

Article

Self-Rated Health, Life Balance and Feeling of Empowerment When Facing Impacts of Permafrost Thaw—A Case Study from Northern Canada

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Abstract: Climate warming in Arctic Canada, e.g., permafrost thaw, comprehensively impacts biota and the environment, which then affects the lives of people. This study aimed to investigate which perceived environmental and adaptation factors relate to self-rated well-being, quality of life, satisfaction with life (sum variable = life balance), self-rated health, and feeling of empowerment to face the changes related to permafrost thaw. The study sample was collected from one community using a questionnaire (n = 53) and analyzed by cross-tabulation. Results indicated that most participants had at least good well-being, quality of life, satisfaction with life, and a medium level of health, and over 40% assessed being empowered to face the changes related to permafrost thaw. Problems and challenges associated with permafrost thaw, e.g., health, traditional lifeways, and infrastructure, were recognized; these had impacts on life balance, feeling of empowerment, and self-rated health. Traditional knowledge regarding adaptation to face changes was seen as important. More adaptation actions from the individual to global level seemed to be needed. This study provides an overview of the situation in one area, but more research, with a larger study sample, should be conducted to achieve a deeper understanding of climate-related impacts on life and holistic well-being.

Keywords: arctic; climate change; permafrost thaw; self-rated health; life balance; feeling of empowerment



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1. Introduction

More research is needed to understand the impact of permafrost thaw on the health and well-being of permafrost communities, and on related adaptation processes. The purpose of this study was to investigate self-rated health, well-being, quality of life, satisfaction with life, and feeling of empowerment when facing changes and impacts of permafrost thaw. The specific aim was to investigate which perceived environmental and adaptation factors relate to self-rated health, well-being, quality of life, satisfaction with life, and feeling of empowerment.

This study focused on evaluating the impacts of climate change and permafrost thaw on the lives of people living in Northern Canada in a settlement where around 95% of residents are Indigenous (in 2021) [1]. Human health is understood as physical, social, spiritual, and mental well-being [2], and mental well-being is understood as overall life satisfaction and being able to live life actively and self-realistically [3]. The health of humans, the environment, plants, and animals is interconnected [4]. Living in connection to one's own environment and nature and being able to maintain traditional culture and

lifeways are often important for Indigenous Peoples' identities and thus support holistic well-being [5–8].

Overview of the Literature

In northern Canada, air temperatures increased by 2.3 °C between 1948–2016 [9]. Warming temperatures can be noticed as increased rain and humidity, decreased levels of snow and ice [10–12], melting glaciers [10], changing wind [12], increased storm frequency [13,14], and flooding [14]. Additionally, permafrost thaw modifies the landscape by increasing, e.g., coastal erosion rates [12,14] and the occurrence of subsidence and slumping [15–17]. These have negative effects on the built environment [13,18] and food and water security [19].

In terms of human health, the impacts of climate change can be seen as an increase in physical injuries and illnesses [20,21], e.g., infectious diseases through contaminated air [22], water, or food [23,24]. Zoonotic diseases are also risking the health of people [24]. Moreover, impacts are causing mental health problems [20,21,25], such as feelings of stress, sadness, or anxiety [23,25–27], feelings of helplessness [23], and long-term and more severe mental illnesses as well [23,26,28]. Furthermore, impacts may indirectly pose a risk to the social environment and the life of people [13,20,25,28], leading to economic challenges [5,20,22]. Additionally, among climate change researchers, feelings of frustration or powerless have been observed [27]. It has been found that a feeling of empowerment is connected to actions taken to address climate change [29,30].

For Indigenous communities in the Arctic, changes affect the cultural and social life and health, including mental health, of individuals and communities [23,31,32], and further raise challenges in transportation, economy, well-being [13], traditional lifeways [13,14,33], and use of traditional food [5,12,23]. Climate change has been found to be one of the main challenges in Northern Canada, which certainly requires tools and knowledge, but also co-operation between people from all over society in order to support the essential adaptation process [34–36]. The population living on permafrost in the Arctic is about five million [37], and around one million of them are Indigenous [38,39]. It has been found that overall, the health profile of Arctic Indigenous People is lower compared to non-Indigenous People living in same region. Moreover, long distances to health services in Northern Canada may further put the health of people at risk and challenge the health system [40].

2. Materials and Methods

The questionnaire was developed within a multidisciplinary research project including researchers from several research fields, e.g., health, anthropology, economy, engineering, and human geography. It was used in and adapted to each case area of the project. This study did not include any personal health information and was conducted under the Northwest Territories Scientific Research License No. 16531. Ethical approval was obtained through the Aurora College Research Ethics Committee (Protocol Nr. 20190101).

