the risks. This may be due to a number of factors:

- *No computers no access to information outside of communities*
- *They don't understand the position they're putting themselves in*
- *They are not educated on how to install technical systems safely*

It is at this point in the discussion that GM brought up the topic of education. Specifically, that educational strategies aimed at increasing residents' knowledge about technical systems and how to ensure safe installations take place.

What are the main sources of energy in this community (e.g. propane, diesel,); what do they use for heating? What do they use for cooking? For electricity?

Propane and solar. Some have generators (diesel or gas). Wood-burning for hot water heating. The main source of electricity is diesel generators. Solar is becoming more affordable/popular/less maintenance. "They do NOT have training to do this kind of stuff."

Insights: this part of the survey can help identify which technical systems are most prominent in each community.

Section 4: Community-specific communications channels

In here would go a set of questions aimed at identifying key individuals within each community with whom BCSA can establish a line of communication with. Gina was asked: Do you have any key personnel contacts that you routinely interact with in this community?

As with the most recent case in Venables Valley: they had one central person that disseminated info to the community. ("But that's only for the community we knew about.")

Insights: This is extremely valuable information – we now know that safety officers interact with community representatives routinely. It is, therefore, reasonable to presume that other safety officers in BC also have useful points of contact through which BCSA can engage off-grid communities. This proves that this survey can be used to uncover key personnel with whom BCSA can establish a consistent line of communications.

GM mentioned that many residents do not have cell phones or landlines. They may also be reluctant to talk. "If it's possible, it's hugely valuable to establish a stream of communication with one key member of the community," said Gina. In the Venables Valley case, they had one contact that had an email address and worked in a region where they can contact him. This was greatly beneficial to them.

As a safety officer, is there a specific community member that you routinely interact with in that community to perform your tasks?

Yes. Contact information available upon request from Gina.

To the best of your knowledge, does this community have a preferred means of disseminating information to its members? For example, churches, temples, religious buildings, community events, bulletin boards, or through community leaders (please name them if can remember), etc.
"Venables Valley have their temple. They also have a secretary that has everyone's home address, as well as other contact information. Most of the residents in Venables Valley do, in fact, have emails."

If there is an injury, where do people in the community go to get help? Are these communities receptive to getting help?

"For the most part, yes; Others, not so much. Venables Valley is a Hare Krishna community. This means that its residents share a common spiritual bond." GM mentioned that it would be most productive to find one person within this community that can serve as the point of contact.

Insights: "Communities that have a structure are easier to penetrate".

It is at this point in the survey that the conversation drifted to the topic of education.

Would educational engagement strategies be useful in your opinion?

"It would work great for some, but for others not so much," said Gina. "If you could find the leader of the community and present the right education, that would be useful."

What is it about the community that would make them receptive? *Some people just are and some people just want to be left alone...They basically need to understand why educational services are serving their best interest."*

"Expanding on this issue: it's not just off-grid communities that need this. There are some communities on grid that need help with education too. What comes to mind, first nations land/ indigenous people: they don't understand that they are required to follow the rules and regulations." According to GM, this is a very prominent issue in aboriginal reserves. It is important for BCSA to communicate to them that they would, in fact, save money if got operating permits.

Take home message: be able to explain to them why they need to comply with certain regulations, and why that is in their best interest.

"Safety officers are great as the first line of raising awareness," said Gina. "For example, for propane use, it would be useful for residents to learn from propane companies (local company) how to fill their tanks."

"An important step is outreaching to rural suppliers that help them get their supplies" Problem: Gina says that more and more people are starting to buy their parts online.

Section 5: points of contact and community engagement

Educational services.

"informational kits" – quick pamphlets; Ikea style. Easy to use. Lots of pictures, etc. Gina says this would be useful. Or the owner of the gas-station filling the propane tanks.

Problem: “if the booklet is telling them how to do regulated work, that’s a problem. Because BCSA can’t promote doing unregulated work. Instead, BCSA would have to promote the value of doing regulated work; the value of having a person with the right credentials do the job properly, or learning how to do it right yourself with a permit. Show them what would go wrong if they did it unregulated.”

“Another potentially useful way to engage a community is by training community leaders as ‘designated safety personnel’ for that community,” said Gina. “This would be like training other points of contact.”

“Taking advantage of community bulletin boards, or other places that community residents frequent, would also be a good strategy,” said Gina “specifically for smaller communities who do not know that BCSA exists.”

“One of the big challenges for BCSA,” said Gina, “is telling people who we are!” – branding.

Strategy recommended by GM:

At this point, we asked GM if she can recommend any strategies that would work specifically for the Venables Valley community. She said, “Find out who is a leader/contact person for the community (has email phone etc) and use them as a portal into that community.”

Free-form section

In this section, we asked GM to mention any other salient information that she finds would be useful to ask in the survey. She mentioned that it would be useful for BCSA to gather information from other Safety Officers within jurisdictions that come in direct contact with off-grid communities.

