The nature buffer: the missing link in climate change and mental health research

Naseem Dillman-Hasso

Abstract

The connections between climate change and mental health are well known (Berry et al., Int J Publ Health 55(2):123–132, 2010; Clayton and Manning 2018; Kim et al., J Environ Sci Health C 32(3):299–318, 2014). Research also points to the positive impacts of nature on mental health, well-being, and attention (Capaldi et al., Int J Wellbeing 5(4):1–16, 2015; Kaplan and Kaplan 1989; Tillmann et al., J Epidemiol Community Health 72(10):958–966, 2018). However, no empirical research has examined how degradation of nature as a result of climate change can impact the mental health benefits that nature provides. This paper first reviews the existing research on the negative mental health consequences of climate change and the benefits of nature exposure for stress, mental health, and well-being. The connection between these two lines of research is examined in order to fully understand the impacts of climate change on mental health. Suggestions for future research are included.

Keywords Climate change · Nature · Mental health · Resilience

The climate crisis is perhaps the most existential problem of the 21st century (Butler 2018). The anthropogenic effects of climate change are often neither recognized nor addressed by those who are most at fault, and many consequences are on time scales that are difficult to conceptualize. Indeed, several studies have demonstrated that individuals discount the impact of environmental issues, and this discounting can affect their willingness to participate in action to mitigate climate change (Jacquet et al. 2013; McDonald et al. 2015). However, a lack of salience does not preclude consequences. Climate change impacts livelihoods and economies (IPCC 2018), and also has repercussions for physical and mental health (Berry et al. 2010; Luber and Lemery 2015). The benefits of nature exposure for mental health and well-being are well studied, but they are largely investigated independently from climate change, as illustrated in Fig. 1 (Kaplan and Kaplan 1989; Lackey et al. 2019; Tillmann et al. 2018; Ulrich 1984). The argument presented here is that there is a gap in the empirical research: studies of climate change and mental health do not look at how nature degradation caused by climate change may affect the positive mental health benefits that nature provides. Climate change affects nature, and reduced access to or quality of nature as a result can limit the buffer that nature has for mental health. A better integration of the two separate fields, climate change and mental health, and nature and mental health, will direct us towards possible strategies for how we can be more resilient in the face of climate change.

Climate change and mental health

The research covering the impacts of climate change on mental health is vast and varied. Many studies focus on “direct impacts” (Doherty 2018), or acute responses to events such as natural disasters or heat waves (Cryder et al. 2006; Fernandez et al. 2015; Galante and Foa 1986; McFarlane 1988; Nolen-Hoeksema and Morrow 1991; Parker et al. 2016). Increased frequency and severity of forest fires, flooding, tornadoes, hurricanes, and other natural disasters have all been tied to climate change, and mental health ramifications increase as a result. For example, increases in posttraumatic stress disorder (PTSD) and major depressive disorder (MDD) rates are consequences of severe weather events and other natural disasters (Hussain et al. 2011). After Hurricane Katrina, the prevalence of PTSD among those impacted by the storm was around 20%, and communities closer to the severe flooding had even...
higher rates (Galea et al. 2008). After the 2010 earthquake in Haiti, the rate of MDD was close to 30% (Cerdá et al. 2013). The link between heat and increased aggression is well known (Anderson et al. 2000), but heat waves are also tied to increased mental health issues (Palinkas and Wong 2019; Manning and Clayton 2018). For instance, trauma associated with natural disasters is exacerbated by displacement, as people are forced to flee their homes. Although a recent literature review has found that more research is needed to examine this additional indirect pathway, the effects of nature on mental health have to be explored.

Other research focuses on “indirect impacts” (Doherty 2018), which can describe the anxiety associated with thinking about climate change and the future, or effects of lasting climate change and chronic disruption on mental health (Manning and Clayton 2018). For instance, trauma associated with natural disasters is exacerbated by displacement, as people are forced to flee their homes. Although a recent literature review has found that more research is needed to examine exactly how climate change-forced migration affects mental health (Schwerdtle et al. 2020), the rates of depressive and anxiety disorders, along with suicide rates, are much higher than average among people who are forced to move for their jobs, such as migrant workers (Hioet et al. 2008; Hovey 2000; Hovey and Magaña 2003; Sullivan and Rehm 2005), primarily due to the stress of this moving. Similar impacts may be seen on those forced to migrate due to sea-level rise resulting from a changing climate (Shultz et al. 2019).