2.1. Data Collection

The data were gathered in Northern Canada, in one community in the Northwest Territories, by a questionnaire from 53 participants during February 2019 and October 2020. The total number of participants represents about 10% of the total population living in this community, and just over 50% of the population are men. Two local research assistants had printed versions of the questionnaire, which were used for data collection. Study participants were informed about the project and the use of the data, and their participation was anonymous and voluntary. All participants signed a consent form prior to participation in the study. The questionnaire was developed together with local experts and community research partners. Before actual data collection, the questionnaire was submitted to a research committee working in the study region to meet cultural and local criteria. It was approved after modification of the terminology, e.g., from “permafrost thaw” to the term “frozen ground”.

2.2. Data Analysis

The questionnaire included 41 questions, which concentrated on the living environment and impacts of permafrost thaw, adaptation, traditional food consumption, and questions describing the participant’s current life situation. The questions (n = 15) were chosen for variables for the analysis of the present paper to describe the impacts of permafrost thaw (perceived environmental and adaptation factors). The questions are presented in the Results part.

Variables of Self-Rated Health, Life Balance and Feeling of Empowerment

Participants were asked to rate their well-being, quality of life, and satisfaction with life using the Likert scale (very bad, bad, OK, good, very good). Similar variables have been used previously in Arctic research [41–43]. Comparisons were made between answers of very good well-being, satisfaction with life and quality of life, and not very good (including answers of OK and good), and those were used in the statistical analyses. This classification was used since participants gave answers between OK to very good, and a minority of the participants rated their well-being, quality of life, or satisfaction with life being OK (Table 1). Moreover, a sum variable was drawn from these variables, with a range from 3 (OK) to 5 (very good). The sum variable was named “life balance” and it was classified into a lower group (named “not very strong” up to 12) and a higher group (named “very strong”, with a sum of 13–15). Cronbach’s alpha of sum variable was 0.750, and the minimum level for very strong life balance was 71%. In addition, the variable of self-rated health was reclassified into three groups: low (0–33%), medium (34–66%), and high (67–100%). Participants rated their health on a scale from 0 to 100. The feeling of empowerment to face the changes related to permafrost thaw was reclassified as follows: no, somewhat/yes. Self-rated health and feeling of empowerment have been used before in similar way in research focusing on the Arctic and climate change [44,45].

Table 1. Demographic variables and self-rated health, life balance, and feeling of empowerment to face changes.

Demographic Variables n (%)							Total	
Age	18–24	25–34	35–44	45–54	55–64	≥65	53 (100)	
	5 (10)	9 (17)	8 (15)	7 (13)	18 (34)	6 (11)		
Profession	Public sector	Private sector	Hunter/fisher	Unemployed	Retired	Home-maker	Other	53 (100)
	7 (13)	2 (4)	6 (11)	11 (21)	7 (13)	5 (10)	15 (28)	
Gender	Female	Male						53 (100)
	30 (57)	23 (43)						
Dependent variables, self-rated n (%)								
Health	Low	Medium	High				53 (100)	
	2 (4)	41 (77)	10 (19)					
Well-being	OK	Good	Very good				53 (100)	
	13 (25)	25 (47)	15 (28)					
Quality of life	OK	Good	Very good	Missing			53 (100)	
	8 (15)	27 (51)	17 (32)	1 (2)				
Satisfaction with life	OK	Good	Very good	Missing			53 (100)	
	5 (9)	27 (51)	20 (38)	1 (2)				
Empowered to face changes	No	Somewhat	Yes				53 (100)	
	11 (21)	20 (38)	22 (41)					

Due to the small sample size (n = 53), statistical tests were not performed, excluding the summarization of the sum variable and counting Cronbach’s alpha. The conducted analyses are descriptive, and the data were analyzed by cross-tabulation to describe perceived environmental and adaptation factors related to permafrost thaw and climate change. This

paper reports the results of self-rated health, feeling of empowerment, and the sum variable “life balance”, which gathers three variables (well-being, quality of life, and satisfaction with life). All the results are presented in the Supplementary Tables S1–S4.

In addition, the associations between perceived demographic, environmental, and adaptation factors were investigated either by the Pearson χ^2 test or by Fisher’s exact test. These results ($p \leq 0.1$) are presented in the Supplementary Tables S5–S7. Statistical data were analyzed using IBM SPSS Software, version 25 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.).

3. Results

3.1. Description of Participants

Altogether, 53 participants, 30 females and 23 males, filled out the questionnaire. Most of the participants answered “other” for their profession ($n = 15, 28\%$). The remaining consisted of participants working in construction or maintenance ($n = 5$), education or supervision ($n = 4$), traditional hunting/fishing ($n = 3$), public services ($n = 2$), and one participant worked from home. A majority of the participants ($n = 41, 77\%$) rated their health at a medium level and 42% of the participants ($n = 22$) had very strong life balance. Among the participants, 41% ($n = 22$) reported feeling empowered to face the changes related to permafrost thaw. (Table 1).

