

# A dual-continuum framework to evaluate climate change impacts on mental health

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Climate change is driving a suite of stressors that could increase the global mental health burden. In this Perspective we consider three mental health frameworks to evaluate this burden. The pathogenic framework focuses on symptom management in the presence or absence of mental disorders. The salutogenic framework emphasizes factors related to psychological wellbeing such as personal strengths, resilience and socio-environmental resources. The third approach—the dual-continuum or ‘complete state’ framework—considers mental disorders and psychological wellbeing simultaneously. Drawing on the cross-disciplinary literature, we find that the dual-continuum framework is a practical and empirically valid approach to evaluate climate-related impacts on mental health. This is because mental disorders and reduced wellbeing, though related, are conceptually and empirically distinct, and encompass different climate-related antecedents and psychosocial endpoints. Both are necessary to evaluate the full burden of climate change.

Climate change is one of the most pressing challenges facing humanity<sup>1</sup>. Every region on Earth is affected, and changes to ice sheets, ocean temperatures and sea levels are expected to persist for centuries, and probably for millennia<sup>2,3</sup>. Extreme weather events—such as storms, droughts, floods and wildfires—are becoming more frequent, severe and unpredictable, and are harming human health and wellbeing<sup>4–8</sup>. Although the impacts on physical health are now well-documented, the consequences for mental health remain understudied, partly because of the complex pathways leading from initial climate hazards to eventual mental health outcomes<sup>9</sup>. Preventing and reducing mental disorders and promoting wellbeing are critical overlapping global health objectives<sup>10</sup>, but, so far, these distinct yet closely linked concepts have not been carefully examined in the context of climate change. Here we argue that a dual-continuum approach provides a practical framework for conceptualizing these overlapping mental health domains and show that the climate-related hazards and pathways to each are not necessarily the same. Although our primary goal is literature synthesis and concept development, we also discuss the implications of the approach for measurement, practice and adaptation planning.

The global mental health burden is vast<sup>11,12</sup>, yet the dimensions and scope of climate-related impacts on this burden are uncertain, and clearer definitions and concepts are sought. The Lancet Countdown on Climate Change, for example, stressed that the persistent lack of standardized definitions impeded the development of valid mental health indicators<sup>13</sup>, and a recent methodological review noted that there was “no consensus approach on how to measure the mental health effects of climate change, with measured outcomes ranging from psychological distress to suicide”<sup>14</sup>. Charlson et al.<sup>15</sup>, meanwhile, have argued that a top priority is to “understand, characterise and quantify the full range of (past, present and future) mental health outcomes impacted by climate change-related exposures.”

The current lack of conceptual clarity creates numerous challenges, including difficulties generating prevalence estimates, measurement selection and evidence synthesis. This, in turn, means that we are not equipped to develop and test the causal pathway and systems models that are needed for climate change policy development and adaptation planning<sup>9</sup>. At a minimum, a clear distinction between disorders and reduced wellbeing should be recognized because, although

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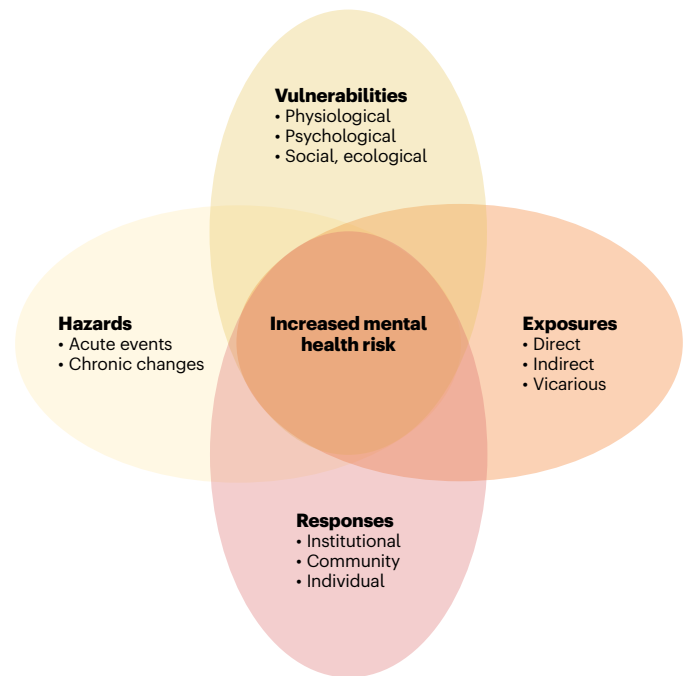
related, the domains are conceptually and empirically distinct and have different antecedents and outcomes<sup>16–20</sup>. A further reason for highlighting this distinction is that efforts to bring wellbeing into the climate change and mental health research and policy space have been only partially realized. For example, Adger et al.<sup>21</sup> note that “well-being seems to have been forgotten as a climate policy goal, despite increasing recognition from governments globally of well-being as a central objective of good governance.” We echo this call and emphasize the need to recognize wellbeing as an important end for climate policies by effectively integrating it into mental health monitoring and adaptation planning.

