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Climate Change and Mental Health: Systems Models for Understanding and Responding

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ABSTRACT

This paper examines systems models proposed for climate change and mental health through a systematic review of the evidence using the Preferred Reporting Items for Systematic Reviews and Meta method and feedback from an Indigenous Elder, knowledge bearer and co-author (Aunty Rhonda Dixon-Grovenor). While published systems models of climate change and mental health are relatively recent, markedly increasing since 2020, Indigenous cultural knowledge that exists for thousands of years helps understand the interconnectedness and interdependence of human mental health and nature. Systems modelling of climate change and mental health better reflects the complex interactions between climate change impacts on mental health and provides windows into ways to improve human mental health at individual, family, community and broader societal levels. We present a non-Indigenous systems model showing direct, indirect, physical health and awareness aspects of climate change impacts on mental health. Using a systems model approach can identify the various levels at which interventions could be considered. Specific examples of using systems models to find solutions for extreme heat are outlined in tables. The potential to improve human mental health using systems modelling to understand climate change and mental health interactions can be enhanced by collaboration and learning together with Indigenous knowledge bearers. In contrast, the failure of the government and companies to value and include the scientific knowledge from Indigenous peoples as solutions to the climate and nature crises means ignoring answers to the greatest threat to human health in this century.

1 | Introduction

1.1 | Indigenous and Non-Indigenous Perspectives on Impacts of Climate Change

Over recent decades, non-Indigenous researchers have observed connections between human mental health and human-caused damage to the natural world, coupled with a broader understanding that the care and well-being of nature is essential for human health, termed planetary health (Friel et al. 2024; Horton and Lo 2015). Systems modelling and Indigenous knowledge and culture are both better able to map these relationships between human mental health and climate and nature crises than

earlier linear models used by non-Indigenous researchers (Berry et al. 2010, 2018; Matthews et al. 2023).

Despite these apparent recent 'discoveries', these findings are not new to Indigenous culture and knowledge bearers (Dixon-Grovenor 2025; Lansbury et al. 2023; Matthews et al. 2023; Redvers et al. 2022). The oldest living culture—Aboriginal people in Australia—maintained their knowledge and culture across generations 'to live in balance with the land, animals, waterways and other people, for thousands of years, before colonization with human-caused upheaval and destruction of Mother Earth by non-Indigenous people' (Dixon-Grovenor 2025). 'People have lost their way as they have forgotten that they

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Summary

- Impacts of climate change such as extreme weather events on mental health include increases in mental disorders and serious mental illness.
- Distress from awareness of climate change is not a mental disorder, but can be a stressor that worsens or precipitates serious mental ill health.
- Systems modelling enables mapping of impacts of climate change on mental health to ways that are not possible with linear models, thus potentially revealing opportunities for improving mental health that may not be apparent otherwise.
- Indigenous cultural knowledge includes sophisticated ways, which include the advantages of systems models and have been maintained over thousands of years, of understanding and responding to the interconnectedness of nature, human activity and human mental health.
- Extractive practices of widespread land clearing and fossil fuel mining caused and continue to drive the climate and nature crises and are linked to colonial cultural views of nature as a resource to be exploited.
- Understanding and responding to the interdependence between human health and the health of nature will be required to solve the impact of climate change on mental health.
- By listening to and valuing 'First Nations' knowledge and how to engage with Mother Earth and Father Sky and each other, we can heal together with respect, communication, truth and action. We need to be out in the beautiful, healing bush and learn from First Nations' people how to love and nurture Mother Earth and each other.

are Nature. Regaining this relationship with ourselves and Mother Earth is crucial for the wellbeing of our planetary home' (Redvers et al. 2022). 'We are not linear, we are circular' (Dixon-Grovenor 2025).

Globally, Indigenous cultures and knowledge include the inherent connection of human mental health and the health of the natural world (Redvers et al. 2022). The Eco-psychology movement presents an alternative to traditional non-Indigenous psychology by seeking a better response to the climate and nature crises over multiple decades through recognising that humans are part of and dependent on nature (Rhodes and Dunk 2023). Indeed, Hippocrates' writings referring to the importance of a healthy environment for human health (Lawrence et al. 2017) echo the ancient and deep understanding of these relationships seen in Indigenous knowledge and cultures.

The anthropogenic (human-caused) impact of the last several hundred years of extractive practices of widespread land clearing and fossil fuel mining on climate change is evident (Lansbury et al. 2023; Redvers et al. 2022), but the impact on First Nations people is even greater. 'Since colonization (1788 to the present), Gadigal and Bidjigal First Nations' people were

institutionalized, put on Missions and pushed back out of our country [Sydney], murdered, massacred and denied our cultural rights to access Traditional Lands and Sacred areas. The local rivers for example, the Gooliari [Cooks River] and George's River were poisoned and many of our waterways were covered in cement. This makes it very hard as First Nations' people to continue to access our bush land so that we can collect our bush food, medicines and cultural objects for Ceremony. But we adapt and we know where to access our sacred land' (Dixon-Grovenor 2025).

Despite the destruction and accumulated trauma seen and experienced by First Nations people—of human and animal lives, of cultural rights, of traditional lands and of sacred places—First Nations' Elders continue cultural responsibilities including willingness to work with non-Indigenous people to heal country and people together (Dixon-Grovenor 2025; Lansbury et al. 2023; Redvers et al. 2022).

1.2 | Climate Change and Mental Health

Climate change has multiple, substantial impacts on mental health, including increased risk of mental disorders and rates of emergency department presentations (Crandon, Dey, et al. 2022; Crandon, Scott, et al. 2022; Lawrance et al. 2021; Nie et al. 2024; Vergunst et al. 2024; WHO 2022). Climate change is also linked with psychological stress and reduced well-being, which may occur separately, co-occur or contribute to mental disorder (Heinz and Brandt 2024; Seth et al. 2023; Vergunst et al. 2024).

For First Nations' people the devastating disruption to the animals, waterways and Mother Earth has again [compounding the ongoing impacts of colonization] traumatized our spirit and heart as everything is connected and holistic for us. When I see the Polar Bear trying to swim to the next iceberg but it's melted and he drowns that breaks my heart. When our Koalas are burnt in the bushfires and their little feet are all bandaged, that breaks my heart. When young people are dying from suicide, that breaks my heart [I am the grandmother of 17 grandchildren].

(Dixon-Grovenor 2025)

Mental disorder and/or reduced well-being can occur due to direct or indirect impacts of climate change on mental health or via mental health consequences of physical health harms of climate change, each of which are in addition to the impacts of awareness of climate change (Aylward et al. 2022; Berry et al. 2010; Crandon, Dey, et al. 2022; Crandon, Scott, et al. 2022; Lawrance et al. 2021; Sundas et al. 2024; Vergunst et al. 2024).

Increases in exposures to known risk factors for mental disorders and mental ill health are occurring across the same time period as increases in rates of mental disorders and emergency department presentations for mental ill health, particularly

among children and young people (Dey et al. 2025; Dey, Foong, et al. 2024; Dey, Wu, et al. 2024; McGorry et al. 2024; Sara et al. 2022). While correlation alone does not prove causality of a mental disorder, there are significant increases in established risk factors, such as increased exposure to more severe and frequent traumatic events (extreme weather events), disruptions to schooling and work, and forced migration (Dey et al. 2025; Vergunst et al. 2024). Indigenous knowledge bearers profoundly understand these interconnections, yet their warnings of environmental neglect have gone unheeded since colonisation (Matthews et al. 2023; Redvers et al. 2022). Both non-Indigenous and Indigenous knowledge and research point to the expectation that climate change-driven increases in exposure to known risk factors for mental health emergency presentations would increase these rates (McGorry et al. 2024). Research indicates a causal relationship between hotter weather and increased emergency presentations for mental ill health. These increases are evident from the first day of hotter weather and continue to escalate daily (Dey, Foong, et al. 2024; Dey, Wu, et al. 2024; Liu et al. 2021; Thompson et al. 2023). These links are seen across populations, time periods and settings in multiple studies, including meta-analyses. They demonstrate a dose–response effect—where milder hot weather is associated with a small but significant increase in mental ill health and the rates of emergency presentations rise, and stronger effects are seen as hot weather worsens (Dey, Foong, et al. 2024; Dey, Wu, et al. 2024; Liu et al. 2021; Thompson et al. 2023).