Global climate change also affects access to resources. Conflict will arise over resources as the growing period for crops shortens, access to freshwater decreases, and drought rates increase (Levy et al. 2017). Research has already found that a crippling drought in the Levant may have contributed to the civil war in Syria (De Châtel 2014). Other conflicts have been linked to oil, food, and fisher scarcities (Adano et al. 2012; Klare 2002; Mearns and Norton 2009). The mental health consequences for civilians who are victims of conflict have been well studied. PTSD and MDD are prevalent among those affected (Morina et al. 2018; Thabet and Vostanis 1999), especially when conflict results in displacement (Miller and Rasmussen 2016), and the effects can last from childhood to adulthood (Dyregrov et al. 2000).

Lastly, climate change increases rates of physical ailments, such as lung diseases, heatstroke, cardiovascular disease, and obesity (Luber and Lemery 2015). Physical maladies are often combined with comorbid psychopathologies (McWilliams et al. 2003), and even an increased rate of suicide (Juurlink et al. 2004).

As can be seen from the literature reviewed here, climate change has significant and varied impacts on public mental health (Bourque and Cunsolo Willox 2014; Kim et al. 2014). Modern textbooks that discuss global climate change and mental health tend to focus direct impacts (Luber and Lemery 2015; Pinkerton and Rom 2014), but more and more research is focusing on indirect impacts. However, these indirect impacts have not yet addressed an important causal connection. Climate change has a deleterious effect on nature in a variety of ways. If nature has positive effects on mental health, then its degradation as a result of climate change could in turn have a negative effect on mental health. In order to start to examine this additional indirect pathway, the effects of nature on mental health have to be explored.

### Nature and mental health

The natural environment has many benefits for mental health.1 The Attention Restoration Theory (Kaplan and Kaplan 1989) posits that interaction with nature reduces attentional fatigue and, through that, rejuvenates cognitive processes and improves mental health (for a detailed explanation of the theory, see Kaplan 1995). A complementary theory, aptly named the Stress Reduction Theory, describes the links between nature and stress. This theory argues that exposure to nature can also reduce stress and improve mental health generally, as a result (Ulrich et al. 1991).

A substantial body of work has found support for and expanded upon both of these theories. Ulrich (1984) discussed the therapeutic benefits nature provides, even with minimal exposure. For example, over a period of 10 years, hospital records showed that those recovering from surgery experienced fewer complications, self-reported lower pain, and were

---

1 For the purposes of this paper, I will be using the term “nature” and “natural environment” as a general term for all non-built environments (including green space) so as to not presuppose anyone’s personal experiences with nature or what they consider to be a natural environment. However, some research in art preferences seems to indicate that the types of natural environments that people prefer are consistent across cultures (Komar and Melamid 1999).
discharged faster if their room had a view of a tree as opposed to a brick wall through a window. Other research has shown that spending time outdoors as opposed to indoors while exercising improves attentional control (Rogerson et al. 2016).

Exposure to nature can also lead to lower levels of stress and act as a buffer in distressing situations, even for gradeschool children (Wells and Evans 2003). Looking at both maternal reports of psychological distress and a child’s self-report of “self-worth,” researchers found that after controlling for socioeconomic status, children with more “natural” area in and near their home experienced less psychological distress in response to stressful life events. In fact, the more stressful the life event, the greater effect nature had on safeguarding against psychological distress.

Other researchers have attempted to identify nature’s link to mental health by exploring autonomic nervous system activation, concluding that there are positive correlations between proximity to nature and parasympathetic nervous system activation (van den Berg et al. 2015; Yeager et al. 2018). In a study examining stress and nature, van den Berg et al. (2015) found that participants presented with pictures of green spaces as opposed to “built” (or urban) spaces for 5 min prior to a stressful task experienced greater recovery, as marked by an increase in parasympathetic nervous system activation (the “rest and digest” system). Yeager et al. (2018) examined the link between “greenness” and cardiovascular disease risk (which has been positively correlated with sympathetic nervous system activation). Using GIS data, the researchers found that participants who had higher greenness exposure had lower levels of sympathetic activation.