### Disordered or distressed?

The World Health Organization (WHO) defines mental health broadly as “a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community”<sup>22</sup>. This definition draws on internationally recognized conceptualizations of mental health and illness, including happiness, wellbeing, quality of life, social suffering, psychosocial disability, recovery and resilience<sup>23</sup>. In this Perspective, the term ‘mental health’ is used as an umbrella concept that encompasses the dual continua of mental disorders and psychological wellbeing. Here, our aim is to first examine the distinction between mental disorders on the one hand and psychological wellbeing on the other, and then evaluate the usefulness of this conceptualization for describing climate change impacts on mental health broadly.

According to the WHO, a mental disorder is “a clinically significant disturbance in an individual’s cognition, emotional regulation, or behaviour [...] usually associated with distress or impairment in important areas of functioning”<sup>10</sup>. These disorders are typically defined based on agreed-upon clinical thresholds using the International Classification of Diseases (ICD) or Diagnostic and Statistical Manual of Mental Disorders (DSM)<sup>24,25</sup>. This categorization places individuals into either a disordered or a non-disordered group, which informs the selection of treatments and prognosis. The central aim of this categorical ‘pathogenic’ approach is to identify and address the underlying causes of disorders and to alleviate or manage symptoms through therapeutic interventions.

Psychological wellbeing is a more challenging concept to define. It is moderately heritable, correlates positively with general life satisfaction, and negatively with mental health problems<sup>26,27</sup>. Definitions commonly include both feeling and functioning well, the experience of positive emotions, healthy social relationships, psychological resilience and the social and practical freedoms that enable individuals to fulfill their potential<sup>28</sup>. Both concepts and measurement practices vary across disciplines<sup>29,30</sup>. The health sciences often view wellbeing as synonymous with mental and physical health, whereas economics and other social sciences focus on financial security and standards of living. These conceptualizations also acknowledge the influential role of environmental conditions and cultural identities in shaping collective wellbeing<sup>21</sup>. Psychological wellbeing is also aligned with the concept of ‘salutogenic’ mental health, an approach that emphasizes the presence of positive emotional states and positive functioning rather than focusing solely on the prevention and treatment of illness or disorders<sup>31</sup>. In the present study, psychological wellbeing is understood as the salutogenic factors related to subjective emotions, thoughts, resilience and personal strengths, as well as objective elements associated with the ecological, material and social circumstances of individuals and groups. We do not propose a single universal definition, but rather emphasize the multidimensional nature of wellbeing that exists independent of the presence or absence of more severe psychiatric symptom manifestations and their corresponding disorders<sup>32,33</sup>. The terms wellbeing and psychological wellbeing are used interchangeably.



**Fig. 1 | Pathways and mechanisms linking climate hazards to mental health and wellbeing risks.** Mental health risks are determined by multiple interacting factors, including (1) the type of hazard, (2) existing vulnerabilities, (3) the type and degree of exposure and (4) individual and community responses to the hazard. Risks to mental health (5) include psychiatric disorders (for example, trauma and stress-related disorders such as PTSD, anxiety and depression) and reduced subjective wellbeing (for example, stress and worry). Note that domains 1 to 4 are not necessarily mutually exclusive; some overlap, and interactions between them may occur. For instance, initial vulnerabilities (2) can increase the initial risk of exposure, but also affect the likelihood of exposure and response capabilities following exposure (4). This is because many risk and protective factors within the described subdomains are linked and can thus have both direct and moderating effects. The aim of this figure is not to fully resolve these conceptual challenges, but instead to illustrate the temporal sequence from climate hazard to mental health outcomes in a way that is both intuitive and practical. Explanations of the subdomains are provided in Table 1. Figure adapted from ref. 3 under a Creative Commons license CC BY 4.0.

