

1 **8. Mental Health and Well-Being**

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1 **8.1 Key Findings**

2 **Mental Health Consequences of Exposure to Disasters**

3 **Key Finding 1:** Many people exposed to climate-related disasters experience stress and serious
4 mental health consequences. Depending on the type of the disaster, these serious mental health
5 consequences include significant symptoms of post-traumatic stress disorder (PTSD), depression,
6 and general anxiety, which often occur at the same time. The majority of affected people recover
7 over time on their own, although a significant proportion of exposed individuals develop chronic
8 levels of psychological dysfunction. [*Very High Confidence*]

9 **Specific Groups of People Are at Higher Risk**

10 **Key Finding 2:** Specific groups of people are at higher risk for distress following climate-related
11 events. These groups include children, the elderly, and women (especially pregnant and post-
12 partum women), people with pre-existing mental illness, low-income persons, first-responders,
13 and people who are homeless. Communities that rely on the natural environment for sustenance
14 and livelihood and populations living in areas most susceptible to specific climate change events
15 are at increased risk for adverse mental health outcomes. [*High Confidence*]

16 **The Threat of Climate Change**

17 **Key Finding 3:** The threat of climate change, the perceived direct experience of climate change,
18 and changes to one's local environment can result in substantial adverse mental health outcomes
19 and social impacts for the American public. Virtually all Americans are exposed to the threat of
20 climate change and to events attributed to the impacts of climate change through frequent multi-
21 media coverage. [*High Confidence*]

22 **Extreme Heat May Increase Risks for People with Mental Illness**

23 **Key Finding 4:** People with mental illness, especially those who take certain prescription
24 medications to treat their illnesses, are at higher risk for poor physical and mental health due to
25 extreme heat. Increases in extreme heat will have an impact on the incidence of disease and death
26 of people with mental illness. Significant segments of people with mental illnesses who are most
27 vulnerable to extreme heat, such as the elderly, are also taking medication that impairs the body's
28 ability to regulate heat and therefore have increased vulnerability to the effects of heat. [*Very*
29 *High Confidence*]

30 **8.2 Introduction**

31 The effects of global climate change on mental health and well-being are an integral part of the
32 overall climate-related human health impacts. Mental health consequences of climate change
33 range from minimal stress and distress symptoms to clinical disorders (such as anxiety,

1 depression, post-traumatic stress, and suicidality) and from interpersonal violence to group
2 conflict (ISSC and UNESCO 2013; Doherty and Clayton 2011; Doherty 2014; Clayton et al.
3 2014). They also include effects on the everyday life, perceptions, and experience of individuals
4 and communities attempting to understand and respond appropriately to climate change and its
5 implications (ISSC and UNESCO 2013; Schmidt et al. 2013; Smith and Joffe 2013).

6 Anything that affects human health and welfare has the potential to impact mental health and
7 well-being. Therefore, the adverse mental health impacts of climate change are likely to be wide-
8 ranging, stressful, and cumulative. The social and mental health consequences of climate-related
9 events have been the focus of research for more than three decades (Chen et al. 1983; Stern
10 1992; ISSC and UNESCO 2013; Clayton et al. 2014; Doherty 2014; Swim et al. 2011). This
11 research demonstrates that the mental health and well-being consequences of climate-related
12 events, particularly natural disasters, are common and form a significant part of the overall
13 effects on health.

14 The mental health consequences of climate change related impacts rarely occur in isolation, but
15 often interact with each other. The *threat* of climate change is a key psychological and emotional
16 stressor in and of itself. Individuals and communities are affected both by direct experience of
17 local events attributed to climate change, and by exposure to information regarding climate
18 change and its effects (Devine-Wright 2013; Leiserowitz et al. 2012, 2013; Fresque-Baxter and
19 Armitage 2012; Reser et al. 2014). For example, public communication and media messages
20 about climate change can affect perceptions of physical and societal risks and projected
21 consequences and consequently affect mental health and well-being. The interactive and
22 cumulative nature of effects on health, mental health, and well-being are critical factors in
23 understanding the overall consequences of climate change on human health.

24 [Figure 1. Climate Change and Mental Health.]

25 **8.3 Effects of Climate Change on Mental Health and Well-being**

26 The cumulative effects of extreme weather events, gradual climate change, and the threat and
27 perception of climate change all result in potential damages to individual and societal health,
28 mental health, and well-being. The following figure illustrates how climate change impacts
29 create cascading and inter-related mental, physical, and community health effects.

30 [Figure 2: The Impact of Climate Change on Physical, Mental, and Community Health.]

31 **Extreme Weather Events**

32 In the United States, the mental health impacts of extreme weather mainly have been studied in
33 response to hurricanes and floods (Bei et al. 2013; Galea et al. 2008; Kessler et al. 2008; La
34 Greca et al. 2010, 2013; Lowe et al. 2013a; Norris et al. 2010; Pietrzak et al. 2012) and, to a
35 lesser extent, wildfires (Maida et al. 1989; Marshall et al. 2007; Jones et al. 2002; Langley and
36 Jones 2005). Many people exposed to climate-related natural disasters experience stress reactions
37 and serious mental health consequences, including significant symptoms of post-traumatic stress

1 disorder (PTSD), depression, and general anxiety, which often occur simultaneously (Lai et al.
2 2013; Ruggiero et al. 2012; Sastry and VanLandingham 2009; Scheeringa and Zeanah 2008;
3 Tracy et al. 2011).

4 Mental health effects include grief/bereavement, increased substance use or misuse, and suicidal
5 ideation (Kessler et al. 2008; Lowe and Rhodes 2013; North et al. 2011; Osofsky et al. 2011;
6 Rohrbach et al. 2009). All of these reactions have the potential to interfere with the individual's
7 functioning and well-being, and are especially problematic for certain groups, such as children,
8 women, the elderly, disaster relief workers/emergency responders, and those with preexisting
9 medical and mental health problems.

10 PTSD is most often observed among individuals who are directly exposed to life-threatening
11 events, including highly destructive disasters such as severe hurricanes (Boscarino et al. 2014;
12 Ehrlich et al. 2010; Galea et al. 2008; Garrison et al. 1995; La Greca et al. 1996, 2010; Lai et al.
13 2013; Norris et al. 2010; Osofsky et al. 2009; Paul et al. 2014; Pietrzak et al. 2013).

14 Highly destructive hurricanes – such as Hurricane Katrina in 2005 – have been associated with
15 acute stress and PTSD, domestic violence, and higher rates of depression and suicide in affected
16 communities (Harville et al. 2009; Roberts and Kelly 2008). These mental health consequences
17 are of particular concern for people facing recurrent disasters, posing a cumulative psychological
18 toll. Following Katrina, veterans with preexisting mental illness were at 6.8 times greater risk for
19 developing any additional mental illness, compared to those veterans without a preexisting
20 mental illness (Sullivan et al. 2013). Following the Florida hurricanes in 2004, increased levels
21 of PTSD were also experienced by individuals who perceived members of their community as
22 being less supportive or helpful to one another (Ursano et al. 2014).

23 Depression and general anxiety are also common consequences of climate-related disaster events
24 that involve a loss of life, resources, or social support and social networks, or events that involve
25 extensive relocation and life disruption (Boscarino et al. 2013, 2014; Felton et al. 2013; Galea et
26 al. 2007; La Greca et al. 2010, 2013; Lai et al. 2013; Norris et al. 2010; Osofsky et al. 2011; Paul
27 et al. 2014; Pina et al. 2008; Ruggiero et al. 2012; Scheeringa and Zeanah 2008; Weems and
28 Graham 2014; Silove and Steel 2006). For example, long-term anxiety and depression, as well as
29 PTSD, and increased aggression (in children) have been found to be associated with floods
30 (Ahern et al. 2005). Adults working as first responders following a disaster also experience
31 increased rates of anxiety and depression (Osofsky et al. 2011).

32 After extreme weather events, there are increases in interpersonal violence (Wenden 2011).
33 Increases in high-risk coping behaviors, such as alcohol abuse, and intimate partner violence
34 toward women have been observed in the wake of climate-related disasters (North et al. 2011;
35 Osofsky et al. 2011; Rohrbach et al. 2009; Williams et al. 2014; Beaudoin 2011; Harville et al.
36 2011).