Nature’s benefit to human health can be further explored when the links between stress and physical health are examined, tying together the work of van den Berg et al. and Yeager et al. Continuous sympathetic nervous system activation, which causes the release of cortisol, has negative impacts on human physical health, increasing risk of cardiovascular disease, and reducing immune system function (see Yaribeygi et al. 2017 for a review of the impact of stress on body function). Activating the parasympathetic nervous system through exposure to nature would lower the risk for all of these problems and, additionally, decrease mental fatigue. As studies have shown, the parasympathetic nervous system is activated both after controlled exposure to nature (such as in a laboratory setting or after viewing a picture of nature) and with long-term continuous exposure to nature (such as living in a green area).

More recent research has focused on the duration and type of nature exposure needed for individuals to gain mental health and well-being benefits. While longer and more immersive experiences are better (Stevenson et al. 2018), even relatively short exposures of 30–120 min a week can show positive results ( Shanahan et al. 2016; White et al. 2019).

Research on the relationship between nature and mental health is not limited to psychology. The topic is also addressed in public health, psychiatry, environmental studies, urban design, and human ecology fields. While this section is not a comprehensive review of all the literature on this topic, the consensus is clear: nature has positive effects on well-being and mental health (see Hartig et al. 2014 and Shanahan et al. 2015 for discussions of public health benefits of nature, especially in urban environments; Annerstedt and Währborg 2011 for a review on nature-assisted therapy; Collado et al. 2017 for a review of restorative environments; and Franco et al. 2017 for a review on other sensory benefits of nature exposure).

**Connecting climate change, nature, and mental health**

The connections between climate change and mental health may seem obvious and well documented, as are the connections between nature and mental health. However, little empirical research includes nature as an explicit buffer between climate change and mental health. The research that does connect climate change, nature, and mental health generally looks at the impact of loss of biodiversity on mental health and ecological grief. An American Psychological Association report in 2009 mentions the need for future research on how climate change may affect the positive benefits nature exposure has, specifically in the context of reduction in biodiversity (Swim et al. 2009). While climate change may not cause areas of nature to vanish, they will transform, and one aspect of this transformation is a reduction in biodiversity. These changes may disproportionately affect lower income communities as the cost of maintaining green spaces rises. An early literature review looking at biodiversity and health and well-being found inconclusive results, particularly the studies focused on psychological well-being (Lovell et al. 2014). A more recent review found that the results are still mixed, with some studies finding evidence that biodiversity promotes mental health and well-being while other studies find non-significant results (Marselle et al. 2019, b); additional research focused on perceived species richness and mental health also found inconclusive correlations (Southon et al. 2018). However, biodiversity loss is only one facet of climate change caused nature degradation.

Another recent line of research that has begun to integrate climate change, nature, and mental health specifically examines the responses people have as a result of nature loss due to climate change (Cunsolo and Ellis 2018), building on previous research of emotional connections to nature (Dufrechou 2004) and distress caused by change in nature (Albrecht et al. 2007). This indirect link between climate change and mental health, called ecological grief, describes the reaction that a person can have in response to either physical ecological losses, loss of environmental identity, or anticipated future

### Acknowledgements

This research was supported by the Natural Sciences and Engineering Research Council of Canada (NSERC) and the Environmental Change Institute, University of Oxford. The authors would like to thank the participants for their participation in the study and the reviewers for their helpful comments. The authors declare no conflict of interest.
ecological loss, tied to the personal experiences that they have had with nature and the loss of a sense of belonging (Cunsolo and Ellis 2018).