3.2. Perceived Environmental Factors and Self-Rated Health, Life Balance and Feeling of Empowerment to Face Changes

Table 2 presents the relationships between variables of interests and perceived environmental variables. Most of the participants who spent time in nature for recreational activities sometimes or very often had very strong life balance ($n = 16, 73\%$). Participants who felt empowered to face the changes related to permafrost thaw ($n = 19, 86\%$) reported being in nature for hunting sometimes or very often. On the other hand, of those who were in nature less for hunting, 35% ($n = 11$) reported not being or only somewhat being empowered to face the changes related to permafrost thaw compared to those who felt being empowered ($n = 3, 14\%$). Similar results can be found for self-rated health. Being in nature for fishing follows the same trend in all variables of interests. However, most of the participants who reported being in nature to pick berries and mushrooms more often did not report a very strong life balance ($n = 26, 87\%$), clear feeling of empowerment ($n = 26, 84\%$), or self-rated health ($n = 35, 85\%$). (Table 2).

Table 2. Self-rated health, life balance and feeling of empowerment and perceived environmental factors.

	Life Balance				Feeling of Empowerment				Self-Rated Health					
	Not Very Strong		Very Strong		No, Somewhat		Yes		Low		Medium		High	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
How often do you use your natural environment for:														
hunting (n = 52–53)														
Never, Rarely	9	(30)	5	(23)	11	(35)	3	(14)	2	(100)	11	(27)	1	(10)
Sometimes, Very Often	21	(70)	17	(77)	20	(65)	19	(86)	0	(0)	30	(73)	9	(90)
fishing (n = 50–51)														
Never, Rarely	10	(33)	5	(25)	12	(39)	3	(15)	2	(100)	10	(26)	3	(30)
Sometimes, Very Often	20	(67)	15	(75)	19	(61)	17	(85)	0	(0)	29	(74)	7	(70)

Table 2. Cont.

	Life Balance				Feeling of Empowerment				Self-Rated Health					
	Not Very Strong		Very Strong		No, Somewhat		Yes		Low		Medium		High	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
picking berries, mushrooms (n = 52–53)														
Never, Rarely	4	(13)	5	(23)	5	(16)	4	(18)	2	(100)	6	(15)	1	(10)
Sometimes, Very Often	26	(87)	17	(77)	26	(84)	18	(82)	0	(0)	35	(85)	9	(90)
Recreational Activities (n = 52–53)														
Never, Rarely	16	(53)	6	(27)	15	(48)	8	(36)	2	(100)	18	(44)	3	(30)
Sometimes, Very Often	14	(47)	16	(73)	16	(52)	14	(64)	0	(0)	23	(56)	7	(70)
economic activities (n = 52–53)														
Never, Rarely	29	(97)	18	(82)	28	(90)	20	(91)	2	(100)	37	(90)	9	(90)
Sometimes, Very Often	1	(3)	4	(18)	3	(10)	2	(9)	0	(0)	4	(10)	1	(10)
scientific activities (n = 52–53)														
Never, Rarely	22	(73)	14	(64)	19	(61)	18	(82)	2	(100)	26	(63)	9	(90)
Sometimes, Very Often	8	(27)	6	(36)	12	(39)	4	(18)	0	(0)	15	(37)	1	(10)

3.3. Perceived Challenges and Impacts Related to Permafrost Thaw and Self-Rated Health, Life Balance and Feeling of Empowerment

Relationships between variables of interests and perceived challenges and impacts related to permafrost thaw are presented in Table 3. Most of the participants who did not feel or felt somewhat empowered to face changes (n = 30, 97%) or had a medium health level (n = 37, 90%) assessed challenges associated with culture as more important. Similarly, challenges associated with infrastructure (housing, buildings, and roads) were recognized among participants who did not feel or felt somewhat empowered (n = 28, 90%) to face changes or had a medium health level (n = 36, 88%). Still, many participants who felt empowered or had a high health level or very strong life balance recognized these challenges as well. For example, physical environment challenges were recognized as important or very important among participants with very strong life balance (n = 19, 86%), feelings of empowerment (n = 18, 82%), and high health levels (n = 35, 85%). (Table 3).

Participants assessed that during the past ten years, thawing of the frozen ground has led to negative changes. Participants who did not have a very strong life balance (n = 26, 90%), did not feel empowered (n = 25, 86%), or had a medium health level (n = 36, 92%) recognized negative changes. Negative changes were also recognized by participants with strong life balance (n = 19, 91%), a high health level (n = 9, 90%), and more often among participants with a feeling of empowerment (n = 21, 96%). Thawing of the frozen ground was connected to other problems, either on an individual or community level. Most of the participants who did not have a very strong life balance (n = 21, 70%), did not have a clear feeling of empowerment (n = 19, 61%), and a medium health level (n = 26, 63.5%) recognized these connected problems. The most common reason given for permafrost thaw was increasing temperatures, which was recognized by participants with a very strong life balance (n = 20, 91%), clear feeling of empowerment (n = 20, 91%), and a high health level (n = 10, 100%). (Table 3).