The complex mental health impacts of environmental disruption are not only amplified by interpersonal interactions and diverse contexts (society, culture, local community, school and family) but also moderated by individual strengths and vulnerabilities (Aylward et al. 2022; Berry et al. 2010; Lawrance et al. 2021; WHO 2022).

These impacts are occurring in parallel with increasing frequency and severity of weather-related disasters, such as wildfires, severe storms, floods and drought. Thus, people may experience compounding effects from multiple events before individuals, families or communities can recover (Aylward et al. 2022; Charlson et al. 2021; Crandon, Dey, et al. 2022; Crandon, Scott, et al. 2022; Lawrance et al. 2021). Clinical mental health impacts are compounded by widespread climate distress, which, while an appropriate and stressful response to experienced threat and loss (Crandon, Dey, et al. 2022; Crandon, Scott, et al. 2022; Lawrance et al. 2021; Sanson et al. 2019; Verplanken and Roy 2013), is more akin to grief or adjusting to chronic illness than necessarily a mental disorder (Crandon,

Dey, et al. 2022; Crandon, Scott, et al. 2022; Koder et al. 2023; Lawrance et al. 2021; Verplanken and Roy 2013).

Historically, published scientific research on climate change and other environmental impacts on mental health predominantly examines single impacts while disregarding co-occurring impacts, their interactions, and the contexts and time frame over which they occur (Berry et al. 2010; Charlson et al. 2021; Lawrance et al. 2021). Systems modelling allows description of the patterns and types of interactions between multiple factors, including where factors are interacting in non-linear patterns (e.g., feedback loops, reciprocal interactions, exponential) (Berry et al. 2010).

There is substantial published evidence of single environmental or climate factors that impact mental health (Charlson et al. 2022; Corvalan et al. 2022; Lawrance et al. 2022; Vergunst and Berry 2022); however, there is much less non-Indigenous research on mapping the multiple, interacting pathways of climate change impacts on mental health (Charlson et al. 2021; Corvalan et al. 2022; Lawrance et al. 2022; Vergunst and Berry 2021).

In contrast, Indigenous knowledge and wisdom of the interconnectedness of human activity and human health with the health of nature date back tens of thousands of years, despite only beginning to be recognised as crucial and important scientific knowledge by non-Indigenous researchers recently (HEAL Network and CRE-STRIDE 2021; Redvers et al. 2022).

2 | Systematic Review of the Literature

To provide more understanding of the published research, a systematic review was conducted to examine the use of systems models in research on climate change and mental disorders using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Page et al. 2021).

2.1 | Sources of Information and Search Strategy

The databases searched were EMBASE, CINAHL, PsycINFO, PubMed (Medline), Scopus and Web of Science. The search used the following keywords: “climate change” OR “greenhouse effect” OR “global warming” AND “mental disease” OR “mental disorder” OR “psychiatric disorder”; the search was from the inception of each database to 31 December 2024 (see Figure 1). Search results were then combined using EndNote and duplicates removed.

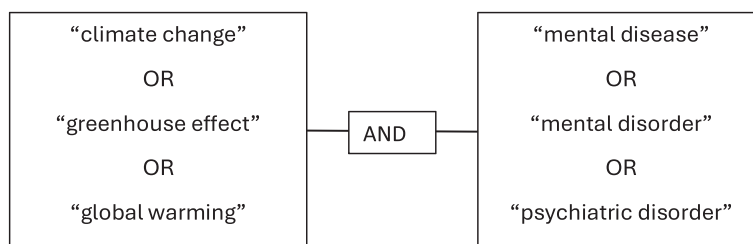


FIGURE 1 | Search terms for database search on climate change and mental disorder.

The articles thus identified were then searched by the first author (C.D.) by title and keywords and, where this did not allow differentiation, abstracts were hand searched for system/s, model/s, framework/s, interaction/s, interconnection*, cycle*, pathway* and descriptions of interactions between factors, models and pathways. Co-author (R.D.-G.) points out that ‘global warming’ actually represents a ‘global warning’ (to humanity) (Dixon-Grovenor 2025).

3 | Methods

*Records excluded by automation tool (Endnote) and excluded by human author (C.D.). From: Page et al. (2021). This work is licensed under CC BY 4.0. To view a copy of this licence, visit <https://creativecommons.org/licenses/by/4.0/>.

4 | Results

Before 2020, nine papers met the inclusion criteria (2001–2019), and in the next 5 years (2020–2024), an additional 29 papers addressed climate change and mental disorder interactions using a systems model. None of the papers identified in this review proposed or measured mental health outcomes in relation to the use of systems models to develop interventions; however, many pointed to using the understanding from these for solutions, including all papers co-authored with Indigenous knowledge bearers (HEAL Network and CRE-STRIDE 2021; Lansbury et al. 2023; Mohamed et al. 2023; Table 1).

5 | Discussion

A systems framework including potential links between climate change and mental health was described by non-Indigenous researchers in this century, by Greenough et al. (2001), and in 2009, a climate change and mental health systems model was published in the scientific literature (Berry et al. 2010; Fritze et al. 2008). We have (finally) arrived at an understanding that has been evident to Indigenous peoples for thousands of years. This is reflected in their interactive, interconnected models of nature and human health, which continue to the present day despite being, at best, largely discounted and often actively suppressed and destroyed through colonisation by non-Indigenous people (Matthews et al. 2023). Not only does Indigenous peoples' cultural knowledge include sophisticated models, but their ways of being also maintained a healthy, millennia-long relationship with the natural world. This stands in stark contrast to the extractive fossil fuel use and land-clearing practices that drive human-caused climate change (Lansbury et al. 2023).

Since the initial non-Indigenous publication of a systems model of climate change and mental health (Berry et al. 2010), benefits such as the potential to identify ways to improve mental health outcomes, whether through prevention (at multiple levels), better targeted intervention or even the way a mental health service becomes more sustainable, have been identified for using systems thinking to model climate change mental health impacts (Berry et al. 2018; Nie et al. 2024). Indigenous knowledge bearers have developed an international consensus on key ways to improve planetary health by understanding its determinants (Redvers et al. 2022). ‘Prevention is through connecting to Mother Earth,