Appendix F: Community websites and social media pages

Town Name	Point of Contact	link	Facebook
Anahim Lake	Anahim Lake Community Association (Facebook) Clinic/Health Care	http://rccbc.ca/anahim-lake/	https://www.facebook.com/Anahim-Lake-Community-Association-291757474269859/
Atlin	Community Website Schools	http://www.atlinbc.com/ http://rccbc.ca/atlin/atlin-general-info/	https://www.facebook.com/places/Things-to-do-in-Atlin-British-Columbia/106068792758236/
Baptiste Smith 1B (Baptiste Meadow 2)	Cheifs & Council	http://inshuckch.com/about/samahquam/	https://www.facebook.com/pages/Baptiste-Smith-Indian-Reserve-1B/1506723282966974
Bella Bella	Heiltsuk Economic Development Corporation (Dave Jephcott) Jorgensen community phone numbers	http://www.macleans.ca/news/bella-bella-the-town-that-solved-suicide/ https://www.heiltsuknation.ca/contact/	https://www.facebook.com/pages/Bella-Bella-BC/330152250407492?ref=br_rs
Bella Coola	Facebook Groups	https://www.facebook.com/BellaCoolaMusicFestival/ https://www.facebook.com/VisitBellaCoola/ https://www.facebook.com/groups/1533967326864053/permalink/1797555987171851/	Advertisement board: https://www.facebook.com/groups/1533967326864053/?ref=br_rs
Douglas / St'at'imc (Douglas 8)	Douglas Band Office and Community events/News Facebook Group	http://www.xaxtsa.ca/ https://www.facebook.com/XaxtsaFirstNation/	https://www.facebook.com/statimchydro/?ref=br_rs and https://www.facebook.com/Statimc-Education-Training-453241161441919/?ref=br_rs or https://www.facebook.com/groups/1603815236506255/?ref=br_rs
Ehattesaht (Chenahkint)	Cheifs & Council	http://ehattesaht.com/chief-and-council/	https://www.facebook.com/groups/Ehattesaht/?ref=br_rs

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Finlay River (Fraser Fort George G data)	Resources and Lands CEO - Danny Case Community Power	http://bcafn.ca/community/kwadacha/ http://www.communitypower.ca/2016/08/05/kwadacha-nation/	https://www.facebook.com/groups/210351286018072/ (Fraser Fort George Community Association)
Kwadacha (Fort Ware)	Cheifs & Council Resoruces & land CEO - Danny Case	http://www.kwadacha.com/contact http://bcafn.ca/community/kwadacha/	https://www.facebook.com/groups/1479458202298591/?ref=br_rs or https://www.facebook.com/groups/10532140565/?ref=br_rs or https://www.facebook.com/places/Things-to-do-in-Fort-Ware-British-Columbia/104324529608356/
Good Hope Lake (Dease River)	Elvis Fjellner - development general manager & community website	http://bcafn.ca/community/dease-river/ http://www.kaskadenacouncil.com/kaska-nations/dease-river-first-nation	https://www.facebook.com/pages/Good-Hope-Lake/138159129538122 or https://www.facebook.com/groups/392894707736501/?ref=br_rs
Greenwood Camp	Newspaper	http://www.boundarycreektimes.com/	n/a
Gwawaenuk Tribe (Hopetown)	Schools	Schools: Hope Secondary, Two Rivers Education http://www.fvdes.com/node/371 , C E Barry Intermediate School https://www.facebook.com/cebarryschool/	https://www.facebook.com/pages/Gwawaenuk-Tribe/279181529202066
Hartley Bay (Kulkayu4)	Council & Corporations (land, marine, forestry, fisheries, tourism, planning and management)	http://www.gitgaat.net/contact.html	https://www.facebook.com/places/Things-to-do-in-Hartley-Bay-British-Columbia/107928869230267/
Hesquiaht (Refuge Cove 6)	Store, Café, Fuel Dock, and Harbour contact	http://www.refugecove.com/	https://www.facebook.com/places/Things-to-do-in-Refuge-Cove-British-Columbia/113530168659222/ and https://www.facebook.com/Hesquiaht/
Iskut/Eddonte najor	Band council, facebook feed, and newsletter	http://iskut.org/	https://www.facebook.com/iskutband/ and https://www.facebook.com/pages/Eddontenajor-Lake/924204290980786 or https://www.facebook.com/groups/392894707736501/?ref=br_rs

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Katit	Tribal Manager - Robert Dunca	http://www.wuikinuxv.net/	n/a
Kennedy Lake	Contact newspapers involved in incident coverage	http://www.vancouversun.com/Kennedy+Lake/3695896/story.html	https://www.facebook.com/groups/249933538379783/?ref=br_rs or https://www.facebook.com/groups/711275982322119/?ref=br_rs
Kitasoo	Kerr Wood Leidal Hydro Generation contact Executive Chief Officer - Ben Robinson	www.kwl.ca/projects/kitasoo-small-hydro-generation-system http://bcafn.ca/community/kitasoo/	https://www.facebook.com/pages/Kitasoo-Band-Council/882917048487786 or https://www.facebook.com/groups/335125879938246/?ref=br_rs
Kluskus (Sundayman's Meadow)	Admin point of contact	http://lhooskuz.com/?page_id=1591	https://www.facebook.com/pages/Kluskus-Indian-Reserve-1/822184437893817
Kwicksutaienuk-ah-kwaw-ah-mish (Gwayasdums)	Community Website	http://www.khfn.ca/	https://www.facebook.com/groups/182053179245/ or https://www.facebook.com/pages/Kwicksutaienuk-Band-Council/507820729423847
Lillooet Lake	City hall contact community facebook	http://lillooetbc.ca/ https://www.facebook.com/vsitlillooet/	https://www.facebook.com/pages/Lillooet-Lake/105484286151474
Lower Post 3	Cheifs & Council	http://www.kaskadenacouncil.com/kaska-nations/liard-first-nation	n/a
Masset	Community Website & Contacts Facebook	http://massetbc.com/contact/ https://www.facebook.com/VillageOfMasset/	https://www.facebook.com/places/Things-to-do-in-Masset-British-Columbia/108270259201355/ or https://www.facebook.com/groups/305456316220031/?ref=br_rs or https://www.facebook.com/groups/212200805469996/?ref=br_rs
Nemaiah Valley (Chilco Lake & Lohbiee)	Chief (Roger William) & Community Website	roger@xenigwetin.ca http://www.xeni.ca/	https://www.facebook.com/pages/Nemaiah-Valley-British-Columbia/139120246115456?ref=br_rs
Port Clements	Community Website	http://www.portclements.ca/village-office/	https://www.facebook.com/groups/152718168842/

