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TOPICAL REVIEW

Indigenous mental health in a changing climate: a systematic scoping review of the global literature

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Abstract

Indigenous Peoples globally are among those who are most acutely experiencing the mental health impacts of climate change; however, little is known about the ways in which Indigenous Peoples globally experience climate-sensitive mental health impacts and outcomes, and how these experiences may vary depending on local socio-cultural contexts, geographical location, and regional variations in climate change. Thus, the goal of this study was to examine the extent, range, and nature of published research investigating the ways in which global Indigenous mental health is impacted by meteorological, seasonal, and climatic changes. Following a systematic scoping review protocol, three electronic databases were searched. To be included, articles had to be empirical research published since 2007 (i.e. since the Intergovernmental Panel on Climate Change’s Fourth Assessment Report); explicitly discuss Indigenous Peoples and describe factors related to climatic variables and mental health. Descriptive data from relevant articles were extracted, and the articles were thematically analyzed. Fifty articles were included for full review. Most primary research articles described research in Canada (38%), Australia (24%), and the United States of America (10%), with the number of articles increasing over time. Mental health outcomes such as strong emotional responses, suicide, depression, and anxiety were linked to changes in meteorological factors, seasonality, and exposure to both acute and chronic weather events. The literature also reported on the ways in which the emotional and psychological impacts of climate were connected to changing place attachment, disrupted cultural continuity, altered food security and systems, forced human mobility, and intangible loss and damages. This review highlights global considerations for Indigenous mental health in relation to climate change, which can support Indigenous-driven initiatives and decision-making to enhance mental wellness in a changing climate.

1. Introduction

Mental health has been recognized as a major concern in the context of climate change [1–4], reflected in burgeoning research, programming, and public interest [1, 2, 4–10]. There are many known and anticipated causal pathways through which climate change and the resultant environmental shifts impact mental health, including: acute trauma and distress resulting directly from exposure to severe weather events [5]; disruptions to the underlying determinants of mental health, such as physical health, infrastructure, and social capital [e.g. 11]; and altered connections to place that threaten knowledge systems and cultural practices [e.g. 12–15]. Population-level studies based on hospital and national mortality databases have indicated that changes in weather and seasonality are associated with mental health-related hospital visits [e.g. 16, 17],
Globally, the burden of mental illness is projected to rise [20], with climate change identified both as a magnifier of already-present mental health challenges, as well as directly and indirectly leading to new climate-sensitive mental health stressors and outcomes that are complex, cumulative, wide-ranging, and far-reaching [11, 21, 22].

The mental health impacts of climate change are amplified among certain populations, including those living in ecologically sensitive areas; those who rely closely on their environment for subsistence and livelihoods; those who already struggle with chronic health issues; and those experiencing ongoing systems of inequity, marginalization, and colonization, such as many Indigenous Peoples globally [1, 23–26]. As such, climate change and resulting environmental changes not only risk amplifying existing health challenges for many Indigenous Peoples, but also potentially create new challenges, such as coping with ecological grief and anxiety [7], solastalgia and the loss of beloved places [14], and intangible impacts of environmental loss and damage [13].

Much of the existing research on Indigenous experiences of mental health in relation to climate change has involved case studies that examined the locally- and culturally-specific mental health impacts of climate change among Indigenous groups [12, 27–30]. Given the diverse understandings of mental wellbeing across Indigenous contexts [31] and the geographical variation in climate change exposures [25], there are likely both similarities and differences globally among the Indigenous mental health experiences of climate change. As such, the current study sought to synthesize these understandings with a systematic scoping review of the published literature. Specifically, the goal of this scoping review was to examine the extent, range, and nature of published research investigating the ways in which global Indigenous mental health is impacted by meteorological, seasonal, and climatic changes, and synthesize these findings to offer a more holistic picture of Indigenous mental health in a changing climate.

### 2. Methods

The review protocol was developed using a scoping review framework [32], and followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses’ reporting guidelines for scoping reviews [PRISMA-ScR; 33]. This process included the following steps: (1) identifying the research question and purpose; (2) identifying relevant articles; (3) selecting articles for inclusion; (4) extracting data from included articles; and (5) summarizing, analyzing, and reporting results. The following question guided this review: What is reported in the existing published research about the ways in which Indigenous mental health is impacted by meteorological, seasonal, and climatic variables? Within this broad question, this review sought to specifically answer: What are the publications trends over time and place? What are the pathways through which climate change is currently effecting, and/or anticipated to effect, Indigenous mental health?

### 2.1. Search strategy

Search terms and strings were developed by the research team in consultation with a university librarian and informed by on-going research collaborations, discussions, and continual learning with Indigenous research colleagues, particularly in Northern Canada and Inuit Nunangat, as well as ongoing collaborations with Indigenous colleagues in Uganda and Peru (see table 1 in the supplementary file,

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| Table 1. Search strategy used in Web of Science™ CORE Collection to identify published articles describing the relationship between Indigenous mental health and meteorological, seasonal, and climatic conditions from 2007 to 2018 (see supplementary table 1 for search strategies applied to MEDLINE® via PubMed®, and Scopus®). |
|---------------------------------------------------------------|
| **Main terms** | **Expanded terms** |
| Indigenous Peoples | Aboriginal OR Aborigine OR Indigenous OR… […]* |
| Meteorological, seasonal, and climatic | ‘Atmospheric pressure’ OR ‘climate change’ OR ‘climatic change’ OR cold OR cool OR cooling OR heat OR humid’ OR ‘ice’ OR meteorolog OR ‘precipitation’ OR rain OR season OR snow OR storm OR ‘temperature’ OR ‘temperatures’ OR warm OR warming OR ‘weather’ OR ‘wind’ OR ‘winds’ OR ‘ultraviolet radiation’ OR UV* |
| Mental health | Aggression OR anxiety OR burnout OR ‘compassion fatigue’ OR depression OR emotion OR ‘mental health’ OR ‘mental illness’ OR ‘mental wellbeing’ OR ‘mental wellness’ OR ‘post-traumatic stress’ OR psychosocial OR ‘psycho-social’ OR PTSD OR self-injur’ OR suicide OR ‘(abuse) NEAR/1 (substance OR alcohol OR drug OR psychological)) OR ((‘disorder’ OR ‘disorders’) NEAR/1 (bipolar OR mental OR ‘mood’ OR ‘personality’ OR ‘psychiatric’ OR psycholog OR ‘seasonal affective’ OR substance)) OR (psychological NEAR/1 (adapt’ OR resilient’)) OR (stress AND (‘emotional’ OR mental OR psychological)) |

* Terms used to identify Indigenous Peoples globally were based on both umbrella terms for Indigenous Peoples as well as individual group names derived from two the Internal Work Group for Indigenous Affairs (IWGIA; www.iwgia.org) and the United Nations Refugee Agency (UNHCR; 34). A shortlisted of expanded search terms is provided here; please see table 1 in the supplementary file for the full list of search terms.
Table 2. Inclusion and exclusion criteria used to identify published articles on the relationship between Indigenous mental health and meteorological, seasonal, and climatic conditions.

