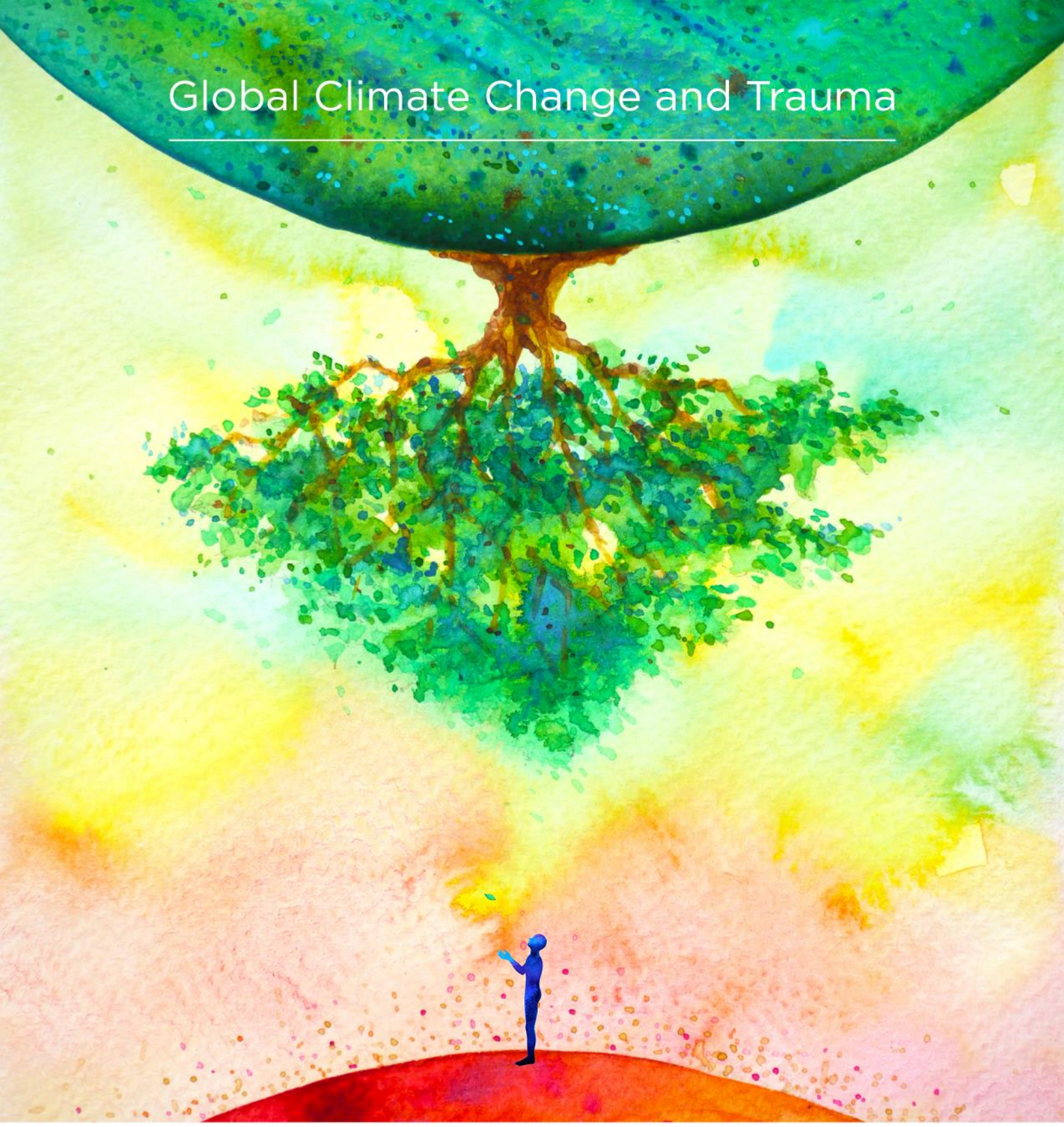
Global Climate Change and Trauma



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Jura L. Augustinavicius, PhD
McGill University, Canada
Johns Hopkins University, United States

Sarah R. Lowe, PhD
Yale University, United States

Alessandro Massazza, PhD
London School of Hygiene and Tropical Medicine, United Kingdom

Katie Hayes, PhD
University of Toronto, Canada

Christy Denckla, PhD
Harvard University, United States

Ross G. White, PhD
University of Liverpool, United Kingdom

Carissa Cabán-Alemán, MD
Florida International University, United States

Susan Clayton, PhD
The College of Wooster, United States

Lena Verdeli, PhD
Columbia University, United States

Helen Berry, PhD
Macquarie University, Australia

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1. Abstract

As human beings, our physical and mental health cannot be separated from the environments in which we live. Climate change, if left unaddressed, is projected to have catastrophic consequences on the mental health of entire populations. The impacts of climate change on traumatic stress and other aspects of mental health arise primarily from problems that are collectively, though not equally, experienced. These include insufficient political will and harmful policies, increased exposure to disasters, poverty, violence, the erosion of important places and landscapes, and harms to human physical health and the health of ecosystems, among others. This briefing paper describes the current state of knowledge in relation to climate change and trauma and highlights a number of gaps to encourage rapid development and collaboration on this topic across public health, policy, clinical, and research areas.

We describe how both acute and chronic (or gradual) climate change conditions can impact the frequency and severity of DSM-5 criterion A traumatic events which, in turn, can result in post-trauma psychopathology. We suggest that climate change contributes to traumatic stress and mental health burden through the accumulation of collectively but unequally experienced climate change induced stressors over the life course across social, economic, and environmental domains. We also describe a growing area of research focused on the impacts of vicariously experienced stressors and anticipation of climate change-related stressors. We highlight a range of factors that may support and enhance mental health in the context of stressful climate change conditions, promote positive collective action, and contribute to psychosocial adaptation, as well as the need for further work in this area. We specifically discuss theoretical implications of individual and collective action on post-traumatic growth and potential new areas of inquiry on post traumatic growth in the context of climate change. We include a range of relevant current and future public health, policy, clinical, and research initiatives, and make recommendations in each of these areas.

Effective and feasible methods for mitigating the impacts of climate change already exist and, if promptly and appropriately implemented, have the potential of preventing trauma for generations. We hope this briefing paper will serve to highlight currently available evidence and the evidence and action needed in order to prioritize, promote, and protect the mental health and well-being of people, communities, and societies in the face of climate change.