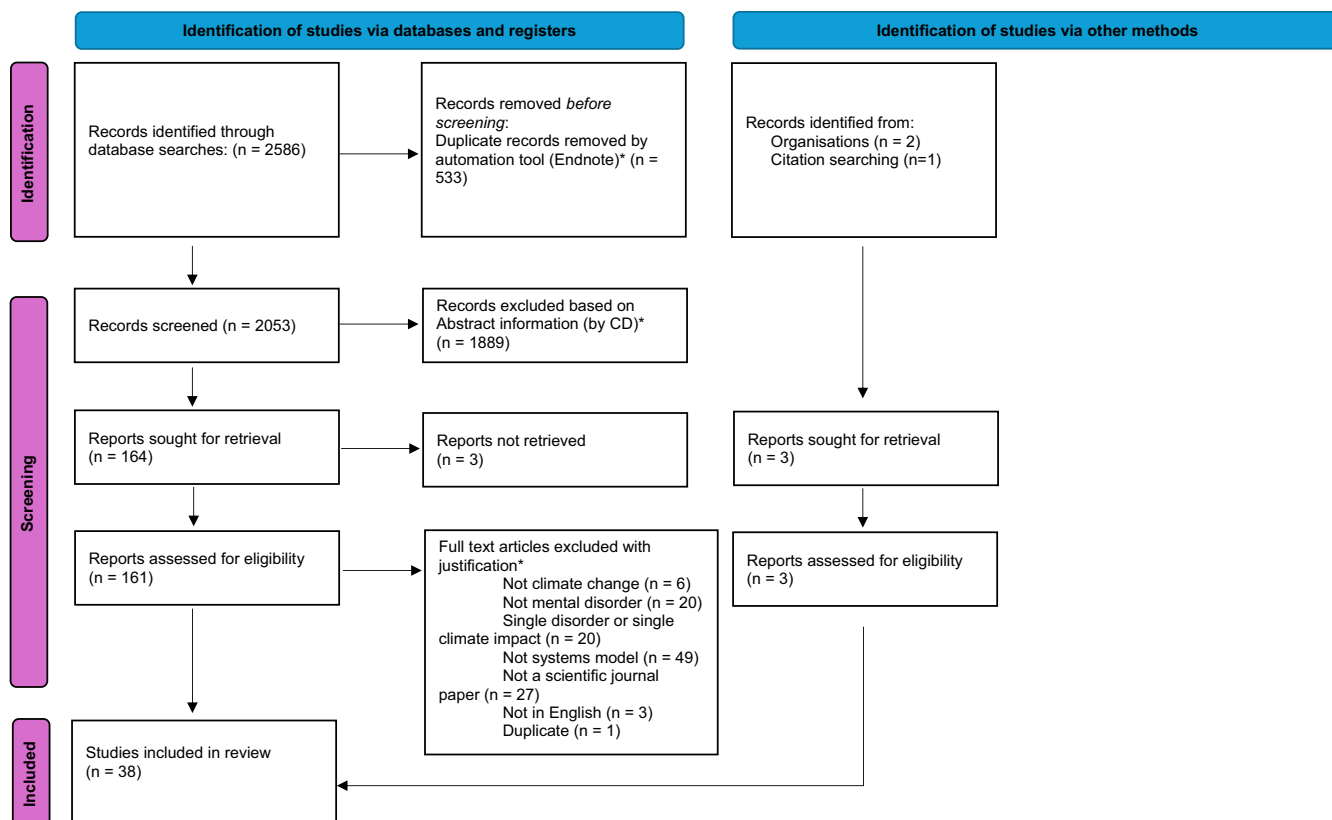


TABLE 1 | Published, peer-reviewed papers addressing climate change and mental disorder/s using a systems model.

Paper by author and year	Climate change and mental disorder as main focus	Other main focus (specified)
Greenough et al. (2001)	×	Climate change and overall health
Fritze et al. (2008)	✓	
Berry et al. (2010)	✓	
Nurse et al. (2010)	×	Climate change and mental health/well-being
Berry et al. (2011)	×	Climate change and farmers' mental health
Friel et al. (2011)	×	Climate change and non-communicable diseases
Hollifield et al. (2011)	×	Climate change and refugee psychological and psychosocial effects
Perera (2017)	×	Climate change, air pollution and child health
Moffic (2019)	×	Ecology and mental health
Nicholas et al. (2020)	×	Climate change and mental health in emergency department
Pacheco (2020)	×	Climate change impacts pre-birth
Clayton (2021)	×	Climate change and mental health
HEAL Network and CRE-STRIDE (2021)	×	Climate change and Aboriginal and Torres Strait Islander health
Marazziti et al. (2021)	×	Climate change, environmental pollution and COVID-19 and mental health
Thoma et al. (2021)	×	Climate change, environmental crisis and mental health
van Nieuwenhuizen et al. (2021)	×	Climate change and mental health
Vergunst and Berry (2021)	×	Climate change and child mental health development
Atwoli et al. (2022)	×	Climate change and mental health
Cianconi et al. (2022)	×	Biodiversity, climate change and mental health
Clemens et al. (2022)	✓	
Corvalan et al. (2022)	×	Climate change and mental health
Ma et al. (2022)	×	Climate change and mental health
Reuben et al. (2022)	×	Environment and mental health
Sahu et al. (2022)	×	Climate change and Indigenous health
Lawrance et al. (2022)	×	Climate change mental health, emotional well-being and mental disorders
Mohamed et al. (2023)	×	Climate change and Aboriginal and Torres Strait Islander health and well-being
Lansbury et al. (2023)	×	Climate justice and First Nations' justice interconnection with climate change, lived experiences
Rothschild and Haase (2023)	×	Climate change, air pollution and women's mental health
Seth et al. (2023)	×	Climate distress with differential on mental disorders
Girardi and Bremer (2024)	×	Climate and environmental changes and health of pregnant women and their babies
Heinz and Brandt (2024)	✓	

(Continues)

TABLE 1 | (Continued)

Paper by author and year	Climate change and mental disorder as main focus	Other main focus (specified)
Kabir et al. (2024)	×	Climate hazards and psychological health
Nie et al. (2024)	✓	
O'Donnell and Palinkas (2024)	✓	
Parnes et al. (2024)	×	Climate change inequity and child mental health
Rice and Usher (2024)	×	Climate change and farmers' mental health
Sundas et al. (2024)	×	Environmental factors and human health
Vergunst et al. (2024)	✓	

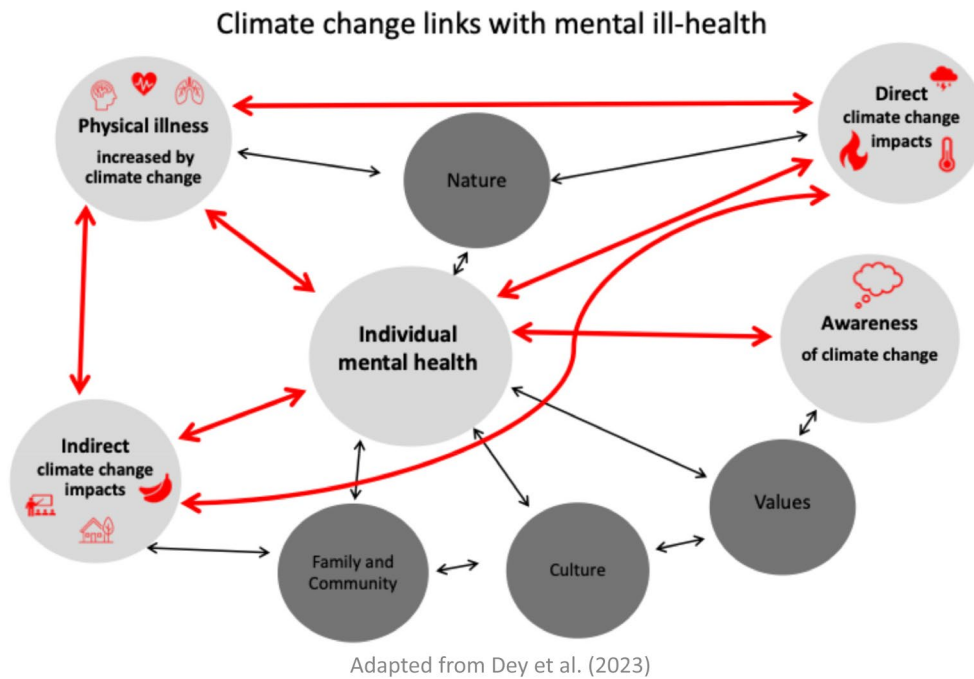


FIGURE 2 | Systems model of climate change and mental health interactions. Pale grey circles denote climate change impacts on mental health: direct, indirect, physical health and awareness. Dark grey circles denote other influences, for example, culture, values, family, friends and community, and positive impacts of nature include biodiversity, that is, clean air, water, soil and green space.

such as planting, restoring to encourage the plants, including kelp and trees and sea and land animals to come back. We need to work together in harmony on country, led by First Nations' people's connection to country, beauty and each other to heal' (Dixon-Grovenor 2025).