1 Among people who are directly affected by a climate-related disaster, there is an increased
2 incidence of suicidal behaviors. In the six months following 1992's Hurricane Andrew, the rate
3 of homicide-suicides doubled in Miami-Dade County, where the hurricane hit, compared to the
4 prior five-year period that did not include hurricane activity of the same scale (Lew and Wetli
5 1996). Further, a study done 18 months after Hurricane Katrina found an increase in both
6 suicidal thoughts (from 2.8% to 6.4%) and actual suicidal plans (from 1.0% to 2.5%) (Kessler et
7 al. 2008).

8 Though many of the studies and examples provided above describe the mental health impacts of
9 specific historical events, they are demonstrative of the types of mental health issues that could
10 arise as climate change leads to further increases in the frequency, severity, or duration of some
11 types of extreme weather (see Ch. 1: Introduction and Ch. 7: Extreme Weather). As a result, the
12 mental health impacts of these events, such as hurricanes, floods, and drought, can be expected to
13 increase as more people experience the stress—and often trauma—of these disasters. When
14 climate-related disasters strike highly populated areas, the number of individuals with severe
15 stress and mental health reactions may be in the many thousands, putting a strain on the
16 availability of resources to provide adequate mental (or even immediate physical) health care.
17 Communities adversely affected by these events also have diminished interpersonal and social
18 networks available to support mental health needs and recovery due to the destruction and
19 disruption caused by the event.

20 Drought, unlike sudden extreme weather events, has a slow onset and long duration. Drought
21 interacts over time with multiple other environmental and social stressors to disrupt lives and
22 livelihoods and the functioning of individuals, households, and communities (Dai 2011; Evans
23 and Lepore 2008; Weissbecker 2011). Prolonged drought can have visible and long-term impacts
24 on landscapes, on rural agricultural industries and communities, and on individual and
25 community resilience (Albrecht et al. 2007; Sartore et al. 2008; Seery et al. 2010).

26 Although the United States has experienced drought across many western and southwestern
27 states (NOAA 2013), the effects of drought on health, mental health, and well-being are largely
28 under-reported and under-documented in the United States. However, Australian studies reveal
29 increases in levels of drought-related worry and psychological distress in drought-declared
30 regions, particularly for those experiencing loss of livelihood and industry. Studies document the
31 cascading and interacting economic, social, and daily life circumstances that accompany
32 prolonged drought in rural regions (Dean and Stain 2010; Hanigan et al. 2012; OBrien et al.
33 2014; Sartore et al. 2008; Stain et al. 2011). Drought may be linked to increased incidence of
34 suicide among male farmers (Hanigan et al. 2012; Miller and Burns 2008; Guiney 2012).

35 **Gradual Climate Change**

36 Many environmental changes linked to incremental climate change (as opposed to extreme
37 weather events) have direct physical health effects, which can activate, worsen, or interact with
38 psychological impacts (Clayton et al. 2014; Swim et al. 2011; Doherty and Clayton 2011).

1 Increasing global temperatures and poorer air quality can result in complex mental health
2 consequences because harmful exposure can vary from person to person depending on
3 preexisting vulnerabilities. The science on mental health impacts from ongoing and cumulative
4 climate change is still emerging and is less robust than the mental health research relating to
5 extreme weather events. The strongest mental health linkages are associated with exposures to
6 rising temperatures, whereas linkages related to exposures to poor air quality, infectious disease
7 vectors, and non-potable water are still emerging. Nevertheless, there is steadily accumulating
8 evidence documenting important associations between more gradual physical environmental
9 impacts due to climate change and adverse mental health and well-being impacts. Consequential
10 environmental changes such as sea level rise have the potential to affect mental health and well-
11 being for coastal communities around the world, including some of the world's largest
12 population centers. Waterborne, vectorborne, and foodborne illnesses and asthma related to poor
13 air quality and high temperatures all result in negative impacts on health, mental health and well-
14 being for the family, work, school, and social life of those who become ill.

15 **Extreme Heat**

16 Most people in the United States live in cities, and urbanization is expected to increase in the
17 future. People in cities may experience greater exposure to heat-related health effects during heat
18 waves (see Ch. 2: Extreme Temperatures). The interplay of mental health and extreme heat
19 results in increased incidences of disease and death, aggressive behavior, violence, suicide, and
20 psychiatric hospital admissions (Anderson 2011; Hansen et al. 2008; Martin-Latry et al. 2007;
21 Hsiang et al. 2013; Page et al. 2012; Ranson 2014; Wang et al. 2014; Vida et al 2012).

22 Individuals with mental illness are especially vulnerable to extreme heat or heat waves. In six
23 case-control studies involving 1,065 heat wave-related deaths, pre-existing mental illness was
24 found to triple the risk of death due to heat wave exposure (Bouchama et al. 2007). The risk of
25 death also increases during hot weather for patients with psychosis, dementia, and substance
26 misuse (Page et al. 2012). Hospital admissions have been shown to increase for those with
27 mental illness as a result of extreme heat, increasing ambient temperatures, and humidity (Wang
28 2014; Vida et al. 2012; Hansen et al. 2008). An increased death rate has also been observed in
29 those with mental illness among the cases admitted to the emergency department with a
30 diagnosis of heat-related pathology (Martin-Latry et al. 2007).

31 People who are isolated and have difficulty caring for themselves, often characteristics of the
32 elderly or those with a mental illness, are also at higher risk for heat-related incidence of disease
33 and death (Bouchama et al. 2007; Vida et al. 2012). Fewer opportunities for social interaction
34 and increased isolation put people at elevated risk for not only heat-related illness and death but
35 also decline in mental health and, in some cases, increases in aggression and violence (Clayton et
36 al. 2014). Hotter temperatures and poorer air quality limit people's outdoor activities. For many,
37 reductions in outdoor exercise and stress-reducing activities leads to worsened physical health,
38 increased stress, and poor mental health (Clayton et al. 2014).

1 Research linking extreme heat (climate-change related or otherwise) to increasing violence,
2 aggressive motives and/or aggressive behavior has been well-documented (Anderson et al.
3 1997). Hotter cities have higher rates of violence, with increasing temperatures associated with
4 parallel increases in violence for specific geographic areas (Anderson 2011). The frequency of
5 interpersonal violence and intergroup conflict rises as the climate moves toward warmer
6 temperatures or more extreme rainfall (Hsiang et al. 2013).

7 Given projections of continued climate warming, there is potential for a significant increase in
8 human conflict (Hsiang et al. 2013). This includes heightened aggression, which may result in
9 increased interpersonal violence and violent crime, negatively impacting individual and societal
10 mental health and well-being (Ranson 2014). The frequency of interpersonal violence and
11 intergroup conflict rises as the climate moves toward warmer temperatures or more extreme
12 rainfall (Hsiang et al. 2013).

13 **Vectorborne Illness**

14 The complex relationship between climate change and vectorborne illnesses is discussed in
15 Chapter 4. Individuals infected with either West Nile Virus (WNV) or Lyme disease may
16 experience a range of mental health consequences following infection that can include reduced
17 cognitive function as well depression associated with other symptoms, such as fatigue, pain, and
18 muscle and joint aches. These mental health symptoms can last for months but usually resolve
19 over time.

20 Clinical depression has been observed in patients who have West Nile Virus (Nolan et al. 2012;
21 Berg et al. 2010). In a long-term observational study, 35% of participants were found to have
22 new-onset depression. Those with the neuroinvasive (more severe) forms of WNV are at greater
23 risk for depression between 13 to 18 months post infection (Nolan et al. 2012).

24 As Lyme disease spreads into new areas, delays in diagnosis and treatment may occur due to the
25 lack of familiarity with the disease. The delay in treatment can contribute to more serious health
26 outcomes and the possibility of persistent and more difficult-to-treat symptoms (Steere et al.
27 2004). People who are left with limited mobility as a result of WNV infection can experience
28 long-term mental health impacts (Nolan et al. 2012). Patient experiences, such as undergoing an
29 extended treatment process or experiencing stress in family or work life due to a lingering
30 illness, can result in mental health consequences.