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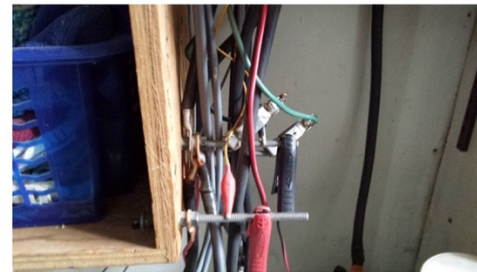
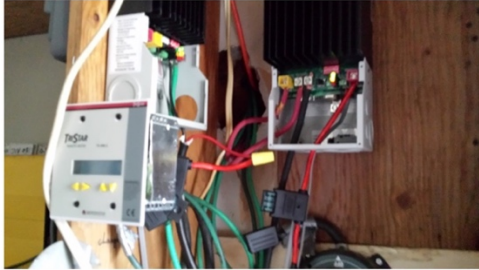
Queen Charlotte City	School (community college)	https://www.nwcc.bc.ca/campus/queen-charlotte-campus	https://www.facebook.com/Village-of-Queen-Charlotte-132877200165045/?ref=search
Seymour Arm	Community Association	http://seymourarm.net/contact/	https://www.facebook.com/groups/1431774517114522/?ref=br_rs
Sim Creek (Dead Point 5)	First Nation Website	http://danaxdaxw.com/index.php?PHPSESSID=711d0834bb81f4f5b4fcad2bf06efaa9&	https://www.facebook.com/pages/Sim-Creek-Indian-Reserve-5/642971422472219
Skidegate Landing (aka Skidgate 1)	Community website and education contacts	http://www.skidegate.ca/Pages/contacts.html http://www.city-data.com/school/sk-aadgaa-naay-elementary-bc.html	https://www.facebook.com/groups/281430868581328/?ref=br_rs
Skookumchuck (Skatin)	Cheifs & Council	http://inshuckch.com/about/skatin/	closed group: https://www.facebook.com/groups/305163116236412/
Telegraph Creek 6A	Schools	http://www.sd87.bc.ca/Contact%20Us.php	https://www.facebook.com/groups/392894707736501/?ref=br_rs or https://www.facebook.com/groups/2253471009/?ref=br_rs
Tipella	Energy Provider	https://www.cclgroup.com/cclinfrastructure/en/home/our-investments-main/cc-l-infrastructure-investments/energy-infrastructure/harrison-hydro-project http://www.innergex.com/en/site/tipella-creek/	https://www.facebook.com/pages/Tipella/1410941665837949?ref=br_rs or https://www.facebook.com/groups/1603815236506255/?ref=br_rs
Tlatlasikwala (Hope Island 1)	Council	http://www.tlatlasikwala.com/	https://www.facebook.com/pages/Tlatlasikwala-First-Nations/839892532849250?ref=br_rs
Toad River	City Hall & Education Contact	http://www.northernrockies.ca/EN/main/Communities/toad-river.html http://www.sd81.bc.ca/	https://www.facebook.com/pages/Toad-River-British-Columbia/133590683348366?ref=br_rs

GRADUATE CONSULTING PROGRAM 2017

Tsawataineuk (Quaee 7)	Community Website & Contacts	http://www.kingcome.ca/	https://www.facebook.com/pages/Quaee-Indian-Reserve-7/949007005195907?ref=br_rs
Uchucklesaht (Elhlateese 2)	Cheifs & Council	http://www.uchucklesaht.ca/cms.asp?wpID=192	https://www.facebook.com/pages/Uchucklesaht/412481582114072?ref=br_rs or https://www.facebook.com/pages/R%C3%A9serve-indienne-Elhlateese-2/991568807549137?rf=1516201865376643

Appendix G - Photos of Installation where Safety Norms are being Violated

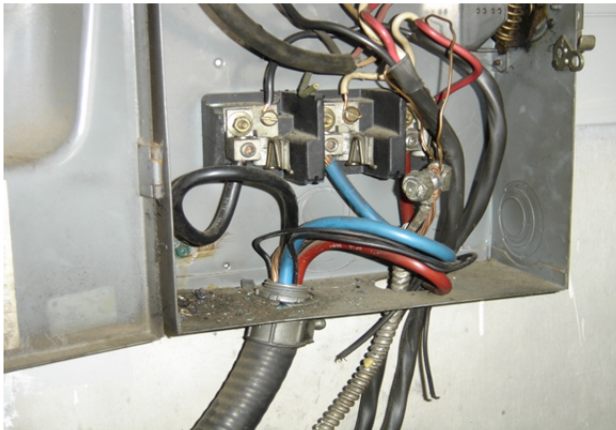
This section shows the Images received from Mr. Graig Pearen.
Unsafe Installations (Site 1):



Burnt Wire:



Junction block; unsafe electrical wiring:



Incorrect bolt sizes used for battery connections, causing lead post to melt, burning a hole in the cell:



Appendix H: Summary of YBS report on “Off-Grid Living in the Yukon”