Ecological grief, while important to consider in the context of climate change and mental health, does not address the gap in empirical research proposed here. Nature itself acts as a buffer for mental health (Marselle et al. 2019, b; Van den Berg et al. 2010; Wells and Evans 2003), and climate change is degrading this buffer. Climate change will disrupt the way individuals interact with nature, potentially leading to changes in mental health. The research outlined above illustrates just a few of the ways that nature can have an impact on physical and mental health. Limiting access to nature may also restrict the benefits humans can get from nature. No research has yet attempted to empirically examine this aspect of climate change’s impact on mental health. In order to fully understand the severity of the climate crisis that we are facing, we should not ignore any aspect of the impacts of climate change on the natural environment or on human health, physical or mental. Not including the more complex and indirect pathways can minimize our understanding of the devastating effects of climate change on mental health, which reduces our ability to adequately respond to and protect against these problems.

**Conclusion**

Thinking about the consequences of climate change on mental health and positive benefits of nature on mental health and well-being separately makes it harder to understand both problems. Currently, there is no empirical research on an important question: what are the mental health implications of the nature buffer that is degraded due to climate change? Rising sea levels, increased temperatures, and more frequent natural disasters will reduce access to nature and may cause a decline in quality, due to lower biodiversity, decreased biological production, migration of invasive species, or many other factors.

While more comprehensively examining the links between biodiversity and mental health may represent a first step for future research, attention must also be paid to places where climate change has already had an impact on the natural environment, to examine the impact on the mental health of those who reside there. Longitudinal studies should also be employed in regions particularly susceptible to nature degradation due to climate change, such as coastal areas where sea level rise is occurring or forested areas that are becoming more prone to fires. In addition, studies can be done in places where nature was damaged for some reason not due to climate change, such as deforestation for development or the loss of protected lands for drilling or the creation of oil pipelines. These studies would allow us to examine the pathways of how loss of nature affects mental health, specifically examining the buffer that nature provides.

While researching how to minimize the effects of climate change is important, we increasingly need to focus on survival in a world where climate change is a reality (Bullock et al. 2017; Ristino 2019). The interactions between nature, climate change, and mental health are complex and are not easy to study. Not only are the issues difficult to understand, but it is easy to become overwhelmed with despair and anxiety at the state of the world. However, research overwhelmingly points towards how nature can help in stressful situations, and even more research discusses the importance of taking breaks and acknowledging struggles in environmental studies and sciences (Wallace et al. 2020). Understanding exactly how climate change affects nature and will therefore impact mental health is imperative if we are to become more resilient in a world affected by rapid global change.

**Acknowledgements** I would like to thank Deborah Gross and her Climate Change and Human Health class for getting me started thinking about this missing link. I’d also like to thank Deborah Gross for her incredible guidance, comments, and insights throughout every step of this project. Additionally, thank you to Julia Strand, Neil Lutsky, Erica Zweifel, Lucia Ray, and Violet Brown for providing invaluable feedback on earlier versions of this paper.

**Code availability** Not applicable.

**Author contribution** Not applicable.

**Funding** Part of this research was funded by the Towsley Endowment for Student-Faculty Research from Carleton College.

**Data availability** Not applicable.

**Declarations**

**Conflict of interest** The author declares that there is no conflict of interest.

**Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

**References**

Adano WR, Dietz T, Witsenburg K, Zaal F (2012) Climate change, violent conflict and local institutions in Kenya’s drylands. J Peace Res 49(1):65–80
Albrecht G, Sartore G-M, Connor L, Higginbotham N, Freeman S, Kelly B, Stain H, Tonna A, Pollard G (2007) Solastalgia: the distress caused by environmental change. Australas Psychiatry 15(sup1): S95–S98

Anderson CA, Anderson KB, Dorr N, DeNeve KM, Flanagan M (2000) Temperature and aggression. Adv Exp Soc Psychol 32:63–129

Annerstedt M, Währborg P (2011) Nature-assisted therapy: systematic review of controlled and observational studies. Scand J Public Health 39(4):371–388

Berry HL, Bowen K, Kjellstrom T (2010) Climate change and mental health: a causal pathways framework. Int J Publ Health 55(2):123–132. https://doi.org/10.1007/s00038-009-0112-0

Bourque F, Cunsolo Willox A (2014) Climate change: the next challenge for public mental health? Int Rev Psychiatry 26(4):415–422

Butler CD (2018) Climate change, health and existential risks to civilization: a comprehensive review (1989–2013). Int J Environ Res Public Health 15(10):2266