The understanding of potential causal links between climate change and mental disorders is enhanced by using a systems model (Charlson et al. 2024; Lawrance et al. 2022; Vergunst et al. 2024), as evidence of impacts through biological, social, ecological and cultural determinants of mental health can be considered without the assumption that these are mutually exclusive pathways (Dey et al. 2025; Lawrance et al. 2022; Vergunst et al. 2024). While social, biological, ecological or cultural factors are valid determinants of mental health, existing models often view climate change as just one type of determinant. A systems model improves on these by drawing

on multiple lines of evidence to show that climate change increases risk through all these pathways, which may also interact or change over time (Berry et al. 2018; Charlson et al. 2024; Vergunst et al. 2024). Transdisciplinary approaches can benefit from systems models that integrate the 'exposome'—defined as all external factors a person is exposed to, including over time and distance—alongside other risk or protective factors from various research areas (Berry et al. 2018; Lawrance et al. 2022). An example is that of a pregnant woman (Girardi and Bremer 2024).

Figure 2 shows a systems model of climate change and mental health interactions by non-Indigenous researchers, who acknowledge their limited and partial knowledge on these relationships and that future work would benefit greatly from collaboration with Indigenous knowledge bearers (Matthews et al. 2023; Redvers et al. 2022; Figure 2).

Other important benefits of using a systems approach and of Indigenous ways of knowing and being (Redvers et al. 2022) are the potential to address risk or preventative factors across different contexts. This is particularly important for understanding climate change impacts on mental health as they stem from human activities previously considered separate (Berry et al. 2018; Charlson et al. 2024; Lawrance et al. 2022). The Royal Australian and New Zealand College of Psychiatrists' submission called for the Australian National Health and Climate Strategy to consider mental health impacts across all government policies, including fossil fuel exports (RANZCP 2023).

While the Australian National Health and Climate Strategy recognises the need for a whole-of-government approach to address the health impacts of climate change (or the climate change impacts of healthcare), there is substantial work to operationalise this, including how to work across different departments, genuinely work alongside Indigenous knowledge bearers and have accountability (Behrens et al. 2024; Friel et al. 2024). This is a practical application of a systems model, contrasting with the frequent siloing of decision-making and policy (Myers 2017), in which departments or public services act without considering the flow-on effects on other public services and the population.

Urban housing development in Western Sydney exemplifies siloed approaches, as tree clearing and roofing standards (a non-health policy) contributed to heat-related illness and deaths, yet the health impacts of urban planning and housing have been overlooked (WSROC 2018). Fortunately, a collaborative approach drawing on people from many different parts of the broader system—community, business, and local and state governments to address the impacts of heat—is enabling innovative solutions to reducing the harms of heat in that region (WSROC 2024). Systems models have also mapped the drivers of climate change and its worsening extreme heat—a relatively small number of powerful companies and governments. These entities are responsible for ongoing fossil fuel extraction and burning, and the degradation of natural environments such as forests, yet remain unaccountable for the resulting human health harms (Doctors for the Environment Australia 2024).

The levels of intervention to prevent and reduce the harms from climate change on mental health are shown in Table 2.

Systems modelling can better map the harmful effects of climate change on mental health, where rather than just drawing attention to the problem, mapping these interdependences or vicious cycles becomes a door to interrupting or reversing them, such as for a therapist or policymaker (Berry et al. 2018). Including climate and nature solutions and prevention is an inherent part of Indigenous ways of knowing and being, in contrast to non-Indigenous approaches, which have historically separated these (Mohamed et al. 2023; Redvers et al. 2022).

A systems model of the example of exposure to extreme heat is shown in Figure 3, and then, the application of an intervention to prevent individual exposure to extreme heat is shown in Figure 4.

Preventing extreme heat prevents mental health harms and provides additional physical health benefits, including improved

sleep and a reduced risk of heat-related illnesses, such as cardiac failure and heatstroke (Jay et al. 2021).

While individual access to sustainable cooling is worthwhile, scaling it up yields even greater mental health benefits, as would be expected from Indigenous ways of knowing and being (Redvers et al. 2022). A systems model highlights mental health benefits visible, such as sustainable community cooling, solutions for homelessness, better heat-safe housing standards, and urban heat island reduction via green and blue spaces (such as tree planting and preserving natural waterways) (Jay et al. 2021; Vergunst et al. 2024).

Table 3 shows solutions drawn from systems models for the specific example of extreme heat as a direct impact of climate change on mental health (Figure 5).

The ability of a systems approach to address trends in the impacts of climate change over time is particularly important for children and adolescents. Prenatal and infant hazards can lead to neurodevelopmental and mental health harms that interact with climate change impacts (Vergunst and Berry 2021). Conversely, accessing green and healthy natural environments protects against multiple mental health symptoms and, over time, reduces the risk of some mental disorders (Dey et al. 2025; Lawrance et al. 2022). Again, the importance of a healthy natural environment and access throughout life is consistent with millennia of Indigenous knowledge and cultural practices (Lansbury et al. 2023; Redvers et al. 2022).

Even for adults, repeated extreme weather events (direct impacts), without sufficient time to recover in between, have compound (not simply additive) effects, which interact with indirect impacts such as unemployment or forced migration and with other determinants of mental health, such as poverty or racism (Lansbury et al. 2023; Longman et al. 2023).

Inequity of climate change impacts on mental health has been articulated by multiple authors using systems approaches (Charlson et al. 2024; Matthews et al. 2023; Parnes et al. 2024; Redvers et al. 2022). Climate change acts as a threat multiplier, increasing inequity through multiple pathways (Charlson et al. 2024). As a general guide, those least responsible for the climate crisis are most impacted (Charlson et al. 2024; Redvers et al. 2022). Groups particularly vulnerable to mental health impacts of climate change include: babies, children and young people; women, pregnant women and those caring for young children; the elderly; people with mental illness or disorder; people with disabilities; people in low- and middle-income countries and those experiencing poverty in high-income countries; people of colour, First Nations' or Indigenous people; and members of the LBGTIQ community (Charlson et al. 2024; Redvers et al. 2022).

Recently, authors using systems models have emphasised distinguishing between climate change links to mental disorders or mental illness and their impacts on well-being that do not constitute a mental disorder (Seth et al. 2023; Vergunst et al. 2024). These differences are crucial for identifying prevention opportunities, optimising treatment access for individuals with mental disorders, implementing population-level

TABLE 2 | Levels of intervention for climate change impacts on mental health.