Table 3. Self-rated health, life balance and feeling of empowerment to face changes and perceived challenges/impacts related to permafrost thaw.

	Life Balance				Feeling of Empowerment				Self-Rated Health					
	Not Very Strong		Very Strong		No, Somewhat		Yes		Low		Medium		High	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
How important is thawing of the frozen ground in explaining each of the following:														
Challenges associated with hunting, harvesting (n = 52–53)														
Not Important, A Little Important	1	(3)	2	(9)	2	(7)	1	(4)	0	(0)	2	(5)	1	(10)
Important, Very Important	29	(97)	19	(86)	28	(90)	21	(96)	2	(100)	38	(93)	9	(90)
I don't know	0	(0)	1	(5)	1	(3)	0	(0)	0	(0)	1	(2)	0	(0)
Challenges associated with economic activities (n = 52–53)														
Not Important, A Little Important	10	(33)	7	(32)	10	(32)	8	(36)	0	(0)	13	(32)	5	(50)
Important, Very Important	15	(50)	14	(64)	17	(55)	12	(55)	2	(100)	23	(56)	4	(40)
I don't know	5	(17)	1	(5)	4	(13)	2	(9)	0	(0)	5	(12)	1	(10)
Challenges associated with the physical environment (n = 52–53)														
Not Important, A Little Important	4	(13)	0	(0)	2	(6)	3	(14)	0	(0)	3	(7,5)	2	(20)
Important, Very Important	24	(80)	19	(86)	25	(81)	18	(82)	2	(100)	35	85	6	(60)
I don't know	2	(7)	3	(14)	4	(13)	1	(4)	0	(0)	3	(7,5)	2	(20)
Challenges associated with human health (n = 52–53)														
Not Important, A Little Important	3	(10)	1	(5)	1	(3)	3	(13,5)	0	(0)	4	(10)	0	(0)
Important, Very Important	25	(83)	17	(77)	27	(87)	16	73	2	(100)	32	(78)	9	(90)
I don't know	2	(7)	4	(18)	3	(10)	3	(13,5)	0	(0)	5	(12)	1	(10)
Challenges associated with culture (n = 52–53)														
Not Important, A Little Important	3	(10)	1	(4)	1	(3)	3	(14)	0	(0)	4	(10)	0	(0)
Important, Very Important	27	(90)	21	(96)	30	(97)	19	(86)	2	(100)	37	(90)	10	(100)
Challenges associated with housing, buildings, roads (n = 52–53)														
Not important, a little important	3	(10)	1	(4)	2	(7)	3	(14)	0	(0)	4	(10)	1	(10)
Important, Very Important	26	(87)	21	(96)	28	(90)	19	(86)	2	(100)	36	(88)	9	(90)
I don't know	1	(3)	0	(0)	1	(3)	0	(0)	0	(0)	1	(2)	0	(0)
Over the past 10 years, thawing of the frozen ground has led to (n = 50–52)														
Negative Changes	26	(90)	19	(91)	25	(86)	21	(96)	1	(50)	36	(92)	9	(90)
Positive Changes	3	(10)	2	(9)	4	(14)	1	(4)	1	(50)	3	(8)	1	(10)
Do you think that thawing of the frozen ground causes problems for you? (n = 48–49)														
No	4	(14)	7	(35)	7	(25)	4	(19)	1	(50)	7	(19)	3	(30)
Yes	24	(86)	13	(65)	21	(75)	17	(81)	1	(50)	30	(81)	7	(70)
Have you lost some picking spots because they became flooded or submerged? (n = 46)														
No	25	(93)	12	(63)	21	(78)	16	(84)	2	(100)	30	(83)	5	(63)
Yes	2	(7)	7	(37)	6	(22)	3	(16)	0	(0)	6	(17)	3	(37)
Thawing of the frozen ground is having an impact on the ability to obtain food/other resources for daily use from the land (n = 51–53)														
No	6	(20)	1	(5)	5	(17)	2	(9)	0	(0)	7	(17)	0	(0)
Yes	12	(40)	11	(52)	15	(50)	8	(36)	1	(50)	19	(48)	3	(30)
Somewhat	12	(40)	9	(43)	10	(33)	12	(55)	1	(50)	14	(35)	7	(70)
Is thawing of the frozen ground connected to other problems you have or your community has? (n = 52–53)														
No	3	(10)	1	(4)	1	(3)	3	(14)	0	(0)	3	(7)	1	(10)
Yes	21	(70)	12	(55)	19	(61)	15	(68)	1	(50)	26	(63,5)	7	(70)
I don't know	6	(20)	9	(41)	11	(36)	4	(18)	1	(50)	12	(29,5)	2	(20)
If yes, which ones: safety problems * ¹ answered to options (n = 36): this option was selected (n = 16)														
	10	(44)	6	(46)	10	(48)	6	(40)	1	(100)	13	(45)	2	(33)
If yes, which ones: infrastructure problems * ¹ answered to options (n = 36): this option was selected (n = 27)														
	17	(74)	10	(77)	19	(91)	8	(53)	1	(100)	22	(76)	4	(67)
According to you, what mainly causes the thawing of the frozen ground? * ²														
Increase in temperatures (option was selected: n = 49–50)	20	(97)	20	(91)	30	(97)	20	(91)	2	(100)	38	(93)	10	(100)