2. Introduction

The fifth assessment report of the United Nations Intergovernmental Panel on Climate Change (IPCC) provides the most recent available authoritative summary of global climate change science (IPCC, 2014). The IPCC's fifth assessment report states that human activity, largely driven by economic growth and global population, has changed the world's climate system, that human greenhouse gas emissions are the highest in history, and that the climate is rapidly changing. These climactic changes are putting pressure on several systems that affect human health, including bodily, natural, built, socioeconomic, and geopolitical systems (IPCC, 2018). These changes amplify existing risks and create new risks for natural and human systems. These risks are unevenly distributed, with people living in more vulnerable contexts generally experiencing the worst outcomes (Bennett & Friel, 2014; Diffenbaugh & Burke, 2019; Ebi, Fawcett, Spiegel, & Tovalin, 2016; Friel, Marmot, McMichael, Kjellstrom, & Vågerö, 2008). There are also impacts on mental health as a result of these pressures, since mental and physical health are reciprocally and causally related

(Prince et al., 2007) and interact dynamically on a continuum from good to poor health (Bemme & Kirmayer, 2020; Purgato et al., 2020).

Mental health problems, including trauma reactions, differ in their causes, symptoms, effects, and treatment, but are all characterised by alterations in thinking, mood or behaviour, and associated distress or impaired functioning. All aspects of mental health and well-being are sensitive to risks from climate change (Berry, Waite, Dear, Capon, & Murray, 2018). Pragmatically, we can think of mental health as a person's ability to think, learn, and live day-to-day with their own emotions and the reactions of others (Herrman, 2001; Herrman & Jané-Llopis, 2012). This definition implies fluidity of response within a given range *under normal circumstances*. The challenge with climate change is that it is rapidly forcing many to live outside normal circumstances.

Most empirical studies on the relationship between climate change and mental health, including trauma related psychopathology, focus on the effects of exposures to weather-related extreme events, primarily acute events such as floods, tropical cyclones, wildfires, and heatwaves (Berry et al., 2018). These exposures are multifaceted and can be traumatic for some (Hrabok, Delorme, & Agyapong, 2020). While most exposed individuals and communities show resilience in the face of disasters, exposure to floods, acute droughts, wildfires, and tropical storms can lead to increased psychological distress, trigger mental health problems such as depression, anxiety, and posttraumatic stress disorder (PTSD), and worsen pre-existing mental health conditions (Bonanno, Brewin, Kaniasty, & Greca, 2010; Norris et al., 2002). Substantially fewer studies have examined the association between mental health, including traumatic stress, and exposure to slow-creeping and chronic climate change-related events such as rising sea levels, melting permafrost, increasing temperatures, and chronic drought (Asugeni, MacLaren, Massey, & Speare, 2015; Basu, Gavin, Pearson, Ebisu, & Malig, 2018; Carleton, 2017; Carlsen, Oudin, Steingrimsson, & Oudin Åström, 2019; Cunsolo & Ellis, 2018; Mitchell & Terhorst, 2017). See Berry et al., 2018, for a more detailed review of the relationship between climate change and mental health generally.

2.1. Situating climate change and trauma

Against the backdrop of existing climate change and mental health literature, *this briefing paper seeks to describe the current state of knowledge in relation to climate change and traumatic stress, to highlight gaps, and to inform future public health, policy, clinical, and research initiatives.* While the focus of this briefing paper is on climate change and traumatic stress, it is important to contextualize the information presented within the broader system of complex relationships between climate change and weather, multiple interacting natural, built and social environments, and physical and mental health (Berry et al., 2018), see Figure 1. Thinking broadly about distal as well as proximal pathways of influence, as well as focusing on whole populations and future scenarios, can help promote the development of effective approaches to addressing the negative effects of climate change on mental health and capitalising on opportunities. It is also important to recognize that although climate change has been associated with a host of adverse impacts on mental health and well-being, including trauma, climate change also offers many important opportunities to improve mental health and well-being. Indeed, in addition to addressing the harms of climate change, efforts are urgently needed to understand and support strengths and opportunities within communities to enhance resilience, promote positive mental health and well-being, reduce trauma, and contribute to climate change adaptation and mitigation (Burgess & Mathias, 2017; Doppelt, 2017; Hrabok et al., 2020).

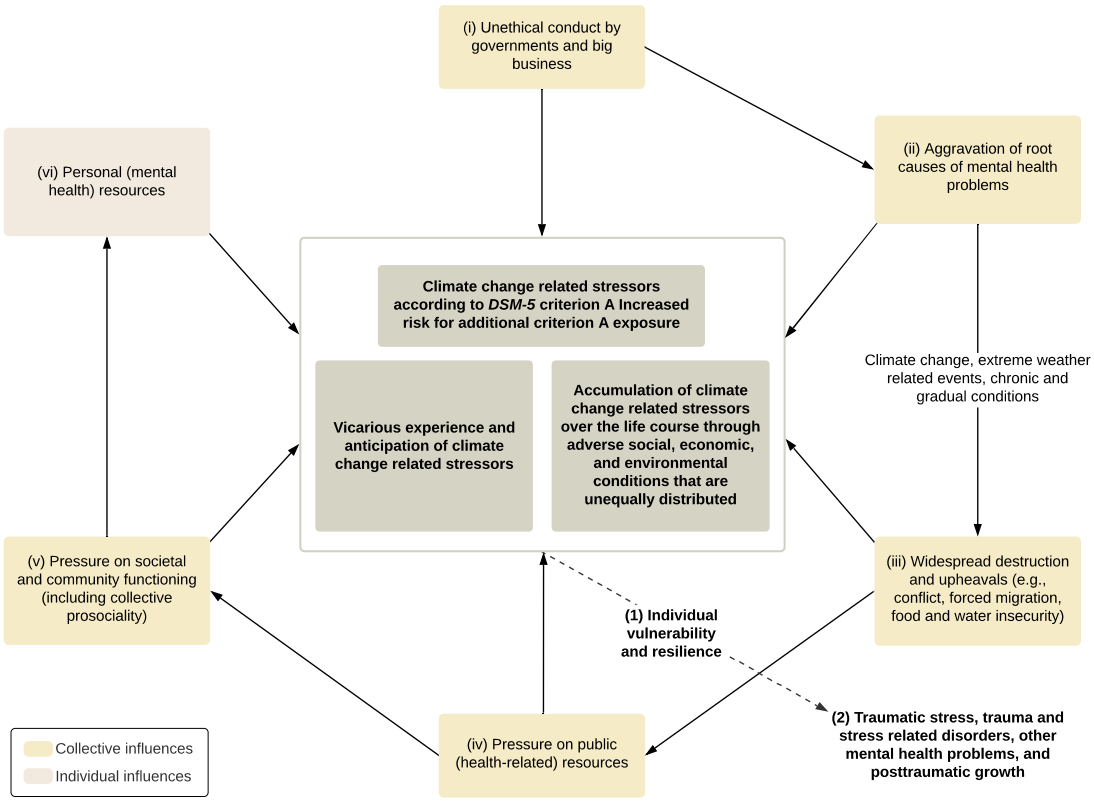

Figure 1. Process linking climate change and trauma, adapted with permission from Berry et al., 2018.