31 **Threat of Climate Change as a Key Stressor**

32 Most Americans and residents of today's developed world are routinely exposed to images,
33 headlines, and risk messages about the threat of current and projected climate change. The threat
34 includes the potential to alter the condition of the planet for many generations, with appreciable
35 and irreversible costs to other species, whole ecosystems, and human societies.

36 Noteworthy environmental changes associated with climate change constitute a powerful
37 *environmental stressor*—an ongoing and stress-inducing condition or aspect of an individual's

1 everyday environment (Aldwin and Stokols 1988; Bell et al. 2001; Evans and Lepore 2008).
2 Significant changes to one's local, natural environment and its seasons are disquieting and
3 concerning, as are projections that some acute and chronic extreme weather events will be more
4 frequent, intense, and destructive. Equally concerning are adverse impacts relating to people's
5 connections to place and identity, and consequent sense of loss and disconnection (Devine-
6 Wright 2013).

7 Public risk perceptions of the phenomenon and threat of climate change is associated with
8 stigma, dread risk (such as a heightened fear of low-probability, high-consequence events), and
9 uncertainty about the future. (Leiserowitz 2006; Lorenzoni et al. 2006; Loewenstein et al. 2001;
10 Slovic 2000, 2010; Smith et al. 2009; ISSC and UNESCO 2013; Lever-Tracy 2010; Smith and
11 Joffe 2013; Swim et al. 2011; Weissbecker 2011).

12 Research evaluating responses to the *hybrid risk* (categories of risk that are part natural and part
13 human-caused) of climate change reveals that many individuals experience a range of adverse
14 psychological responses. These reactions include heightened risk perceptions, preoccupation,
15 general anxiety, pessimism, helplessness, eroded sense of self and collective control, stress,
16 distress, sadness, loss, and guilt (Agho et al. 2010; Clayton et al. 2014; Doherty and Clayton
17 2011; Doherty 2014; Fritze et al. 2008; Reser et al. 2012a,b; Searle and Gow 2010; Ferguson and
18 Branscombe 2010).

19 Media portrayals of serious environmental risks, such as climate change, are thought to elicit
20 strong emotional responses (Nabi and Wirth 2008; Smith and Joffe 2013). The threat of climate
21 change is evidenced through frequent mention in media coverage, increasingly visible changes in
22 local environments and seasonal patterns, and in the frequency, magnitude, and intensity of
23 extreme weather events. Furthermore, 39% of national survey respondents in North America and
24 45% in Australia report direct personal encounters with environmental changes or events they
25 deemed to be manifestations of climate change (Leiserowitz et al. 2013; Reser et al. 2014).

26 While accurate risk information dissemination can result in adaptive and preventive individual
27 and collective action, the matter of virtual exposure to climate change through extensive and
28 often indiscriminate or sensationalized multi-media coverage is of concern (Clayton et al. 2014;
29 Doherty 2014; Gow 2009; Marshall 2009).

30 **Resilience and Recovery**

31 Research on individual resilience and recovery shows that a majority of individuals
32 psychologically affected by a traumatic event (such as a climate-related disaster) will recover
33 over time (Bonanno 2004). A set of positive changes which can occur in a person as a result of
34 coping with or experiencing a traumatic event is called post-traumatic growth (Shakespeare-
35 Finch et al. 2003; Tedeschi and Calhoun 1996; Lowe et al. 2013b; Taku et al. 2008).

36 Additionally, there is emerging evidence that individuals who are actively involved in climate
37 change adaptation or mitigation experience appreciable health and well-being benefit from such

1 engagement. These multiple psychological and environmental benefits do not necessarily
2 minimize distress. However, evidence suggests that when people have distress related to relevant
3 media exposure or to thinking about or discussing climate change, taking action to address the
4 issue can heighten their resolve. Such engagement both addresses the threat, and helps manage
5 the emotional responses as people come to terms with, and adjust their understandings and lives,
6 in the context of climate change (Bradley et al. 2014; Reser et al. 2012b).

7 While most people who are exposed to a traumatic event can be expected to recover over time, a
8 significant proportion (up to 20%) of individuals directly exposed develop chronic levels of
9 psychological dysfunction, which may not get better or resolve (Kronenberg et al. 2010; La
10 Greca et al. 2013; Lowe and Rhodes 2013; Mills et al. 2012; Pietrzak et al. 2013; Self-Brown et
11 al. 2013; Wadsworth et al. 2009; Weems and Graham 2014). Multiple risk factors contribute to
12 these adverse psychological effects, including disaster-related factors such as physical injury,
13 death, or loss of a loved one (Galea et al. 2007, 2008; McLaughlin et al. 2009; Norris et al. 2010),
14 loss of resources such as possessions or property (La Greca et al. 1996, 2010; Lai et al. 2013;
15 Paul et al. 2014; Pietrzak et al. 2013), and displacement (Abramson et al. 2008; Hansel et al.
16 2013; Jacob et al. 2008; Davydov et al. 2010; Freedy and Simpson 2007; Sastry and
17 VanLandingham 2009). Life events and stressors secondary to climate-related events also affect
18 mental health, including loss of jobs and social connections, financial worries, loss of social
19 support, and family distress or dysfunction (Banks and Weems 2014; Galea et al. 2008; La Greca
20 et al. 2010; McLaughlin et al. 2009; Paul et al. 2014; Pietrzak et al. 2013).

21 These disaster-related stress reactions and accompanying psychological impacts occur in many
22 individuals directly exposed to the event and can continue over extended time periods (up to a
23 year or more). For example, three months after Hurricane Andrew, 38% of children (ages 8 to 12
24 years) living in affected areas of south Florida reported symptom levels consistent with a
25 “probable diagnosis” of PTSD. At ten months post-disaster, this proportion declined to about
26 18% (La Greca et al. 1996, 2013), representing a substantial decrease but still indicating a
27 significant number of individuals with serious mental health issues resulting from the disaster
28 event.

29 **8.4 Populations of Concern**

30 Certain *populations of concern* will be at higher risk for poor mental health outcomes as the
31 negative effects of climate change progress (Swim et al. 2011; Berry et al. 2010). Significant
32 populations of concern are described below. Higher risk also exists for farmers, those with
33 limited mobility, immigrants, those living on coastal areas, those from indigenous communities
34 or tribes, and veterans (Swim et al. 2010, 2011; Doherty and Clayton 2011; Norris et al. 2002;
35 Somasundaram and van de Put 2006; Bourque and Consulo Willox 2014; Turner and Clifton
36 2009; Consulo Willox et al. 2012) (see also Ch. 9: Populations of Concern).

1 **Children**

2 Children are at particular risk for distress, anxiety, and other adverse mental health effects in the
3 aftermath of a climate-related disaster. As children are constantly growing, their reactions will
4 vary by age and developmental level. Children have an innate resilience, but can and do exhibit
5 various stress symptoms when exposed to a traumatic event. These symptoms will depend on the
6 developmental stage of the child, the level and type of exposure, the amount of destruction seen,
7 and that particular child's risk factors and protective factors (Joshi and Lewin 2004). Children
8 are dependent on others for care (Simpson et al. 2011; Clayton et al. 2014) and a significant
9 predictor of mental health and well-being in a child is the mental health status of the primary
10 caregiver. If the primary caregiver's mental health needs are being addressed, then a child will
11 fare better after experiencing a disaster or other trauma (Tees et al. 2010; Joshi and Lewin 2004;
12 Simpson et al. 2011; Clayton et al. 2014). The potential exists for an array of difficult emotional
13 and behavioral responses in children shortly after a disaster, such as depression, clinginess,
14 aggressiveness, and social withdrawal, some of which are normal and expected and will resolve
15 over time with proper support. However, children may be at a higher risk than adults of having
16 symptoms persist in the long-term. In one study, significantly more children than adults
17 demonstrated continued PTSD symptoms more than two years post-disaster, and, in general,
18 were more likely to be impaired by the disaster (Norris et al. 2002). Chronic stress from the acute
19 and ongoing impacts of climate change may alter the biological stress response systems and
20 make growing children more at risk for later mental health conditions (Simpson et al. 2011) such
21 as anxiety, depression, and other clinically diagnosable mental health conditions.