### Climate change and mental health

Before turning to the mental health domains described in the dual-continuum framework, it is helpful to first consider the climate-related hazards that can lead to them<sup>34</sup>. Acute hazards, such as those arising from storms, floods, wildfires and heatwaves, are the primary direct hazard that humans currently face from climate change<sup>3</sup>. These events cause widespread damage and destruction and contribute to acute stress, which is associated with increased risk for a range of psychiatric disorders through well-documented causal pathways<sup>6,35–38</sup>. Extreme weather hazards have multiple flow-on and indirect effects, including contributions to damaged infrastructure, food insecurity, disease, unemployment, displacement and forced migration. Chronic or slow-onset hazards, such as changes to landscapes and ecosystems, can also affect mental health and wellbeing<sup>6,39</sup>. Neither acute nor chronic hazards affect people equally. They are moderated and mediated by existing individual and systemic factors, including prior vulnerabilities, the type of exposure, and individual and community responsiveness (Fig. 1 and Table 1). The pathways from the initial hazard are often non-linear and act in additive, interactive and cumulative ways to increase risk for mental health vulnerability<sup>40</sup>. Mental health outcomes are, in other words, the product of collisions between initial climate hazards and the complex, interacting social and ecological systems within which individuals live their lives. Our aim here is to elucidate the mental

**Table 1 | Pathways from climate-related hazards to increased mental health vulnerability with subdomain examples for Figs. 1 and 3**

<b>1. Climate hazards</b>
<ul style="list-style-type: none"> <li>• Acute events, including extreme weather such as storms, floods, heatwaves and wildfires</li> <li>• Chronic and slow-moving changes, such as droughts, changed landscapes, shifted weather baselines, rising sea levels and lost ecosystems</li> </ul>
<b>2. Vulnerabilities</b>
<ul style="list-style-type: none"> <li>• Existing mental and physical health conditions</li> <li>• Socioeconomic inequalities, such as location, income and healthcare infrastructure</li> <li>• Sociodemographic factors, such as gender and age</li> </ul>
<b>3. Exposures</b>
<ul style="list-style-type: none"> <li>• Direct, such as the experience of extreme weather and hotter average temperatures</li> <li>• Indirect, such as lost employment, displacement, forced migration and food insecurity</li> <li>• Vicarious, such as observed experiences of others' exposure and media coverage of climate disasters</li> </ul>
<b>4. Responses</b>
<ul style="list-style-type: none"> <li>• Institutional, such as state and non-state actors' early responses, communication and resource provision</li> <li>• Community, such as the provision of social, material and information channels</li> <li>• Individual and family, such as climate change awareness and mental health support structures</li> </ul>
<b>5. Mental health vulnerability</b>
<ul style="list-style-type: none"> <li>• Mental disorders</li> <li>• Lowered wellbeing</li> </ul>

health endpoints that these collisions may generate—that is, increased disorders and lowered psychological wellbeing. The dual-continuum mental health framework is well-suited to this goal.