3. Defining exposure in a trauma framework

3.1. Climate change related stressors according to DSM 5 criterion A

Climate change has the potential to increase exposure to a range of potentially traumatic events as defined in criterion A of the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) diagnosis of PTSD (American Psychiatric Association, 2013). The DSM-5 defines traumatic events as those involving actual or threatened death, serious injury, or sexual violence, and can entail direct or witnessed exposure, learning that a relative or close friend has been exposed, or repeated exposure to aversive details of the trauma as part of one's professional duties (American Psychiatric Association, 2013). Notably, the DSM definition of a potentially traumatic event has undergone several major changes since the addition of PTSD in *DSM-III* and remains a source of continued debate (North, Surís, Smith, & King, 2016). Key points of controversy center on whether the definition should be more narrowly defined to include only events that involve direct life threat or physical injury, or more broadly to include other events, such as those related to systemic oppression or involving indirect exposure to aversive trauma-related exposures (e.g., via the media) (Holmes, Facemire, & DaFonseca, 2016; May & Wisco, 2016; North et al., 2016). Although a review of these issues is beyond the scope of this briefing paper, they are relevant in considering the proportion of the world's population that will be exposed to climate change-related trauma. For example, the existential threat of climate change, as well as exposure to its subtler and more chronic forms likely would not be considered potentially traumatic under DSM-5 yet could potentially trigger

emotional responses and psychiatric symptoms similar to those that would be. Media exposure to climate change related events associated with DSM-5 criterion A trauma (e.g., weather-related extreme events, violence), discussed in more detail below, is also pervasive and may evoke PTSD and other psychiatric symptoms (Pfefferbaum et al., 2014; Thompson, Holman, & Silver, 2019).

Weather-related extreme events are likely to increase in number, duration, and intensity as a result of climate change and often include a range of potentially traumatic exposures, including serious injuries, bereavement, and limited or disrupted access to life-sustaining resources, such as food, water, shelter, and access to necessary medical care (Goldmann & Galea, 2014; IPCC, 2018). Weather-related disasters are often followed by secondary stressors, including financial strain, displacement, and disruptions in social support networks, that can exacerbate mental health risks, especially for individuals and groups with preexisting vulnerabilities or who are highly exposed (Goldmann & Galea, 2014). Further research indicates that exposure to weather-related extreme events can result in increased risk for other criterion A traumas, such as intimate partner violence, child and elder abuse, family violence, and other forms of gender based and community violence (Anastario, Shehab, & Lawry, 2009; Gearhart et al., 2018; Gutman & Yon, 2014; Harville, Taylor, Tesfai, Xu, & Buekens, 2011; Lowe et al., 2020; Molyneaux et al., 2020; Seddighi, Salmani, Javadi, & Seddighi, 2019; Weitzman & Behrman, 2016). Weather-related extreme events have been associated with increased rates of trauma-related disorders, including acute stress disorder and PTSD (Danese, Smith, Chitsabesan, & Dubicka, 2020; Goldmann & Galea, 2014) as well as major depressive disorder, generalized anxiety disorder, substance use disorder, and mental health problems that fall outside of diagnostic categories (e.g. non-specific psychological distress, internalizing and externalizing problems) (Goldmann & Galea, 2014; Rubens, Felix, & Hambrick, 2018). A wide range of PTSD prevalence estimates have been reported in the aftermath of weather-related extreme events (i.e., from 0.0 to 75.1%) (Lowe, Bonumwezi, Valdespino-Hayden, & Galea, 2019).

While the links between exposure to acute, weather-related extreme events and trauma have been extensively described, the links between chronic or gradual climate change conditions and trauma have received significantly less attention. There are, however, examples of how chronic climate change exposures may increase the risk of trauma through death or serious injury. For example, a classic finding in the social psychology literature is that higher temperatures are associated with increases in aggression and violence (Anderson, 1989), including murder, simple and aggravated assaults, intimate partner violence and rape, and political conflicts, as well as property crimes, such as robbery, burglary, and motor vehicle theft (Bollfrass & Shaver, 2015; Sanz-Barbero et al., 2018; Sorg & Taylor, 2011; Williams, Hill, & Spicer, 2015). Higher temperatures have also been linked to increased rates of self-harm and suicide (M. Burke et al., 2018; Carleton, 2017; Qi, Hu, Mengersen, & Tong, 2014), with suicide rates expected to further increase as temperatures surge (Parks et al., 2020). Other slow-paced changing climate conditions, such as melting sea ice, can increase the risk of death or serious injury, with subsequent downstream effects on mental health (Cunsolo Willox et al., 2015; Harper et al., 2015). Climate change may also impact traumatic stress and other aspects of mental health by causing or exacerbating physical health conditions (Berry, Bowen, & Kjellstrom, 2010; Watts et al., 2019). For example, mental health may be impacted as a result of climate change related increases in transmission of infectious diseases (e.g., dengue fever, diarrhoeal disease), heat-related illnesses (e.g., stroke, acute kidney injury, congestive heart failure), respiratory conditions as a result of air pollution and wildfire smoke (Watts et al., 2019; Watts et al., 2018). Both morbidity and mortality resulting from these conditions can detrimentally impact mental health and, in

some cases, result in sudden death, threatened death, serious injuries and other criterion A qualifying events (Ginzburg et al., 2003).

Climate change is increasing the risk of violent conflicts and forcing some populations to migrate with disproportionate impacts in low- and middle-income countries (Burke, Hsiang, & Miguel, 2015; Burrows & Kinney, 2016; Hoffmann, Dimitrova, Muttarak, Crespo Cuaresma, & Peisker, 2020; Nel & Righarts, 2008; OCHA, 2020). By the end of 2019, 79.5 million people had been forcibly displaced (UNHCR, 2020). The International Organization for Migration reports that more people are now being displaced due to disasters caused by natural hazards than conflicts or violence (McAuliffe, Khadria, & Céline Bauloz, 2020). Since 2008, an estimated 26.4 million people have been displaced due to weather-related extreme events annually (IDMC, 2015). Survivors of weather-related extreme events and those displaced by other aspects of climate change may settle in new communities facing different climate change related and social challenges (Anastario et al., 2009; McMichael, 2020). Others who are intensively affected by climate change may remain trapped and unable to move (McMichael, 2020; The Lancet, 2020). It has been argued that climate change related migration could heighten risks for violence by increasing conflicting interests (e.g., resources and employment opportunities) and conflicting identities (e.g., cultural, occupational) between migrants and members of the host population (Brzoska & Fröhlich, 2016). Migrants, including internally displaced persons and refugees, face various forms of discrimination, sometimes escalating to violence and these experiences have been linked to adverse mental health outcomes (Asad, 2015; Reed, Fazel, Jones, Panter-Brick, & Stein, 2012; Ellis, MacDonald, Lincoln, & Cabral, 2008; Mölsä, Kuittinen, Tiilikainen, Honkasalo, & Punamäki, 2017; Nickerson et al., 2017; Perreira & Ornelas, 2013). Further, a recent systematic review of factors associated with quality of life of refugees indicated a need for greater focus on physical and environmental contributors to quality of life (van der Boor, Amos, Nevitt, Dowrick, & White, 2020).