22 **Women, Pregnant Women, and Post-partum Mothers**

23 Post-disaster stress symptoms are often, but not universally, reported more frequently by women
24 than men (Dasgupta et al. 2010; Rahman 2013). Women have higher prevalence of PTSD and
25 other mental health disorders after disasters than do men (Xiong et al. 2010), and are prone to
26 greater worry and feelings of vulnerability (Trumbo et al. 2011), anxiety disorders and other
27 adverse mental health outcomes (Corrarino 2008; Norris et al. 2002). Increases in domestic
28 violence are also common after a disaster (Fritze et al. 2008; Clayton et al. 2014).

29 Pregnant and postpartum women can be quite resilient, but their resilience diminishes when
30 social supports are reduced and when they have experienced injury, illness or danger due to the
31 disaster, and when they have lived through multiple disaster experiences (Harville et al. 2009,
32 2010, 2011). Estimates indicated that there were 56,100 pregnant women and 74,900 infants
33 directly affected by hurricane Katrina (Callaghan et al. 2007) and that pregnant women with high
34 hurricane exposure and severe hurricane experiences were at a significantly increased risk for
35 PTSD and depression (Xiong et al. 2010). The increases in PTSD and depression found in
36 pregnant women exposed to hurricane Katrina was likely due to the severity of the event and the
37 intensity of the disaster experience rather than a general exposure to the event (Xiong et al. 2010;
38 Ehrlich et al. 2010).

1 The many consequences of natural disasters, such as destruction of homes, and of gradual
2 climate change impacts, such as rising temperatures, incidence of vectorborne illness, waterborne
3 illness, and even compromised food (Callaghan et al. 2007), can all contribute to the emotional
4 stress that women have while pregnant, nursing, or responsible for young children. Nutrition is
5 essential to women's health and well-being, especially if pregnant or nursing. Access to clean
6 water and food is critical, and the lack of either may affect women's ability to cope with the
7 impacts of climate change. Poor nutrition can lead to difficult pregnancies and delivery problems
8 or even low birth weight and/or death of a newborn, all of which can be immensely stressful to
9 the mother. (Triunfo and Lanzone 2015)

10 **Elderly**

11 In the United States, the number of individuals 65 years of age and older is expected to climb
12 from 47,830,000 by the end of 2015 to 98,165,000 in 2060, an increase from 14.9% of the
13 population to 23.6% (U.S. Census Bureau 2014). The aging population may have difficulty
14 responding to the challenges that come with climate change as they tend to have higher rates of
15 untreated depression and physical ailments that contribute to their overall vulnerability, such as
16 increased susceptibility to heat and accompanying physical and mental health and wellbeing
17 impacts.

18 Physical health problems are causally and reciprocally associated with the development of
19 mental health problems (Miller et al. 2009; Prince et al. 2007), particularly among older adults
20 (Katz 1996; Berry et al. 2010). Research on long-term exposures to air pollution has shown
21 poorer cognitive function and an increased rate of cognitive decline among the elderly (Power et
22 al. 2011; Ranft et al. 2009; Wellenius et al. 2012; Weuve et al. 2012; Tonne et al. 2014). The
23 literature findings, however, are mixed regarding observed responses to events (Bei et al. 2013)
24 in the elderly population. One study found a small proportion of elderly who had experienced a
25 flood had adverse reactions, such as PTSD symptoms and decline in mental health. Greater flood
26 exposure, lack of social support, higher stoicism, and the use of maladaptive coping were all
27 associated with greater deterioration in mental health after floods for seniors (Bei et al. 2013).
28 The mental health consequences experienced by the elderly in response to a disaster may
29 ultimately be due more to challenges they face with physical health, mobility, and difficulty
30 managing the disaster, rather than vulnerabilities more closely associated with clinical mental
31 health disorders (Somasundaram and van de Put 2006).

32 **Economically Disadvantaged**

33 People living in poverty and with fewer socioeconomic resources have less capacity to adapt to
34 the challenges brought by climate change. They are less able to evacuate should there be a
35 natural disaster, and are more exposed to harmful conditions created by heat waves and poor air
36 quality. Low-income people disproportionately experience the most negative impacts (Swim et
37 al. 2010; Bourque and Consulo Willox 2014) and weather-related mental distress due to more
38 fragile overall health, reduced mobility, and economic limitations reducing ability to buy goods
39 and services that could address basic comfort levels and mitigate disaster effects.

1 Many low-income people in the United States have lower educational attainment and are
2 employed in climate-dependent sectors, such as agriculture, or they live in weather- and
3 temperature-vulnerable areas, such as cities, flood zones, and drought-prone areas. As a result of
4 these cumulative risk factors, these individuals also have higher levels of distress (Coelho et al.
5 2004; Berry et al. 2010) and are more vulnerable to experiencing poor mental health due to
6 extreme weather events or other climate change impacts. This has been documented in Australia,
7 where farming communities appear to be particularly vulnerable to negative mental health
8 outcomes. The most severe impacts potentially affect older farmers, who reported experiencing
9 an overwhelming sense of loss as a result of chronic drought and its consequences (Polain et al.
10 2011).

11 **Emergency Workers and First Responders**

12 Emergency workers and first responders are exposed to deaths, injuries, diseases, and mental
13 stress caused by weather-related disasters. As some extreme weather events increase in
14 frequency and severity (See Ch. 7: Extreme Weather), there will be an increased need for
15 emergency response workers involved in rescue and cleanup (Keim 2008). Firefighters,
16 emergency medical service providers, healthcare workers, those handling human remains and
17 body recovery, as well as non-traditional first responders who may be involved with supporting
18 the community after a natural disaster are all at increased risk for mental health consequences,
19 including substance use, both in the short-term and long-term (Benedek et al. 2007; Laugharne et
20 al. 2011). The very nature of the work, which involves being exposed to a traumatic event and
21 helping others in crisis, frequently working long hours in difficult environments and away from
22 loved ones, increases the susceptibility of first responders and emergency workers to
23 experiencing negative mental health consequences. The level of stress and distress on the
24 responders increases when the injured are children or people they know (Alexander and Klein
25 2009). Vicarious trauma or identifying with the victim's suffering, and being overwhelmed by the
26 number and scope of injuries, can also impact the general mental health and well-being of all
27 responders (Fullerton et al. 1992; Alexander and Klein 2009).

28 Some studies have found rates of PTSD ranging from 13% to 18% one to four years following
29 large-scale response events. A long-term study of Australian firefighters observed that 77% of
30 those who had developed PTSD had other simultaneously occurring mental health conditions
31 such as depression, panic disorder, or phobic disorders (Benedek et al. 2007). In a study of Coast
32 Guard responders who responded to Hurricane Katrina and Rita, local responders were three
33 times more likely to report depression than non-local responders (Rusiecki et al. 2014).

34 Extreme weather events can cause damage to infrastructure (power grids, roads, and
35 transportation) and buildings and put response workers at increased risk of traumatic injury (Ch.
36 7: Extreme Weather). Responders may also be at increased risk of violence when dealing with
37 members of the public who may be stressed from shortages of food, water, sanitation, power, and
38 medical assistance. The impacts of more frequent and intense weather events result in increased

1 stress for responders and threaten their overall mental health and well-being (Noyes et al. 2009;
2 Kiefer et al. 2014).

3 **People Who Are Homeless**

4 The homeless have higher rates of mental illness than the general population. Up to 91% of
5 homeless populations in the United States live in urban and suburban areas where there is an
6 increased risk from heat waves (Ramin and Svoboda 2009). The combination of risk factors,
7 including high rates of mental illness and the geographical location of the homeless, make the
8 homeless very vulnerable to the effects of extreme heat. Those who are homeless due to natural
9 disasters are at increased risk for post-traumatic stress symptoms. This number will likely grow
10 as some extreme weather events become more frequent. The homeless are also vulnerable to
11 acquiring a vectorborne illness. For example, increases in mosquitoes have been seen after
12 hurricanes, such as after Hurricane Katrina. Those who sleep outdoors at night are at an added
13 risk for mosquito-borne illness due to increased prevalence of mosquitoes at night (Ramin and
14 Svoboda 2009). In addition to pre-existing mental health conditions and the stress and distress
15 that comes from with experiencing a natural disaster or other impact of climate change, the
16 cognitive, neurological and mental health complications that come with some of the vectorborne
17 illnesses make the homeless even more vulnerable to climate change.