| Inclusion                                                                 | Exclusion                                                                 |
|--------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Empirical research                                                       | Conference abstracts or proceedings, protocols/frameworks, commentaries,  |
|                                                                          | articles in media, editorials, calls for research, literature reviews without |
|                                                                          | a search strategy, letters to the editor, book reviews, textbooks, replies from |
|                                                                          | author, erratum, thesis, or opinion pieces                                |
| Article discussed meteorological, seasonal, and/or climatic variables in  | Meteorological, seasonal, or climatic conditions in a built or controlled |
| the natural world                                                        | environment (e.g., ‘work climate’, laboratory or clinical settings, endogenous |
|                                                                          | systems such as body temperature and circadian rhythms), or if the article   |
|                                                                          | exclusively discussed geological events (e.g., earthquake, volcano, etc)    |
| Article discussed human mental health and related outcomes               | Mental health terms used in relation to an inanimate object, or outside the  |
|                                                                          | context of human wellbeing (e.g., growth depression, or system stresses)    |
| Article explicitly discussed Indigenous Peoples                           | Only non-Indigenous populations                                            |
| Published online on 1 January 2007, or later                             | Published online prior to 1 January 2007                                  |

* Articles that only considered seasonality in relation to daylight hours were not included as our objective was concerned with seasonality in meteorological factors (e.g., temperature) that may be directly impacted by climate change.

b Articles that exclusively discussed geological events were excluded, as our objective was concerned with meteorological variables directly subject to change from anthropogenic climate change.

available online at stacks.iop.org/ERL/15/053001/med, for a detailed search strategy). The final search string (table 1) was designed to capture articles that discussed the relationship of climatic, seasonal, and/or meteorological factors with mental health among Indigenous Peoples globally.

Three electronic databases were selected to cover a broad range of disciplines and methodologies: MEDLINE via PubMed (biomedical sciences; 1946—present), Scopus (multidisciplinary; 1823—present), and Web of Science™ CORE Collection (the sciences, social sciences, arts, humanities, and others; 1900—present). The initial search was conducted on 19 March 2018 to identify articles published before 31 December 2017; a subsequent search was conducted on 09 August 2019 to identify articles published between 1 January 2018 and 31 December 2018. No limits were placed on these searches. A manual search of the reference lists in included articles was completed to identify additional relevant articles not captured in the electronic database searches.

2.2. Relevance screening and eligibility criteria
Citations retrieved through the electronic database searches were imported into the desktop bibliographic manager Mendeley™ (Mendeley Ltd, London, UK, v1.19.3) and duplicates were removed. Citations were then uploaded to the web-based literature review software, DistillerSR® (Evidence Partners, Ottawa, ON, Canada, v2.12.0), to facilitate relevance screening and data extraction.

Relevance screening was conducted in two stages using inclusion criteria based on study design, content, and year of online publication (table 2): first, titles and abstracts were screened; second, the full texts of potentially relevant articles were screened (see table 2 in the supplementary file for a complete list of screening questions). Articles were independently screened by two reviewers at both stages of screening, where those articles deemed ineligible by both reviewers were excluded. At both stages of screening, the level of agreement between reviewers was assessed using Cohen’s Kappa (κ), where κ ≥ 0.80 indicated excellent agreement [35]. Reviewers met regularly throughout the review to discuss and reconcile any conflicting screening results. Articles were considered to be relevant to this review if: they presented empirical research; humans were the focus or a primary subject; they were published online in 2007 or later (i.e., after the Intergovernmental Panel on Climate Change’s Fourth Assessment Report, when more diverse human health and wellbeing impacts of climate change began to be considered [36]); mental health was discussed; meteorological and climatic conditions were discussed; and the articles’ authors considered mental health and meteorological and climatic conditions as they relate to each other. Additionally, in the second stage of screening, Indigenous Peoples had to be reported as a population of interest within the article (table 2). In this review, we focus on research with Indigenous Peoples, recognizing them as distinct peoples with specific rights, diverse cultural backgrounds, and diverse approaches to self-determination [37].

2.3. Data analysis and synthesis
A data charting form was created and applied in DistillerSR® (see table 3 in the supplementary file). The data charting form served to capture descriptive data on article information (e.g., year of publication, and authors’ institutional affiliations) and study characteristics (i.e., primary or secondary research, country of study, geographic scope of study, and methodology). Additionally, information relevant to the scoping review objective was extracted, including categories of mental health topics relevant in both Indigenous and climate change contexts; how mental health was considered within the context of climate change; and
how the article reported Indigenous engagement in the research process. Following this descriptive data charting, results were exported into Microsoft® Excel 2016 (Microsoft Corporation, Redmond, WA, USA) and Stata® 13.1 (StataCorp, College Station, TX, USA) to visualize and summarize study characteristics.

In addition to descriptive data charting, all articles were thematically analyzed using a constant-comparative approach to identify patterns within and across articles, methodologies, and research contexts [38, 39]. This qualitative analysis served to identify, characterize, and synthesize important themes and gaps across all articles, and also provided context to information extracted during the data charting stage.

2.4. Consultation and engagement
Ongoing engagement and collaboration with Indigenous research partners and leaders guided the conceptualization, analyses, and interpretation of findings for this review. Two co-authors (AC and SLH) have been working with Indigenous Peoples on climate change and mental health community-led research for more than ten years, and this ongoing work continues to inform related research, including this scoping review. Ongoing meetings with Indigenous community members, government representatives, and graduate students also informed the creation and interpretation of this review and assisted in the contextualization of the results.

2.5. Search strategy limitations
While this scoping review strategy was comprehensive, there were limitations. First, only published research was examined; gray literature was not reviewed. While gray literature may likely contain a variety of information relevant to mental health and wellbeing programming, policy, and action plans, the purpose of this review was to understand findings and trends in the published literature. Second, while we included non-English articles, the search string was developed in English, and therefore may have limited the ability to identify literature that was not indexed in English.

3. Results
Searches of the three electronic databases identified 8096 articles after removing duplicates (figure 1). Our search identified articles published in 10 different languages, including English, French, Russian, Spanish, Chinese, Portuguese, Turkish, German, Swedish, and Afrikaans. After screening, 50 articles met all inclusion criteria and underwent full data extraction and analyses (see table 4 in the supplementary file for the complete list of included articles). The level of agreement between
reviewers was excellent (κ ≥ 0.80). Articles that were relevant and met the inclusion criteria were written in English and Chinese.

3.1. What are the publication trends over time and place?
Articles included in this review discussed or reported a variety of Indigenous determinants of mental well-being (figure 2) and climatic stressors related to mental health (table 3). Almost all included articles were primary research (n = 48/50 articles; 96%), and predominantly used qualitative methods (n = 28/50 articles; 56%). The majority of primary research was conducted in Canada (n = 19/48 articles; 39.6%), Australia (n = 12/48 articles; 25%), or the United States of America (n = 5/48 articles; 10.4%; figure 3), and occurred at a local/community level (n = 25/48 articles; 52.1%; figure 4) that were predominantly set in remote or rural contexts [e.g. 40–42]. The number of articles discussing Indigenous mental health in relation to weather and climate generally increased over time (figure 5).

Indigenous involvement in the research process was reported in 48% of the included articles (n = 24/50 articles). Of these articles, Indigenous involvement was most often reported in the data collection (n = 20/24 articles; 83.3%), study design (n = 17/24 articles; 70.8%), and analysis (n = 15/24 articles; 62.5%) stages of research. Indigenous engagement was less commonly reported in the study conceptualization (n = 12/24 articles; 50%) and writing (n = 7/24 articles; 29.2%) stages of research. Overall, the proportion of articles reporting Indigenous involvement did not appear to increase over time (figure 5), and were reported more commonly within specific co-author networks [e.g. 30, 43, 44].