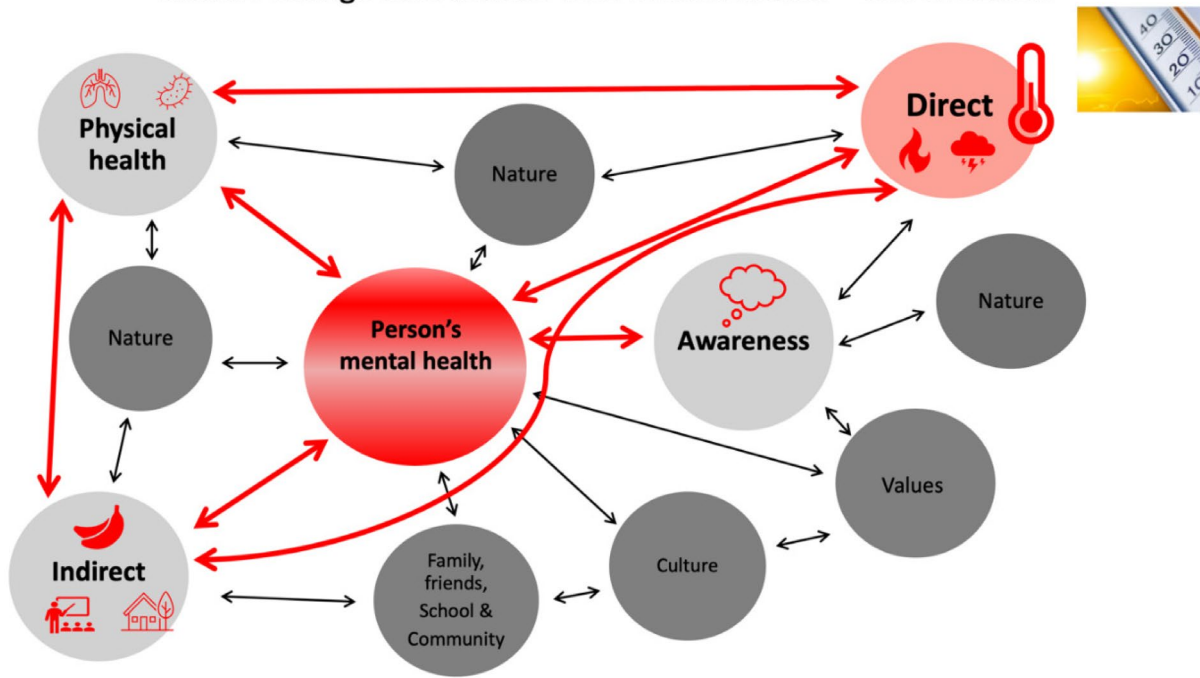
	Clinician	Healthcare service	Local community	Universities and other healthcare education settings	Non-government organisations (national and local)	Government and large businesses	International organisations—IPCC, UN, WHO, IEA, WEF and NGOs
Universal prevention	Healthcare sustainability and role model	Healthcare sustainability and role model Sufficient, local, culturally appropriate mental health services based on best available evidence	Local projects for rapid, equitable transition and protection of nature	Research, communicate research findings Education on health impacts and sustainable healthcare	Advocacy climate action and climate-resilient health systems—including identifying barriers	Support rapid, equitable transition off fossil fuels including fossil gas across all sectors Advocacy for protection of environment as universal human rights Protect nature across all sectors	Advocacy for rapid, equitable transition off fossil fuels including fossil gas across all sectors Advocacy for protection of environment as universal human rights Advocacy on each main pathway of climate change mental health impact: 1. Direct—for example, extreme weather, heat, pollution 2. Indirect—for example, forced migration, food and water insecurity, unemployment conflicts 3. Physical health—for example, increased infections, asthma, heart disease, cancer 4. Awareness—for example, demonstration of leadership, empowering local communities and accountability reduces harms Protect nature across all sectors

(Continues)

TABLE 2 | (Continued)

	Clinician	Healthcare service	Local community	Universities and other healthcare education settings	Non-government organisations (national and local)	Government and large businesses	International organisations—IPCC, UN, WHO, IEA, WEF and NGOs
Selective prevention	Disaster preparedness Awareness of recommendations regarding advice to patients and families (e.g., flagging resources)	Disaster preparedness specific to location and risks Sustainable cooling in mental healthcare facilities Restore local, culturally appropriate mental health services based on the best available evidence	Community disaster preparedness Mental health first aid Prioritise cool shelter for people with or at risk of mental illness (in addition to other at risk groups)	Research and education	Disaster preparedness specific to locations and risks	Disaster preparedness—coordination and funding support Mental health—specific heat warnings Stable and secure housing which is resilient to extreme weather including heat Cool shelter where it is not yet possible to provide/ensure stable and secure housing as above	Mental health—specific heat warnings and advice Disaster preparedness Priority populations both globally and locally—advocate for these groups to be both included in solutions and prioritised for support
Indicated prevention		Timely access to appropriate treatment for people who have a mental disorder or illness		Research and education			

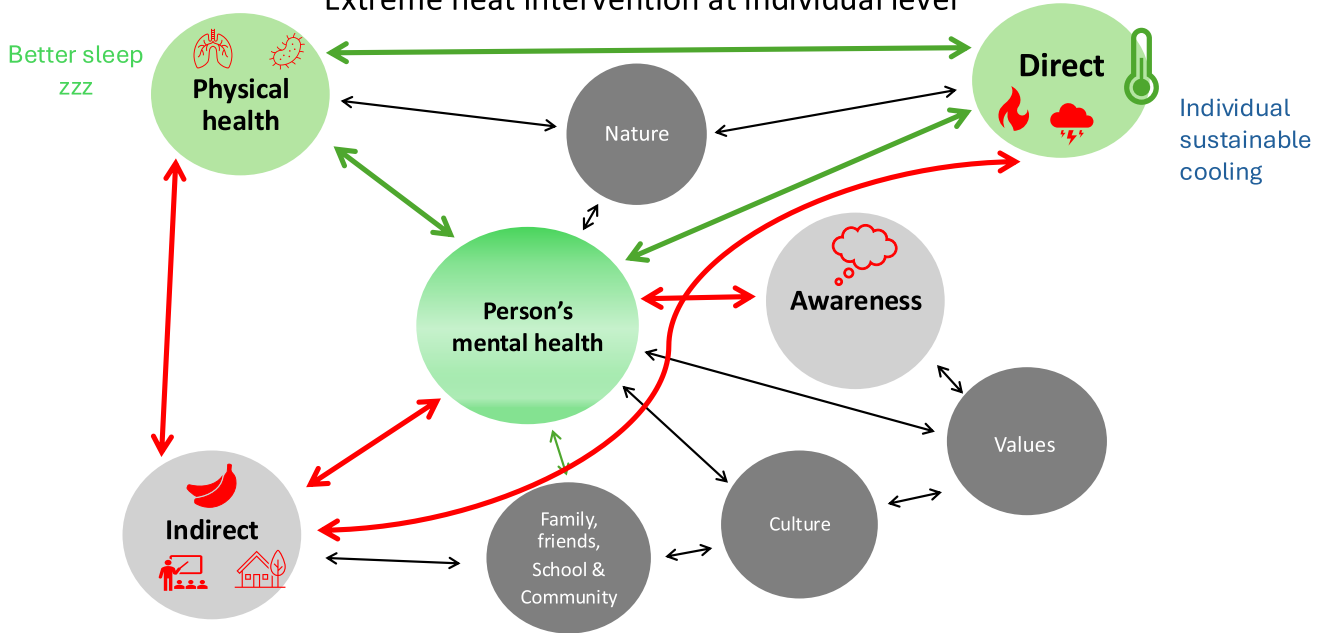
Climate change interactions with mental health – extreme heat



Adapted from Dey et al. (2023)

FIGURE 3 | Systems model of extreme heat (direct climate change impact) on mental health.

Climate change & mental health – Extreme heat intervention at individual level



Adapted from Dey et al. (2023)

FIGURE 4 | Systems model of extreme heat (direct climate change impact) showing the effect of intervening at the individual level by preventing exposure to the extreme heat through information and sustainable cooling; the systems model enables observation of the flow-on benefit via improved physical health to sleep and thus mental health.

interventions to improve mental well-being and establishing measurable outcomes to guide future policy and practice (Vergunst et al. 2024).