3.2. Accumulation of climate change related stressors

In addition to direct exposure to climate change induced trauma, the accumulation of climate change related stressors over the life course and through the social and environmental determinants of mental health is also related to mental health burden. There is evidence from outside of the climate change literature indicating that cumulative trauma exposure over childhood and adulthood can result in trauma-related psychopathology and may lead to more complex mental health presentations (Cloitre et al., 2009; Wilker et al., 2017). Earlier in the life course, prolonged and intensive adverse experiences, such as climate change related events, are associated with greater impacts on child health and well-being relative to limited and short-term experiences (Garcia & Sheehan, 2016). This evidence supports the hypothesis that the cumulative impact of multiple climate stressors is likely to lead to more severe and complex mental health sequelae in children (Burke, Sanson, & Van Hoorn, 2018).

Over the life course, climate change related stressors beginning in utero and continuing through older adulthood have been shown to impact neurodevelopment and mental health (S. E. L. Burke et al., 2018; Gamble et al., 2013; Pacheco, 2020; Sanson, Van Hoorn, & Burke, 2019). Children and youth are at greater risk of poor health outcomes related to climate change because they are more dependent on others for their survival and well-being, are still developing their physiological defense systems, and will experience climate change for longer than older generations (Clark et al., 2020; Committee on Environmental Health, 2007; Sanson et al., 2019; Watts et al., 2019). Child development, including neurodevelopment, is impacted by climate change, through food and water

scarcity, spread of infectious disease, toxic stress and early childhood adversity, poverty, disrupted education, and air pollution (Anderko, Chalupka, Du, & Hauptman, 2020; Perera, 2017; Perera, Ashrafi, Kinney, & Mills, 2019; Save the Children, 2007, 2009; UNICEF, 2015).

In addition to developmental impacts, the exacerbation of climate change related stressors through the social and environmental determinants of mental health over time is simultaneously increasing mental health disparities (Patel et al., 2018). Such determinants are outcomes of structural imbalances in power and access to resources and make some communities invisible to systems (including under-resourced mental health services), left with limited or absent political power, at risk of increased social or spatial marginalization, and can lead to the forced invisibility of marginalized populations (Parry et al., 2019). Climate change has already increased global economic inequality (Diffenbaugh & Burke, 2019). Ongoing livelihoods displacement due to resource depletion, increased climate change related conflict, and climate migration also likely exacerbate existing mental health inequalities (Burrows & Kinney, 2016; Drabo & Mbaye, 2011; Hayes, Blashki, Wiseman, Burke, & Reifels, 2018; Shultz, Rechkemmer, Rai, & McManus, 2019; Weissbecker & Czincz, 2011). Low and middle-income countries are often at greater risk from climate change hazards and are more vulnerable to climate change related events (Garcia & Sheehan, 2016), thus leaving people and communities in lower-resource settings with fewer health supports, services, and resources to prepare for and adapt to a changing climate. Unequal climate change related risks to mental health and well-being exist across but also within countries. For example, there is evidence to suggest that those living in low-income neighborhoods during heatwaves have increased risk of experiencing poor mental health outcomes, including mood and behavioral disorders relative to those living in higher-income neighborhoods (Bélanger, Gosselin, Valois, & Abdous, 2014; Gronlund, 2014). To understand how climate change impacts mental health in low-resource settings, it is crucial to identify decision and policy making that define social, economic, and environmental conditions collectively experienced by communities. Identifying and addressing unequal structures is part of addressing the social inequity associated with a higher vulnerability for adverse mental health impacts associated with climate change.

While the effects of climate change are global in scale given the earth's integrated climate systems, the felt impacts are often highly specific to geographic location and the local social, environmental, and cultural features of these regions. At this local scale, populations that are deeply integrated with the natural landscape are likely to be more vulnerable to mental health-related climate change impacts. These include, for example, indigenous and subsistence communities, farmers in drought-prone areas, and outdoor laborers (Berry, Hogan, Owen, Rickwood, & Fragar, 2011; Cunsolo Willox et al., 2012; Ellis & Albrecht, 2017; Keshavarz, Karami, & Vanclay, 2013; Middleton, Cunsolo, Jones-Bitton, Wright, & Harper, 2020; Parida, Dash, Bhardwaj, & Chowdhury, 2018; Watts et al., 2018). An emerging literature on the 'science of loss' is chronicling reactions to a range of losses associated with climate change, from health and safety to landscapes, places, cultures, and social bonds (Barnett, Tschakert, Head, & Adger, 2016). Some of these losses, particularly those associated with the disappearance or altering of places and landscapes, have been associated with psychological grief, giving rise to the terms "ecological grief" more generally and "reef grief" in the specific case of the degradation of the Great Barrier Reef in Australia (Cunsolo & Ellis, 2018; Marshall et al., 2019). The extent to which place-based grief is generalizable to the significant theoretical and empirical literature on human loss and grief remains an open question and further empirical work in this area is needed.

Acknowledging compounding risks to well-being, highlighting populations most at risk, and identifying the factors and processes that put people at risk, are critical for mobilizing resources to support mental health and well-being as well as positive climate change adaptation and mitigation. Recognizing that many of the most affected communities have already been developing creative solutions to address these challenges is equally important (Hayward, Salili, Tupuana'i, & Tualamali'i, 2020). Emphasizing climate change-related risks without acknowledging and supporting local and collective strengths, traditions, systems, and solutions may exacerbate fear and despair, potentially resulting in social disengagement and pessimism (O'Neill & Nicholson-Cole, 2009). These reactions are dangerous if they inhibit action, particularly among populations who may be least affected but most responsible for greenhouse gas emissions (Hayward et al., 2020).