3.2. How does climate change impact Indigenous mental health?
3.2.1. A variety of climate-sensitive mental health outcomes were studied
The included articles described a variety of mental health impacts that were linked to acute and extreme weather exposures, chronic and cumulative exposure of multiple weather variables, as well as vicarious and anticipated experiences of climatic stressors. Importantly, mental health impacts and climatic stressors were not exclusive to any one pathway, peoples, or region, and were often overlapping (table 3).

Both qualitative and quantitative research linked acute and short-term weather variables such as storms, flooding, temperature, and seasonality with a range of psychological and mental health impacts including depression and anxiety [e.g. 10, 49, 50], suicide [47–49], self-harm [50], post-traumatic stress disorder [PTSD; 51–53], psychological resilience [53], self-reported mood and behavior [54, 55], mental illness and behavioral disorders [56], and strong emotional reactions such as fear and anxiety [e.g. 27]. Changes in temperature and precipitation were the most commonly reported weather variables, and often investigated in relation to suicide or self-harm, substance abuse, depression, and stress (figure 6).

The majority of the included articles reported on the effect of chronic exposure to multiple climatic variables, and/or subacute weather events, and subsequent environmental changes (table 3), which were often linked with emotional responses and feelings of loss, worry, anger, sadness, and ongoing emotional distress (figure 6). These subacute and chronic climatic exposures, including drought, sea ice changes, changes to wildlife and vegetation, and altered seasons were not directly linked to the onset of acute mental and behavioral illnesses such as suicide, depression, and PTSD. Although, several articles and study
Table 3. Individual mental health impacts and climatic stressors reported in primary research articles.

| Climatic stressors | Individual mental health impacts |
|--------------------|---------------------------------|
|                   | Anxiety                         |
|                   | Depression                      |
|                   | Stress                          |
|                   | Social isolation                |
|                   | Fatigue                         |
|                   | Insomnia                       |
|                   | Eating disorders                |
|                   | Alcoholism                      |
|                   | Suicidal ideation               |
|                   | Attempted suicide               |
|                   | Suicide                         |
|                   | Other mental health disorders   |

Not all combinations are documented in the research articles included in the study.

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populations expressed concern that the cumulative effects of repeated exposure to both acute and chronic climatic stressors, and climate-sensitive drivers of mental health (e.g. food and water insecurity, further discussed below), could manifest in the form of mental illness \[e.g. 46, 48\], an increased use of health services \[e.g. 8, 44\], and maladaptive coping strategies such as substance abuse, and self-harm \[e.g. 8, 48, 57\]. For example, Bunun adolescents in Taiwan who had a history of traumatic experiences were more likely to receive a diagnosis of PTSD following a typhoon, and struggle with higher levels of depression, cognition, and social relations \[51\]. Similarly, forums held with Indigenous Peoples across rural New South Wales (Australia) suggested that communities facing multi-year drought were struggling with increased substance use leading to interpersonal conflict, and suicidality, in addition to strained social and emotional wellbeing \[57\]. Despite concerns regarding cumulative effects of projected climatic changes, none of the included articles reported on active monitoring or surveillance of mental health among affected Indigenous Peoples. Articles in this review also highlighted that neither chronic or acute climatic stressors needed to be experienced directly to induce mental health impacts. Several qualitative studies reported vicarious distress among Indigenous participants who feared or empathized for those, particularly those within their social networks such as family and friends, experiencing intense weather or environmental conditions. For example, Inuit women felt anxiety and fear for family and friends’ out on the land during stormy conditions \[58\]. Moreover, many people interviewed shared strong emotional responses such as sadness \[e.g. 59\], anger \[12\], and grief \[e.g. 57\] for anticipated environmental changes they will have to cope with under a rapidly changing climate.

Very few research articles noted potential positive mental health outcomes resulting from exposure to climatic variables (figure 2), although several articles investigating Indigenous mental health following exposure to a typhoon in Taiwan \[e.g. 52\] and wildfires in Canada \[e.g. 27\] reported enhanced community cohesion, compassion, and psychological resilience and growth among some individuals. Overall, however, there were no
Figure 5. Number of articles over time that reported Indigenous engagement in the research process.

Figure 6. A matrix tabulating the number of articles by mental health impacts and climatic stressors reported across primary research articles (n = 48 primary research articles).
positive mental health outcomes reported in the context of cumulative and chronic climatic change.

3.2.2. Climate change disrupts place-attachment and mental health
Many articles identified the strong, deep, and ancestral connections Indigenous Peoples have to place and land [e.g. 28, 40, 43]. Access to, and time spent on, the land was not only important for subsistence and livelihoods [e.g. 40, 52, 60, 61], but was also linked to fulfilling psychological needs, such as a strong sense of identity [e.g. 12, 62, 63] and self-worth [e.g. 8, 43], as well as strengthening interpersonal relationships and cultural practices [e.g. 41, 44, 64, 65]. As such, climatic and resultant environmental changes were strongly linked to an altered sense of place or loss of place, resulting in negative consequences for livelihoods [e.g. 40, 42, 60], cultural practices [e.g. 8, 41, 64, 66], and social networks [e.g. 42, 67]. These place-sensitive outcomes were also linked to alterations in personal and collective identities intimately tied to the health of the environment, leading to negative mental health outcomes [e.g. 12, 28]. Changing environmental conditions that impeded peoples’ connection to place, such as ongoing drought [e.g. 40], declining sea ice [e.g. 28], and increased storms and flooding [e.g. 42, 65], were linked to mental health struggles such as substance abuse [e.g. 8, 68], suicide and suicidal ideation [e.g. 8, 57], distress and depression [e.g. 43, 59], and strained interpersonal relationships [e.g. 8, 68, 69]. For example, a population-level study in rural Western Australia found the relative risk of depression to be greater in areas with dryland salinity (an indicator of environmental degradation) and higher proportions of Indigenous Peoples in an area [46].

3.2.3. Articles examined Indigenous mental health-climate experiences by age and gender
Many articles investigated a diversity of perspectives, including various age groups, genders, and livelihoods [e.g. 12, 28, 40, 64, 67]. These articles reported shared experiences, including the importance of place-based connections to identity and wellbeing felt across communities [e.g. 12, 28]. Five articles explicitly interviewed or surveyed women about their mental health experiences [45, 58, 59, 62, 70], two of which investigated women’s wellbeing in the context of seasonal and climate-dependent food security [45, 70]. Research also indicated that some emotional responses to climate change differed by gender [12, 59]. For example, an Australian study found that ‘Aunties’ shared more symptoms of solastalgia (i.e. distress and sadness due to environmental change in their home) [59]. Similarly, in a subarctic Inuit community, female respondents reported higher levels of frustration, sadness, fear, anger, helplessness, and distress in response to observed and lived climatic changes [12], and the odds of reporting feeling angry, scared, and frustrated by changes in the environment were significantly higher for women compared to men [44]. Although no articles reported exclusively investigating males, some articles suggested that anxiety [12], suicide [e.g. 48, 49], and substance abuse [e.g. 42] were more of a challenge among males. Of particular concern for male mental health was when seasonal and climate-dependent employment (e.g. farming, hunting) were at risk, as climate-related environmental change had important impacts on their land-based identity [e.g. 43].

