

Rating Evaluation - Impacts of extreme weather (REvIEW): A quantitative measure of the impacts of exposure to extreme weather events

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Abstract

Purpose – Extreme weather event exposure can be associated with a range of direct and indirect health and wellbeing impacts. There is a recognised need to improve the assessment of exposure to extreme weather, beyond mainstream epidemiology techniques and psychopathology, to include the subjective and individual experience of extreme weather events. In response, this study aims to outline the development and initial validation of a quantitative measure, the Rating Evaluation - Impacts of Extreme Weather (REvIEW), designed to assess the differential impacts of extreme weather events.

Design/methodology/approach – The REvIEW is a novel 29-item measure, developed in consultation with an advisory group consisting of multidisciplinary healthcare practitioners, academics and environmental scientists. An Australian mixed-method, cross-sectional study was conducted. The REvIEW assesses the extent of negative impacts from extreme weather events, with each item rated on a 6-point Likert scale.

Findings – The results supported the three domains of the REvIEW (livelihood, wellbeing and connection) and provide preliminary support for the use of this scale to quantitatively assess impacts from exposure to extreme weather events.

Originality/value – The REvIEW offers a novel approach to conceptualising and measuring the differential impacts of extreme weather event exposure, with the potential to inform multidisciplinary research and practice relating to understanding and responding to the impacts of extreme weather events.

Keywords Climate change, Extreme weather, One health, Wellbeing, Impacts, Scale

Paper type Research paper

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Introduction

Extreme weather events are recognised to be increasingly prevalent, extensive and intense, often without recovery time following the event (Longman *et al.*, 2023). People who have experienced extreme weather events report a range of negative impacts, including physical and mental health issues (Fatema *et al.*, 2023; Gergis *et al.*, 2023), such as anxiety, depression, post-traumatic stress symptoms, sleep disruption and problematic alcohol use. Impacts are believed to be related to wellbeing directly, as well as indirectly through environmental, economic and social pathways (Yazd *et al.*, 2019). Thus, there are likely to be multidimensional pathways of interaction between the effects of extreme weather events (Patrick *et al.*, 2023; Rice and Usher, 2024). In addition, an assessment of both the immediate impacts and the “downstream consequences” of extreme weather events is needed (Chique *et al.*, 2021). Appropriate measures are needed to identify and evaluate these impacts, the trajectory and the relationships between different impacts. Currently, measurement of extreme weather experiences differs significantly between studies and often neglects the potentially traumatic characteristics and the psychological effects of such exposure (Massazza *et al.*, 2022). Standardised measurement is needed to enable comparison of impacts across different extreme weather types and between different regions and populations to account for successive exposures, track change over time and allocate resources. To address this need, this paper outlines the development and validation of the Rating Evaluation - Impacts of Extreme Weather (REVIEW), a novel multidimensional, quantitative measure to assess the impacts of extreme weather events.

Characterisation of extreme weather events

Extreme weather events have been described as events in which conditions such as temperature (leading to heatwaves and bushfires), drought, flooding or precipitation rank above 95% of historical measurements (or, in some cases, are outside the range of historical measurements). These have generally been considered in terms of intensity, frequency, duration or magnitude. While extreme weather events can be singular, there is an increasing consideration of compound events, where multiple hazards have greater overall impact, for example, concurrent drought and heatwaves (McPhillips *et al.*, 2018).

One health approach

Extreme weather events can have multi-level impacts on communities and disrupt the interconnected relationships between people and their environment (Skinner, 2022). This is consistent with the [One Health High-Level Expert Panel (OHHLEP) *et al.*, 2022] “One Health” approach that recognises the interdependence between people, the environment, animals and plants [One Health High-Level Expert Panel (OHHLEP) *et al.*, 2022]. This approach has been traditionally applied in understanding and preventing the transmission of disease between animals and people (WHO, 2022). However, more broadly, a One Health approach extends beyond disease transmission to incorporate the shared environment and promote holistic conceptualisation and systemic interdependence (Rice and Usher, 2024; Usher *et al.*, 2024). This approach is consistent with the centrality of connection to country for wellbeing that is recognised by Australian Indigenous people (Skinner, 2022) and farming populations (Kennedy *et al.*, 2021). Within this lens, extreme weather events can have profound effects on the psychological wellbeing of those connected to and dependent on the land (Ellis and Albrecht, 2017).