18 **Individuals with Prior or Preexisting Mental Illness**

19 There are an estimated 60 million Americans who currently suffer from mental health disorders.
20 People with mental illness and those using medications to treat a variety of mental health
21 disorders such as depression, anxiety, and other mood disorders are particularly vulnerable to
22 extreme weather events and extreme heat (Berry et al. 2010). Between 2005 and 2010
23 approximately 6% of the U.S. adolescents aged 12–19 reported using medications to treat a
24 mental illness (Jonas et al. 2013). From 2005–2050, as the U.S. population and average age
25 increases, the total number of U.S. adults with depressive disorders specifically is projected to
26 increase from 33.9 million to 45.8 million, a 35% increase, with those over 65 years old having
27 the largest increase of 117% (Heo et al. 2008). As the number of people with mental health
28 disorders increases, so will the numbers of those who take medications for mental health
29 disorders, creating a larger population vulnerable to the effects of extreme heat and extreme
30 weather events.

31 Extreme weather events carry threats of psychological trauma and disruption to behavioral health
32 services systems. Individuals with mental health and stress-related disorders, such as PTSD,
33 depression, anxiety, sleep difficulties, and sometimes drug or alcohol abuse, can experience an
34 exacerbation of symptoms following a traumatic event. When infrastructure is damaged and
35 communication lines are weakened, mental health services and personal support networks get
36 disrupted too, leaving those with a mental illness vulnerable to experiencing additional negative
37 mental health consequences.

1 As discussed above, many medications used to treat a variety of mental health disorders interfere
2 with temperature regulation and heat elimination and may directly induce hyperthermia. Being
3 dehydrated can also influence the way some medications such as lithium (used to stabilize mood)
4 or anti-epileptics work in the body (Stollberger et al 2009). One of the major underlying risks for
5 death due to extreme heat is the use of medications that affect the body's ability to regulate heat
6 or have neurological effects, increasing susceptibility to the effect of heat (Berko et al. 2014).

7 After the 2012 heat wave in Wisconsin, nearly 52% of the heat-related deaths studied occurred
8 among people with at least one mental illness, and half of those were taking a medication that
9 treats mental illness and sensitizes people to heat (Christenson 2013). For cases at an emergency
10 department studied after the 2003 heat wave in France, certain drugs prescribed for depression,
11 sleep disorders, psychosis, and anxiety-related disorders were found to be independent risk
12 factors for hospitalization for heat-related causes (Martin-Latry et al. 2007). Medications used to
13 treat psychosis were also associated with increased risk of fatal heatstroke during the 1980 heat
14 wave in St. Louis and Kansas City. This increased susceptibility to heat due to certain classes of
15 medication typically used to treat mental health disorders, as well as for alcohol- and drug-
16 dependent people, and other conditions is supported by many studies (Kwok and Chan 2005;
17 Cusack et al. 2011; Faunt et al. 1995; Weir 2002; Kaiser et al. 2001; Kovats et al. 2006; Nitschke
18 et al. 2007; Hansen et al. 2008).

19 It is important to note several other factors besides the effects or side-effects of medication use
20 that might explain why people with mental illness are vulnerable to heat-related death (Kovats et
21 al. 2006; Page and Howard 2010). Isolation and deficits in care, common to those with severe
22 mental illness are critical characteristics of those with the highest rates of heat related illness and
23 death as they can lower the likelihood of utilizing preventive strategies such as showers and
24 cooling shelters during times of extreme heat (Christenson et al. 2013). Those with mental illness
25 often experience poorer overall health and have fewer social supports. Those with a combination
26 of disorders and who are taking combinations of medications are also at greater risk of heat-
27 related death.

28 **8.5 Emerging Issues**

29 Multiple issues warrant further attention regarding the impact of climate change on individuals'
30 and communities' mental health and well-being. Broadly, these include the impact on many
31 individuals from indirect, virtual exposure to the threat and attributed manifestations of climate
32 change, including climate change related disasters, the impacts of mass evacuation and
33 relocation, how individuals' understandings and attitudes toward climate change and associated
34 risk perceptions influence their disaster-related psychological reactions, and the cumulative
35 effects of media presentations of the climate-related events on mental health and well-being.

36 A more specific issue is the effects of thermal extremes on mental health, in particular
37 suicidality. Some studies report a connection between higher temperature and suicide
38 (Deisenhammer et al. 2003) with some indicating increased risk of suicide (Lee et al. 2006; Page

1 et al. 2007; Preti et al. 2007). The association between hotter temperatures and suicide appears to
2 be stronger for violent suicides than for non-violent suicides (Maes et al. 1994) and there is
3 emergent evidence that death by suicide may increase above a certain temperatures (Page et al.
4 2007; Qi et al. 2009), suggesting hot weather may trigger impulsive and aggressive behaviors.
5 More studies are needed to better understand if any correlations exist, as negative correlations
6 have also been found (Sou tre et al. 1987, 1990), as well as no correlation at all (Partonen et al.
7 2004; Dixon et al. 2007; Ruuhela et al. 2009).

8 More frequent and prolonged heat waves may increase the amount of time spent indoors. A
9 question for future exploration is what will be the effect of extended periods staying indoors on
10 people’s mental health, in particular for children and those who use the outdoors for exercise and
11 stress management?

12 Another specific issue is the effect of changes in air quality. Research has explored the effect that
13 poor air quality may have on mental health as it relates to depression and suicide (Szyszkowicz
14 2007; Szyszkowicz et al. 2009, 2010). While the current published research is not robust enough
15 to imply causation, studies have found significant associations between short-term exposure to
16 air pollution (SO₂, PM₁₀, NO₂, and CO) and emergency department admissions for depressive
17 episodes in Canada (Szyszkowicz 2007; Szyszkowicz et al. 2009). Additionally, recent studies
18 conducted outside of the United States found associations between air pollution, including
19 aeroallergens, with risk of suicide and emergency department admissions for suicide attempts
20 (Szyszkowicz et al. 2010; Kim et al. 2010; Qin et al. 2013). These emerging issues may prove to
21 have a significant impact if poor air quality conditions worsen within the United States.

22 The severity of risks to mental health and wellness for indigenous populations that have a close
23 connection to the environment, and in some cases lower economic resources, is also a concern
24 (Turner and Clifton 2009; Consulo Willox et al. 2012; Maldonado et al. 2014). All of these areas
25 will require further study.

26 With regards to the impact of climate change-related food safety risks to mental health, increased
27 CO₂ levels could decrease the nutritional value of some foods (see Ch. 6: Food Safety).
28 Malnutrition (specifically, iron deficiencies) can cause fatigue and depression in children and
29 adolescents (NCTSN 2003) but more needs to be learned regarding the mental health and
30 wellbeing impacts that will result from changes to food composition, quality, and safety due to
31 climate change.

32 There is some emerging evidence that climate change could increase the rate of food allergies.
33 Such an increase in food allergies would have an impact on mental health status, where those
34 with food allergies have higher rates of stress and anxiety (Teufel et al. 2007). Food allergy in
35 children and adolescents has been connected to psychological distress, including anxiety and
36 depression. Parents of children with food allergies have been found to have higher rates of stress
37 and anxiety than children without food allergies (Cummings et al. 2010). Some studies even

1 found that those with food allergies have higher rates of major depression, bipolar disorder, panic
2 disorder, and social phobia than those with no food allergy (Patten and Williams 2007).

3 Increasingly, people are exposed to multiple media accounts of climate change impacts. People
4 experience both indirect exposure to climate change (for example, through media accounts of
5 distant extreme weather events) as well as direct experience of unusual weather and
6 environmental changes where they live. Taken together, these create a combination of virtual,
7 vicarious, and direct exposures to climate change.

8 **8.6 Research Needs**

9 More research is needed in a number of broad areas related to mental health and well-being. As
10 health effects are studied in relation to climate change, the mental health effects and
11 consequences should be integrated into those studies to better understand the complete picture of
12 climate change's impact on human health. The effects of secondary exposure (including
13 cumulative media representations of climate change), and how an individual's understanding and
14 attitude toward the threat of climate change affects their psychological well-being and resilience
15 merit further exploration. Further research is needed to clarify the mental health effects of mass
16 evacuation and relocation resulting from loss of habitable environments in the United States.
17 Degradation of air quality, diminished food safety and security, and increased vectorborne risks
18 need to be better understood in order to project mental health consequences. The mental health
19 consequences of higher ambient temperatures may vary by region, and further research would
20 help clarify these effects and how they vary with location. Finally, as climate risks evolve and
21 interact, the stress on individual and societal mental health and well-being will require
22 standardized monitoring and study to more fully understand the risks that cumulative stress
23 poses.