### A dual-continuum approach

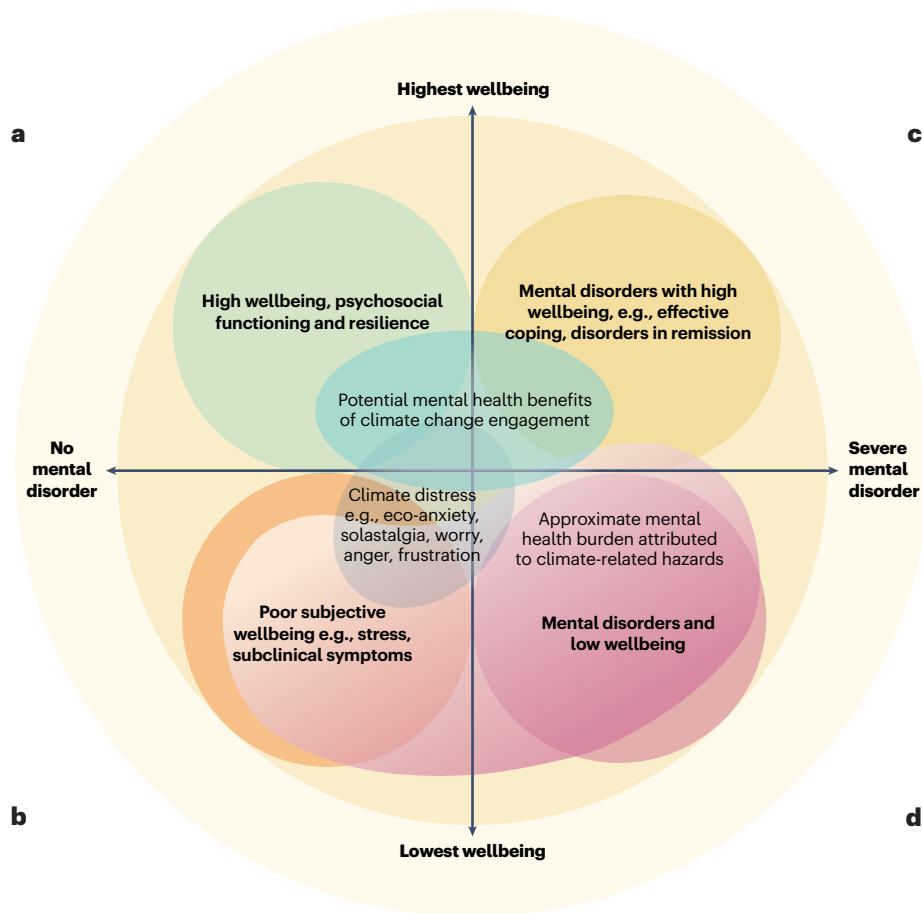
The absence of a clear dividing line between mental health and mental illness is a core idea in clinical psychology, psychiatry and mental health sciences. It implies that mental health and illness lie at opposing ends of a continuum along which individuals move between symptom states over time<sup>41</sup>. Understood this way, mental health and illness are defined by the severity of symptoms, and symptom reduction is a primary treatment objective<sup>42</sup>. This bipolar pathogenic view of mental health has widespread currency due to its clinical utility, but it has been challenged<sup>43</sup>. Early criticisms focused on its narrow and simplistic conceptualization of mental health, the arbitrary nature of clinical cut-points, and the problem of floor and ceiling effects, such that individuals cannot 'gain' mental health when it is defined by the presence or absence of a disorder<sup>42</sup>. As early as 1958, Jahoda<sup>44</sup> argued that absence of a disorder was not sufficient for mental health, and described six dimensions of positive mental health: autonomy, environmental mastery, personal growth, positive relations with others, purpose in life and self-actualization. These ideas were later incorporated into Ryff's<sup>45</sup> work on psychological wellbeing, and, together with Diener's work on subjective wellbeing, helped to bring the concept of 'positive mental health' into the social and psychological sciences mainstream<sup>43</sup>. Furthermore, the late-twentieth-century mainstream establishment of positive psychology—which emphasized the importance of studying and promoting positive aspects of human experience, such as happiness, life satisfaction and flourishing<sup>46</sup>—accelerated the move from the pathogenic model to

modern salutogenic approaches to mental health care<sup>47,48</sup>. The goal of the dual-continuum model is to integrate the pathogenic and salutogenic approaches into a single framework<sup>49</sup>.

The conceptual and empirical claim of the dual-continuum approach is that mental disorders and psychological wellbeing are influenced by related yet distinct factors, and both states coexist in different combinations. The model conceptualizes these factors as four approximate quadrants derived from two intersecting axes: the presence-to-absence of a mental disorder (pathogenic), and simultaneous low-to-high wellbeing (salutogenic)<sup>50</sup> (Fig. 2). According to this model, people in group A have no mental disorder and experience high levels of subjective wellbeing; they are well-equipped to handle life's usual stressors, even in the face of climate change and its attendant stresses<sup>51</sup>. The sociologist Corey Keyes describes people in this group as 'flourishing' or having 'complete mental health'<sup>41</sup>. People in group B do not meet criteria for a mental disorder but experience lower subjective wellbeing, and, at the extreme low end, this could harm their psychosocial functioning and reduce full participation in society. Keyes describes people in this group as 'vulnerable'<sup>42</sup>. People in group C have a mental disorder and are therefore at greater risk of future relapse and functional deterioration, although they experience high levels of subjective wellbeing. This could be due to the disorder currently being in remission or due to effective psychosocial or other support systems and personal coping strategies. People in this group are described as 'symptomatic but content'<sup>42</sup>. Finally, people in group D meet diagnostic criteria for a mental disorder and are experiencing low subjective wellbeing. This population faces the highest risks for functional impairment and social exclusion and for self-harm and suicidal behaviors. Keyes describes people who have a disorder and low psychological wellbeing as 'struggling' or 'languishing'<sup>42</sup>.