* a minimum of 15 participants chose the option reported. ¹ Options: Financial, happiness, spiritual, safety, work, political, health, infrastructure, fresh-water supply, food storage, religious. ² Options: Increase in temperatures, fires, anger from spirits, too many trails, increase in shrubs, decrease in snow depth, God, roads and housing, other (participants were asked to select two options).

3.4. Perceived Adaptation and Factors and Self-Rated Health, Life Balance and Feeling of Empowerment to Face Changes

Overall, participants assessed that not enough has been done to adapt to or face the impacts of permafrost thaw. This was clearer between the variables of feeling of empowerment and self-rated health and adaptation actions from individual to local levels

compared to the variables of life balance, where participants especially assessed that not enough was done on the regional to global level. (Table 4). Still, the relationships varied between variables of interests and levels of adaptation actions. Most of the participants who did not feel empowered or felt somewhat empowered to face changes (n = 17, 55%), as well as 49% (n = 20) of participants with a medium health level, assessed that not enough has been done by individuals. The participants who did not have a very strong life balance recognized that not enough has been done on the global level to adapt to or face impacts (n = 13, 43%). Participants assessed that the strongest adaptation needs are in the areas of traditional knowledge and hunting/fishing activities. (Table 4).

Table 4. Self-rated health, life balance and feeling of empowerment to face changes and perceived adaptation factors.

	Life Balance				Feeling of Empowerment				Self-Rated Health					
	Not Very Strong		Very Strong		No, Somewhat		Yes		Low		Medium		High	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Do you feel that enough is being done to adapt or face the impacts related to thawing of the frozen ground by:														
individuals (n = 52–53)														
No	11	(37)	11	(50)	17	(55)	5	(23)	0	(0)	20	(49)	2	(20)
Yes	6	(20)	2	(9)	4	(13)	4	(18)	0	(0)	7	(17)	1	(10)
Somewhat	13	(43)	9	(41)	10	(32)	13	(59)	2	(100)	14	(34)	7	(70)
the community (n = 52–53)														
No	7	(23)	6	(27)	10	(32)	3	(14)	0	(0)	10	(24)	3	(30)
Yes	12	(40)	7	(32)	10	(32)	9	(41)	1	(50)	14	(34)	4	(40)
Somewhat	11	(37)	9	(41)	11	(36)	10	(45)	1	(50)	17	(32)	3	(30)
local authorities (n = 52–53)														
No	8	(27)	7	(32)	10	(32)	6	(27)	0	(0)	3	(32)	3	(30)
Yes	13	(43)	7	(32)	12	(39)	8	(36,5)	1	(50)	15	(36)	4	(40)
Somewhat	9	(30)	8	(36)	9	(29)	8	(36,5)	1	(50)	13	(32)	3	(30)
regional authorities (n = 52–53)														
No	10	(33,3)	2	(9)	9	(29)	4	(18)	0	(0)	11	(27)	2	(20)
Yes	13	(43,3)	8	(36)	11	(35,5)	10	(46)	1	(50)	16	(39)	4	(40)
Somewhat	7	(23,3)	12	(55)	11	(35,5)	8	(36)	1	(50)	14	(34)	4	(40)
national authorities (n = 52–53)														
No	12	(40)	4	(18)	10	(32)	7	(32)	0	(0)	13	(32)	4	(40)
Yes	13	(43)	9	(41)	12	(39)	10	(45)	1	(50)	17	(41)	4	(40)
Somewhat	5	(17)	9	(41)	9	(29)	5	(23)	1	(50)	11	(27)	2	(20)
global community (n = 52–53)														
No	13	(43)	1	(4)	8	(26)	6	(27)	0	(0)	10	(24)	4	(40)
Yes	11	(37)	9	(41)	11	(35)	10	(46)	1	(50)	16	(39)	4	(40)
Somewhat	6	(20)	12	(55)	12	(39)	6	(27)	1	(50)	15	(37)	2	(20)
In which ways do you think your community is best prepared to adapt to thawing of the frozen ground? (selected the option) * 1														
Hunting/fishing activities (n = 19)	11	(37)	8	(36)	11	(35)	8	(36)	0	(0)	16	(39)	3	(30)
Traditional knowledge (n = 28–29)	16	(53)	12	(55)	19	(61)	10	(45)	1	(50)	21	(51)	7	(70)
The strongest need to adapt to thawing of the frozen ground in order to facilitate day to day activities (selected the option) * 2														
Health (n = 15)	8	(27)	7	(32)	11	(35)	4	(18)	0	(0)	15	(37)	0	(0)
Housing (n = 18)	11	(37)	7	(32)	10	(32)	8	(36)	0	(0)	16	(39)	2	(20)
Hunting/fishing activities (n = 27–28)	14	(47)	13	(59)	16	(52)	12	(54)	0	(0)	24	(59)	4	(40)
Traditional knowledge (n = 32–33)	14	(47)	18	(82)	20	(65)	13	(59)	2	(100)	27	(67)	4	(40)