This project was in collaboration with Yukon Energy Solution Center (ESC) and Natural Resources Canada (NRCan). It was targeted towards improving the reliability, cost effectiveness and social and environmental advantages of the renewable energy technologies and systems so that they become the preferred energy options for the people who live off the electrical grid. The project consisted of telephonic survey of 254 off-grid owners in Yukon. Even though, the work was targeted towards understanding the “energy” perspective, the results from the survey could be readily useful to BCSCA in formulating the safety strategies since, the survey throws a light on what energy resources are used in the off-grid houses. Following are the findings as summarized in the reports we privately received (some of the findings are published in the open literature):

Summary Report:

In the winter of 2003, 254 individuals, owning residential property off the electric grid, were surveyed by the Yukon Bureau of Statistics on their energy use and generation.. Of these, 85 stated that the dwelling was their main residence (110 said it was a recreational property and the remaining 59 indicated other uses. The rest of this summary deals only with main residences. Of the main residences:

- Almost all (94%) use their dwelling year-round.
- 60% operated some kind of business from the property.
- Most (46%) were more than 5km from the grid.
- Of those close to the grid (less than 1 km) more than half (58% of 19 respondents) do not intend to connect. Of those further away, 40% said they would want to connect if it were available, another 30% stated that it depends (mainly on cost or price) and 27% stated they would not connect to the grid. Overall, 34% of respondents indicated they did not want to connect to the grid.

Energy use

- Propane is used for cooking by most (84%)
- Most have a wood stove (84%), and the majority rely on it most for heating (63%). 90% use wood heat of some kind or another. Free standing heaters are second after wood stoves, but much less popular.
- More than 2/3 use AC lights and fixtures for lighting and half rely on them for most of their light. Other popular forms of lights are propane lamps and DC bulbs and fixtures, used by about 30%.
- Pumping water is done more often using 120/240 AC pumps (39%) than by gasoline-powered pumps (30%)

- Propane is the most popular energy source for heating water (62%) followed by wood (40%). Hot water tanks are the most popular hot water heating system, followed by kettles or pots on the stove and in-line demand heaters.
- The majority have refrigerators (propane are most popular) and washers. Smaller numbers have freezers and dryers, with dishwashers being the least popular major appliance.
- Small appliances used in order of popularity are:

○ TV	78.8%
○ VCR	74.1
○ Stereo music system	70.6
○ Blender food processor	62.4
○ Radio	57.6
○ Block heater	56.5
○ Satellite dish	51.8
○ Printer	50.6
○ Iron	48.2
○ Desktop computer	45.9
○ Microwave	44.7
○ Toaster	43.5
○ Other small appliance	32.9
○ Other computer peripherals	27.1
○ Laptop computer	25.9
○ Clock radio	23.5
○ Clock	20.0
○ Coffee maker	20.0
○ Fax	20.0
○ Electric kettle	15.3
○ Can opener	8.2
○ None	5.9
- Tools and equipment used, in order of popularity are:

○ Small 120V electric hand tools	87.1
○ Cordless power tools	76.5
○ Large stationary power tools	70.6
○ Compressor	56.5
○ Welder	44.7
○ Heavy equipment	34.1
○ Other	9.4
○ None	7.1

Energy Generation

- Almost everyone has a gasoline or diesel powered generator.
- 57 percent also use green energy (mostly PV – 53% – and some wind – 7%; no respondents used micro-hydro)

- Two thirds have a battery bank and 60 percent an inverter; i.e. some of respondents without green energy generation still use batteries & inverters.
- Hardly anyone generates most of their electricity using PV in the winter, about 40% do so in the summer months. For those with PV, about three-quarters generate most of their electricity using PV during the summer.
- Median generating system cost was \$10,000. However, those using PV had double the median cost (\$12,500) of those who did not (\$6,000)

Generators:

- Median power of generators was 6.7kW. The majority have more than one generator.
- During the winter months, very few used their generators all the time, but close to the majority used them every day. Only about one quarter used them every day during the summer months.
- Median cost of generators was \$4,750. Surprisingly, not very different for those with green energy (\$4,500) vs. those without (\$5,000).
- Median annual reported generator fuel cost was \$1,440. Considerably higher for those without green energy \$3,000 Vs, \$775 for those with PV and/or wind electricity generation.
- In sizing their generators, the majority (56%) based it on power consumption of their largest tool or appliance. The next most important factor was price (17%)
- Most felt their generator worked well (91%) although 29% mentioned some desirable changes: e.g. switch to diesel, quieter, or replacements.

Photovoltaic systems

- Average number of PV panels was five, with median 295 total Watts
- Most common location of PV panels was on the roof (51%) followed by fixed free standing panels (30%) and on the wall (14%)
- 40% had modified their PV systems since original installation. Most common changes were adding panels (18% of dwellings with PV) and adding batteries (9%).
- In designing system, over 60% stated that they estimated energy consumption.
- Median cost of PV system was \$6,000.
- 41% of respondents with PV systems would like a larger system or more panels. 42% stated it worked well.

Batteries

- Two-thirds of total survey respondents (main residences) had a battery bank.
- 78% of respondents with battery banks had 12-volt batteries. 13% used 24 Volts and 9% did not know their battery voltage.
- 35% use deep-cycle batteries, 20% “other” batteries, 16% 6-Volt batteries, and 11% used 2-Volt batteries in series.
- More than 2/3 used their generators to charge battery banks. The majority of those without green energy also used generators to charge their batteries.

Inverters

- 60% of respondents who generate electricity have inverters.
- Median inverter wattage was 2,000 Watts.

We contacted Yukon Energy Solution Center and had an e-mail conversation with **Cathy Cottrell**. Cathy is a senior energy planner at ESC and worked on this project. Cathy sent us the progress reports at various stages of this project. After going through these documents, we realized that some of their recommendations, approaches and findings are useful to BCSA. These are discussed below.