Age was also discussed in some articles: four primary research articles explicitly focused on youth [30, 51, 71, 72], two of which examined protective factors for Inuit mental wellbeing in Nunatsiavut, Labrador, Canada [30, 71]. Articles described the importance of focusing on youth experiences of climate not only because youth mental health experiences can differ from other generations, but also because these experiences are often formative for mental health and wellbeing later in life [51]. Elders and older community members were also identified as a ‘vulnerable’ group for mental health impacts related to changing climates [66, p 19], as their identities, livelihoods, and wellbeing were often deeply rooted in time spent on the land [e.g. 57]. Notably, Inuit youth participants expressed particular concern for Elders and seniors in their community, acknowledging that the drastic changes they perceived in environment and culture must be felt even more so among older generations [30].

3.2.4. Food security was a common link between climate and mental health
Food security was a pathway through which climatic and Indigenous mental health were frequently linked [e.g. 44, 45, 54, 73]. For example, seasonal fluxes in food harvesting were associated with mental health outcomes [e.g. 45, 54, 74], but mental health was also framed as a risk factor for food insecurity [e.g. 42, 60, 70]. For instance, those struggling with substance abuse may have less disposable income to prevent food shortages following a poor harvest [60] and/or may be excluded from social safety nets of food sharing networks [42]. Several papers reported how the practice of harvesting and sharing traditional food was tied with fulfilling psychological needs at both individual and community levels. For example, the ability to provide food for one’s family was reported as a source of positive identity, and the process of harvesting and subsequent food sharing also contributed to stronger social networks [e.g. 43, 57].

Climatic changes were reported as impacting Indigenous Peoples access to adequate quantity and quality of food. In the Australian context, chronic drought deteriorated crops and livestock, resulting in loss of livelihoods and subsequent negative mental health outcomes [e.g. 40, 57, 68]. In the Arctic, changes in sea ice, wildlife, and vegetation due to altered weather patterns compounded existing high rates of food...
insecurity among Inuit households [e.g. 60], and impacted relationships supported through the sharing of country food [e.g. 43, 69, 75]. Grief and mourning for climate-related loss of livestock and wildlife was also documented: Sami reindeer herders in Sweden reported loss of animals due to increased climate-driven predation [76, 77]; Indigenous Peoples in northern Vietnam experienced the loss of water-buffalo due to changing temperatures [42]; and Inupiak in Alaska experienced an insufficient whale harvest as ‘a starvation at emotional and spiritual levels’ [69, p 296].

3.2.5. Climate-induced human mobility was a mental health concern
The mental health implications of human mobility (i.e. migration and displacement) were also discussed in many articles. Climatic change and resultant environmental impacts, such as sea level rise and chronic drought, may alter landscapes to such an extent that they are no longer able to support Indigenous cultures and livelihoods in the same way [e.g. 65, 67]. For example, forced out-migration was either suggested or documented for Indigenous Peoples in both Australia [40, 68] and Tanzania [73] due to loss of farming livelihoods following prolonged drought.

Mental health concerns resulting from unplanned relocation following extreme, acute weather events were also reported. For example, in the year following a typhoon in Taiwan, individuals who were able to stay in their community showed higher resilience compared to those who relocated to urban centers [53]. Furthermore, poor planning and policy had more severe psychological consequences than the disaster itself; as such, ‘governments should set aside more space, hold longer discussions, and provide different alternatives’ for relocation [33, p109].

Of note, only two articles specifically asked participants about planned relocation due to environmental changes as an adaptation strategy [12, 65]. For example, over 90% of Inuit who were surveyed in the community of Rigolet, Nunatsiavut, Labrador, Canada, indicated they would not leave their community due to climatic and environmental changes [12]. Similarly, the Inupiat community of Shishmaref, Alaska, USA, were also resistant to planned relocation due to rising sea levels, ongoing flooding, and six state-declared disasters since 1988, where the potential trauma of loss of meaningful places, social networks, and culture was reported to be of great concern [65, p419]:

While community members largely agree that relocating is necessary, they believe that remaining in culturally significant rural areas is paramount to long-term, successful adaptation.

3.2.6. Climate change compounds emotions tied to historical and ongoing disempowerment
Helplessness [e.g. 12, 78] and anger were commonly reported across articles as participants lamented their limited ability to mitigate global climate change [e.g. 64] and, in some cases, were linked in the research to feelings of abandonment by governments and the broader global community [65, 76, 79]. The urgent need to adapt to and/or mitigate climate changes also resurfaced previous traumas for some Indigenous Peoples. For example, Sami reindeer herders in one study likened climate change to the Chernobyl disaster, where ‘interviewees described feelings of being alone, powerless and left to fend for themselves after what happened and they had to deal with the problems caused by other people’ [76]. A similar finding was reported among Nunatsiavut Inuit in Labrador, Canada, as an Inuit harvester shared [8, p 264]:

For example, Inuit in Nain, Nunatsiavut, Labrador, Canada, associated sea level rise with residential schools and assimilation, and thought those effects would be felt further if climate change impacts will either come more to the forefront and have to be dealt with or they may just be built upon. … I think that those effects [from trauma and emotional impacts] will either come more to the forefront and have to be dealt with or they may just be built upon. … I think that those effects [from trauma and emotional impacts] will either come more to the forefront and have to be dealt with or they may just be built upon. …

Related to feelings of helplessness and lack of control, several articles discussed the impacts of a changing climate on Indigenous autonomy and self-determination [e.g. 28, 43]. For example, Inuit in Nain, Nunatsiavut, Labrador, Canada, associated sea level rise with residential schools and assimilation, and thought those effects would be felt further if climate change impacts will either come more to the forefront and have to be dealt with or they may just be built upon. … I think that those effects [from trauma and emotional impacts] will either come more to the forefront and have to be dealt with or they may just be built upon. … I think that those effects [from trauma and emotional impacts] will either come more to the forefront and have to be dealt with or they may just be built upon. …

In a place where the risks of death and material destruction are very real possibilities in the event of a large storm and flooding event, ethnographic accounts demonstrate that residents discuss these immediate risks less frequently than the long-term psychological and cultural ramifications of relocating the entire community…. 
ice with freedom, which means that rapid sea ice loss limits peoples’ ability for self-determination, such that climate change was framed as a driver of ‘environmental dispossession’ [28, p25]. Related to self-determination in the context of climate change, many articles discussed the need for increased Indigenous engagement in climate change policy and relevant programming, and argued that it would likely improve adaptation efforts [e.g. 29].

4. Discussion

This scoping review synthesized published research to identify global considerations for Indigenous mental health in relation to climate change and, in so doing, highlighted a diversity of pathways through which climate and weather impacts Indigenous Peoples’ mental wellbeing. While the variety of study designs and methodologies in the included literature, as well as limited research at regional and national scopes, make it difficult to draw broad conclusions regarding patterns of specific mental health impacts and climatic stressors, similar to the broader literature on climate and mental health [11, 24], this scoping review indicates that the onset and type of mental health impacts may be tied to the timing and intensity of climatic exposures. Acute and extreme weather, for example, were linked with a range of psychological and behavioral struggles, such as post-traumatic stress disorder [31–53], depression [31, 53], suicide and self-harm [47, 48, 50], and seasonal fluctuations in mood [54], depression [45], and trauma mortality [49]. Importantly, much of the literature in this scoping review reported on how cumulative exposure of increasingly unpredictable and intense weather patterns were associated with individual level distress. For example, research in Arctic and Subarctic regions commonly listed the interaction of changes in sea ice, wind, precipitation, and storms as important variables to land access and thereby for emotional and mental wellbeing [41, 43, 44, 61, 66, 70, 80]. Additionally, indirect experiences of climatic stressors produced emotional distress either vicariously or in anticipation of climatic projections that threaten individuals’ and communities’ futures. Moreover, articles in the present review suggest that emotional and behavioral distress from repeated exposure to multiple climatic stressors and subsequent environmental adversities over time, may be precursors to mental illness, suicidality, substance abuse, and limited psychological resilience [e.g. 8, 53]. This is of note since the literature in this review indicated that it is often the subtle, cumulative, non-clinical mental health impacts that are widespread among Indigenous Peoples and communities (see table 3), and thus, may present potentially far-reaching and complex consequences within a continually changing climate.