* a minimum of 15 participants chose the option reported. ¹ Options: Health, housing, mobility, hunting/fishing activities, traditional knowledge, other. ² Options: Health, housing, mobility, hunting/fishing activities, traditional knowledge, other.

3.5. Results of the Open Questions

The questionnaire had structure questions that included an “other” option (Tables 3 and 4). These open-ended answers, as well as specific open questions, were included in the study. The open questions were as follows:

1. Mention three words you associate with the thawing of the ground.
2. Is there anything else you would like to say about thawing ground in your community?
3. Mention three words you associate with challenging changes in your daily life.

Based on the answers, participants expressed worries related to changing weather and challenges related to their personal life. Changing weather was observed, e.g., warmer temperatures, melting snow and ice, permafrost thaw, erosion, slumps, and mud slides. Additionally, global warming and pollution were mentioned as causes of permafrost thaw, as well as seasonal changes, especially longer summers. Changes affect fishing, hunting or harvesting activities, but also travelling routes on water and on land. Adaptation was seen as important, but people still expressed feelings that they are not necessarily prepared for these changes or the adaptation actions themselves. Furthermore, participants raised concerns related to infrastructure, housing, traditional food and lifestyles, and economic or financial problems, e.g., lack of income and safety. Finally, alcohol use and health problems were raised, and traditional knowledge was seen as important.

4. Discussion

Figure 1 illustrates the life balance (well-being, quality of life, and satisfaction with life), feeling of empowerment, and self-rated health. Overall, participants reported good and satisfied lives, with good well-being and health, and they felt at least somewhat empowered to face the impacts of permafrost thaw (Figure 1). Findings of self-rated well-being and health are in line with the results presented by Parlee & Furgal [5]: in one Canadian case study, 92% of participants rated well-being and 90% their health as being either good or excellent. Similarly, Wu [46] points out that overall life satisfaction among Indigenous People living in Northern Alaska was found to be generally strong. The study showed that, e.g., an untreated physical health problem, female gender, and an employment situation that did not support culture or being out in nature negatively affect life satisfaction. Instead, subsistence activities and strong family and social relationships supported life satisfaction [46].

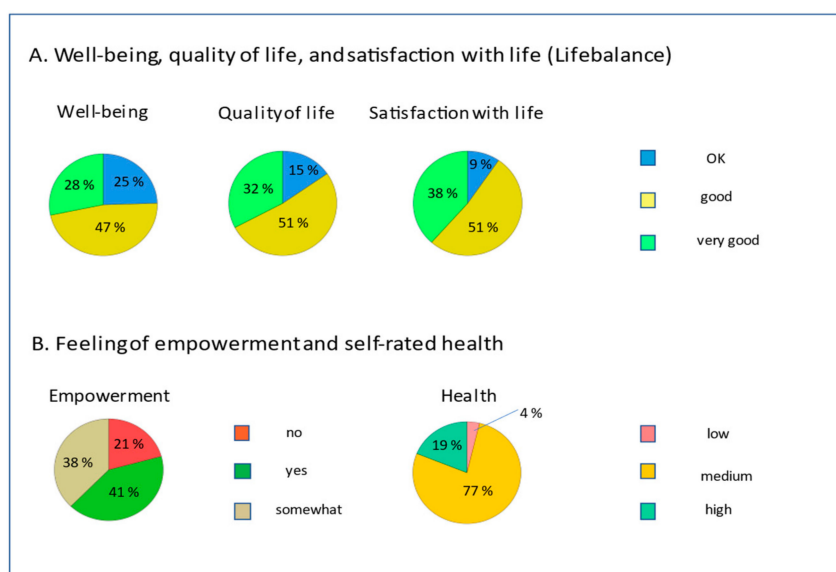























Figure 1. Summary of frequencies: Self-rated health, life balance and feeling of empowerment to face changes.