A large body of empirical work supports the distinction between the pathogenic and salutogenic domains of the dual-continuum model<sup>16,20</sup>. These studies support the validity of the approach at the phenotypic and genotypic levels<sup>49,52</sup>, across clinical and non-clinical populations<sup>53–55</sup>, in children, adolescents and adults<sup>56–58</sup>, and across the life course<sup>19,59</sup>. Furthermore, the domains described by the dual-continuum model appear to be linked to real-world outcomes, including social, educational and occupational participation and success<sup>43,60,61</sup>. Recent literature reviews support these broad findings. For example, a systematic review of 85 studies found that 87.5% of studies demonstrated factorial evidence supporting a dual-continuum model of mental health as independent but related domains<sup>16,20</sup>. The evidence, taken together, suggests that the dual-continuum model has higher utility and explanatory power than a single-continuum model, and may be particularly relevant when evaluating the impacts of complex, multidimensional stressors, such as those driven by climate change. The approach also converges with the WHO's conceptualization of mental health as a complete state<sup>22</sup>. Most importantly, the approach provides a conceptual foundation for formulating interventions across time (for example, early intervention and treatment) and levels (for example, individual and community) that may simultaneously address poor mental health and build individual wellbeing where clinically indicated and more broadly across society.

Figure 2 provides a practical illustration of how mental disorders and high or low wellbeing can be present at a point in time, and change over time, in the face of complex, multidimensional and ongoing hazards that characterize climate change. The approximate burden of climate hazards is illustrated with pink shading. Darker pink to the lower right illustrates the initial burden of acute events—especially those involving direct exposures—which, in the short and medium term, are more likely to trigger the onset of mental disorders that meet diagnostic criteria (for example, post-traumatic stress disorder (PTSD), anxiety and depression)<sup>3</sup>. The lighter pink to the left shows the initial burden of chronic hazards and the indirect and vicarious effects



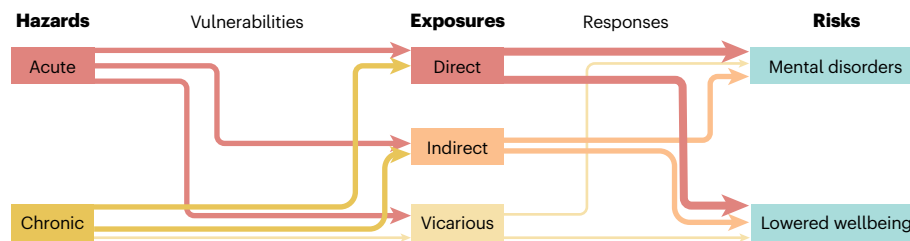
**Fig. 2 | A dual-continuum model showing the approximate burden of climate change-related risks for mental disorder and lowered wellbeing.** Although climate-related hazards will increase the incidence of mental disorders, much of the overall burden will be attributable to the domains of subclinical symptoms and lowered subjective wellbeing. According to the model, people in the left half of the figure have either high (group a) or low (group b) subjective wellbeing in the absence of a mental disorder, and people in the right half can have high (group c) or low (group d) subjective wellbeing in the presence of a mental disorder. Because mental health fluctuates over time, people may move between different segments of the figure, day by day and across the life course, especially

in response to new mental health risk or protective factors. The approximate mental health burden of climate-related hazards is illustrated by the pink shading in segments b and d. Negative psychological responses to climate change, referred to as ‘climate distress’, are shown in the purple oval. This burden lies primarily in the domain of lowered wellbeing, with potential overlap with mental disorders at the margins<sup>102,103</sup>. The potential benefits of climate action, such as opportunities for psychosocial enrichment through proactive engagement or mitigation, are shown in the teal oval in segments a and c. Note that the pathways from acute and chronic climate hazards to eventual mental health outcomes are shown in Fig. 3, with a description of pathways given in Table 1.

of direct hazards, which predominantly undermine subjective wellbeing in the absence of psychiatric disorders. In both cases, the risks to mental disorders and to lowered wellbeing can reinforce each other, as chronic stress exposure can heighten vulnerability to further harms during future acute stress events<sup>62</sup> (see section From climate hazards to mental health harms).

Another relevant impacted mental health domain is ‘climate distress’. The concept is an umbrella term for a cluster of negative emotional and psychological responses to the observed and anticipated impacts of climate change. It includes states such as feelings of fear, worry, anxiety, anger, frustration, guilt and loss, as well as broader concepts such as eco-anxiety, solastalgia and moral injury<sup>63</sup>. An emerging consensus indicates that these experiences are a rational response to the real and significant threat of climate change and are therefore not pathological<sup>63–65</sup>. There is currently little evidence linking these negative emotional states to increased risk of mental disorders in a way that is convincingly causal—indeed, the reverse is arguably more plausible, namely, that some individuals living with anxiety or mood disorders may be more likely to worry about climate change. Consequently, we suggest that climate distress is primarily associated with a reduction in subjective wellbeing.