Capaldi CA, Passmore H-A, Zelenski JM, Dopko RL (2015) Flourishing in nature: a review of the benefits of connecting with nature and its application as a wellbeing intervention. Int J Wellbeing 5(4):1–16

Cerdá M, Paczkowski M, Galea S, Nemethy K, Péan C, Desvarieux M (2013) Psychopathology in the aftermath of the Haiti earthquake: a population-based study of posttraumatic stress disorder and major depression. Depress Anxiety 30(5):413–422

Clayton S, Manning C (2018) Psychology and climate change: human perceptions, impacts, and responses. Academic Press

Collado S, Staats H, Corraliza JA, Hartig T (2017) Restorative environments and health. In: Fleury-Bahi G, Pol E, Navarro O (eds) Handbook of Environmental Psychology and Quality of Life Research. Springer International Publishing, pp 127–148. https://doi.org/10.1007/978-3-319-31416-7_7

Cryder CH, Kilmer RP, Tedeschi RG, Calhoun LG (2006) An exploratory study of posttraumatic growth in children following a natural disaster. Am J Orthopsychiatry 76(1):65–69

Cunsolo A, Ellis NR (2018) Ecological grief as a mental health response to climate change-related loss. Nat Cling Chang 8(4):275–281

De Châtel F (2014) The role of drought and climate change in the Syrian uprising: untangling the triggers of the revolution. Middle East Stud 50(4):521–535

Doherty TJ (2018) 10 Individual impacts and resilience. In: Clayton S, Manning C (eds) Psychology and Climate Change. Academic Press, pp 245–266. https://doi.org/10.1016/B978-0-12-813130-5.00010-2

Dufrechou JP (2004) We are one: grief, weeping, and other deep emotions. Intra-and intergenerational discounting in the climate game. Nat Cling Chang 3(12):1025–1028

Fernandez A, Black J, Jones M, Wilson L, Salvador-Carulla L, Astell-Burt T, Black D (2015) Flooding and mental health: a systematic mapping review. PLoS One 10(4):e0119929

Francesco I, Shankah DF, Fuller RA (2017) A review of the benefits of nature experiences: more than meets the eye. Int J Environ Res Public Health 14(8):864

Galante R, Fox D (1986) An epidemiological study of psychogenic trauma and treatment effectiveness for children after a natural disaster. J Am Acad Child Psychiatry 25(3):357–363

Galea S, Tracy M, Norris F, Coffey SF (2008) Financial and social circumstances and the incidence and course of PTSD in Mississippi during the first two years after Hurricane Katrina. Journal of Trauma Stress 21(4):357–368

Hargit T, Mitchell R, De Vries S, Frumkin H (2014) Nature and health. Annu Rev Public Health 35:207–228

Hiott AE, Grzywacz JG, Davis SW, Quandt SA, Arcury TA (2008) Migrant farmworker stress: mental health implications. J Rural Health 24(1):32–39

Hovey JD (2000) Acculturative stress, depression, and suicidal ideation in Mexican immigrants. Cult Divers Ethn Minor Psychol 6(2):134–151

Hovey JD, Magaña CG (2003) Suicide risk factors among Mexican migrant farmworkers in the Midwest United States. Arch Suicide Res 7(2):107–121

Hussain A, Weisaeth L, Heir T (2011) Psychiatric disorders and functional impairment among disaster victims after exposure to a natural disaster: a population based study. J Affect Disord 129(1–2):135–141

IPCC, I. P. C. C (2018) 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, sustainable development, and efforts to eradicate poverty. Intergovernmental Panel on Climate Change

Jacquet J, Hagel K, Hauert C, Marotzke J, Röhl T, Milinski M (2013) Intra-and intergenerational discounting in the climate game. Nat Cling Chang 3(12):1025–1028

Jayarajan K, Hermann N, Szalai JP, Kopp A, Redmeiler DA (2004) Medical illness and the risk of suicide in the elderly. Arch Intern Med 164(11):1179–1184. https://doi.org/10.1001/archinte.164.11.1179

Kaplan S (1995) The restorative benefits of nature: toward an integrative framework. J Environ Psychol 15(3):169–182