Interestingly, very little of the included research articles were population-level studies [e.g. 48, 49] or came from the disaster-based literature [27, 51–53], which have historically linked prevalence and incidence of specific mental illnesses with extreme heat events [16, 81], humidity [82], flooding [83], wildfires [84], and hurricanes [85], among other acute climatic stressors across the globe [5]. Few studies in the present review used metrics of mental health and/or climate that are comparable across populations [e.g. 12, 47, 51]. Rather, the majority of articles were local or regional case studies, which explored more holistic concepts of mental health in depth, and Indigenous Peoples’ emotional and behavioral responses to changes in the environment, and the social, cultural, and economic implications of those changes, such as loss of wildlife, livelihoods, and food security. This represents an important gap in the literature on climate-sensitive Indigenous mental health globally, and highlights the need for additional population-level studies.

Only more recently has the broader literature on climate change and mental health begun to quantitatively link subacute weather events with mental health outcomes [5, 86]. As such, even globally the implications of repeated and cumulative exposure on individuals’ and communities’ mental health remains unclear. While some of the research included in the present review linked measures of depression and anxiety with seasonality [45, 54] and drought [46], there was otherwise no quantitative evidence of subacute weather and associated environmental events (e.g. heatwaves, and delayed sea ice freeze-up) in the present review. Recent research suggests that factors such as length and intensity of exposure to extreme weather, including drought [87] and extreme temperature [4, 19], are important to consider. Notably, there are limited studies projecting mental health under future global climate change scenarios [4], further highlighting the need for more population-level and longitudinal studies examining the mental health impacts of climate change [88].

Despite limited understanding of population-level, and longitudinal patterns of climatic stressors and mental health, it appears that different climatic stressors affects Indigenous Peoples differently. Research examining climate–mental health experiences in Indigenous contexts identified potentially gendered and age-specific mental health outcomes and coping strategies [e.g. 30, 57, 59, 62]. This theme aligns with the broader mental health literature, where mental health outcomes such as suicide and depression, are known to vary by sex and age [89, 90]. Notably, climate change research and reports often identify women, children, and the elderly as vulnerable groups for climate-sensitive health outcomes [26]; however, the articles from the present review suggest that Indigenous adults, particularly those with land-based livelihoods, also face specific mental health challenges [e.g. 8, 42, 60, 77]. Similar findings have been found in research from farming contexts in India and Australia,
where drought is driving deterioration of farming livelihoods, leading to struggles with suicide and depression [15, 19]. Articles in the present review identified differences in coping methods and access to social networks across gender and age groups, suggesting that intersectional approaches to mental health programming and support is important alongside individual-level resources and those that address community wellbeing more broadly [11, 45, 57].

The articles reviewed emphasized the importance of the concept of connection to place and its centrality in protecting and enhancing Indigenous mental wellbeing and supporting livelihoods, culture, social structures, and identity [e.g. 1, 41]. The importance of place attachment is consistent with findings from the broader Indigenous mental health literature, where a secure sense of place and land-based wellness programming have been linked to improved physical and mental health outcomes among Indigenous Peoples, regardless of urban or rural status [91–94]. As articles in this review identified, however, both the slow and sudden onset of climate-related changes are disrupting, and in some cases severing, Indigenous Peoples’ connections to place [43, 65, 69]. Researchers have begun to frame these deteriorating connections as another form of environmental dispossession [28, 95, 96], as well as a human rights issue within climate justice discussions [97, 98]. Importantly, as climate change progressively impacts place and health, it is unclear how these climate-induced emotional and mental stressors may interact with concurrent health concerns and pre-existing mental illness [99], and possibly compound already-present health concerns [86]. Given the importance of place for mental wellbeing identified in this review, preserving connection to place has been highlighted as an important mental health adaptation for Indigenous Peoples in the context of climate change [11, 12, 65].

Research also highlighted increasing concern related to forced migration and displacement due to drought [40, 73], sea level rise [e.g. 65, 69], and environmental degradation [46]. Migration and displacement as an adaptation strategy is contested, given that it is often forced upon peoples when irrevocable loss and damage means that local adaptation is no longer an option [100–102]. Importantly, articles in the current review suggested that Indigenous communities do not perceive relocation and migration as desirable adaptation options [12, 65]. Climate-driven human mobility is particularly complicated for Indigenous Peoples, as it may resurface past traumas related to forced relocation and displacement, all while meaningful places and associated protective mental wellbeing factors are altered [8, 28, 103]. Moreover, forced human migration is linked to higher rates of mental illness and substance abuse [104] in conjunction with the loss of critical social support systems [73, 105]. This literature makes clear: as unstable and extreme climatic conditions will likely increase the need for climate-driven human mobility, it is important to consider and support the complex mental health needs of Indigenous migrants who may experience disruptions to health-sustaining cultural, social, familial, and environmental networks [65, 106].

The deterioration of protective factors for community-wellbeing, such as local cultures and knowledge systems, and the subsequent emotional and mental impacts are examples of intangible (non-economic) climate-induced losses and damages [13, 107, 108]. These less visible forms of harm were widespread across Indigenous mental health and climate research [1, 77, 107]; however, as a relatively under-explored topic in global climate justice discussions [109], explicitly describing intangible loss and damage is integral for Indigenous communities to receive appropriate support [13, 109]. Yet, in a recent review of intangible harm, less research was reported among Indigenous Peoples in low-income countries; this lack of research was cited as an epistemological disparity in which forms of loss and damage are not being acknowledged, or are absent from the literature, leading to important and inequitable gaps in understanding [107].

Although understandings of the inequitable and diverse mental health impacts of climate change have expanded over the last decade, only recently have these intangible forms of loss and damage been recognized by international scientific bodies leading the calls for action on climate change [25]. Notably, recent updates to the United Nations’ Paris Agreement have called for a place for nations to systematically report their intangible losses and damages alongside climate change interventions within the transparency framework [110]. Existing loss and damage tracking systems, such as insurance databases, are ill-suited or incapable of documenting intangible climate-driven impacts [111]. Evidence shows that the application of diverse methodological approaches [13, 109] and increased engagement with Indigenous communities [112] will be necessary to document these intangible losses and damages, determine the potential limits of adaptation, and propose desirable alternative pathways.