Negative psychological responses to climate change could offer mental health and wellbeing benefits. For example, concern and worry about climate change has been linked with greater engagement with news and politics, more pro-environmental behaviors, and more proactive engagement in collective action<sup>65–69</sup>. These actions can, in turn, increase individuals’ sense of purpose, promote social and community engagement, and enhance subjective wellbeing—while also benefiting the climate<sup>70,71</sup>. Further work is of course needed to better understand the causal direction of associations seen in these studies. Thus, in the face of the climate crisis, there is potential for the growth of individual and community resilience, and climate-related action can serve as an impetus for psychosocial enrichment—for example, by creating new sources of meaning, identity, connection—which thus bolsters wellbeing. The inclusion of these positively valenced experiences is important in the development of strategies to reduce the climate-related mental health burden by enhancing population wellbeing. A caveat, however, is that certain types of climate engagement (for example, political protest) have been associated with increased distress in some studies, although results are correlational and may depend on the definitions of political activity and types of engagement<sup>65,72</sup>.



**Fig. 3 | Schematic diagram of pathways from acute and chronic climate hazards to initial mental disorders and lowered wellbeing.** The strength of associations is indicated by the size and color of the arrows, with larger, darker arrows indicating stronger links. According to this model, acute hazards that

are directly experienced have the strongest link with increased risk of mental disorders. See also Fig. 1. A description of hazards, vulnerabilities, exposures, responses and risks is given in Table 1.

### From climate hazards to mental health harms

One consideration when applying a dual-continuum framework within the climate change context is that different types of climate hazard and exposure can differentially affect mental health outcomes. Here we describe two primary hazard types identified in the IPCC (2022)<sup>3</sup> report—acute and chronic—each of which can produce direct, indirect and vicarious exposures (Fig. 2).

Acute hazards such as extreme weather events have been linked with increased risk of mental disorders with ‘very high confidence’<sup>3</sup>. These hazards, especially when they result in direct exposures, increase the risk of post-traumatic psychopathology, including the onset of new disorders such as PTSD, anxiety and depression, through clearly defined causal pathways<sup>73–75</sup> (Fig. 3). This is because many acute climate change-related stressors—such as serious injury or displacement caused by extreme weather events—can be conceptualized as potentially traumatic events (PTEs) within standard diagnostic frameworks, such as the DSM-5 criterion A. Furthermore, these ‘primary’ PTEs can amplify risk for further exposure to PTEs (for example, intimate partner and community violence) if they affect the stability and resilience of families, neighborhoods and communities, sometimes long after the initial shock. Importantly, however, epidemiological studies show that direct exposure to acute weather disasters rarely affects the mental health of more than roughly 30% of people in most samples, often considerably fewer, and a sizeable majority regain psychological equilibrium within one to two years<sup>76–78</sup>. Children, however, are more vulnerable. According to a large, multilingual systematic review of longitudinal studies of mental health following disaster exposure, the prevalence of PTSD, depression and anxiety gradually reduced over time for the adults, whereas children and adolescents experienced significantly higher rates of depression and anxiety, with delayed rates of improvement in the years following exposure<sup>79</sup>.

Chronic or slow-onset hazards can also increase risk for mental disorders, but the causal pathways are harder to establish owing to the temporal distance between the exposure and outcome and the presence of multiple potential confounding factors that make them hard to study. For example, the experience of changing weather patterns, landscapes and ecosystems could operate as ‘background’ stressors that erode resilience and undermine wellbeing (Fig. 3). A recent systematic review on chronic and slow-onset climate hazards found that some quantitative studies—particularly those on higher temperatures and drought—show positive associations between mental health problems such as depression, suicide and non-specified psychological distress, although other studies show mixed findings or null results<sup>39</sup>. Only one study in the review examined the link between chronic climate hazards and PTSD and found no association. One challenge is the uncertainty about how to define chronic and slow-onset stressors. For example, heat stress can vary in duration from days to months, making it both a short-term and long-term hazard, and adverse effects on physiology and cognition occur primarily in the short term, unless mediated by additional factors, such as sleep loss<sup>80</sup>. Clearer definitions of acute

and chronic climate hazards are therefore needed. Here we agree with Burrow and colleagues<sup>39</sup> on the need to expand the trauma-based focus to include a framework that “acknowledges how chronic, slow-onset exposures are likely to lead to more generalized outcomes unlinked to a specific event”. However, the exposures and outcomes must be more clearly specified first. Together, the current state of evidence suggests that chronic and slow-onset climate hazards have mixed or uncertain effects on rates of mental disorders—with some support for long-term heat stress and especially drought—and most of the burden is likely to fall in the domain of lowered wellbeing.