Systems models of climate change mental health impacts align with Indigenous-led solutions. Both provide frameworks that go beyond the individual, incorporating interconnected

TABLE 3 | Systems model intervention to improve mental health in the face of climate change at different levels—for example, extreme heat (direct climate change impact on mental health).

Clinician	<p>Identify heat as contributing factor to mental health presentation or patient at increased risk</p> <p>Advice to patient, carer/family and referring practitioner on mental health benefits of staying cool and likely link to mental health symptom/impact for that patient</p> <p>Preventive advice based on ongoing risk of heat</p> <ul style="list-style-type: none"> – Provide advice based on health service recommendations (where available), with other resources if needed – Sustainable cooling information, for example, The Lancet downloadable – Localised heat health risk, for example, Heatwatch website <p>Increase mental health monitoring if clinically indicated</p>
Local community	<p>Awareness of heat impacts on health, resources on heat health information, sustainable cooling and access to cool shelter</p> <p>Connected community—looking out for people at higher risk during extreme heat</p> <p>Community facilities—libraries, public transport</p> <p>Trees—and awareness of cooling benefits of established trees</p>
Healthcare service	<p>Planning, including increased staffing for increased mental health risk, aggression and assault risk during extreme heat</p> <p>Ensuring sustainable cooling will have energy security during power outages (e.g., battery/solar)</p>
Health education (Uni, TAFE)	<p>Education of student health professionals and managers on heat and mental health</p> <p>Research and communication of research on heat and health</p>
NGOs (national and local)	<p>Advocacy for public health campaigns, addressing access to safe homes (heat safe homes), rental standards, for example,</p> <p>https://swelteringcities.org/about-us-2/</p> <p>Heat and mental health advocacy;</p> <p>https://www.climatepsychiatry.org/heat-wave-resources</p>
Government, large business	<p>Local, state and national governments</p> <p>Public health campaigns on heat should include mental health benefits of staying cool (and risks of heat)</p> <p>Access to adequate, safe housing in the face of extreme heat and, where this is not yet possible, access to cool shelter during extreme hot weather</p> <p>Planning for increased health, social support and police demands during extreme heat and heatwaves</p> <p>For example, https://www.climatechange.environment.nsw.gov.au/news/Greater-heat-resilience-for-Greater-Sydney</p> <p>Climate change impacts on health (via heat) considered across all policies—including healthcare planning, education, decisions on fossil fuel projects and protection of nature</p>
International organisations	<p>International advocacy on impacts of heat on human health</p> <p>International accountability on link between increasing extreme heat and fossil fuel extraction, land clearing</p> <p>International advocacy on equity (those least responsible are most impacted) includes people who are most impacted</p> <p>Link with national and local approaches</p>

risk and protective factors, the broader community, culture and the natural environment. This holistic perspective is for understanding individual predicaments and identifying opportunities to interrupt vicious cycles through therapy or broader societal interventions (Berry et al. 2018; Redvers et al. 2022). Just as the connection between human health and the natural world is understood, the potential of Indigenous knowledge bearers and cultural experts to contribute to solutions for complex climate challenges is only just beginning to be recognised and included (Lansbury et al. 2023; Redvers et al. 2022).

Prioritising the inclusion of all planetary health impacts addresses the limitations of assessing them individually, which often overlooks their complex interactions (Pongsiri et al. 2017; Redvers et al. 2022). Clemens et al. (2022) identified the exclusion of other aspects of planetary health from research, such as pollution and loss of biodiversity, as a limitation in their review on climate change, noting that these are known to adversely impact child and adolescent mental health.

A less well-known example is the indirect effect on mental health of extreme heat or heavy rain via social media (Lawrance et al.

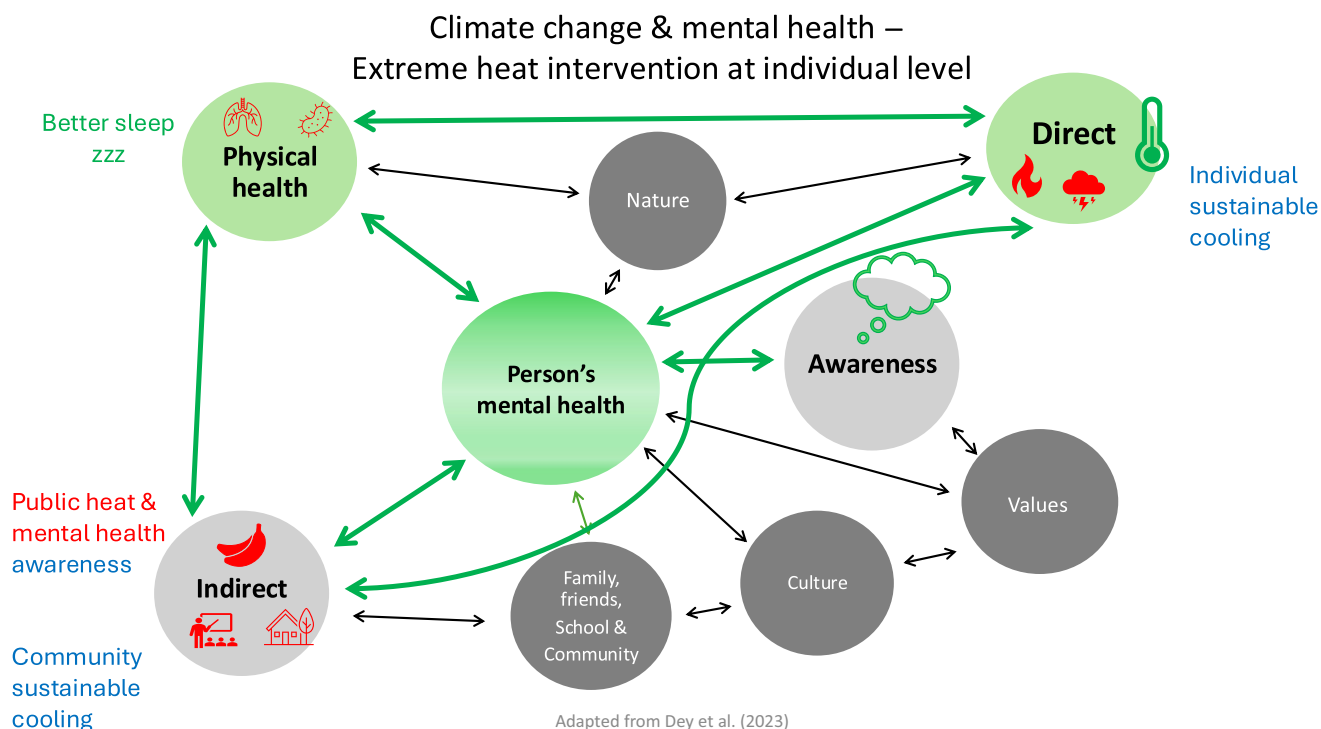


FIGURE 5 | Systems model of extreme heat (direct climate change impact) showing the increased beneficial effect of intervening at multiple levels—individually as in Figure 3, and also through improving family well-being (via access to sustainable cooling and reliable information), local community and broader public health messaging and access to protection from extreme heat.