3.3. Vicarious experience and anticipation of climate change related stressors

The existential threat of climate change, as well as exposure to its other more subtle and chronic impacts, would not be considered potentially traumatic according to DSM-5 criteria for PTSD. However, these types of exposures could still trigger adverse emotional responses and psychiatric symptoms. General distress and anxiety related to climate change is a growing concern not only amongst those directly exposed to climate change related hazards but also among those experiencing climate change impacts vicariously or that are anticipating the impacts of climate change (Clayton, 2020). Emerging concepts to describe reactions unique to climate change specific losses, including past, current, or anticipated, include ecological grief, psychoterratic syndromes such as *solastalgia* (the distress caused by environmental change) (Albrecht et al., 2007), and climate change anxiety. Increasingly, there is evidence to suggest that children and youth are at increased risk of poor mental health outcomes related to knowledge and awareness of climate change writ-large, including feelings of impending doom, anxiety, and grief (Ojala, 2012; Sanson & Burke, 2020). Such responses vary in severity and may be normative, not necessarily representing a pathological mental health concern (Clayton, 2020; Cunsolo et al., 2020). Although uncomfortable, non-pathological ecological grief and climate anxiety may actually help individuals engage in change that support climate adaptation and mitigation efforts, though this is a hypothesis in need of further testing (Cunsolo et al., 2020).

Ecoanxiety has been used as a general term to describe anxiety associated with the perception of environmental changes, whereas climate anxiety refers more specifically to a preoccupation with climate change. Despite national surveys showing significant worry about climate change (Marlon, Howe, Mildenberger, Leiserowitz, & Wang, 2020), limited data exist describing levels of climate anxiety in the general population. Some people may feel overwhelmed by the scale, complexity, and severity of climate change impacts on human lives. The fact that climate change is affecting values and systems that are generally understood to be fundamental and stable, such as the global ecosystem and the human relationship with the natural world, may lead to what has been described as an “existential crisis”. There is a high level of uncertainty about what to do given accumulating evidence that the status quo is no longer sustainable, and a high level of potential significance for one’s own fate and the fate of one’s children in a climate changed world. Research on climate anxiety is still in its early stages. Several measures have been developed to assess negative emotions associated with climate change (Reser, Bradley, Glendon, Ellul, & Callaghan, 2012; Searle & Gow, 2010). A scale developed by Clayton & Karazsia (2020) was designed to measure clinically relevant aspects, such as impaired concentration or sleep associated with concern about climate change (Clayton & Karazsia, 2020). The differentiation of climate change anxiety responses from generalized anxiety disorder symptoms deserves further exploration, however preliminary work

suggests that climate change anxiety responses are associated with general anxiety and depression responses but show some distinctive patterns of relationships with other variables (Clayton & Karazsia, 2020). There is evidence that anxiety about climate change is, for some people, impairing their ability to function by interfering with sleep, work, socializing, or emotional regulation (Clayton & Karazsia, 2020; Gibson, Barnett, Haslam, & Kaplan, 2020). Climate-related anxieties are likely more common amongst those with strong, pro-environmental concerns and behaviors, however, increasing exposure and awareness of climate change effects and the bearing witness to a lack of coordinated, global actions to address the issue has created a "social problem" potentially contributing to rising levels of climate anxieties overall (Clayton, 2020).

4. Protective factors, resilience, and post-traumatic growth

Psychosocial adaptation to climate change has been defined as enhancing, or supporting, the mental health and psychosocial well-being and well-being of individuals and communities so that they can cope and thrive in a changing climate, thereby increasing resilience to future impacts" (Brown & Westaway, 2011; Hayes, Berry, & Ebi, 2019). Collective action at multiple scales (by individuals, groups, and governments) is a critical component of climate change adaptation and for supporting community-based resilience amidst increasing climate impacts (Adger, Arnell, & Tompkins, 2005). Research on psychosocial adaptation in the context of climate change and traumatic stressors has identified individual- and community-level factors that can enhance or support mental health and well-being while simultaneously promoting positive climate change adaptation (Hayes et al., 2019). A recent scoping review identified eleven factors that influence the capacity to adapt to the mental health impacts of climate change, including social capital; sense of community; government assistance; access to resources; community preparedness; intersectoral/transdisciplinary collaboration; vulnerability and adaptation assessments; communication and outreach; mental health literacy; and culturally relevant resources (Hayes et al., 2019). A body of research has also documented the human ability to adapt to change and demonstrate resilience to adverse or traumatic exposures more broadly (Bonanno, 2008), and disasters specifically (Bonanno et al., 2010). Findings from this perspective are of particular interest to researchers, practitioners, and policy makers, including traumatic stress experts, seeking to develop interventions and prevention strategies to mitigate the adverse effects of climate change.

4.1. Protective factors in the context of climate change and trauma

Most of the extant literature on climate change and mental health has focused on individual-level protective and resilience factors with little consideration of community-level and higher order factors (Berry et al., 2018). The most robust evidence exists for the protective role of social support, including perceived social support (Boullion, Pavlacic, Schulenberg, Buchanan, & Steger, 2020), social connection (Kafeety et al., 2020), and social networks (Chu & Yang, 2020). However, it is important to recognize that social support is not uniformly protective and that in some cases it may have an adverse effect. Mixed findings highlight the importance of careful interpretation with specific consideration of local context and culture. Post-disaster sense of meaning, religiosity, appraisals, and meaning making may also contribute to resilience (Park, 2016; Shannonhouse et al., 2019), although ethnic and age differences are salient across many studies (Milstein, 2019). In some settings, religious power structures have been found to inhibit personal autonomy and well-being in relation to climate change adaptation efforts (Kuruppu, 2009). While several potentially promising protective factors likely to reduce mental health burden in relation to climate change stressors have

been identified in the literature, further work is necessary to elucidate how these factors operate across contexts, and to identify others.

4.2. Prosociality in psychosocial adaptation

Climate change can present an opportunity for advancing progressive action that ultimately strengthens communities, reverses social and structural inequality by adopting a climate justice stance, and generates the development of climate-smart practices that improve health and well-being (Berry, 2009; Mcleod et al., 2019; White-Newsome, 2016). Prosociality may play a key role in these and other efforts to limit environmental degradation and enhance positive psychosocial adaptation to climate change (Fletcher, Sah, Margot, & Diaz, 2020; White, 2020). Prosociality "involves particular behaviors, attitudes and values related to providing assistance to others, being actively involved in a community, and developing as a person" (White, 2020). To fully address and adapt to the scale of climate change, human empathy will need to extend to consideration of impacts on nonhuman entities such as animals and plants (Nolan & Schultz, 2015). Multiple disciplines have advanced this idea, including ecopsychology and ecofeminism (e.g. (Mitten, 2017)). From within the field of economics, Elinor Ostrom's "design principles" represent a framework for guiding the sustainable and equitable management of shared planetary resources while facilitating prosociality (Baggio et al., 2016; Cox, Arnold, & Tomás, 2010; Ostrom, 1990). This work contradicted a previously established assumption that granting people access to shared planetary resources would result in a ''tragedy of the commons'' (i.e., the depletion of these resources, including the ecosystems in which people live, to everyone's detriment (Hardin, 1968)). White (2020) proposed that Ostrom's ''design principles'' can be used proactively to assist community members in negotiating and applying functioning constraints (i.e., limits on the specific forms of being and doing that people value - as opposed to the freedom they have to choose what they value (Peeters, Dirix, & Sterckx, 2015)) to promote environmental justice whilst not compromising efforts aimed at promoting human development and enhancing levels of quality of life and well-being.