5. Conclusion

Since the IPCC’s Fourth Assessment Report [36], burgeoning research has advanced our understanding of current and future impacts of climate change on Indigenous mental health [e.g. 113]. By synthesizing the published research relevant to Indigenous mental health and climate change, this scoping review has highlighted the multifaceted ways in which climate links to the mental wellbeing of Indigenous Peoples globally, the already widespread climate-driven mental and emotional impacts, as well as identified important opportunities to support Indigenous mental wellbeing within a changing climate. As Indigenous Peoples face a rapidly changing environment, this literature review indicates that acute mental health
impacts can arise while existing mental health struggles are often exacerbated, and intangible losses and damages will continue to create new mental health challenges. In recognizing the highly interconnected and potentially pervasive mental health challenges Indigenous Peoples will face, there exist important opportunities for global research efforts to engage Indigenous Peoples on this topic, while building upon existing causal understandings to better plan and prepare for the mental health implications of rapid climate change.

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Data availability statement

**Any data that support the findings of this study are included within the article and supplementary file.**

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References

[1] Cunsolo Willox A et al 2014 Examining relationships between climate change and mental health in the Circumpolar North Reg. Environ. Change 15 169 – 82
[2] Stanke C, Kerac M, Prudhomme C, Medlock J and Murray V 2013 Health effects of drought: a systematic review of the evidence PLoS Curr. 5 e
[3] Berry H L, Hogan A, Owen J, Rickwood D and Fragar L 2011 Climate change and farmers’ mental health: risks and responses Asia-Pac. J. Public Heal. 23 1195 – 325
[4] Burke M et al 2018 Higher temperatures increase suicide rates in the United States and Mexico Nat. Clim. Change 8 723 – 9
[5] Berry H L, Bowen K and Kjellstrom T 2010 Climate change and mental health: a causal pathways framework Int. J. Public Health. 55 123 – 32
[6] Bourque F and Cunsolo Willox A 2014 Climate change: the next challenge for public mental health? Int. Rev. Psychiatry 26 415 – 22
[7] Cunsolo A and Ellis N R 2018 Ecological grief as a mental health response to climate change-related loss Nat. Clim. Change 8 275 – 81
[8] Cunsolo Willox A et al 2013 Climate change and mental health: an exploratory case study from Rigolet, Nunatsiavut, Canada Clim. Change 121 255 – 70
[9] Hayes K and Poland B 2018 Addressing mental health in a changing climate: Incorporating mental health indicators into climate change and health vulnerability and adaptation assessments Int. J. Environ. Res. Public Health 15 1806
[10] Swin I et al 2009 Psychology and global climate change: addressing a multi-faceted phenomenon and set of challenges A Report by the American Psychological Association’s Task Force on the Interface Between Psychology and Global Climate Change (Washington) (http://apa.org/science/about/publications/climate-change.aspx)
[11] Clayton S, Manning C M, Krygsman K and Speiser M 2017 Mental Health and Our Changing Climate: Impacts, Implications, and Guidance (Washington, DC: American Psychological Association, and eco America) (https://apa.org/news/press/releases/2017/03/mental-health-climate.pdf)
[12] Cunsolo Willox A et al 2012 From this place and of this place: climate change, sense of place, and health in Nunatsiavut, Canada Soc. Sci. Med. 75 338 – 47
[13] Tschakert P et al 2017 Climate change and loss, as if people mattered: values, places, and experiences Wiley Interdiscip. Rev. Clim. Change 8 1 – 19
[14] Albrecht G et al 2007 Solastalgia: the distress caused by environmental change Australas Psychiatry 15 595 – 8
[15] Ellis N R and Albrecht G A 2017 Climate change threats to family farmers’ sense of place and mental wellbeing: a case study from the Western Australian Wheatbelt Soc. Sci. Med. 175 161 – 8
[16] Hansen A, Bi P, Nitschke M, Ryan P, Pisanelli D and Tucker G 2008 The effect of heat waves on mental health in a temperate Australian city Environ. Health Perspect. 116 1369 – 75
[17] Vida S, Durocher M, Ouada T B and Gosselin P 2012 Relationship between ambient temperature and humidity and visits to mental health emergency departments in Québec Psychiatr Serv. 63 1150 – 3
[18] Anderson C A 2001 Heat and violence Curr. Dir. Psychol. Sci. 10 33 – 8
[19] Carleton T A 2017 Crop-damaging temperatures increase suicide rates in India Proc. Natl Acad. Sci. USA 114 8746 – 51
[20] Vigo D, Thornicroft G and Atun R 2016 Estimating the true global burden of mental illness Lancet Psychiatry 3 171 – 8
[21] Berry H 2009 Pearl in the oyster: climate change as a mental health opportunity Australas Psychiatry. 17 453 – 6
[22] Doherty T J and Clayton S 2011 The psychological impacts of global climate change Am. Psychol. 66 263 – 76
[23] Cardona O-D et al 2012 Determinants of risk: exposure and vulnerability Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation ed C B Field et al (Cambridge, New York: Cambridge University Press) pp 65 – 108
[24] Hayes K, Blashki G, Wiseman J, Burke S and Reifeis L 2018 Climate change and mental health: risks, impacts and priority actions Int. J. Mental Health Syst. 12 28
[25] Hoegh-Guldberg O et al 2018 Impacts of 1.5 °C global warming on natural and human systems Global Warming of 1.5 °C An IPCC Special Report on the Impacts of Global Warming of 1.5 °C Above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of
Strengthening the Global Response to the Threat of Climate Change ed V. Mason-Delmo et al (accepted)

[26] Smith K R et al 2014 Human health: impacts, adaptation, and co-benefits Climate Change 2014: Impacts, Adaptation, and Vulnerability Part A: Global and Sectoral Aspects Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change ed C B Field et al (Cambridge, New York: Cambridge University Press) pp 709–54

[27] Dodd W et al 2018 Lived experience of a record wildfire season in the Northwest Territories, Canada Can. J. Public Heal. 109 327–37

[28] Durkalec A, Furgal C, Skinner M W and Sheldon T 2015 Climate change influences on environment as a determinant of Indigenous health: relationships to place, sea ice, and health in an Inuit community Soc. Sci. Med. 136–137 17–26

[29] Petheram L, Zander K K, Campbell B M, High C and Stacey N 2010 ‘Strange changes’: Indigenous perspectives of climate change and adaptation in NE Arnhem Land (Australia) Glob. Environ. Change 20 681–92

[30] Petrasek MacDonald J, Harper S L, Cunsolo Willox A, Smith K R McLaughlin J and Valaskakis G G 2009 Healing Traditions: The Mental Health of Indigenous Peoples in Canada (Vancouver: UBC Press) p 528

[31] Arsey H and O’Malley I 2005 Scoping studies: towards a methodological framework Int. J. Soc. Res. Methodol. 8 19–32

[32] Tricco A C et al 2018 PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation Ann. Intern. Med. 169 607–73

[33] Bishop-Williams K, Sargant J M, Berrang-Ford L, Edge V, IHACC Research Team, Harper S L 2017 A protocol for a systematic narrative synthesis review: the global impact of climate change on acute respiratory infections in Indigenous people BMC Med. Res. Methodol. 17 59

[34] McHugh M I 2012 Interrater reliability: the kappa statistic Biochem. Med. 22 276–82

[35] Confalonieri U et al 2007 Human health ed M Parry et al Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (Cambridge: Cambridge University Press) pp 391–431

[36] General Assembly of the United Nations 2007 United Nations Declaration on the Rights of Indigenous Peoples (New York: UN General Assembly)

[37] Braun V and Clarke V 2006 Using thematic analysis in psychology Qual. Res. Psychol. 3 77–101

[38] Boeije H 2002 A purposeful approach to the constant comparative method in the analysis of qualitative interviews Qual. Quant. 36 391–409