Both acute and chronic hazards can also lead to indirect and vicarious exposures. Indirect exposures include the flow-on effects of acute hazards (for example, post-disaster job losses, social disruption, displacement and forced migration) and can contribute directly to trauma and distress and lower the threshold for the onset of mental disorders<sup>81</sup>. There is extensive epidemiological evidence linking the indirect exposures described here with increased risk of mental disorders; however, the complex nature of the pathways and temporal disassociation between exposure and outcome means that the causal links are harder to demonstrate with confidence<sup>9,82</sup>. Consequently, there is a need for well-controlled longitudinal studies to identify the causal pathways from indirect exposures to adverse mental health outcomes<sup>9</sup>. Vicarious exposures occur when individuals experience distress through, for example, exposure to news media or other people’s trauma, such as by seeing, hearing or reading about distant climate-related tragedies (for example, humanitarian workers being exposed to distressing stories by survivors of climate hazards). Although vicarious exposures can affect mental wellbeing, the empirical support linking them to increased risk of disorders is limited and probably applies mainly to already-vulnerable populations who experience generally limited and transient symptoms<sup>76</sup>. Nevertheless, the subject deserves greater research attention including the question of conceptual overlap between vicarious exposures and climate distress.

Current evidence indicates that chronic and slow-onset climate hazards, as well as indirect and vicarious exposures (irrespective of the hazard type), will produce smaller initial effects on rates of mental disorders compared with acute hazards that result in direct exposures<sup>73</sup>. As noted, this observation is partly the result of methodological and measurement limitations that make it hard to identify and follow the pathways from first exposures to final outcomes. In practice, the effects of acute hazards and direct exposures may lead to more immediate and measurable acute mental health impacts (that is, disorders) and, over time, produce sustained stress that undermines wellbeing<sup>39</sup>. In the long run, the increase in minor daily stressors can increase the risk of mental disorders through multiple pathways that are often difficult to define and quantify—this includes many of the social determinants of mental health and illness<sup>62,83</sup>. The boundary between distressed and disordered is frequently blurred, and individuals may move between disordered and non-disordered states across time, depending on the time horizon. We therefore emphasize the ongoing need to define

**BOX 1****Key points**

- The mental health burden associated with climate change is vast and multifaceted; the dual-continuum framework combines pathogenic and salutogenic models to conceptualize this burden in a more holistic way.
- Acute weather hazards, especially when directly experienced, are the primary pathway to increased rates of mental disorders, with post-trauma having a key role.
- Indirect effects, including flow-on effects from acute hazards, can also lead to psychological distress, but the primary burden is likely to lie, initially, within the domain of lowered wellbeing.
- Negative psychological responses to climate change, such as worry, may be adaptive if they propel individuals to action, and probably represent a small portion of the mental health burden, associated primarily with lowered wellbeing.
- Current conceptual and methodological challenges mean that quantifying the mental distress outside of circumscribed diagnoses is difficult, and new tools are needed to measure and track this burden.
- Efforts to reduce the impact of climate change should also focus on modifying existing vulnerabilities, exposure pathways and response capabilities rather than focusing only on the treatment of mental health endpoints.

and track climate hazards and exposure types across multiple time horizons that include the immediate direct effects of acute hazards, their indirect and vicarious effects, as well as chronic hazards occurring over months or years<sup>9,40</sup>.