24 Currently, the kind of programmatic, long-term, psychological and social impact and monitoring
25 programs and measures necessary to identify and document important changes and impacts in
26 mental health and well-being associated with climate change do not exist. National psychosocial
27 impact assessment and monitoring programs as well as standardized methodologies and
28 measures that can adequately address and document those psychological and social parameters,
29 processes, and pathways of particular relevance to current and projected mental health and well-
30 being impacts of climate change are needed.

8.7 Traceable Accounts

Process for Developing Key Messages

The key messages were developed during technical discussions and expert deliberation at a two-day workshop of all report authors on September 10–11, 2014, held in Washington D.C.; a workshop of all chapter authors held October 29, 2014, in Washington D.C.; and through multiple technical discussions via teleconferences from August through January 2015, based on reviews provided by the steering committee and the NOAA Technical Support Unit; and through other various communications on points of detail and issues of expert judgment in the interim. The author team also engaged in targeted consultations during multiple exchanges with Contributing Authors, who provided additional expertise on subsets of the key messages. These discussions were held subsequent to multiple rounds of reviews and revisions of the draft chapter, particularly between August and November 2014.

Mental Health Consequences of Exposure to Disasters

Key Finding 1: Many people exposed to climate-related disasters experience stress and serious mental health consequences. Depending on the type of the disaster, these serious mental health consequences include significant symptoms of post-traumatic stress disorder (PTSD), depression, and general anxiety, which often occur at the same time. The majority of affected people recover over time on their own, although a significant proportion of exposed individuals develop chronic levels of psychological dysfunction. [*Very High Confidence*]

Description of evidence base

The key message and supporting text summarizes extensive evidence from peer-reviewed literature demonstrating the impact of extreme weather and climate events on mental health. Individuals exposed to these extreme events experience increased rates of PTSD, anxiety, and depression. These extreme events primarily include hurricanes, tornadoes, and floods, with some studies of wildfires, drought, and winter storms.

The mental health impacts of extreme weather and climate primarily have been studied in response to hurricanes and floods (Bei et al. 2013; Boscarino et al. 2013, 2014; Felton et al. 2013; Galea et al. 2007, 2008; Felton et al. 2013; Kessler et al. 2008; La Greca et al. 2010, 2013; Lowe et al. 2013a; Norris et al. 2010; Pietrzak et al. 2012) and wildfires (Maida et al. 1989). Many people exposed to climate-related natural disasters experience stress reactions and serious psychological harm, including significant symptoms of post-traumatic stress disorder (PTSD), depression, and general anxiety, which often occur simultaneously (Lai et al. 2013; Ruggiero et al. 2012; Sastry and VanLandingham 2009; Scheeringa and Zeanah 2008; Tracy et al. 2011). PTSD (or its significant symptoms) is most often observed after acute and highly destructive disasters, such as severe hurricanes, and among individuals who are directly exposed to life-threatening events (Boscarino et al. 2014; Ehrlich et al. 2010; Galea et al. 2008; Garrison et al. 1995; La Greca et al. 1996, 2010; Lai et al. 2013; Norris et al. 2010; Osofsky et al. 2009; Paul et al. 2014; Pietrzak et al. 2013).

1 Because climate change is associated with an increase in the frequency and severity of these
2 acute weather events, people will be increasingly exposed to the precursors of PTSD such as
3 exposure to imminent danger, injury, death, and harm to significant others (Berry et al. 2010).

4 Other psychological effects also include grief/bereavement, increased substance use or misuse,
5 and suicidal ideation (Kessler et al. 2008; Lowe et al. 2011; Lowe and Rhodes 2013; North et al.
6 2011; Osofsky et al. 2011; Rohrbach et al. 2009; Williams et al. 2014) as well as distress,
7 pessimism, and frustration. All these reactions have the potential to interfere with the
8 individual's functioning and well-being, and are especially problematic for certain groups, such
9 as children, women, the elderly, disaster relief workers/emergency responders, and those with
10 pre-existing medical and psychological problems.

11 Drought also poses mental health concerns as it interacts over time with multiple other
12 environmental and social stressors to disrupt lives and livelihoods and the functioning of
13 individuals, households, and communities (Dai 2011; Evans and Lepore 2008; Weissbecker
14 2011). Prolonged drought can have very visible and long-term impacts on landscapes, on
15 sustainable rural agricultural industries and communities, and on individual and community
16 adaptive capacity and resilience (Albrecht et al. 2007; Sartore et al. 2008; Seery et al. 2010).

17 Research that has studied individual resilience and recovery shows that a majority of individuals
18 psychologically affected by a traumatic event (such as a climate-related disaster) will recover
19 over time. However, a significant proportion (typically 20% or less) of individuals directly
20 exposed to the event develop chronic levels of psychological dysfunction, which may not get
21 better or resolve (Kronenberg et al. 2010; La Greca et al. 2013; Lowe and Rhodes 2013; Mills et
22 al. 2012; Pietrzak et al. 2013; Self-Brown et al. 2013; Wadsworth et al. 2009; Weems and
23 Graham 2014). Multiple risk factors contribute to these adverse psychological effects, including
24 disaster-related factors such as physical injury, death or loss of a loved one (Galea et al. 2007;
25 Galea et al. 2008; McLaughlin et al. 2009; Norris et al. 2010), loss of resources such as
26 possessions or property (La Greca et al. 1996, 2010; Lai et al. 2013; Paul et al. 2014; Pietrzak et
27 al. 2013), and displacement (Abramson et al. 2008; Hansel et al. 2013; Jacob et al. 2008; Freedy
28 and Simpson 2007; Sastry and VanLandingham 2009).

29 These numerous studies have examined the mental health and wellness impacts of extreme
30 weather and climate events among a variety of populations. Taken on the whole, this scientific
31 evidence provides a very high level of confidence regarding the cumulative adverse impacts of
32 environmental changes and events associated with global climate change on individual and
33 societal mental health and well-being.

34 **Major uncertainties**

35 There remains uncertainty about the degree to which future extreme weather and climate events
36 will impact mental health and wellness. An increase in the scope, frequency, and/or severity of
37 these events would likely increase the number of people impacted and the degree to which they

1 are impacted. Efforts that effectively increase preparation for both the physical and psychological
2 consequences of extreme weather and climate events could decrease the impact on mental health
3 and well-being.

4 **Assessment of confidence and likelihood based on evidence**

5 Confidence level is **very high** that many people exposed to climate-related natural disasters
6 experience stress and serious mental health consequences. Increases in the number of extreme
7 weather and climate events will result in increased opportunities for more people to experience
8 traumatic exposure which can result in more people suffering adverse psychological and stress
9 reactions.

10 **Specific Groups of People Are at Higher Risk**

11 Key Finding 2: Specific groups of people are at higher risk for distress following climate-related
12 events. These groups include children, the elderly, and women (especially pregnant and post-
13 partum women), people with pre-existing mental illness, low-income persons, first-responders,
14 and people who are homeless. Communities that rely on the natural environment for sustenance
15 and livelihood and populations living in areas most susceptible to specific climate change events
16 are at increased risk for adverse mental health outcomes. [*High Confidence*]

17 **Description of evidence base**

18 Specific populations within the United States are particularly vulnerable to the mental health
19 impacts of climate change events (Swim et al. 2010, 2011; Berry et al. 2010; Somasundaram et
20 al. 2006; Bourque and Consulo Willox 2014; Doherty and Clayton 2011). Some evidence
21 suggests that children are at particular risk for distress, anxiety, and other clinical mental health
22 impacts (Joshi and Lewin 2004), such as depression, clinginess, aggressiveness, and social
23 withdrawal in the aftermath of a climate-related disaster. Children may be at a higher risk than
24 adults of having such symptoms persist in the long-term. In some studies, significantly more
25 children than adults demonstrated continued PTSD symptoms more than two years post-disaster,
26 and, in general, were more likely to be impaired by the disaster (Simpson et al. 2011; Norris et al.
27 2002).