4.3. Posttraumatic growth in psychosocial adaptation

Posttraumatic growth (PTG) refers to positive psychological changes that result from the experience and processing of potentially traumatic events (Tedeschi & Calhoun, 1996, 2004). In their seminal work, Tedeschi and Calhoun (1996) defined five domains of PTG: improved relations with others, enhanced spirituality, a greater feeling of personal strength, a sense of new possibilities, and greater appreciation of life. The five domains of PTG have been documented in the aftermath of a variety of weather-related extreme events, including tropical storms (Lowe, Manove, & Rhodes, 2013), floods (Dursun, Steger, Bentele, & Schulenberg, 2016), wildfires (Felix et al., 2015), and droughts (Zeligman, Majuta, & Shannonhouse, 2020). Predictors of higher PTG across these and other studies include female gender; higher levels of optimism, social support, and purpose; positive reappraisal and religious coping; and higher levels of disaster exposure (e.g., (Felix et al., 2015; Lowe et al., 2013; Prati & Pietrantoni, 2009; Vishnevsky, Cann, Calhoun, Tedeschi, & Demakis, 2010).

Action on climate change, including individual and community actions toward climate adaptation and mitigation, could potentially trigger PTG, but further research is needed to test this hypothesis. A source of controversy within the PTG literature is whether self-reported PTG reflects authentic and adaptive growth, or illusory growth that may serve as self-enhancement or avoidance of psychological suffering (Hobfoll et al., 2007; Zoellner & Maercker, 2006). This debate stems in part

from the mixed findings regarding the association between PTG and posttraumatic stress (PTS), with studies showing positive, negative, and non-significant associations (Liu, Wang, Li, Gong, & Liu, 2017; Zoellner & Maercker, 2006). One explanation for this inconsistency is that the relationship between PTG and post-traumatic stress evolves over time in the aftermath of trauma such that some degree of initial posttraumatic stress is required to develop PTG which then further develops through processing and coping with the traumatic experience (Zoellner & Maercker, 2006). Contrary to this explanation, however, studies have shown that decreases in posttraumatic stress do not correspond to increases in PTG (e.g., (Lowe et al., 2013; Whealin et al., 2020). Another explanation is that PTG is only protective against posttraumatic stress when it is accompanied by growth-related action (Hobfoll et al., 2007), which has particular relevance to climate change and trauma. In the context of weather-related extreme events, for example, such actions might entail involvement in disaster preparedness or relief efforts that protect at-risk communities from further harm.

The latter explanation might be relevant when considering the potential for PTG in the context of more chronic or slow-creeping impacts of climate change. To our knowledge, there have been no published studies on PTG related to such impacts. However, as argued by Hayes and colleagues (2018), it is possible that those who recognize the existential threat of climate change and who engage in climate change activism and advocacy derive psychological benefits from their experiences, which could be examined in future research.

5. Current and future clinical, public health, and policy initiatives

5.1. Public Health initiatives

Few current public health initiatives address traumatic stress specifically in the context of climate change, although some public health programs are beginning to recognize the needs in this area. Examples of existing initiatives include a Climate and Health Resilience Plan established by Oregon's Department of Health in 2017 that provides resources to support mental health. The plan includes a collaboration (called "Trauma-Informed Oregon") with the International Transformational Resilience Coalition (ITRC) (https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/CLIMATECHANGE/Pages/messages-mental-health.aspx). Although not always explicitly climate change focused, many organizations, governments, and regional Departments of Health already offer mental health resources in the aftermath of weather-related extreme events and other environmental disasters, including by integrating mental health resources into disaster preparedness and response (Gray et al., 2021; James, Welton-Mitchell, Noel, & James, 2020; Newnham, Titov, & McEvoy, 2020; Osofsky, Osofsky, Wells, & Weems, 2014).

Future public mental health initiatives should focus on prevention and promotion alongside treatment of mental health problems, including adverse trauma reactions in the context of climate change (Patel et al., 2018; Tol, 2015). Without a specific focus and resources to support prevention and promotion of mental health problems, the scale of mental health challenges presented by climate change could become insurmountable. In this scenario, mental health inequities will almost surely increase as most current health systems are already unable to cope with the existing mental health burden (McBain, Salhi, Morris, Salomon, & Betancourt, 2012). Public mental health initiatives could also be developed to promote well-being and support social processes more broadly, including promoting pro-sociality according to frameworks such as Ostrom’s design principles (Cox et al., 2010; Ostrom, 1990). This will require the creation of global networks of people who are committed

to upholding Ostrom's design principles (White, 2020). The Evolution Institute provides one example of efforts to create a global network of this kind (The Evolution Institute, 2020).

Public mental health approaches, whether prevention, promotion, or treatment focused, could also be integrated with climate change adaptation and mitigation strategies. Adaptations that promote co-benefits and which minimize undesirable trade-offs should be favored, particularly where they make inroads into harmful ways in which people utilize the natural environment (the main cause of current and future climate change). Adaptation and mitigation can be carried out in all sectors, though specifically what can be done will vary by sector and region. More research is needed to identify the potential mental health (including traumatic stress) benefits of efforts such as inclusive organic permaculture and agroecology projects, community gardens, solar energy cooperatives, and regenerative ranching, and others. There is already some evidence suggesting that those who participate in such initiatives report social and mental health benefits (Labrador, Pérez, Moreno, & Pérez-Vera, 2020; Nova, Pinto, Chaves, & Silva, 2018). When implemented in communities with few resources, such initiatives could address other social determinants of mental health that contribute to climate change vulnerability, such as food insecurity and poverty, while simultaneously contributing to climate change mitigation (Gosnell, Charnley, & Stanley, 2020; McIlvaine-Newsad, Porter, & Delany-Barmann, 2020).