Effects of extreme weather events

The effects of extreme weather events vary in their impact on different populations, with vulnerable groups experiencing more acute impacts on both livelihood and mental health (Benevolenza and De-Rigne, 2019; Gergis *et al.*, 2023; Usher *et al.*, 2023). Occupation is also a risk factor for experiencing negative impacts of extreme weather events. For example, “the agricultural sector is hit the hardest by drought, with farmers experiencing declined production, crop loss and livestock failure. Farmers reported a strong association between prolonged drought and stress and higher levels of psychological morbidity” (Yazd *et al.*, 2019, p. 10). In Australia, farmers who experience extreme weather report psychosocial impacts such as reduced time for family, losing contact with friends, reduced social engagement, together with farm management issues of financial stress, workload increases and business concerns (Austin *et al.*, 2018; Fennell *et al.*, 2016). In addition, extreme weather events disturb the essential connection between people and place, which is paramount for farmers, who are recognised to have a profound emotional and psychological place-based attachment to their land (Ellis and Albrecht, 2017). Farmers are dependent on the land for their livelihood and wellbeing and are likely to face interacting and cumulative effects from extreme weather events (Rice and Usher, 2024). Together with farmers, construction, fishery and forestry workers are exposed to greater risk and experience increased climate-related disease and productivity loss (Wuersch *et al.*, 2023).

The impacts of extreme weather events can be exacerbated for vulnerable populations, including women, children, elder people and people experiencing homelessness. In the South and Southeast Asian context, women with no formal education or lower levels of education were consistently at the highest risk of developing post-traumatic stress disorder (PTSD), depression, common mental disorders, disability and poor physical health (Fatema *et al.*, 2021). For those who are in marginal housing, extreme weather events can force them into homelessness, while those who are already homeless suffer from exposure to climate-related health risks, including extreme heat or cold, disease and air pollution (Kidd *et al.*, 2021). Thus, it is important to be able to assess impacts of extreme weather events to understand risks and vulnerabilities and facilitate aid.

Measuring extreme weather event exposure

Understanding the impacts of exposure to extreme weather events is limited by current measures and available data. This limitation has been recognised as an important research priority, with an identified need for more specific conceptualisation and operationalisation of environment and health measures (Charlson *et al.*, 2021). While evidence for health impacts of the changing climate has gained momentum in the literature, mental health has had less attention (Charlson *et al.*, 2022). The research that is available has demonstrated how certain risk factors (such as gender, education level, socioeconomic backgrounds and the presence of pre-existing mental health symptoms) are linked to a greater vulnerability to mental health issues after an extreme weather event (Hrabok *et al.*, 2020; Fatema *et al.*, 2021). Negative associations between mental health and climate-related events that are reported in the literature tend to rely on identifying symptoms of psychopathology (Charlson *et al.*, 2021). However, caution has been raised about psychopathologising emotions related to the environment, as this infers the issue is “caused by some type of dysfunction within the individual” (Bhullar *et al.*, 2022, p. 1), rather than considering such emotions as a functional response to a genuine threat to individual and collective wellbeing (Bhullar *et al.*, 2022).

Accordingly, there have been recent calls for the development and validation of measures specifically assessing the relationship between emotions and the environment to enable the understanding of how mental health outcomes may relate to climate-specific reactions

(Charlson *et al.*, 2022). In a recent scoping review, Massazza *et al.* (2022) specifically identified the need to improve the assessment of environmental exposures and suggested that using mainstream epidemiology techniques (e.g. temperature, postcode and rainfall) neglects to capture the subjective and individual experience of extreme weather event exposure that may be crucial in mental health outcomes. “Factors that are probably predictive of subsequent psychopathology at the individual level are not necessarily the exposure to the environmental hazard alone... but the potentially traumatic characteristics of exposure and effects of the environmental hazard (e.g. duration and intensity of exposure, losing property, being injured and witnessing injury or death) and the psychological reactions that people have during such events” (Massazza *et al.*, 2022, p. 618). As such, environmental markers are inadequate to measure individual, subjective experiences of extreme weather events and the exposure measures that are currently available are “suboptimal” (Massazza *et al.*, 2022, p. 614). Hence, the development of measures that can assess individual experiences of the impacts of extreme weather events is crucial in understanding and mitigating, outcomes for those exposed.