[39] Pearce M, Eagle L, Low D and Schurrmann A 2013 Cut from ‘country’: the impact of climate change on the mental health of aboriginal pastoralists Australas J. Reg. Stud. 21 59–79

[40] Wolf J, Allicie I and Bell T 2013 Values and traditional practices in adaptation to climate change: evidence from two communities in Labrador, Canada Glob. Environ. Change 23 548–62

[41] Delisle S and Turner S 2016 The weather is like the game we play: coping and adaptation strategies for extreme weather events among ethnic minority groups in upland northern Vietnam Asia Pac. View 57 351–64

[42] Cunsolo Willox A et al 2013 The land enriches the soul: on climatic and environmental change, affect, and emotional health and well-being in Rigolet, Nunatsiavut, Canada Emotion Space Soc. 6 14–24

[43] Harper S L et al 2015 Climate-sensitive health priorities in Nunatsiavut, Canada BMC Public Health 15 605

[44] Hadley C and Patil C I 2008 Seasonal changes in household food insecurity and symptoms of anxiety and depression Ann. J. Phys. Anthropol. 135 223–32

[45] Spedewinde P C, Cook A, Davies P and Weinstein P 2009 A relationship between environmental degradation and mental health in rural Western Australia Health Place 15 880–7

[46] Qi X, Tong S and Hu W 2009 Preliminary spatiotemporal analysis of the association between socio-environmental factors and suicide Environ Heal. 8 46

[47] Qi X, Hu W, Mengersen K and Tong S 2014 Socio-environmental drivers and suicide in Australian Bayesian spatial analysis BMC Public Health 14 681

[48] McDermott K M, Brearley M B, Hudson S M, Ward L and Read D J 2017 Characteristics of trauma mortality in the Northern Territory, Australia Inj. Epidemiol. 4 15

[49] Rock D J and Hallmayer J F 2008 The seasonal risk for deliberate self-harm: determined by place of birth, but occurrence determined by place of residence Crisis 29 191–201

[50] Yang P et al 2011 Posttraumatic stress disorder in adolescents after Typhoon Morakot: associated muddlesides J. Anxiety Disord. 25 362–8

[51] Chen C H, Chi M T, Huang H M and Sun F K 2012 Traumatic response experiences: one year after Typhoon Morakot J. Nurs. 29 29–39

[52] Cheng S-F, Cheng C-W, Hsieh W-C, Chi M-C, Lin S-J and Yao Y-T 2012 Effects of individual resilience intervention on Indigenous people who experienced Typhoon Morakot in Taiwan Kaohsiung J. Med. Sci. 28 105–10

[53] Tam B Y, Gough W A, Edwards V and Tsuji L J 2013 Seasonal and weather-related behavioral effects among urban aboriginal, urban non-aboriginal, and remote aboriginal participants in Canada 35 65–67

[54] Pututia A A 2018 A cross-sectional study of retrospectively reported seasonality in native and non-native residents of Chukotka and Turkmenistan Int. J. Occup. Environ. Health 24 17–26

[55] Schmeltz M T and Gamble J L 2017 Risk characterization of hospitals for mental illness and/or behavioral disorders with concurrent heat-related illness PLoS One 12 e0186509

[56] Rigby C W, Rosen A, Berry H L and Hart C R 2011 If the land’s sick, we’re sick: the impact of prolonged drought on the social and emotional well-being of Aboriginal communities in rural New South Wales Aust. J. Rural Health 19 249–54

[57] Dowles M, Gearheard S, Johnson N and Insketter J 2010 Should we run the tent? Inuit women and climate change Études/InuitStudies 34 151–65

[58] McNamara K E and Westoby R 2011 Solastalgia and the gendered nature of climate change: an example from Erub Island, Torres Strait Ecohealth 8 233–6

[59] Ford J D and Beaumier M 2011 Feeding the family during insecurity in an Inuit community Glob. Environ. Change 21 391–403

[60] Read D J 2017 Characteristics of trauma mortality in the Northern Territory, Australia Inj. Epidemiol. 4 15

[61] Prno J J, Bradshaw B B, Wandell J J, Pearce T T, Smit B B and Tozer L L 2011 Community vulnerability to climate change in the context of other exposure-sensitivities in Kugluktuk, Nunavut Polar Res. 30 7363

[62] Bunce A, Ford J, Harper S, Edge V and IHACC Research Team 2016 Vulnerability and adaptive capacity of Inuit women to climate change: a case study from Izaluit, Nunavut Nat. Hazards 83 1419–41

[63] Sakakibara C 2010 Kiavallikakkikput Agqiu (into the whaling cycle): cetacean and climate change among the Inupiat of Arctic Alaska Ann Assoc. Am. Geogr. 100 1083–12

[64] Jayer P O B, Timoti P, Jones C J, Richardson S J, Tahil B L and Greenhalgh S 2017 An Indigenous community-based monitoring system for assessing forest health in New Zealand Biodiversity Conserv. 26 3183–212

[65] Wolosz C and Marino E 2016 Disasters, migrations, and the unintended consequences of urbanization: what’s the harm in getting out of harm’s way? Population Environ. 37 411–28

[66] Ostapchuk J, Harper S, Cunsolo Willox A, Edge V L and Rigolet Inuit Community Government 2015 Exploring Elders’ and seniors’ perceptions of how climate change is
impacting health and well-being in Bagolet, Nunatsiavut

[67] Green D and Martin D 2017 Maintaining the healthy
country–healthy people nexus through sociocultural and
environmental transformations: challenges for the Wilk.
Aboriginal people of Aurukun, Australia Aust. Geogr. 48
285–309

[68] Hart C R, Berry H L and Tomma A M 2011 Improving the
mental health of rural New South Wales communities facing
drought and other adversities Aust. J. Rural Health 19
231–8

[69] Sakakibara C 2009 ‘No whale, no music’: Inuiaq drumming
and global warming Polar Rec. 45 289–303

[70] Beaumier M C and Ford J D 2010 Food insecurity among
inuit women exacerbated by socioeconomic stresses and
climate change Can. J. Public Health. 101 196–201

[71] Petrasek MacDonald J et al 2015 Protective factors for mental
health and well-being in a changing climate: perspectives
from Inuit youth in Nunatsiavut, Labrador Soc. Sci. Med. 141
133–41

[72] Tai A 2016 Dancing climate on a high mountain Res. Dance
Educ. 19 294–305

[73] Kasen A K and Winter S J 2016 Climate-driven migration:
an exploratory case study of Maasai health perceptions and
help-seeking behaviors Int. J. Public Health 61 641–9

[74] Mercer N and Hanrahan M 2017 ‘Straight from the heavens
into your bucket’: domestic rainwater harvesting as a measure
to improve water security in a subarctic Indigenous
community Int. J. Circumpolar Health 76 131223

[75] Pearce T, Smit B, Duerrden F, Ford J D, Goose A and
Katsayak J 2010 Inuit vulnerability and adaptive capacity to
climate change in Ulukhaktok, Northwest Territories,
Canada Polar Rec. 46 157–77

[76] Furbberg M, Evengård B and Nilsson M 2011 Facing the limit
of resilience: perceptions of climate change among reindeer
herding Sami in Sweden Glob. Health Action 4 8417

[77] Jaakola J K, Juntunen S and NakkalaJärrvi K 2018 The
holistic effects of climate change on the culture, well-being,
and health of the Sami, the only Indigenous people in the
European UnionCurr. Environ. Heal. Rep. 5 401–17