- 1) **Knowledge Transfer** - The report mentions that large number of the off-grid residents has access to the internet. Therefore, we recommend BCSA to add a webpage describing this “Off-Grid Safety Initiative”. This will be a communication platform where off-grid residents can post their questions about the safety and experts at BCSA will try to answer those. This webpage will also be a complete safety guide for the off-grid residents. The researchers working on this project recommended the same – “It is recommended that ESC add an off-grid forum page to its website. Off-grid residents and other interested parties would visit the site to post technical questions related to renewable energy systems north of 60° or receive support from ESC staff and others. The focus would be on solving building envelope, mechanical system and renewable energy systems problems in an integrated fashion and the initiative would rely on government and non-government contacts established during the charette. A surprisingly high number of off-grid residents have Internet access. But for those who do not the site would also require a phone-based system”.
- 2) **Engagement of the residents**- We recommend while developing the strategy for the off-grid residents, it is important to educate them about the safety concerns and more importantly involving them in the discussion. The success of the Yukon project was based on this fact. As mentioned in the report – “The key to getting people interested in making their homes more energy efficient is to educate them about the issues and involve them in the discussions of what needs to be done.”
- 3) **Surveying** – The results show that surveying the off-grid residents yielded valuable results. Based on this evidence, going forward we recommend BCSA to implement methodology of surveying in the data collection.

Reports sent by Cathy mention that the surveying was done by Yukon Bureau of Statistics (YBS) because of their experience in surveying in rural communities and a quotation with low cost. We contacted YBS and communicated with Rachel Westfall. Rachel is a senior statistician at YBS. Since, she has started working with YBS from 2007 and the surveying was done in 2002, she did not know how it was done and how the initial contact to the residents was established. However, she sent us a complete questionnaire that was used to survey the off-grid residents. This questionnaire is comprehensive from the energy perspective but not exhaustive from the safety point of view. Nonetheless, it serves as an effective framework for the “safety” survey and we recommend BCSA to consider using it. She also mentioned that YBS did not pay anything to the residents for the survey except the cost of the phone bill.

We also asked Rachel if it is possible for YBS to conduct similar work in BC, to which Rachel forwarded our e-mail to the program director (at YBS), Bishnu Saha. We are waiting to hear back from him.

Appendix I: Key Contacts for module 2

Cathy Cottrell

Senior Energy Planner at Yukon Energy Solution Center (ESC)
Email: cathy.cottrell@gov.yk.ca
Ph: (867) 393-7148

Rachel Westfall

Senior Statistician at Yukon Bureau of Statistics (YBS)
Email: rachel.westfall@gov.yk.ca
Ph: (867)-667-5383

Bishnu Saha

Program Director at Yukon Bureau of Statistics (YBS)
Email: Bishnu.Saha@gov.yk.ca

Community Power

Email: info@communitypower.ca
Website: www.communitypower.ca
Ph: (604)-598-8428 (Vancouver)

First Nations Health Authority (FNHA)

Email: info@commun
Website: www.fnha.ca
Ph: (604)-693-6500, Toll Free: 1-866-913-0033

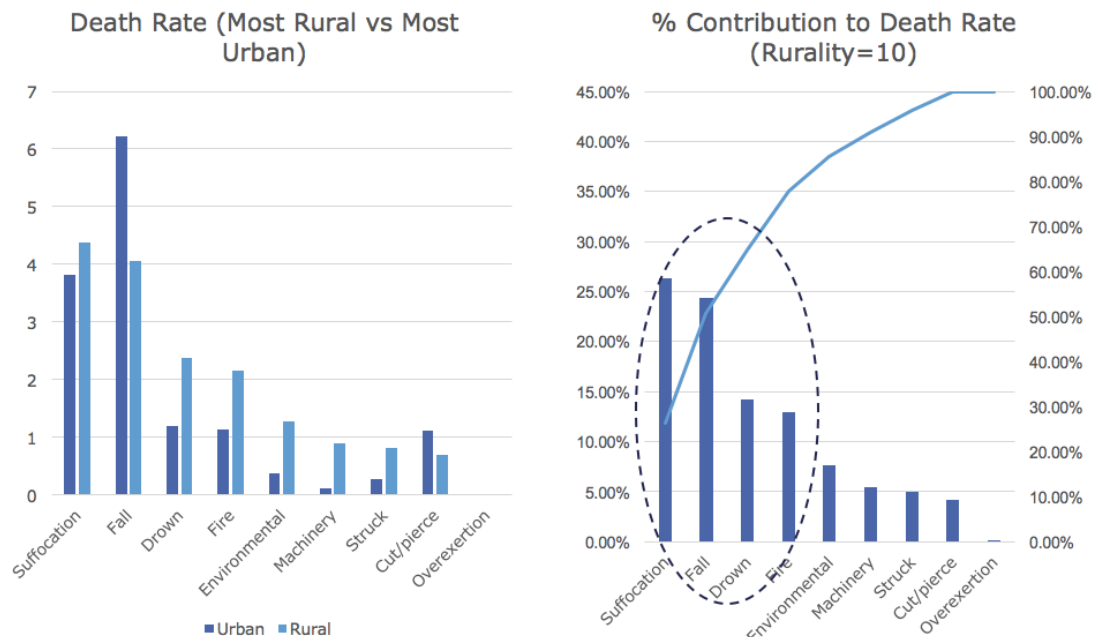
Alcoholics Anonymous in BC/Yukon Area 79

Email: remotecomunities@bcyukonaa.org
Website: www.bcyukonaa.org
Mail: c/o Remote Communities Committee Chair BC/Yukon Area 79 P.O. Box 4211 Vancouver, BC V5S 4R5.