28 Nearly 50 million Americans are over 60 years of age. Those in the United States who are 65
29 years of age and older are expected to increase from 12.4% of the population in 2000 to 20% in
30 2060 (CDC 2015). The elderly have high rates of physical and mental health disorders leaving
31 them more vulnerable to the impacts of climate change (Miller et al. 2009; Prince et al. 2007; Bei
32 et al. 2013; Somasundaram and van de Put 2006).

33 People living in poverty, including the approximately 12 percent of U.S. residents (36 million
34 people) who live below the poverty line, have less capacity to adapt to the trials that climate
35 change presents. They are less able to get out of the way of natural disasters and are more
36 exposed to harmful environmental conditions such as heat waves and poor air quality (U.S.
37 Census Bureau 2014) and disproportionately experience the most negative impacts (Swim et al.

1 2010; Bourque and Consulo Willox 2014). Those living in drought prone areas are vulnerable to
2 lower socioeconomic status and high levels of distress (Coelho et al. 2004; Berry et al. 2010;
3 Polain et al. 2011).

4 The estimated 60 million Americans who currently suffer from psychological disorders of
5 varying degrees of severity will face additional challenges when confronted with the harsh
6 realities of climate change. Additionally, post-traumatic stress disorder is frequently seen in
7 populations exposed to violent disasters, particularly, those that recur. Post-disaster stress
8 symptoms are often, but not universally reported more frequently by women than men (Dasgupta
9 et al. 2010; Rahman 2013). Following a disaster, women often have higher prevalence of PTSD
10 and other mental health disorders (Xiong et al. 2011) and other adverse psychological outcomes
11 (Trumbo et al. 2011; Corrarino 2008; Norris et al. 2002b; Fritze et al. 2008; Clayton et al. 2014;
12 Harville et al. 2009, 2010, 2011; Callaghan et al. 2007).

13 Disaster responders are at increased risk of mental and physical health problems after climate-
14 related disasters (Laugharne et al. 2011; Benedek et al. 2007; Rusiecki et al. 2014) and violence
15 when dealing with a public already stressed from shortages of food, water, sanitation, power, and
16 medical assistance. The impact of more frequent and intense weather events will threaten the
17 responder's overall mental health and well-being (Keifer et al. 2014; Noyes et al. 2009; Fullerton
18 et al. 1992).

19 **Major uncertainties**

20 Other populations living within the United States for which we have fewer published research on
21 may also be particularly vulnerable to the impacts of climate change. While there is uncertainty
22 around the magnitude of effect, there is a general agreement that climate related disasters cause
23 different emotional and behavioral responses that will lead to a psychological toll increasing the
24 likelihood of a mental illness.

25 **Assessment of confidence and likelihood based on evidence**

26 The assessment of confidence is **high** due to the scientific literature suggesting the increased
27 likelihood of a psychological toll faced by populations of concern in the aftermath of a climate-
28 related disaster. An increase in adverse climate events could result in increased exposure of
29 populations of concern and elevate the risk for mental health consequences.

30 **The Threat of Climate Change**

31 Key Finding 3: The threat of climate change, the perceived direct experience of climate change,
32 and changes to one's local environment can result in substantial adverse mental health outcomes
33 and social impacts for the American public. Virtually all Americans are exposed to the threat of
34 climate change and to events attributed to the impacts of climate change through frequent multi-
35 media coverage. [*High Confidence*]

1 **Description of evidence base**

2 The threat of climate change and perceptions of unfolding related physical environment changes
3 and extreme events attributed to climate change together constitute an unprecedented
4 environmental stressor. An environmental stressor is an ongoing and stress-inducing condition or
5 aspect of an individual's everyday environment. The scientific literature here is principally a
6 social and behavioral science literature addressing public risk perceptions, understandings, and
7 responses to the threat and unfolding environmental impacts of climate change (for example,
8 Lever-Tracy 2010; ISCC and UNESCO 2013). This includes quasi-experimental laboratory
9 research, social science-based national survey research, and survey-based mental health
10 epidemiological research. Specific research area subjects include health psychology and clinical
11 psychology based health and well-being research, social and environmental psychology
12 multidisciplinary environmental risk perception and appraisal research psychology research,
13 psychology and psychiatry based disaster mental health research, and psychosocial
14 environmental impact assessment research. Given the range and extent of this evidence base, a
15 number of the illustrative sources are themselves reviews of research areas and their findings. As
16 some particularly strong research studies have been comparative, cross-national initiatives,
17 corroborating and validating U.S. studies and measures, a number of these have been cited.

18 **Major uncertainties**

19 The major uncertainties here derive from the often challenging distinction between objective and
20 subjective exposure and experience in the case of environmental threats, given the multi-media
21 information environment that individuals are exposed to and experiencing, and the 24/7 coverage
22 of climate change and events attributed to climate change, and the multiple uncertainties in
23 public perceptions and understandings integral to the contested issue status of 'climate change
24 (social, environmental, political/policy). As well the relative absence of programmatic, longer-
25 term, impact assessment and monitoring programs and databases relating to the psychosocial
26 impacts of climate change necessitate reliance on smaller scale, typically cross-sectional studies,
27 and limited research surveys, with these latter often using single item indicators rather than
28 standardized, climate change specific, multi-item psychometric measures. Notwithstanding these
29 issues, the consistency and robustness of social science-based U.S. and cross-national survey
30 findings, the high convergence of findings between established survey indicators and sensitive
31 psychometric measures, and the convergent validity of very independent and distinctive avenues
32 of research would suggest that those inherent uncertainties of the methodologies required to
33 measure, document, and monitor important mental health and well-being impacts of climate
34 change can be confidently addressed by the consistency and convergence of programmatic
35 research findings undertaken by highly credible researchers and research institutions.

36 **Assessment of confidence and likelihood based on evidence**

37 The scientific evidence provides **high** confidence that the threat of climate change and changes to
38 one's local environment can result in mental health consequences. Scientific understanding of the
39 nature of ongoing environmental stressors generally, and climate change specifically, suggests

1 that greater environmental stressors may increase the extent and adverse nature of mental health
2 and well-being impacts.

3 **Extreme Heat May Increase Risks for People with Mental Illness**

4 Key Finding 4: People with mental illness, especially those who take certain prescription
5 medications to treat their illnesses, are at higher risk for poor physical and mental health due to
6 extreme heat. Increases in extreme heat will have an impact on the incidence of disease and
7 death of people with mental illness. Significant segments of people with mental illnesses who are
8 most vulnerable to extreme heat, such as the elderly, are also taking medication that impairs the
9 body's ability to regulate heat and therefore have increased vulnerability to the effects of heat.
10 [*Very High Confidence*]

11 **Description of evidence base**

12 In six case-control studies involving 1065 heat wave–related deaths, pre-existing mental illness
13 was found to triple the risk of death due to heat-wave exposure (Bouchama et al. 2007). After the
14 heat wave in Wisconsin in 2012, close to 52% of the heat-related fatalities studied had at least
15 one mental illness and half of those were taking a psychotropic medication (Christenson 2013).
16 After the 2013 heat wave in France, among patients admitted to the emergency department, anti-
17 cholinergic drugs, antipsychotics, and anxiolytic drugs were found to be independent risk factors
18 for hospitalization for heat-related pathologies (Martin-Latry 2007). Antipsychotics were also
19 associated with increased risk of fatal heatstroke during the 1980 heat wave in St. Louis and
20 Kansas City. This increased susceptibility to heat due to medication use for psychiatric and other
21 mental health disorders, as well as for alcohol- and drug-dependent people, is also supported by
22 numerous other studies (Kwok 2005; Cusack et al. 2011; Faunt et al. 1995; Weir 2002; Kovats et
23 al. 2006; Nitschke et al. 2007; Hansen et al. 2008).

24 Several other factors besides the effects or side-effects of medication use might explain why
25 people with mental illness are particularly vulnerable to heat-related death (Kovats et al. 2006;
26 Page et al. 2010). Isolation and deficits in care contribute to those with mental illness having
27 increased vulnerability to heat. These characteristics can lower the likelihood of utilizing
28 preventive strategies such as showers and cooling shelters during times of extreme heat
29 (Christenson et al. 2013). This population often experiences poorer overall health and has fewer
30 social supports.