The present study

To address the need for standardised measures (Charlson *et al.*, 2021; Massazza *et al.*, 2022; Patrick *et al.*, 2023), this study aimed to develop a scale to quantitatively assess the impacts of exposure to extreme weather events. This scale aimed to address the gap in existing measures by seeking to assess idiographic experiences and direct impacts of exposure to extreme weather events, to facilitate multidisciplinary research and practice relating to understanding and responding to the impacts of extreme weather events. As such, this paper outlines the development and initial validation of the REvIEW measure and provides an initial exploration of the differential impacts of extreme weather events.

Specific hypotheses guiding the evaluation of the REvIEW were as follows:

- The items comprising the REvIEW will group together, reflecting a global impact of extreme weather events (scale internal consistency), while also forming distinct subgroups based on the type of impact. Specifically, items reflecting impacts on livelihood, wellbeing and connection will group together within their respective domains (subscales internal consistency), supporting the idea that exposure to extreme weather events affects multiple important life domains.
- Impact ratings on the REvIEW will remain stable over time, with individuals showing consistent levels of retrospective impact for one previously experienced extreme weather event across multiple assessments, indicating test-retest reliability of the scale.
- Higher scores on the REvIEW would be related to more post-traumatic stress symptoms, to assess convergent validity, with higher impact on lowered wellbeing as assessed by the REvIEW being expected to be related to post-traumatic stress symptoms. To evaluate divergent validity, it is expected that higher scores on the REvIEW would be related to lower general wellbeing, with higher impact on lowered wellbeing as assessed by the REvIEW being related to lower general wellbeing.
- Participants with a high dependence on the land for their livelihood would report higher impacts from extreme weather events across all factors of the REvIEW compared to participants with lower dependence on the land for their livelihood.
- More impact on livelihood would be related to lower wellbeing and lower connectedness and lower wellbeing would be related to lower connectedness. As

these dimensions of impact are expected to be associated, such relationships would provide some convergent validity evidence for the measure and demonstrate climate impact aspects are interconnected.

Method

This study applied [Boateng et al.'s \(2018\)](#) measure development guidelines, with three phases of 1) item development, 2) scale development and 3) scale evaluation.

Item development

The domains and initial items were generated by the first author (KR) a from review of the existing literature and refined throughout the scale development process. The scale commences with questions about the characteristics of the extreme weather events that have been experienced by respondents (e.g. drought, bushfire and flood). For the purposes of this initial validation, the respondent then identifies the extreme weather event to be evaluated and specifies when this occurred and how long the impacts lasted. Following these initial questions about the characteristics of the event experienced, respondents are asked to rate the extent that the event caused them direct impacts across three domains of livelihood, wellbeing and connection.

To provide content validity and refine the measure, multidisciplinary advisory review was sought on the content relevance, representativeness and quality of items ([Boateng et al., 2018](#)). The scale domains and items and response scale were evaluated and refined by an iterative process with advisors across multiple professions and disciplines. Input was obtained from multidisciplinary healthcare practitioners, environmental scientists and academics with health, mental health, environmental science and/or scale development expertise. These advisors were predominantly located in rural and remote Australian locations and had different cultural perspectives and varied experiences with a range of extreme weather events.

Advisory members were explicitly asked to review and comment on the response format, with all endorsing the Likert rating scale and the three domains of livelihood, wellbeing and connection. Based on advisory member feedback, several items were refined to improve clarity (e.g. “reduced mood” was reworded to “negative mood”; “disrupted personal relationships” was reworded to “relationship issues”). Advisory member feedback differed about items related to connection to the land. This discrepancy was resolved through consultation and consensus with additional advisory members and these items were refined and retained for survey administration. These two items were “distress about the landscape changes” in the wellbeing domain and “disrupted connection to the land” in the connection domain. This process endorsed a total of nine items within the livelihood domain, 13 items in the wellbeing domain and seven items in the connection domain, providing a 29-item scale for survey administration.

An open-ended question allowed for a text response from participants to identify any other impacts of extreme weather events experienced by participants. The first 40 responses were checked as a pilot test to assess if additional impacts were provided by participants. Analysis revealed that all of the impacts identified could be classified by one of the other categories (e.g. “fear” could be coded in the existing “anxiety” item). No new novel impacts were identified by these participant responses.