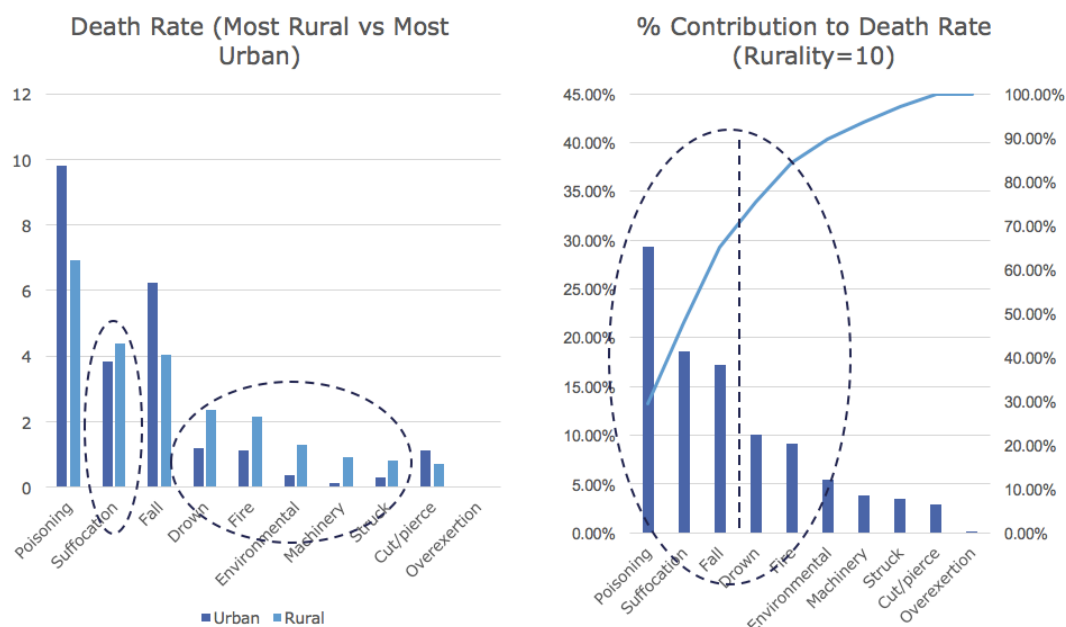
Gina McPherson Gina McPherson | Safety Officer, Electrical

BRITISH COLUMBIA SAFETY AUTHORITY
Email: gina.mcpherson@safetyauthority.ca
Mail: A - 1278 Dalhousie Dr, Kamloops BC V2C 6G3
Ph: 250.299.3888 | cell: 250.299.3888 | toll free: 1.866.566.7233

Appendix J: Causes of Accidental Deaths and Their Prevalence in Rural and Urban Settings



* Charts only reflect deaths related to BCSA purview (MVA, suicide and firearm deaths are excluded)



* Charts only reflect deaths related to BCSA purview (MVA, suicide and firearm deaths are excluded)

Data extracted from Ruscio et al., 2014⁷ and graphically transformed

Appendix K: Injury Risk Factors

Full List of Risk Features

• Education Level	• Employment Ratio and Rate	• Average income	• Delays in Accessing Tertiary Trauma Services
• Income Level	• Unemployment Rate (ages 15-24)	• Home Ownership	• Prolonged (Injury) Discovery Times
• Aboriginal Status	• Unemployment Rate (ages 25+)	• Age Dependency Ratio	• Community Well-Being
• Socioeconomic Status	• Distance From Urban Center	• Population	• Average number of persons per room
• Age	• Distance From Trauma Center	• EMS Training Level	• Proportion of dwelling in need of major repairs
• Ethnicity	• Female Single Parent Household	• Delays in Accessing Hospital Care	• Females in the labour force
• Race	• Single Parent Families	• Level of Local Trauma Services	
• Gender Proportion	• Substance Abuse Rates	• Health Service Delivery Area Location	
• Remoteness Index	• Environmental Index	• Main Industries in Community	

A full list of risk features that were assessed in British Columbia. EMS = Emergency Medical Services. Data was extracted from references 2,3,6,7,9, and 12.

Appendix L: Socioeconomic Status Indices

List of Socioeconomic Status Indices

Where More Information Can Be Found

• Socioeconomic Factor Index (SEFI)	(Schuurman et al. 2007)
• Vancouver Area Neighborhood Deprivation Index (VANDIX)	(Schuurman et al. 2007)
• Community Well Being Index/Score (CWB)	https://www.aadnc-aandc.gc.ca/eng/1419864229405/1419864303946 https://open.alberta.ca/dataset/canadian-deprivation-index-cdi-alberta/resource/8bed2367-e7b9-4e6a-bc63-2bc53b58f659
• Canadian Deprivation Index (CDI)	(Schuurman et al. 2007)
• Deprivation Index for Health and Welfare Planning in Quebec (DIHWQPQ)	(Schuurman et al. 2007)
• Jarman UPA 8	(Schuurman et al. 2007)
• Carstairs Index	(Schuurman et al. 2007)
• Townsend Index	(Schuurman et al. 2007)
• General Deprivation Index (GDI)	(Schuurman et al. 2007)

Common socioeconomic indices. It is suggested that BCSA uses the Schuurman et al. 2007 reference when selecting a socioeconomic indicator as this reference compares and contrasts the indices in a concise manner. Data was extracted from references 3 and 8.