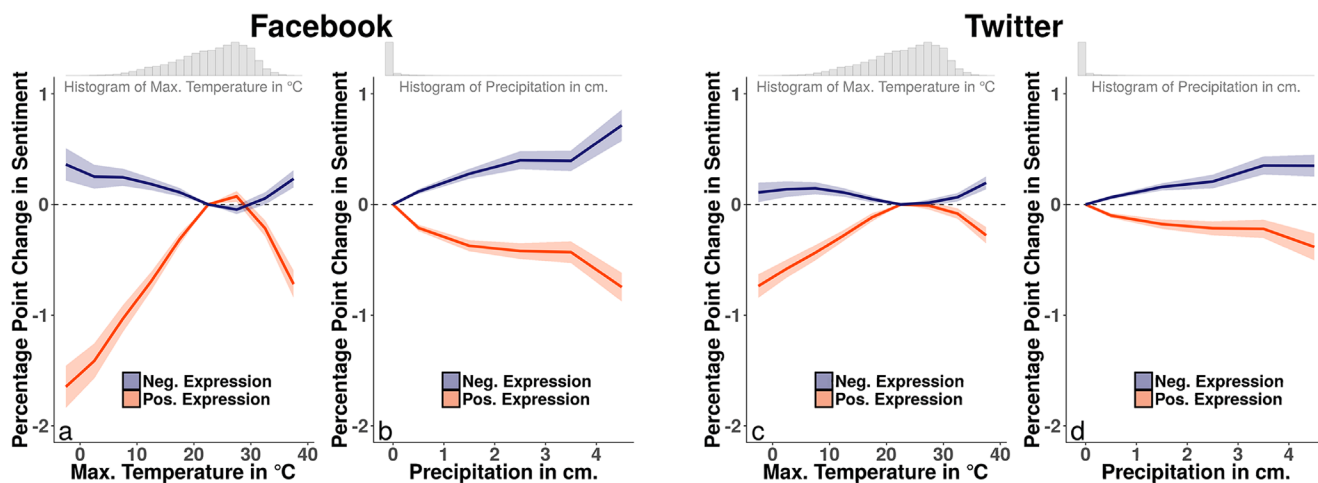


FIGURE 6 | Panel (a) depicts the relationship between daily maximum temperatures and the rates of expressed sentiment of approximately 2.4 billion Facebook status updates from 2009 to 2012, aggregated to the city level. Panel (b) depicts the relationship between daily precipitation and rates of sentiment expression of Facebook status updates. Panels (c) and (d) replicate these analyses for nearly 1.1 million Twitter posts between 2013 and 2016 aggregated to the same cities. Shaded error bounds represent 95% confidence intervals. Facebook and Twitter analyses of negative and positive sentiment expression with concurrent maximum temperature and precipitation. Reproduced under creative commons licence from Baylis et al. (2018).

2022). In this case, mental distress can be triggered indirectly through negative or critical posts on social media, where the climate change impact affects the person doing the posting directly (seen through them making fewer positive and more negative social media posts) and the person viewing the posts online indirectly (Figure 6).

While social media use (regardless of content) has been raised as a potential cause of increased youth mental distress over recent decades, the extent of this remains in doubt at a population level

(McGorry et al. 2024). Indigenous knowledge bearers and non-Indigenous researchers have raised the possibility that disconnection from direct contact with other human beings and the natural environment could be bigger factors in youth mental ill health than the use of social media itself (Kelly 2025; McGorry et al. 2024).

Interestingly, research findings on youth mental health presentations to emergency departments during extreme heat locally are more consistent with a causal link than the findings

for social media use. A dose–response relationship between hot weather exposure (where the link strengthens with increasing heat) has been established in numerous studies across diverse populations. Even at high temperatures, access to better housing and infrastructure for cool shelter appears protective (Dey, Foong, et al. 2024; Dey, Wu, et al. 2024; Niu et al. 2023).

For some young people, social media may be their main source of connection and support (McGorry et al. 2024); however, exposure to distressing posts on social media has also been linked to serious mental distress for some young people, particularly when the young person is isolated or marginalised (McGorry et al. 2024).

A systems model can help identify that social media may be the source of increased distressing posts when there is extreme heat or precipitation elsewhere in the world, not only when it is occurring locally. From the point of view of intervention, awareness of this phenomenon can help guide advice and practice around social media use when extreme weather is occurring, and awareness that this can be expected to increase with increasing extreme weather (heat and precipitation) with climate change. A similar approach can be used to identify and apply multiple points for intervention, such as the psychological distress experienced by a child or adolescent being aware of the scientific reality of climate change (see Figures 7 and 8).

Using a systems model to look at the effect of intervening only individually with the patient presenting to the clinician with distress about climate change is shown in Figure 8. This could

provide a safe space for children or young persons to express their concerns and, after appropriately addressing any clinical mental disorders, offer validation of their climate change concerns, opportunities for action tailored to their developmental stage and values, and connection with healthy natural environments and supportive people (Dey et al. 2025; Seth et al. 2023).

Figure 9 summarises this approach for mental health assessment.

Beyond the individual child or adolescent concerned about climate change, a clinician thinking systemically can make sense of the child’s presentation in the broader family, community and cultural context, with the potential to further improve the child or young person’s mental health outcome through either direct work with other family or community members and/or support for the child or young person to do so in developmentally and professionally appropriate ways (Crandon, Dey, et al. 2022; Crandon, Scott, et al. 2022; Dey et al. 2025; Seth et al. 2023). For example, the approach to parent/s or carer/s bringing their 10-year-old daughter who has become worried about climate change will benefit from taking the parents’ or carers’ emotional response to climate change into account. If a parent or carer is also overwhelmed with distress about climate change, they may be emotionally unavailable so that their child may feel more worried and alone by perceiving that their parent cannot tolerate their distress. Conversely, the child might be left feeling invalidated where a parent or other important adult is coping with climate change information by avoiding it or denying its importance. In either situation, if the parent/carer is not ready to empathise with the child’s distress about climate change, then another adult (such as their general practitioner, teacher, school counsellor or therapist) who can listen and appropriately