Participants recognized impacts affecting their lives; these are descriptively summarized in Table 5. The results showed that nature and being in nature for different activities seem to have an important role for participants. This finding is supported by current literature that indicates the importance of nature as a supportive factor for overall well-being, and it is important for many Indigenous Peoples [5,43,46–48]. However, being in nature to pick berries or mushrooms seemed to have a slightly different relationship to variables of interests, as also found in a study by Timlin and colleagues [43].

Table 5. Interpretive summary of the main results: Descriptive relationships between themes (formulated from perceived environment and adaptation factors) and life balance, feeling of empowerment, and self-rated health.

	Life Balance (Well-Being, Quality of Life, Satisfaction with Life)	Feeling of Empowerment	Self-Rated Health
Being in nature for, e.g., fishing, hunting, recreation			
Being in nature for picking berries, mushrooms			
Permafrost thaw and related problems/changes			
Challenges related to permafrost thaw, e.g., traditional lifeways, health, infrastructure			
Impacts of thawing ground on food forage from nature			
Enough has not been done to adapt/face impacts on an individual—local level			
Enough has not been done to adapt/face impacts on a regional—global level			

Challenging  Supporting.

Permafrost thaw caused problems and negative impacts that affected the lives of participants, and the relationship between variables seemed to be clearer for life balance and self-rated health. Similarly, challenges associated with health, infrastructure, and traditional lifeways were recognized among participants and were found to be important, especially among participants who assessed their health to be on a medium level, or who did not have a clear feeling of empowerment. These findings are likewise supported by the current literature, for example, in the recently published report of IPCC [49] that pointed out negative climate change impacts in the Arctic on health and well-being, but also on infrastructure and food security. Physical and mental health are at risk and may be impacted in direct or indirect ways due to extreme weather conditions, demands on infrastructure, livelihoods, or the economy [49]. It has been found that due to impacts of climate change, human health can be at risk as people can be infected with diseases through contaminated water, food, animals (zoonotic), or air [49,50]. Permafrost thaw is damaging infrastructure [13,47], and Bell and colleagues [51] found that in Northern Alaska, it has caused mental challenges, such as feelings of stress and uncertainty, but also put water supplies at risk. Moreover, permafrost thaw is negatively affecting traditional hunting and fishing [47] due to the need to use new, unknown hunting routes instead of traditional trails and paths, and nature is not as accessible anymore [12,14]. Climate change is challenging the life of Indigenous Peoples in other areas of the Arctic as well, for example, the Sami

people in Scandinavia [52,53] and the Nenets people in Russia, where changes in climate are impacting reindeer herding [54,55]. Similar results were found in this study too, as participants recognized challenges associated with hunting and harvesting.

Climate change has been found to be one threat to the traditional living habits of communities, peoples' identities, and social bonds in Arctic Alaska [47,51] and in the Canadian Arctic [5,48,56]. Sakakibara [32] found that Indigenous communities in Arctic Alaska faced serious changes in climate, putting their traditional lifeways at risk. For example, communities rely on sea water and sea ice for whale hunting, and it is an important part of their traditional culture. Now, due to climate change, the natural yearly cycle of whale hunting has been challenged, and decreased ice levels have put the safety of people at risk. Greaves [57] points out that Canadian Inuit are experiencing environmental changes, e.g., climate change and changes in the social environment, which further challenge cultural identity and autonomy and impact the feeling of security. Similarly, participants recognized in this study that permafrost thaw is connected to safety problems on a personal and community scale. However, this result does not clarify what kind of safety problems—i.e., physical or social.

Participants of this study highlighted the importance of traditional knowledge. Impacts of climate change, together with other social changes in the community, e.g., changes in lifeways or values, are challenging the knowledge transfer from elders to youth [14]. Most participants who did not have a very strong life balance, had a medium health level, or did not have a clear feeling of empowerment, assessed that the community is best prepared to adapt to permafrost thaw, especially in terms of traditional knowledge. Interestingly, traditional knowledge was also felt to be the strongest need in adapting to day-to-day activities among the same group of participants, except on life balance, where participants with very strong life balance assessed the same need.

Overall, participants reported that not enough or somewhat enough has been done to adapt to or face the impacts of permafrost thaw on different levels, from individual to global actions. This assessment was clearer among participants who did not have a very strong life balance, high health level, or felt somewhat or not at all empowered to face the changes related to permafrost thaw. According to Chapin [47], in Alaska the feeling of empowerment in communities was found to be stronger when, e.g., local lifeways and agriculture were supported. Adaptation and actions should include possibilities for engagement of residents, too. In a review concentrating on Canada's Arctic coast, Ford and colleagues [13] point out that in adaptation processes, active communication and co-operation between different levels, e.g., local people and decision-makers [13], as well as the collaboration between researchers, are necessary, and traditional knowledge should be included [13,34]. This is especially important when supporting the adaptation process of Indigenous communities [49]. Furthermore, adaptation processes should be supported [13,25,49], and it cannot be only the individual's responsibility [25]. We found similar findings from the open answers of our study participants.