Kaplan R, Kaplan S (1989) The experience of nature: a psychological perspective. CUP Archive

Kim K-H, Kabir E, Ara Jahan S (2014) A review of the consequences of global climate change on human health. J Environ Sci Health C 32(3):299–318

Klare MT (2002) The deadly nexus: oil, terrorism, and America’s national security. Curr Hist 101(659):414–420

Kumar V, Melamid A (1999) Painting by numbers: Komar and Melamid’s scientific guide to art. Univ of California Press

Lackey NQ, Tyso DA, McNay GD, Joyce L, Baker KH, Hodge C (2019) Mental health benefits of nature-based recreation: a systematic review. Ann Leis Res:1–15

Levy BS, Sidel VW, Patz JA (2017) Climate change and collective violence. Annu Rev Public Health 38:241–257

Lovell R, Wheeler BD, Higgins SL, Irvine KN, Depledge MH (2014) A systematic review of the health and well-being benefits of biodiverse environments. J Toxicol Environ Health B 17(1):1–20

Luber G, Lemery J (2015) Global climate change and human health: from science to practice. John Wiley & Sons

Manning C, Clayton S (2018) 9 Threats to mental health and wellbeing associated with climate change. In: Clayton S, Manning C (eds) Psychology and Climate Change (pp. 217–244). Academic Press. https://doi.org/10.1016/B978-0-12-813130-5.00009-6

Marselle MR, Martens D, Dallimer M, Irvine KN (2019) Review of the mental health and well-being benefits of biodiversity. In: Biodiversity and health in the face of climate change. Springer, Cham, pp 175–211

Marselle MR, Warber SL, Irvine KN (2019) Growing resilience through interaction with nature: can group walks in nature buffer the effects of stressful life events on mental health? Int J Environ Res Public Health 16(6):986

McDonald RI, Chai HY, Newell BR (2015) Personal experience and the psychological distance in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Intergovernmental Panel on Climate Change

Mehlbach SG, Tysor DA, McNay GD, Joyner L, Baker KH, Hodge C (2015) Migrant farmworker stress: mental health implications. J Rural Health 31(4):329–335

Mehlbach SG, Tysor DA, McNay GD, Joyner L, Baker KH, Hodge C (2015) Migrant farmworker stress: mental health implications. J Rural Health 31(4):329–335

McFarlane AC (1988) The aetiology of post-traumatic stress disorders. Acute Stress Disorder and Posttraumatic Stress Disorder. Academic Press, pp 127–132. https://doi.org/10.1007/s00038-009-0112-0

McFarlane AC (1988) The aetiology of post-traumatic stress disorders. Acute Stress Disorder and Posttraumatic Stress Disorder. Academic Press, pp 127–132. https://doi.org/10.1007/s00038-009-0112-0

McFarlane AC (1988) The aetiology of post-traumatic stress disorders. Acute Stress Disorder and Posttraumatic Stress Disorder. Academic Press, pp 127–132. https://doi.org/10.1007/s00038-009-0112-0
McWilliams LA, Cox BJ, Enns MW (2003) Mood and anxiety disorders associated with chronic pain: an examination in a nationally representative sample. Pain 106(1–2):127–133. https://doi.org/10.1016/s0304-3959(03)00301-4

Mearns N, Norton A (2009) The social dimensions of climate change: equity and vulnerability in a warming world. The World Bank

Miller K, Rasmussen A (2016) The mental health of civilians displaced by armed conflict: an ecological model of refugee distress. Epidemiol Psychiatri Sci 26(2):129–138

Morina N, Stam K, Pollet TV, Priebe S (2018) Prevalence of depression and posttraumatic stress disorder in adult civilians survivors of war who stay in war-afflicted regions. A systematic review and meta-analysis of epidemiological studies. J Affect Disord 239:328–338

Nolen-Hoeksema S, Morrow J (1991) A prospective study of depression and posttraumatic stress symptoms after a natural disaster: the 1989 Loma Prieta Earthquake. J Pers Soc Psychol 61(1):115–121

Palinkas LA, Wong M (2019) Global climate change and mental health. Curr Opin Psychol