[78] Graybill J K 2013 Imagining resilience: situating perceptions
and emotions about climate change on Kamchatka, Russia
Geojournal 78 817–32

[79] Gergan M D 2017 Living with earthquakes and angry deities
at the Himalayan borderlands Ann. Am.Assoc. Geogr. 107
490–8

[80] Ford J D and Pearce T 2010 What we know, do not know, and
need to know about climate change vulnerability in the
western Canadian Arctic: a systematic literature review
Environ. Res. Lett. 5 014008

[81] Casaccl L, de Crespiigny C and Athanasos P 2011 Heatwaves
and their impact on people with alcohol, drug and mental
health conditions: a discussion paper on clinical practice
and governance challenges Abingdon: Routledge

[82] Berry H L, Kelly B H, Hanigan I C, Coates J H, McMichael A J,
Welsh J A and Kjellstrom T 2008 Rural mental health impacts
of climate change (Commissioned Report for the Garnaut
Climate Change Review) The Australian National University,
Canberra, Australia

[83] Walker–Sprinjett K, Butler C and Adger W N 2017 Wellbeing
in the aftermath of floods Heatlhe 43 66–74

[84] Bryant R A et al 2014 Psychological outcomes following the
Victorian Black Saturday bushfires Aust. N. Z. J. Psychiatry
48 48

[85] Kessler R C, Galea S, Jones R T, Parker H A and Hurricane
Katrina Community Advisory Group 2006 Mental illness and
suicidality after Hurricane Katrina Bull. World Health Organ.
84 930–9

[86] Berry H L, Waite T D, Dear K B G, Capon A G and Murray V
2018 The case for systems thinking about climate change and
mental health Nat. Clin. Chang 282–90

[87] O’Brien I V, Berry H L, Coleman C and Hanigan I C 2014
Drought as a mental health exposure Environ. Res. 131 181–7

[88] Watts N et al 2015 Health and climate change: policy
responses to protect public health Lancet 386 1861–914

[89] Pollock N J, Mulay S, Valour C and Jong M 2016 Suicide rates
in aboriginal communities in suicide rates in aboriginal
communities in Labrador, Canada Ann. J. Public Health 106
1309–15

[90] Vos T et al 2017 Global, regional, and national incidence,
prevalence, and years lived with disability for 328 diseases
and injuries for 195 countries, 1990–2016: a systematic analysis
for the global burden of disease study 2016 Lancet 390
1211–9

[91] Kirmayer L J, Dandeneau S, Marshall E, Phillips M K and
Williamson K J 2011 Rethinking resilience from Indigenous
perspectives Can. J. Psychiatry 56 86–91

[92] Petrasek MacDonald J, Ford J D, Cunlloso Willox A and
Ross N A 2013 A review of protective factors and causal
mechanisms that enhance the mental health of Indigenous
Circumpolar youth world Int. J. Circumpolar Health 72 21775

[93] Ragusa A and Kime K 2016 ‘Back’ to Country: socio-cultural
identity and the relationship between revering and re-
shaping landscapes and people Fusion J. 4 453–61 (http://www.
fusionjournal.com/wp-content/uploads/sites/28/
2016/12/24-Kime-Ragusa.pdf)

[94] Burgess C P et al 2009 Healthy country, healthy people: the
relationship between Indigenous health status and ‘caring for
country Commun. Cult. Heal—Res. 190 567–72

[95] Richardson C A M and Ross N A 2009 The determinants
of first nation and inuit health: a critical population health
approach Healthlhe 15 403–11

[96] Big-Canhe K and Richardson C A M 2014 Anishinabe youth
perceptions about community health: toward environmental
repossess Healhe 26 127–35

[97] Crowley P 2005 Petition to the Inter-American Commission
on Human Rights seeking relief from violations resulting
from global warming caused by acts and omissions of the
United States: Summary of the Petition (http://
inizitcircularpon.com/uploads/3/0/5/7/30542564/
finalpetitionsummary.pdf) (cited: 22 October 2018)

[98] Nixon R 2011 Slow violence, gender, and the
environmentalism of the poor Environment at the Margins:
Literary and Environmental Studies in Africa (Athens, OH:
Ohio University Press) pp 257–85

[99] Albrecht G 2012 Psychoterratic conditions in a scientific and
technological world Ecopsychology: Science, Totems, and the
Technological Species ed P H Kahn and P H Hasbach
(Cambridge, MA: MIT Press) pp 241–64

[100] Adger W N et al 2014 Human security Climate Change
2014: Impacts, Adaptation, and Vulnerability Part A: Global
and Sectoral Aspects Contribution of Working Group II to the
Fifth Assessment Report of the Intergovernmental Panel on Climate
Change ed C B Field et al (United Kingdom and New York:
Cambridge University Press) pp 775–91

[101] Mirzaeeb A et al 2019 Desertification Special Report on
Climate Change and Land. Intergovernmental Panel on Climate
Change ed M Akhtar-Schuster et al (https://ipcc.ch/site/
assets/uploads/2019/08/2d—Chapter_3_FINAL.pdf)

[102] Warren K 2010 Global environmental change and migration:
governance challenges Glob. Environ. Change 20 402–13

[103] Fullilove M T TT 2013 ‘The frayed knot’: what happens to place
attachment in the context of serial forced displacement? Place
Attachment: Advances in Theory, Method and Applications ed
L Manzo and P Devine-Wright (Abingdon: Routledge)
pp 141–53

[104] Habtamu K, Minaye A and Zeleke W A 2017 Prevalence and
associated factors of common mental disorders among
Ethiopian migrant returnees from the Middle East and South
Africa BMC Psychiatry 17 144

[105] Kim-Godwin Y S and Bechtel G A 2004 Stress among migrant
and seasonal farmworkers in rural southeast North Carolina
J. Rural Health 20 271–8
[106] Torres J M and Casey J A 2017 The centrality of social ties to climate migration and mental health BMC Public Health 17 600

[107] Tschakert P, Ellis N R, Anderson C, Kelly A and Obeng J 2019 One thousand ways to experience loss: a systematic analysis of climate-related intangible harm from around the world Glob. Environ. Change 55 58–72

[108] Morrissey J and Oliver-Smith A 2013 Perspectives on Non-economic Loss and Damage: Understanding Values at Risk from Climate Change (Bonn: United Nations University Institute for Environment and Human Security) (http://loss-and-damage.net/download/7213.pdf) (cited: 28 January 2018)

[109] Preston C J 2017 Challenges and opportunities for understanding non-economic loss and damage Ethics, Policy Environ. 20 143–55

[110] Puig D, Calliari E, Hossain M F, Bakhtiari F and Huq S 2019 Loss and damage in the Paris Agreement’s transparency framework Technical University of Denmark, University College London, and Independent University Bangladesh. Copenhagen, London and Dhaka

[111] Gall M 2015 The suitability of disaster loss databases to measure loss and damage from climate change Int. J. Glob. Warming 8 170–90

[112] Barnett J, Tschakert P, Head L and Adger W N 2016 A science of loss Nat. Clim. Change 6 976–8

[113] Alianait Inuit-specific Mental Wellness Task Group 2007 Alianait Inuit Mental Wellness Action Plan (Ottawa, ON: Inuit Tapiriit Kanatami) (https://itk.ca/wp-content/uploads/2009/12/Alianait-Inuit-Mental-Wellness-Action-Plan-2009.pdf)