Climate change is putting mental health at risk, but it also challenges people socially [25]. As recognized in the current literature, the impacts can negatively affect mental health. According to Obradovich and colleagues [58], one-degree Celsius warming during a five-year period can increase mental health problems by two percent. However, participants of this study assessed their life balance (well-being, quality of life, satisfaction with life), feeling of empowerment, and self-rated health as mostly good—despite the impacts and challenges that were recognized. Maybe there are other factors that support the life of study participants, or the adaptation process is part of life as there is no other choice—people need to find new ways to live. Adaptation may also happen slowly and in a way such that some changes become a natural part of life, as is similarly the case in Greenland [43]. Even though challenges affect peoples' well-being differently, resilience capacity generally allows successful adaptation over time [59].

It must be admitted that this study has central limitations. First, the sample size was small, limiting the statistical analyses. Still, the Cronbach's alpha of sum variable (life

balance) was conducted, and it can be considered as being on a good level [60]. A larger study sample would have meant stronger statistical analysis, allowing for statistical tests to investigate, for example, odds between variables, which in turn, would have led to stronger conclusions. Moreover, during data collection, the COVID-19 pandemic occurred, thus creating new challenges. It also needs to be pointed out that it was not asked in the survey if the participants defined themselves as Indigenous or non-Indigenous. However, as mentioned in the introduction, around 95% of the inhabitants living in this community are Indigenous.

These results provide a description of the situation for people living in the study area in Northwestern Canada when facing the impacts of climate change and permafrost thaw. Additionally, the results describe how residents are adapting to changes and what is still required for successful adaptation. The same questionnaire has been used before in studies completed in Greenland among the Indigenous population [43,45], but also in Svalbard [44]. Similar challenges, which impacted the life and well-being of people, were observed with these studies compared to the present study. Due to the larger sample size in Greenland and Svalbard, binary logistic regression analysis showed that recognizing impacts and challenges supported holistic well-being. It may be that knowledge related to challenges and impacts of climate change helps people to deal with problems and, furthermore, to adapt to them. As found in the study by Aitken and colleagues [30], people were able to deal with issues of climate change when they felt they had the power and tools to act. Even though the results of this study cannot be generalized, they still may provide essential information for academia, politicians, and also for other Indigenous communities dealing with similar issues. For future research, it would be beneficial to complete a similar study with a larger study sample, as well as a qualitative study in order to learn in greater depth the impacts of climate-related changes on life and well-being. In addition, it would be beneficial to receive more comprehensive research information that presents the experiences of both Indigenous and non-Indigenous People.

5. Conclusions

Based on a self-assessment in this case study, participants from this permafrost community have good holistic well-being and are satisfied with their life. They feel they have power to face the changes related to permafrost thaw. Still, central challenges and problems related to permafrost thaw, e.g., in nature, infrastructure, traditional lifeways, and health and safety, are recognized—and they influence the life and mental well-being of people. Adaptation is important and necessary for study participants; there are no other options in order to continue with life. However, more adaptation actions are needed, and they should be supported and carried out in co-operation with decision-makers from different levels. In addition, more research with a larger study sample is needed to achieve a comprehensive description of the investigated area.

The results of the study suggest the following policy implications:

1. More/better adaptation measures are needed and preparedness for adaptive measures must be developed and strengthened. Stronger interaction between scientific and administrative organizations and residents is needed.
2. Infrastructure and housing, traditional food and lifestyles, and financial problems are among the main issues that need to be addressed through local citizen involvement in research and strategic adaptation planning
3. A holistic approach that takes culture, identity, and language as well as animal and environmental health into account (such as the One Health approach [4]) should be employed and fostered to cultivate preparedness for changes related to climate change and adaptation measures. Intergenerational resilience in response to the long-term effects of colonization, forced assimilation, and (attempted) cultural genocide should be part of addressing the challenges related to climate change adaptation and preparedness.

4. Capacity-building is needed both within communities as well as for researchers, technicians, companies, etc., to ensure equal participation and adequate cooperation with Indigenous Peoples and other citizens, to use and find the best solutions as well as foster and harness local expertise guided by Indigenous Knowledge and the Inuit Qaujimaqatuqangit [35,36].

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/atmos13050789/s1>, Table S1. Variables of interest (self-rated) and perceived environmental factors; Table S2. Variables of interest (self-rated) and perceived environmental challenges; Table S3. Variables of interest (self-rated) and perceived environmental impacts; Table S4. Variables of interest (self-rated) and perceived adaptation factors; Table S5. Variables of interest and associations with demographic/perceived environmental factors ($p = <0.1$); Table S6. Variables of interest and associations with factors describing specific impacts at the individual and community levels ($p = <0.1$); Table S7. Variables of interest and associations with perceived adaptation factors ($p = <0.1$).

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