**Implications, limitations and future directions**

Standardized diagnostic approaches such as the ICD and DSM<sup>24,25</sup> will continue to form the backbone of efforts to track and respond to the impacts of climate change impacts on mental health. However, this framework, on its own, is not sufficient to capture the mental health domains impacted, and a broader conceptualization can be realized in several ways. First, reviews of the epidemiological evidence show that most people—typically more than two-thirds of those exposed—exhibit considerable resilience in the face of acute traumas, such as weather disasters, and will not meet criteria for a mental disorder, although they may still experience psychological suffering and distress<sup>76,77,84</sup>. Consequently, efforts to reduce climate impacts on mental health cannot focus only on clinical endpoints, such as disorders and symptoms, but must also consider wellbeing. In practice, this could take the form of describing and emphasizing prevention and intervention strategies that can reduce symptoms while simultaneously improving wellbeing, such as increasing social support<sup>85,86</sup>. The intuitive nature of the dual-continuum model means that it can be readily shared with patients to help conceptualize their mental health situation and treatment objectives in the face of climate-related hazards. This can be done by emphasizing that mental health is best characterized by intersecting pathogenic and salutogenic models, and gains in psychological wellbeing are possible even in the presence of a mental disorder. More broadly, the approach opens the door to a wider range of feasible and cost-effective preventative and restorative policy and practice interventions that are urgently needed, especially in low-resourced regions that are often most vulnerable to climate change<sup>87–89</sup>. For instance, building and strengthening community resilience, such as peer support groups, community centers, and helplines can provide individuals with information, material resources and referrals to specialized mental

health services—while also improving wellbeing<sup>90,91</sup>. Additionally, many effective methods for supporting mental health can be fostered without professional intervention. For example, increasing physical activity has positive effects on psychological wellbeing and symptoms for many common disorders<sup>92–94</sup>, so infrastructure and policy efforts that facilitate this goal should have salutogenic effects on population mental health<sup>95,96</sup>.

Second, validated measures of subjective wellbeing can be included alongside standardized clinical instruments. At a minimum, this could include the relevant subjective wellbeing domains that have been shown to have convergent, discriminant and factorial validity, which include (1) cognitive appraisal of one's life such as happiness levels, (2) positive affect and (3) negative affect<sup>32</sup>. So far, efforts to validate measures of psychological wellbeing within a dual-continuum framework have shown promising results in population and clinical samples<sup>34</sup>. Measures like these may be especially relevant to tracking long-term and slow-onset climate-related hazards. Other relevant functional domains should also be considered, such as health and social relationships, which can be assessed using a variety of validated instruments. Our aim is not to be prescriptive, but rather to highlight the availability of alternate measures, the choice of which will depend on contextual factors including the goals of community members, health practitioners, policymakers and researchers. Third, and relatedly, an even broader range of functional domains are arguably relevant and should be considered. For example, Sen's capabilities approach, which has been widely applied in development economics, emphasizes the substantive freedoms that individuals have to be and do the things that they value<sup>97,98</sup>. The capabilities approach covers multiple domains of functioning including housing, personal safety, social connection, education, meaningful activities and physical and psychological health. The capabilities approach has been applied to a mental health context, and validated instruments with good psychometric properties are available and can provide an even broader conceptualization of wellbeing<sup>99</sup>. Fourth, the delineation of mental health outcomes, and the complex pathways leading to them, underscores the need for interdisciplinary efforts to understand and mitigate climate-related threats to mental health.

Several limitations of this Review should be highlighted alongside avenues for potential future work. First, even if a single universally agreed-upon definition cannot be achieved, the inclusion of wellbeing concepts and measures alongside traditional diagnostic approaches can enrich our understanding of the mental health burden of climate change. Further work is needed to evaluate conceptualizations of wellbeing that are relevant to the diverse contexts and populations exposed to climate-related hazards and their flow-on effects<sup>23,100</sup>. Second, the proposed model does not account for health and functional domains that are known to covary with mental health vulnerability, such as cognitive development, educational attainment, physical illness and disability. Separate models are probably needed to address these domains and their interactions with mental disorders and wellbeing and should be the subject of future work. Third, the dual-continuum model provides a primarily cross-sectional view of mental health. It does not fully address the pathways that led there, such as risks that occur in early development and unfold across life, which are critical for prevention and adaptation planning. Efforts to understand and measure the mental health burden of climate change should adopt a developmental life-course perspective<sup>101</sup> that considers the additive, interactive and cumulative effects of experience and stressors on mental health outcomes<sup>40</sup>.

**Conclusions**

Although the observation that climate change is impacting mental health and wellbeing is no longer new, novel conceptualizations and measurement approaches are needed to evaluate the growing burden. Mental disorders and psychological wellbeing are empirically

distinct but overlapping concepts, independently impacted by climate change, but with different antecedents and psychosocial endpoints. Recognizing this distinction is important for conceptual development, clinical management and policy development so that a more complete understanding of the burden of climate change on mental health can be realized (Box 1).

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### Author contributions

F.V. conceptualized the Perspective and drafted the manuscript. R.W., A.M., H.L.B. and M.O. contributed to revision of the concepts, text and figures. All authors approved the final version for submission.

### Competing interests

The authors declare no competing interests.

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