Appendix M: Socioeconomic Status Indices and associated factors

List of Socioeconomic Status Indices With Factors

Socioeconomic Factor Index (SEFI):

Age dependency ratio—The ratio of the population aged 20–64 to the population

Female single parent households—The Percent of female single parent households among households with children at home

Females in the labour force—Women working or seeking work on census day

Single parent households—The Percent of single parent households among households with children at home

Unemployment (ages 15–24) —Unemployment rates of people ages 15–24

Unemployment (ages 25)—Unemployment rates of people ages 25 and over

Education—Percentage of residents with a minimum of high school diploma

Vancouver Area Neighborhood Deprivation Index (VANDIX):

Average income—Average Individual Income

Home ownership—The percent of private dwellings that are owned

Single parent families—The proportion of single-parent families of households with children at home

No high school completion—The proportion of the population without a high school certificate

With a university degree—The proportion of the population with a university degree

Employment ratio—The employment/population ratio of individuals 15 and over and in the labour force

Employment rate—The unemployed as a percentage of the labor force

Community Well Being Index/Score (CWB):

Education— Number of how many community members have at least a high school education and how many have attained a university degree

Housing — Number of community members whose homes are in an adequate state of repair and are not overcrowded

Income — Total Income per Capita

A sample of socioeconomic indices and the factors they are based on. Data was extracted from reference 7 and <https://www.aadnc-aandc.gc.ca/eng/1419864229405/1419864303946>.

Appendix N: Models of Risk Injury

Four quality papers, all of which were generated with British Columbia data, were identified as potential models for BCSA to predict and depict injury risk in off-grid communities. In this appendix, we discuss the general input, output, and brief methods of each. One of the papers, titled “The RISC Research Project: Injury in First Nations Communities in British Columbia, Canada” will also have data from the 37 communities, found in module one, run through its model.² Papers will be reviewed in the following order: 38,39,45, and 48.

Model 1: “The RISC Research Project: Injury in First Nations Communities in British Columbia, Canada”

This paper looks at correlative data comparing HSDA location and Aboriginal status (input) to discharge summaries, primary care visits, and compensation injuries (method). Using a weighting factor, they are then able to obtain a correlative measure (output). In particular, this paper provides a geographical model which can be rapidly generated and utilized by BCSA.

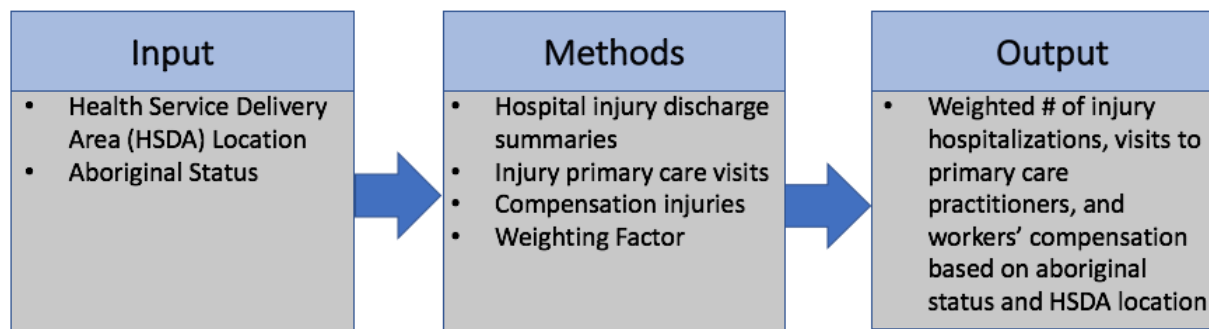


Figure 6. Depicts the input of information required to use the model, the method's database the input is compared against, and the final output that occurs when inputting information through the methods process.

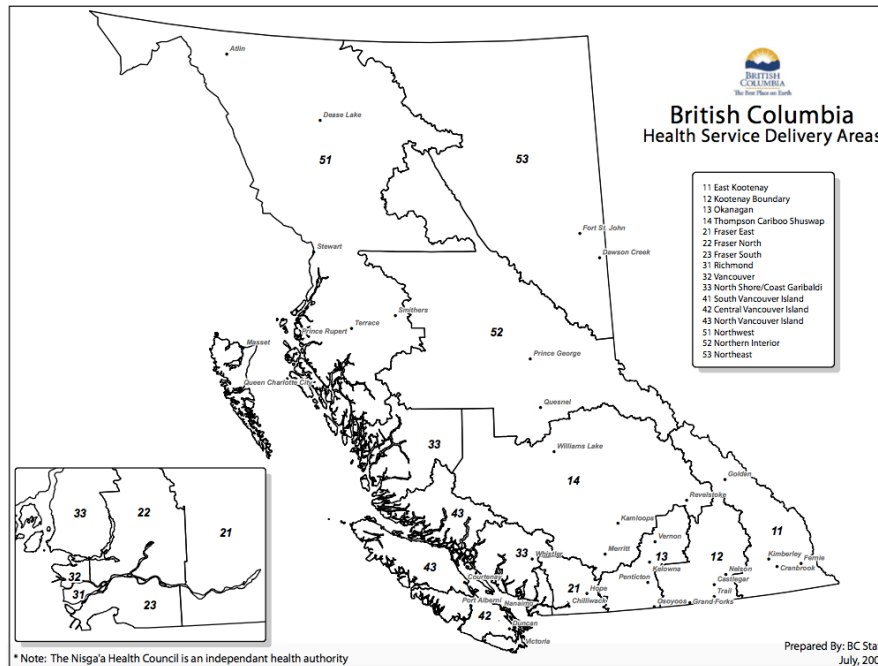
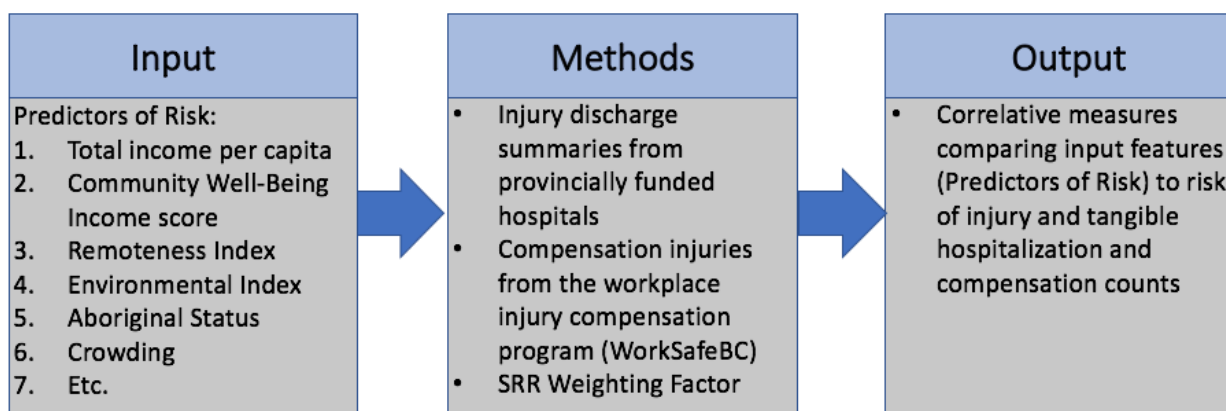