Scale development
Survey administration and sample size. Following approval from the University Ethics Committee, participants were recruited in an Australian community sample through the [Online Research Unit \(2014\)](#) and all participants provided consent prior to undertaking the Qualtrics survey. Only the participants who reported experiencing an extreme weather event were presented with the questions for this study ($n = 318$).

Participants
The average age of participants was 44.7 years [standard deviation (SD) = 17; ranging from 18 to 93 years] and consisted of 176 (55%) males and 142 (45%) females. Participants were married ($n = 173$) or in a de facto relationship ($n = 28$), single ($n = 89$) or separated ($n = 24$). The majority of the participants had no dependent children ($n = 188$), with 61 participants caring for one dependent child, 29 caring for two dependent children and 20 caring for three or more dependent children. The average hours worked by participants were 25 h per week (SD = 19), with 77 participants (24.2%) not engaged in current employment. Using the Modified Monash Model, 218 (69.4%) participants were residents of a metropolitan area, while 96 (30.6%) lived in regional or remote areas. Further, 81 (26.5%) participants indicated high dependence on the land for their livelihood (greater than 30%). The characteristics of extreme weather events experienced are presented in [Table 1](#). The most common types of extreme events experienced were floods, droughts and bushfires. The mean and SD of each ReVIEW item, broken down by flood, drought and bushfire, are displayed in [Table 2](#).

Materials
Demographics
Participants were asked to provide their age, gender, relationship status, cultural background, number of dependents, occupation and postcode (to classify rural and urban responses). An additional question asked participants to rate “To what extent does your livelihood depend on the land?” on a 0–100 visual analogue scale. Participants were then asked details about the extreme weather event/s they had experienced.

Rating Evaluation - Impacts of extreme weather
The REVIEW is a newly developed, self-report rating scale that assesses the impacts of exposure to extreme weather events. The ReVIEW consists of 29 items within three domains of livelihood, wellbeing and connection and the items and response format are presented in [Figure 1](#). As per [Figure 1](#), the items are rated on a 6-Point Likert Scale, whereby 0 = none, not

Table 1. Types of extreme weather events and impacts

Type	Type of extreme weather events experienced	Frequency (% of participants)
Drought		72 (22.9%)
Bushfire		84 (26.7%)
Flood		104 (33.0%)
Hurricane / tornado / cyclone		20 (6.3%)
Other		35 (11.1%)

Note(s): $N = 315$

Table 2. Descriptive statistics of REvIEW items split by flood, drought and bushfire

Item	Flood mean, SD (n = 104)	Drought mean, SD (n = 72)	Bushfire mean, SD (n = 84)
<i>Livelihood</i>			
(1) Loss of income	2.23 (1.45)	1.89 (1.34)	1.93 (1.33)
(2) Increased expenses	3.07 (1.56)	2.81 (1.37)	2.48 (1.26)
(3) Increased personal workload	3.17 (1.56)	2.10 (1.34)	2.63 (1.51)
(4) Increased professional workload	2.46 (1.57)	1.80 (1.31)	2.13 (1.31)
(5) Loss of property or infrastructure	2.64 (1.51)	1.76 (1.25)	2.12 (1.47)
(6) Loss of home and/or displacement	2.32 (1.54)	1.65 (1.22)	1.90 (1.46)
(7) Destruction of land	2.43 (1.45)	2.29 (1.46)	2.14 (1.54)
(8) Loss of stock or crops	2.08 (1.54)	2.06 (1.33)	1.83 (1.34)
(9) Increase or disruption to off farm work and/or study	2.19 (1.48)	1.69 (1.20)	1.99 (1.36)
<i>Wellbeing</i>			
(10) Negative physical health impact or injuries	2.19 (1.43)	1.94 (1.30)	2.30 (1.34)
(11) Reduced water and/or food availability	2.70 (1.44)	3.15 (1.45)	2.23 (1.40)
(12) Reduced personal energy levels and/or exhaustion	3.00 (1.44)	2.30 (1.24)	2.68 (1.42)
(13) Disrupted sleep patterns or quality	2.93 (1.52)	2.27 (1.30)	2.79 (1.27)
(14) Reduced motivation	2.63 (1.43)	2.38 (1.45)	2.44 (1.35)
(15) Witnessed trauma or death	2.02 (1.48)	1.79 (1.24)	2.24 (1.53)
(16) Flashbacks or images of the extreme weather event	2.11 (1.48)	1.67 (1.43)	2.28 (1.48)
(17) Increased anxiety or worry	2.80 (1.38)	2.46 (1.34)	2.87 (1.54)
(18) Increased stress	3.15 (1.44)	2.56 (1.35)	3.00 (1.41)
(19) Increased shame or guilt	2.17 (1.60)	1.79 (1.19)	1.84 (1.34)
(20) Feelings of hopelessness	2.51 (1.55)	2.01 (1.39)	2.40 (1.56)
(21) Distress about landscape changes	2.35 (1.43)	2.58 (1.40)	2.66 (1.59)
(22) Negative mood	2.71 (1.41)	2.31 (1.27)	2.61 (1.45)
<i>Connection</i>			
(23) Death of friend or family member	1.92 (1.45)	1.75 (1.31)	1.66 (1.28)
(24) Reduced connection with others and/or community	2.50 (1.49)	1.96 (1.39)	2.08 (1.43)
(25) Reduced social motivation and/or and activities	2.60 (1.50)	1.94 (1.37)	2.10 (1.38)
(26) Reduced recreational activities	2.53 (1.43)	2.14 (1.37)	2.52 (1.62)
(27) Disruption to personal/caring roles	2.32 (1.46)	1.71 (1.22)	1.92 (1.34)
(28) Relationship issues	2.17 (1.48)	1.89 (1.32)	1.95 (1.42)
(29) Disrupted connection to the land	2.27 (1.60)	2.03 (1.29)	2.02 (1.39)