31 People with pre-existing mental illness and those on psychotropic medications, including the
32 elderly and children, will be at higher risk for poor mental health outcomes due to increased heat
33 given projections of climate warming. Those with a combination of disorders and who take
34 combinations of medications are also at greater risk of heat-related mortality.

35 Climate-related events and incidents have the potential to expose an estimated 200 million
36 Americans to serious psychological distress. Most Americans live in cities, where individuals
37 may be more exposed to heat waves. Individuals with prior mental illness are especially

1 vulnerable to extreme heat or heat waves and there is a large body of research, which supports
2 this finding with a high level of agreement. In six case-control studies involving 1065 heat wave–
3 related deaths, pre-existing mental illness was found to triple the risk of death due to heat-wave
4 exposure (Bouchama et al. 2007). Mental, behavioral, and cognitive disorders can be triggered or
5 exacerbated by heat waves. Studies have observed an increased risk of death during hot weather
6 in patients with specific illnesses impacted by heat including dementia, mood disorders, neurosis
7 and stress related, and substance abuse (Hansen et al. 2008; Martin-Latry et al. 2007; Page et al.
8 2012). Studies from the United States, Australia, Taiwan, Canada, and the UK have shown
9 increases in hospital admissions for those with mental illness due to extreme heat, increasing
10 ambient temperatures, and humidity (Wang et al. 2014; Vida et al. 2012; Hansen et al. 2008).

11 According to the National Survey on Drug Use and Health between 2002 and 2013, the
12 percentage of adults ages 18 or older using prescription medication for mental health issues
13 increased from 10.5% to 12.5%, a 19% increase (SAMHSA 2014). Furthermore, extreme heat,
14 heat waves, and hotter temperatures in geographic areas not accustomed to higher temperatures
15 will become more frequent and intense. With this warming we can anticipate a significant
16 increase in human conflict (Hsiang et al. 2013) within the United States and abroad, including
17 heightened aggression which may result in increased inter-personal violence and violent crime
18 negatively impacting individual and societal mental health and well-being (Ranson 2014).

19 One of the major underlying risks for death due to extreme heat is psychotropic drug use and use
20 of other medications that interfere with the body’s temperature regulation, and heat elimination,
21 and may directly induce hyperthermia, increasing vulnerability to heat. Being dehydrated can
22 also influence the way some medications such as lithium or antiepileptics work in the body. This
23 increased susceptibility to heat due to medication use as well as for those who are alcohol- and
24 drug-dependent, is supported by numerous studies (Bouchama et al. 2007; Kaiser et al. 2001;
25 Martin-Latry et al. 2007; Berko et al. 2014; Christenson 2013; Kwok 2005; Cusack et al. 2011;
26 Berry et al. 2010; Faunt et al. 1995; Weir 2002; Page and Howard 2010; Kovats et al. 2006;
27 Nitschke et al. 2007; Hansen et al. 2008; Stollberger et al. 2009).

28 The interplay of mental health and extreme heat results in observed incidence of illness and
29 death, increased aggressive behavior, violence, suicide, and psychiatric hospital admissions.
30 Individuals who are isolated and have difficulty caring for themselves are also at higher risk for
31 heat related morbidity and mortality (Bouchama et al. 2007; Vida et al. 2012) and these are
32 sometimes characteristics of the elderly or those with a mental illness.

33 **Major uncertainties**

34 Uncertainties include whether pharmaceutical companies will develop new medications to treat
35 mental illness and other health conditions that make individuals less susceptible to heat; whether
36 better strategies for prevention of heat related illness and death are implemented; whether
37 individuals begin to adapt over time to increases in heat. Prevention, detection, and treatment
38 without the use of medications that negatively impact the body’s ability to regulate heat, could

1 moderate the magnitude of extreme heat’s impact on those predicted to have psychiatric and
2 stress related disorders.

3 **Assessment of confidence and likelihood based on evidence**

4 Based on the evidence, there is **very high** confidence that people with mental illness, especially
5 those who take certain prescription medications to treat their illnesses, are at higher risk for poor
6 physical and mental health due to extreme heat. Given the predictions in population growth
7 among the percentage of the population who have mental health conditions and/or take the range
8 of pharmaceuticals that sensitize them to heat, there could be increases in the number of people
9 experiencing negative mental health and health outcomes due to climate change’s influence on
10 increasing temperatures.

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8.8 References

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18

1 **8.9 Figures**

2 **Figure 1. Climate Change and Mental Health**



3
4 **Caption:** Conceptual diagram illustrating the exposure pathways by which climate
5 change influences mental health and well-being. The central blue pathway includes
6 selected examples of climate drivers, the pathways by which humans are exposed to
7 health threats from those drivers, and the resulting mental health outcomes. The orange
8 path to the left indicates selected examples of additional risk factors that are not aspects
9 of climate change but that can affect human vulnerability to mental health impacts of
10 climate change. The green path to the right indicates additional protective factors that
11 may lessen human vulnerability to mental health impacts of climate change.

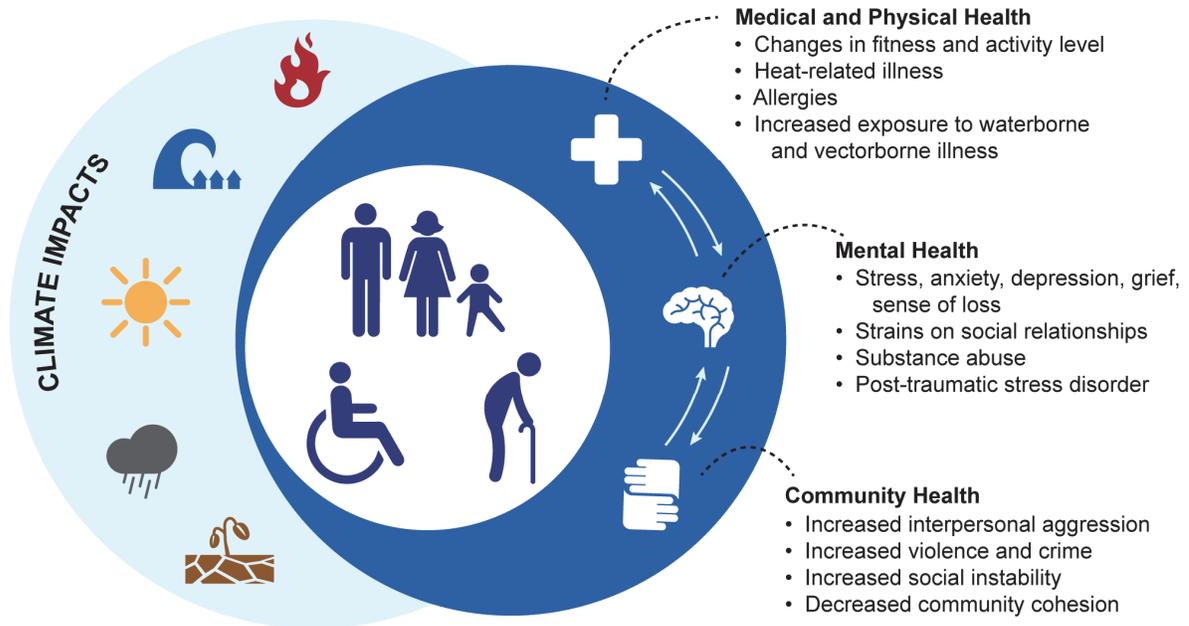
12 *These lists of risk and protective factors are not all-inclusive, but are examples.

13 **Mental health outcomes can be negative or positive depending on the individual's
14 particular circumstance, personal strengths, and individual and community risk and
15 protective factors.

16

1 **Figure 2. The Impact of Climate Change on Physical, Mental, and Community Health**

The Impact of Climate Change on Physical, Mental, and Community Health



2

3 **Caption:** At the center of the diagram are human figures representing adults, children,
4 older adults, and people with disabilities. The left circle depicts climate impacts
5 including heat, wildfires, sea-level rise, storms, and drought. The right circle shows the
6 three interconnected health domains, Medical and Physical Health, Mental Health, and
7 Community Health, that will be affected by climate impacts. (Figure source: adapted
8 from Clayton et al. 2014).