Health education, including in the psychology, psychiatry, social work, and public mental health professions, is another opportunity to support mental health and prevent traumatic stress in the context of climate change. There have been calls to incorporate approaches that acknowledge reciprocities among ecological and social determinants of health (i.e., "eco-social" approaches) as a foundation for education of health professionals and practitioners (Parkes et al., 2020). An eco-social approach to the education of mental health professionals and practitioners would enhance awareness of, and interventions to, address climate change as a determinant of mental health in research, policy, and practice. This can specifically include undergraduate, graduate and post-graduate training and professional development in the mental health disciplines (Every-Palmer, McBride, Berry, & Menkes, 2016; Hamel Green et al., 2009; Maughan, Berry, & Davison, 2014).

5.2. Policy initiatives

Policy initiatives can mitigate the impacts of climate change and thus represent an effective way to prevent mental health problems that result from climate change, including traumatic stress, in the first place. To better support adaptation to climate change, policymakers will need to acknowledge the impacts of climate change on mental health and take them into account in developing programs that promote societal resilience. White (2020, p48) points out that "environmental/climate change factors may have an enduring impact on mental well-being by restricting the opportunities that individuals have to enhance their capabilities and engage in forms of being and behaving that are consistent with their personal and cultural values". Policy initiatives are therefore required at an international level to manage what Ostrom (2014) termed *social dilemmas*, i.e., ''settings where uncoordinated decisions motivated by the pursuit of individual benefits generate suboptimal payoffs for others and for self in the long run'' (pp. 101–102). White (2020) notes that policy initiatives need to "inculcate an ethos of restraint that promotes the mental wellbeing of community members, without adversely impacting on environmental justice".

Several ongoing policy initiatives support work relevant to climate change and traumatic stress. For example, a joint initiative by 17 U.S. organizations, including Eco America, the American

Psychological Association, and the American Public Health Association, has formed a Social Climate Leadership Group to encourage efforts to address the mental health impacts of climate change. The goals are to draw attention to the issue as well as to help in coordinating innovative responses to the mental health care needs that will arise from the impacts of climate change. The Climate Psychiatry Alliance and the Climate Psychology Alliance are examples of forums through which clinical professionals can advocate on climate change and mental health issues.

The ITRC has developed a policy proposal to address the mental health and psycho-social-spiritual impacts of climate change by establishing community-centered initiatives across the U.S. to build capacity for well-being and resilience (ITRC, 2020). Their goal is to help communities achieve transformational resilience, a concept based on PTG and defined as the capacity to use climate change-generated psychological and psychosocial traumas and toxic stresses as catalysis for positive learning, growth, and change. They propose the formation of Resilience Coordinating Councils (RCCs) in communities (or regions) to bring together all stakeholders in a community, to co-create, implement, and continually improve innovative age and culturally appropriate plans to: a) teach mental wellness and resilience information and skills; b) build individual and community skills and strengths; c) establish and connect quality social support networks; d) transform unhealthy cultural norms; and e) construct a local culture that enables people to safely overcome distress, and find meaning, purpose, and hope in the midst of ongoing climate adversities. The RCCs would use population-based community resilience collaborative approaches to support communities in (1) managing their distress so they feel they have some influence over their situation (“Presencing”), (2) helping people find ways to learn, grow, and find new sources of meaning, direction, and hope in life (“Purposing”), and (3) creating a local culture of well-being and resilience by institutionalizing the principles and practices in organizations and policies. In one example offering support for this model, a study described the impact of response efforts by Community-Based Organizations (CBOs) on traumatic stress and community resilience after disaster and climate change-related events in South Louisiana (Everett et al., 2020). Participants from 47 CBOs emphasized the importance of organizing community-led coalitions and partnerships, implementing trauma-informed care in schools and health care settings, providing infrastructure and educational resources to navigate housing and financial barriers, and creating dialogue to better understand and accept climate change. The ITRC policy proposal is consistent with these recommendations, which emphasize the crucial role of community leaders that have already endured the effects of climate change events as key stakeholders in the development of policies to address climate change-related traumatic stress.

5.3. Clinical approaches

In the context of climate change, it is important to emphasize that normal psychological reactions to adversity and disaster should not be pathologized (Horwitz & Wakefield, 2007). While individual and community resilience is common in the face of disasters, it becomes increasingly less common as the severity of the disaster increases and with increasing numbers of events experienced. That is, there is a dose-response relationship between the severity and number of traumatic exposures and the development of traumatic symptomatology. Unchecked climate change means growing risk of more severe and more frequent exposure and thus potentially a greater number of people in need of additional support. Clinical approaches alone will not sufficiently address mental health problems, including traumatic stress, in the context of climate change, but will need to be integrated and delivered alongside a wide range of public health and policy initiatives that include but must also go beyond health and environmental policy. Few existing clinical approaches focus explicitly on climate change and mental health, or climate change and trauma, but the effectiveness of many existing

approaches could be examined in the context of climate change (Palinkas & Wong, 2020). These include evidence-based interventions used in the context of extreme weather-related events and other disasters, such as trauma focused cognitive behavioral therapy, narrative exposure therapy, eye movement desensitization and reprocessing therapy, behavioral activation, and interpersonal therapy (Palinkas & Wong, 2020; Purgato et al., 2018).

Although they have not yet been explicitly examined in the context of climate change, characteristics of 'Third-wave' psychological interventions could potentially prove useful for supporting climate change affected populations. 'Third-wave' psychological interventions build on the cognitive-behavioral tradition pioneered by theorist-practitioners such as Aaron T. Beck. Examples of third wave therapies include Mindfulness-based Cognitive Therapy (Segal, Williams, & Teasdale, 2002), Dialectical Behavior Therapy (Linehan et al., 1999) and Acceptance and Commitment Therapy (ACT; (Hayes, Strosahl, & Wilson, 2011)). These approaches place particular emphasis on experiential practices that aim to bring about shifts in how people relate to their present moment experiences, rather than focusing on the specific content of internal experiences (such as thoughts and emotions) and trying to exert control over the nature of these experiences. These approaches tend to share a focus on helping people to develop a mindful orientation (i.e., a non-judgmental, present moment awareness). Relevant to climate change adaptation and mitigation, Brown and Kasser (2005) highlighted that mindfulness is both associated with subjective well-being and "ecologically responsible behavior" in both adolescents and adults (Brown & Kasser, 2005). ACT places specific emphasis on helping people to be open and present with difficult emotions whilst supporting people in exploring their values and committing to actions that are consistent with these values. ACT could potentially be harnessed to transform the sense of despair and fatalism that can arise in relation to climate change into action that can lead to progress on climate adaptation or mitigation objectives (Sharry, 2019).