To what extent did this extreme weather event of _____ cause you negative impacts of:						
None, not directly impacted	Slightly	Somewhat	Moderately	Severely	Extremely impacted	
0	1	2	3	4	5	
Livelihood:						
Loss of income	0	1	2	3	4	5
Increased expenses	0	1	2	3	4	5
Increased personal workload	0	1	2	3	4	5
Increased professional workload	0	1	2	3	4	5
Loss of property or infrastructure	0	1	2	3	4	5
Loss of home and/or displacement	0	1	2	3	4	5
Destruction of land	0	1	2	3	4	5
Loss of stock or crops	0	1	2	3	4	5
Increase or disruption to off farm work and/or study	0	1	2	3	4	5
Livelihood subscale score						
Wellbeing:						
Negative physical health impact or injuries	0	1	2	3	4	5
Reduced water and/or food availability	0	1	2	3	4	5
Reduced personal energy levels and/or exhaustion	0	1	2	3	4	5
Disrupted sleep patterns or quality	0	1	2	3	4	5
Reduced motivation	0	1	2	3	4	5
Witnessed trauma or death	0	1	2	3	4	5
Flashbacks or images of the extreme weather event	0	1	2	3	4	5
Increased anxiety or worry	0	1	2	3	4	5
Increased stress	0	1	2	3	4	5
Increased shame or guilt	0	1	2	3	4	5
Feelings of hopelessness	0	1	2	3	4	5
Distress about landscape changes	0	1	2	3	4	5
Negative mood	0	1	2	3	4	5
Wellbeing subscale score						
Connection:						
Death of friend or family member	0	1	2	3	4	5
Reduced connection with others and/or community	0	1	2	3	4	5
Reduced social motivation and/or and activities	0	1	2	3	4	5
Reduced recreational activities	0	1	2	3	4	5
Disruption to personal/caring roles	0	1	2	3	4	5
Relationship issues	0	1	2	3	4	5
Disrupted connection to the land	0	1	2	3	4	5
Connection subscale score						
REVIEW Total Score						

Figure 1. Rating Evaluation – Impacts of Extreme Weather (REVIEW) response form

directly impacted, 1 = slightly, 2 = somewhat, 3 = moderately, 4 = severely, 5 = extremely. The psychometric properties of the REVIEW are the focus of this study and as such, are reported in the results below.

Post-Traumatic stress disorder index (PTSD-8)

The PTSD-8 was developed as an abbreviation of the Harvard Trauma Questionnaire (Mollica et al., 1992) to measure the degree to which respondents experienced symptoms of

hyperarousal, intrusion and avoidance. The PTSD-8 scale consists of eight items rated on a four-point Likert scale (1 = not at all, 4 = very often), corresponding to eight PTSD symptoms (Hansen *et al.*, 2010). A total symptom severity score can be calculated (sum score 4–32). The measure has demonstrated good internal consistency in previous research ($\alpha = 0.84$; Andersen *et al.*, 2018) and demonstrated excellent internal consistency in the current study ($\alpha = 0.93$).