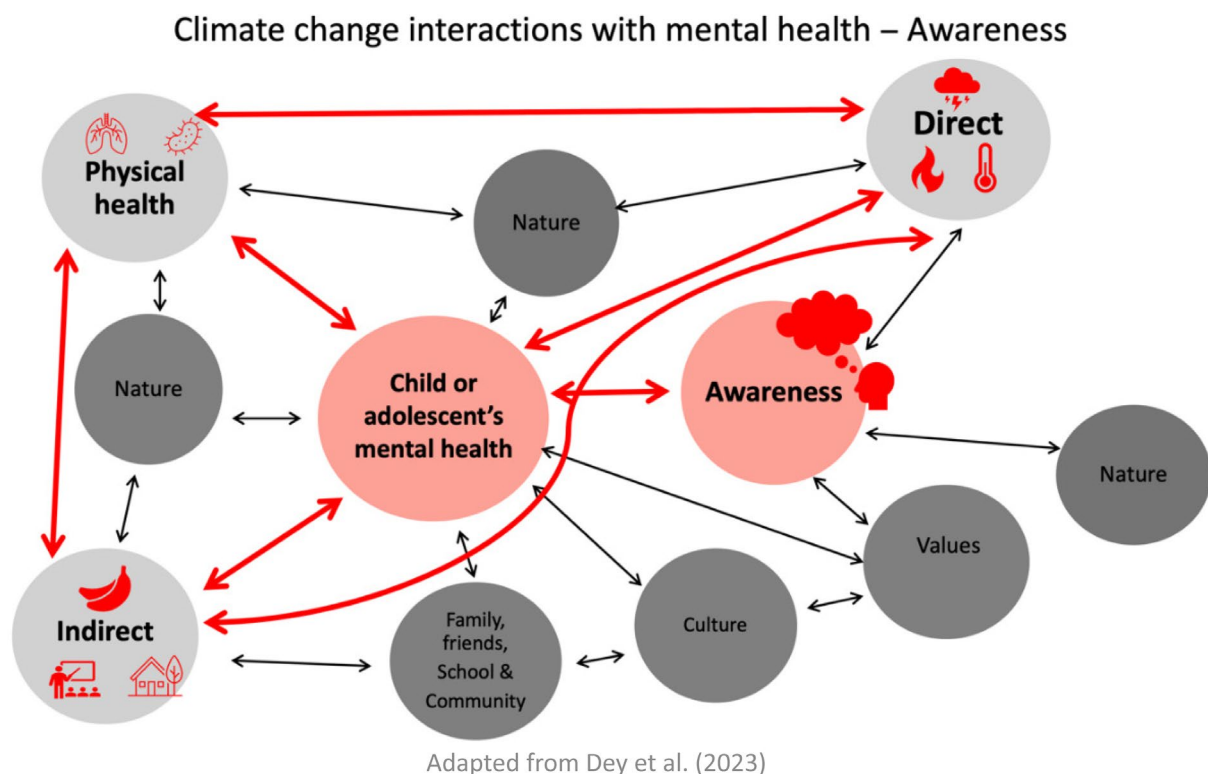
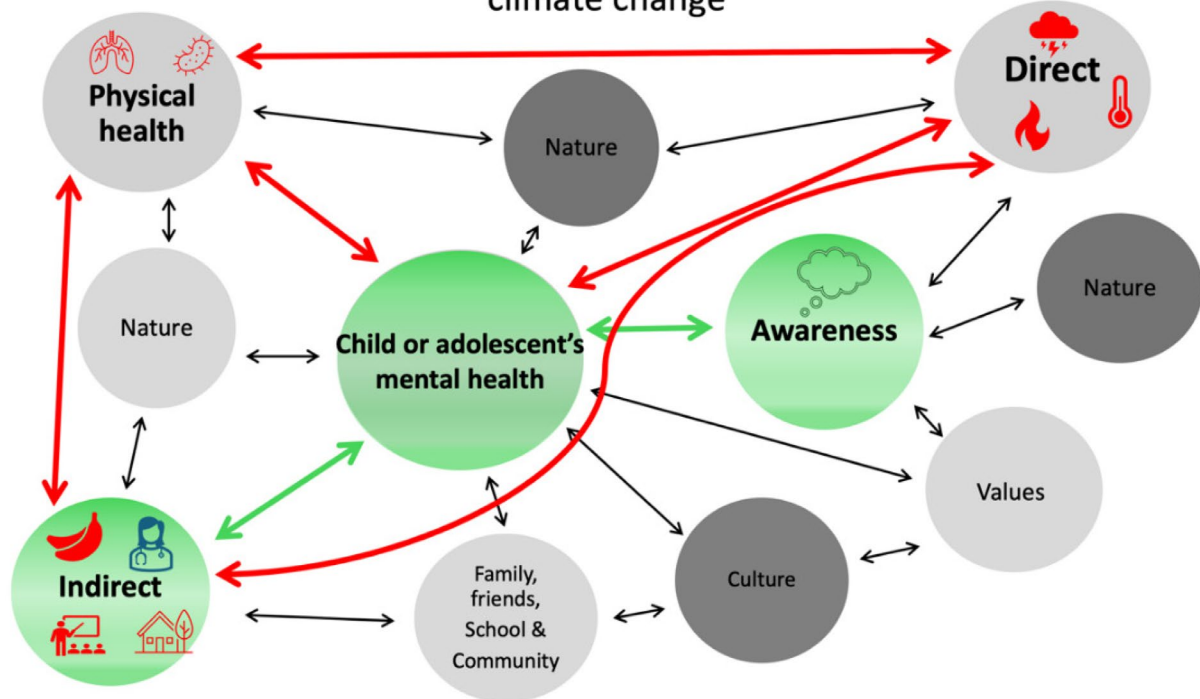


FIGURE 7 | Systems model of climate change mental health impact—awareness.

Climate change and solutions to mental health impacts of awareness of climate change



Adapted from Dey et al. (2023)

FIGURE 8 | Systems model of climate change mental health impact—intervening with the individual patient with distress linked to awareness of climate change.

S.A.F.E mental health assessment



SAFE to discuss planetary health-related issues	
Setting:	Waiting area/entrance with cues of safety to share Concerns about planetary health
Awareness	Clinician is aware of and has suitable support for the response to planetary health
Facts	Clinician knowledge of mental health impacts of planetary health and identifying need for clinical intervention
Engagement	Engage client/patient through validation, connection to others, values-based action

FIGURE 9 | Safe mental health assessment with key aspects in approaching a patient with planetary health-related concerns.

validate the child's concerns without catastrophising or avoiding while maintaining respectful contact with their parents or carers can invite healthier coping by the child.

There may be opportunities to invite the parent/s or carer/s to reflect and consider working on strategies to enable them to be emotionally present with their child or to support other opportunities for their child if working on the barriers is an unrealistic goal.

Clearly if the child's distress is out of proportion to the threat (of climate change) or has precipitated a mental disorder, then providing evidence-based treatment should be prioritised.

6 | Future directions

The recognition that non-Indigenous systems science on climate and mental health validates Indigenous knowledge and advocacy is important for truth-telling and healing and as a practical solution to the century's biggest threat to human health (Redvers et al. 2022; Zielinski 2023). Systems models provide a useful lens for understanding climate change mental health impacts and identifying opportunities for change, from individual and therapeutic settings to broader societal levels, while also integrating different sources of knowledge and learning.

Continuing to reject offers of collaboration based on the wisdom and cultural knowledge of Indigenous peoples is profoundly harmful to Indigenous peoples; this maintains the same cultural frame (based on colonialism) that not only fails to address the human-caused climate and nature crises, it also continues to make them worse (Redvers et al. 2022; Rhodes and Dunk 2023).

My people have seen and experienced destruction and greed happening for so long. The loss of Country, Culture, our people. We have been described as savages—the lowest form of people. [Only] now that the effects of climate [and nature] destruction worldwide is affecting everything and everyone, are people turning to First Nations people.

(Dixon-Grovenor 2025; 31 March 2025)

By listening to and valuing 'First Nations' knowledge and how to engage with Mother Earth and Father Sky and each other, we can heal together with respect, communication, truth and action. We need to be out in the beautiful, healing bush and learn from First Nations' people how to love and nurture Mother Earth and each other' (Dixon-Grovenor 2025).

7 | Conclusion

Unlike linear models, systems models of climate and mental health better reflect complex interactions and identify avenues for improving mental health across individual, family, community and societal levels. Indigenous peoples have maintained cultural knowledge and ways of being that recognise humanity's interconnectedness with nature (Redvers et al. 2022). Urgent and wise translation of research findings into effective mental health policy and action is crucial. Such efforts must value and incorporate Indigenous ways of knowing and being to succeed (Lawrance et al. 2022; Redvers et al. 2022; Vergunst et al. 2024).

We need to reduce the silo effect, which limits the impact of solutions. For example, insights from mental health funding and planning are not fed back to other government departments making decisions on energy, including fossil fuels (Friel et al. 2024). Indeed, trying to improve mental health while supporting fossil fuel expansion is analogous to trying to address smoke-related lung disease while supporting the tobacco industry (Dey, Foong, et al. 2024; Dey, Wu, et al. 2024). We need to encourage prioritising the connection of different sources of expertise and different groups and enabling a great transfer of knowledge and propose a systems approach as an elegant method of facilitating this.

Every fraction of a degree matters and family therapists' training and ability to hold different frameworks, keep their own well-being in mind and facilitate work across siloes is a strength that humanity needs now.

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Resource List

List of resources for health professionals, patients and the broader community, hosted by the NSW Department of Health: <https://www.health.nsw.gov.au/netzero/Pages/mental-health-resources.aspx>.

Additional reports and resources (to those above): <https://www.climatehealth.net/>; <https://ecoamerica.org/mental-health-and-our-changing-climate-children-and-youth-report/>.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

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