Figure 7. Depicts the Health Service Delivery Areas of British Columbia. Map prepared by the government of British Columbia. Retrieved from: <http://www2.gov.bc.ca/gov/content/data/geographic-data-services/land-use/administrative-boundaries/health-boundaries>

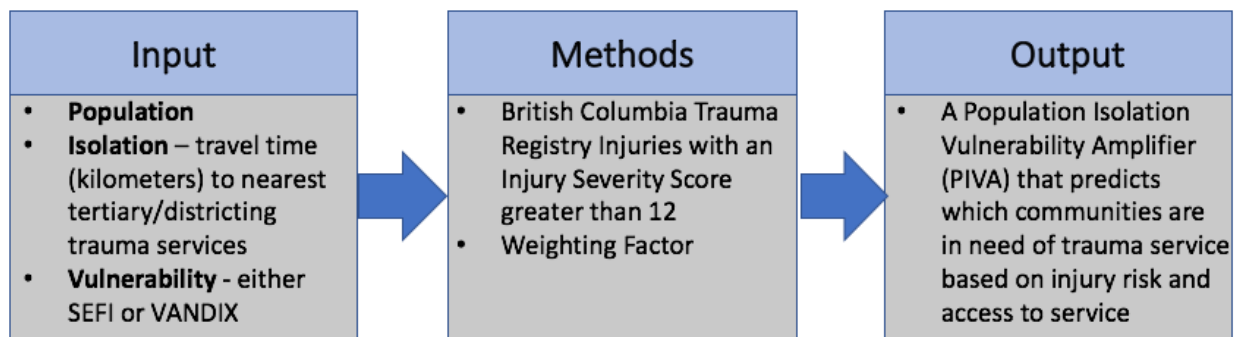
Model 2: “Aboriginal Community-Level Predictors of Injury-Related Hospitalizations in British Columbia, Canada.”

This paper looks at correlative data comparing predictors of risk such as total income per capita, remoteness, environmental index, etc. (input) to discharge summaries and compensation injuries (method). Using a weighting factor, Standardized Relative Risk (SRR) of indirect standardization by Kahn and Sempos 1989, adjusting for gender, age, and HSDA, they are then able to obtain a correlative measure (output). All in all, this paper considers the greatest number of predictors of risk input and would aid BCSA should they wish to pursue a complex multi-parameter model.



Model 3: “A Model for Identifying and Ranking Need for Trauma Service in Nonmetropolitan Regions Based on Injury Risk and Access to Services”

This paper looks at correlative data comparing predictors of risk including population, isolation, and vulnerability (input) to the British Columbia Trauma Registry with an injury severity score greater than 12 (method). Using a weighting factor, the inputs are then standardized and summated or “amplified” and correlated to the trauma data to determine which community is the most to least vulnerable (output). Unique to this paper is that the output is also modeled as a web graphic which allows easy visualization of the location and the degree of vulnerability of each community. This paper not only uses a variety of risk features found in Appendix C but also provides a powerful web graphic tool that BCSA may utilize should they wish to create their own model.



Model 4: “A Population-Based Analysis of Injury-Related Deaths and Access to Trauma Care in Rural-Remote Northwest British Columbia.”

This paper looks at the spatial geographical relation of communities (input) and relates them to their HSDA’s trauma related death, injury, and hospitalization (methods). A standard weighting factor is then applied to achieve a correlative relationship between trauma and NHS location (Output). Unique to this paper is the addition of qualitative data in the form of chart reviews and focus group interviews. The chart review helped provide a better understanding of the access and quality of trauma service within NHA while the focus groups highlighted barriers of trauma service such as time of incident scene discovery, primary transport, stabilization, hospital access, intraregional and tertiary referral processes, and continuing trauma education.¹² This data, therefore, will not only elucidate the likelihood of an injury occurring but will also reveal the probability of that trauma related injury resulting in death due to the lack of access and quality of trauma care.