World health organisation well-being index (WHO-5)

The 5-item WHO-5 is one of the most common measures of subjective psychological well-being (Topp *et al.*, 2015). The WHO-10 [Topp *et al.*, 2015] was the source of this brief and general global rating scale, which was adapted from a 28-item rating scale [Warr *et al.*, 1985] that was used in WHO multicentre research in eight different European nations. The respondent is asked to score the degree to which each of the five statements accurately describes themselves over the last 14 days. A score ranging from 0 (none of the time) to 5 (all of the time) is assigned to each of the five items. Accordingly, the theoretical range of the raw score is 0 (absence of well-being) to 25 (maximal well-being). The WHO-5 has demonstrated strong internal consistency reliability in previous research (Cronbach's alphas ranging from 0.81–0.90; Cruwys *et al.*, 2024; Lara-Cabrera *et al.*, 2022) and in the current study ($\alpha = 0.85$).

Analysis

This study aimed to assess the psychometric properties of the REvIEW, firstly assessing internal consistency of the total score and three domains using Cronbach's alpha. To assess the second hypothesis, test-retest reliability was calculated using intraclass correlation coefficients (ICC). To assess the third hypothesis, convergent validity was calculated through a correlation between the REvIEW and post-traumatic stress symptoms and divergent validity was calculated with a correlation between the REvIEW and general wellbeing. To assess the fourth hypotheses and assess differences between known groups, multivariate analysis of variance (MANOVA) was conducted. The final hypothesis was tested with correlations.

Results

Reliability of the REvIEW scale

Internal consistency. To assess the internal consistency of the REvIEW scale, Cronbach's alpha was calculated for the overall scale and its three subscales of livelihood, wellbeing and connection. The overall REvIEW demonstrated excellent internal consistency, with a Cronbach's alpha of 0.98, indicating that the items effectively capture a global impact of extreme weather events (Taber, 2017). Similarly, each subscale exhibited excellent internal consistency. The Livelihood subscale had a Cronbach's alpha of 0.92, while the wellbeing subscale yielded a Cronbach's alpha of 0.95. The Connection subscale also showed excellent reliability, with a Cronbach's alpha of 0.94. Reliabilities at these levels may be suggestive of redundancy (Tavakol and Dennick, 2011) and reducing the number of items is often suggested. However, a narrow focus on the items on the REvIEW is required to elucidate various impacts of extreme weather events and removing items will omit important impacts. Further, it is also likely that responses on items within each domain are related and the high reliability is reflective of the interrelationship of the various impacts from extreme weather events. Thus, these reliability findings support the hypothesis that the REvIEW items cluster both globally and within distinct life domains, reflecting the varied impacts of extreme weather events on livelihood, wellbeing and connection.

Test-retest reliability. The test-retest reliability of the REvIEW was assessed using the ICC with a two-way mixed-effects model and consistency type. The analysis, conducted with 142 participants, demonstrated good test-retest reliability (Koo and Li, 2016). Specifically, the livelihood factor had an ICC of 0.73, 95% CI [0.65, 0.80], $F(141, 141) = 6.47, p < 0.001$. The wellbeing factor had an ICC of 0.78, 95% CI [0.71, 0.84], $F(133, 133) = 8.17, p < 0.001$. The connection factor had an ICC of 0.78, 95% CI [0.71, 0.84], $F(137, 137) = 8.12, p < 0.001$.

Validity of the Rating Evaluation - Impacts of Extreme Weather scale

Convergent and divergent validity. To assess convergent validity, the correlation between the REvIEW scale and the PTSD-8 was calculated. The findings showed a strong positive correlation ($r[284] = 0.75, p < 0.001$) (Akoglu, 2018), indicating that higher scores on the REvIEW were associated with more PTSD symptoms, providing some support for convergent validity. Further, analysis of the subscales demonstrated similar patterns. The livelihood subscale was moderately correlated with the PTSD-8 ($r[291] = 0.63, p < 0.001$), while the wellbeing subscale showed a strong positive correlation with PTSD-8 scores ($r[287] = 0.76, p < 0.001$). The connection subscale was also strongly correlated with PTSD-8 scores ($r[264] = 0.72, p < 0.001$).