There is also some interest in eco-psychological approaches although further evidence is needed in this area. Ecotherapy can include many variations of nature-assisted therapeutic activities (e.g., water sports, animal assisted therapy, wilderness or adventure therapy, horticultural therapy, green exercise therapy, nature arts and crafts) performed in a systematic manner to improve well-being by developing a balanced and respectful relationship with nature (Smith, 2015). For example, a recent pilot study of ecotherapy practices found that symptoms of stress-related trauma disorders were alleviated through engagement in techniques (i.e., kayaking and fishing) and knowledge (i.e., psycho-education on post-traumatic stress) through a program designed to support the process of reconnecting individuals to their natural environment in order to abate psychological issues stemming from isolation, loneliness, stress, and anxiety (Price-Howard & Matise, 2020). The extent to which these approaches would be effective if integrated with evidence-based interventions for mental health symptoms like PTSD is also not known.

5.4. Research approaches

In line with current gaps in the climate change and mental health literature and in relation to climate change and trauma, research is needed to better understand and operationalize mental health and traumatic stress constructs in the context of climate change. This includes work to understand and develop tools to measure emerging constructs, epidemiological studies to understand risk, protective, and promotive factors in the context of climate change, and studies that use systems thinking to understand and contextualize the linkages between climate change and traumatic stress within the social and environmental determinants of mental health more broadly. Intervention

research should also be conducted using a systems thinking approach, with careful consideration of the broader impacts on people and communities within the system (Berry et al., 2018).

An additional avenue for future climate change and traumatic stress research would be to examine both resilience and PTG across different types of climate change-related exposures. For example, as mentioned previously, whereas several studies have assessed psychological resilience and PTG resulting from exposure to weather-related extreme events, none to our knowledge have done so in the context the subtler and more chronic impacts of climate change. The larger research on resilience further suggests that, whereas resilience and other prototypical trajectories (e.g., chronic, recovery, delayed) are apparent across a range of traumatic events, the prevalence of each pattern varies considerably depending on the trauma context and survivor characteristics (Galatzer-Levy, Huang, & Bonanno, 2018). Additional research is therefore needed on a range of climate change-related impacts across different geographic areas and affected populations to better understand the conditions that facilitate resilience and adaptive PTG, so that these phenomena can be supported among disaster survivors and the general public.

Although climate change has been associated with a host of adverse impacts on mental health and well-being, including traumatic stress, climate change may also offer many important opportunities to improve mental health and well-being (Berry, 2009). The ways in which positive mental health and well-being might contribute to engagement in climate adaptation and mitigation and vice versa are deserving of further investigation. This could include examining reciprocal relationships between resilience or PTG and climate change adaptation and mitigation. For example, adaption and mitigation activities, both at the individual level and within communities, could potentially increase the likelihood of resilience and PTG. This proposal relates to the prior findings that PTG results from not just the cognitive processing of trauma, but also engagement in action (Hobfoll et al., 2007). Less is known about whether psychological resilience and PTG could contribute to support for or engagement in climate change mitigation and adaptation. On the one hand, it is possible that psychological well-being and growth-related capacities, such as a sense of personal strength, are critical to engaging in adaptation and mitigation. On the other, the more illusory side of PTG could lead to avoidance of existential threats.

Intervention research is also needed to support future work on climate change and traumatic stress. This includes research that examines the effectiveness and implementation of prevention and promotion interventions and integrated programs that combine multiple interventions, including mental health interventions and interventions that support climate adaptation and mitigation across sectors. The impacts of climate change adaptation and mitigation interventions alone on mental health, including traumatic stress, could also be examined. Implementation research is also needed to support the scale up of mental health and psychosocial support programs, ensure intervention quality, and test appropriate and feasible delivery models at many levels, such as task sharing, which has already been used and examined in many low-resource settings but could be implemented much more broadly (Javadi, Feldhaus, Mancuso, & Ghaffar, 2017).

6. Recommendations

6.1. Public Health and policy recommendations

- Develop a framework to categorize the stressors caused by climate change, delineating differences according to the conceptualization and categorization of stressors more generally

and traumatic stressors more specifically (as we have attempted to do above), in order to best understand their potential impacts on mental health and well-being.
- Support efforts for prevention of mental health problems, including traumatic stress, and promotion of well-being alongside treatment in order to prepare for a potential increase in the burden of mental health problems with climate change.
- Support people in committing to actions they are willing to take to bring about changes in policy and behavior.
- Engage community leaders and grassroots organizations as partners in the process of initiating and developing efforts to improve traumatic stress in the context of climate change.
- Initiate networks of care among interdisciplinary health professionals, community leaders, educators, and other disciplines involved in sustainability and ecological efforts to address climate change. Such networks could engage in research and delivery of evidence-based interventions (including non-mental health focused interventions) to promote mental health and prevent traumatic stress in a changing climate.
- [As guided by a climate change and traumatic stress framework] Support positive climate change adaptation and mitigation strategies.

6.2. Clinical recommendations

- Deliver mental health and psychosocial support services at multiple levels, including at the community level through community networks with strong initial investment and ongoing support.
- Respect human rights and abide by a do-no-harm approach when addressing mental health needs in the context of climate change.
- Where existing (e.g. to address distress and trauma reactions among disaster affected populations and those in settings of complex adversity) use evidence-based approaches and follow international guidance (Inter-Agency Standing Committee (IASC) Reference Group for Mental Health and Psychosocial Support in Emergency Settings, 2007).

6.3. Research recommendations

- Use systems thinking frameworks and tools to understand how trauma and trauma-related psychopathology are affected by the social and environmental determinants of mental health and develop targeted interventions to address these in context.
- Explore how climate change impacts the occurrence of traumatic events (e.g., urban violence, sexual violence, armed conflict) and how this in turn impacts trauma-related psychopathology at a global level (e.g., with links to the Global Collaboration on Traumatic Stress).
- Develop a battery of measures that could be used to assess climate change-related exposures and traumatic stress impacts across a range of geographical contexts for comparative purposes and integrative analyses.
- Test climate change adaptation and mitigation, including involvement in grassroots social and climate justice projects, as a mechanism through which to prevent traumatic stress and support psychological resilience.
- Investigate the role of global networks in promoting prosocial action, collective responsibility and collective action aimed at managing resources effectively in improving mental health and well-being and preventing traumatic stress. Identify the most effective governance for such networks.
- Test acceptance-based, as well as evidence based cognitive behavioral approaches to help people manage persisting uncertainty and precarity about fragile environments in the context of climate change.

- Evaluate mental health and trauma-focused interventions for their environmental costs as well as economic costs and clinical benefits (e.g. using the methodology proposed by Vergunst et al., 2020).

6.4. Recommendations for ISTSS

- Support opportunities within ISTSS to explore issues of climate change and traumatic stress, such as at the ISTSS Annual Meeting.
- Establish an ISTSS special interest group on climate change and traumatic stress.

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