Parker G, Lie D, Siskind DJ, Martin-Khan M, Raphel B, Crompton D, Martin-Khan M, Raphael B, Crompton D, Milam J, Albright AE (2019) Global climate change and mental health. Springer, New York

Shultz JM, Rechkemmer A, Rai A, McManus KT (2019) Public health impacts of environmental induced forced migration. Disaster Med Public Health Preparedness 13(2):116–122

Southon GE, Jorgensen A, Dunnett N, Hoyle H, Evans KL (2018) Perceived species-richness in urban green spaces: cues, accuracy and well-being impacts. Landsc Urban Plan 172:1–10. https://doi.org/10.1016/j.landurbplan.2017.12.002

Stevenson MP, Schilhab T, Bentsen N (2018) Attention Restoration Theory II: a systematic review to clarify attention processes affected by exposure to natural environments. J Toxicol Environ Health B 21(4):227–268. https://doi.org/10.1080/10937404.2018.1505571

Sullivan MM, Rehm R (2005) Mental health of undocumented Mexican immigrants: a review of the literature. Adv Nurs Sci 28(3):240–251

Swim J, Clayton S, Doherty T, Gifford R, Howard G, Reser J, Stern P, Weber E (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. American Psychological Association, Washington

Thabet AAM, Vostanis P (1999) Post-traumatic stress reactions in children of war. J Child Psychol Psychiatry Allied Discip 40(3):385–391

Thompson R, Hornigold R, Page L, Waite T (2018) Associations between high ambient temperatures and heat waves with mental health outcomes: a systematic review. Public Health 161:171–191. https://doi.org/10.1016/j.puhe.2018.06.008

Tillmann S, Tobin D, Avison W, Gilliland J (2018) Mental health benefits of interactions with nature in children and teenagers: a systematic review. J Epidemiol Community Health 72(10):958–966

Ulrich RS (1984) View through a window may influence recovery from surgery. Science 224(4647):420–421. https://doi.org/10.1126/science.614302

Ulrich RS, Simons RF, Losito BD, Fiorito E, Miles MA, Zelson M (1991) Stress recovery during exposure to natural and urban environments. J Environ Psychol 11(3):201–230. https://doi.org/10.1016/S0272-4944(05)80184-7

van den Berg MM, Maas J, Muller R, Braun A, Kaandorp W, van Lien R, van Poppel MN, van Mechelen W, van den Berg AE (2015) Autonomic nervous system responses to viewing green and built settings: differentiating between sympathetic and parasympathetic activity. Int J Environ Res Public Health 12(12):15860–15874

van den Berg AE, Maas J, Verheij RA, Groenewegen PP (2010) Green space as a buffer between stressful life events and health. Soc Sci Med 70(8):1203–1210

Wallace RL, Greenburg J, Clark SG (2020) Confronting anxiety and despair in environmental studies and sciences: an analysis and guide for students and faculty. J Environ Stud Sci:1–8

Wells NM, Evans GW (2003) Nearby nature: a buffer of life stress among rural children. Environ Behav 35(3):311–330

White MP, Alcock I, Grellier J, Wheeler BW, Hartig T, Warber SL, Bone A, Depledge MH, Fleming LE (2019) Spending at least 120 minutes in green outdoors versus indoors environmental settings: differentiating between sympathetic and parasympathetic effects. Landsc Urban Plan 172:1–13. https://doi.org/10.1016/j.landurbplan.2017.12.002

Yaribeygi H, Panahi Y, Sahraei H, Johnston TP, Sahebkar A (2017) The impact of stress on body function: a review. EXCLI J 16

Yeager R, Riggs DW, DeJarnett N, Tollerud DJ, Wilson J, Conklin DJ, Everson RA, Huber MS, Strawhecker JM, Holmgren SE, Utterback R, Billing GD, DePeters K, DePeters L, Toole TE, McCracken J, Lorkiewicz P, Xie Z, Zafar N, Krishnasamy SS, Srivastava S, Finch J, Keith RJ, DeFilippis A, Rai SN, Liu G, Bhatnagar A (2018) Association between residential greeness and cardiovascular disease risk. J Am Heart Assoc 7(24):e009117. https://doi.org/10.1161/JAHA.118.009117