To assess divergent validity, the correlation between the REvIEW and the WHO-5 was calculated. Consistent with the hypothesis, there was not a significant relationship between climate impact as assessed by the REvIEW and general wellbeing ($r[284] = 0.09, p = 0.119$), therefore supporting divergent validity. Further, analysis of the subscales demonstrated similar patterns. Both the livelihood subscale ($r[300] = 0.01, p = 0.819$) and the connection subscale ($r[306] = 0.09, p = 0.091$) had very weak, non-significant correlations with the PTSD-8. The wellbeing subscale, while showing a significant correlation, still exhibited a very weak positive correlation with PTSD-8 scores ($r[296] = 0.09, p < 0.001$).

To test for a significant difference between these correlations, a Fisher r -to- z transformation was performed. The outcome was significant ($z = 10.46, p < 0.001$), indicating that there is a significant difference between the REvIEW scale's correlations to the PTSD-8 and the WHO-5. These findings add support to the convergent and divergent validity of the REvIEW scale.

Differentiation between known groups. A further measure of validity was assessed to differentiate between "known groups" (Boateng et al., 2018). Specifically, it was expected that participants who had a high dependence on their land for their livelihood (defined as participants indicating greater than 30% dependence on the land for livelihood) would report greater impacts on extreme weather events than those who had a low dependence on the land for their livelihood (defined as less than 30% dependence on the land for livelihood). We used MANOVA for each of the factors of the REvIEW for this analysis. The multivariate test revealed a statistically significant difference between high and low dependency groups on the combined dependent variables, $F(3, 273) = 8.30, p < 0.001$; Wilk's $\Lambda = 0.916$, indicating that the level of dependence on the land related to the overall response to extreme weather events. Follow-up univariate tests demonstrated significant differences for each of the dependent variables – livelihood, wellbeing and connection. For Livelihood, participants with high dependence on land reported significantly higher impacts than those with low dependence, $F(1, 275) = 20.26, p < 0.001$. Similarly, for wellbeing, high-dependence participants reported significantly greater impacts, $F(1, 275) = 8.20, p = 0.005$. Finally, participants with high land dependence also reported significantly higher impacts on connection, $F(1, 275) = 15.10, p < 0.001$.

A further MANOVA was conducted to test for significant differences in the impact of extreme weather events on participants from metropolitan versus regional areas across three factors of the REvIEW (livelihood, wellbeing and connection). The multivariate test revealed a statistically significant difference between metropolitan and regional participants on the combined dependent variables, $F(3, 279) = 3.31$, $p = 0.020$; Wilk's $\Lambda = 0.966$, indicating that there was a significant difference between participants from metropolitan and regional areas across the subscales of the REvIEW. Univariate tests were conducted to follow up on the multivariate findings. For livelihood, participants from regional areas reported significantly greater impacts than those from metropolitan areas, $F(1, 281) = 6.45$, $p = 0.012$. However, no significant differences were found between the groups for wellbeing, $F(1, 281) = 1.11$, $p = 0.292$ or connection, $F(1, 281) = 3.21$, $p = 0.074$.

We examined the correlations between the REvIEW subscales (livelihood, wellbeing and connection) to test the hypothesis that higher impacts on livelihood would be associated with greater impacts on wellbeing and connectedness and that greater impacts on wellbeing would be related to greater impacts on connectedness. Based on the reported conventions by [Akoglu \(2018\)](#), there was a statistically significant and very strong positive correlation between livelihood and wellbeing ($r[289] = 0.80$, $p < 0.001$), indicating that greater impacts on livelihood were associated with greater impacts on wellbeing. Similarly, there was a statistically significant and very strong correlation between livelihood and connection ($r[297] = 0.81$, $p < 0.001$), suggesting that greater impacts on livelihood were related to greater impacts on connection. Finally, there was a very strong and significant positive correlation between wellbeing and connection ($r[292] = 0.89$, $p < 0.001$), indicating that greater impacts on wellbeing were associated with greater impacts on connectedness.

Discussion

This paper outlined the development and initial validation of the REvIEW; a unique scale that quantitatively assesses the impacts of exposure to extreme weather events. Initial exploration of the differential impacts of various extreme weather events was also reported. The REvIEW addresses the need for more specific and standardised measures related to environmental exposure ([Charlson et al., 2021](#); [Massazza et al., 2022](#); [Patrick et al., 2023](#)) and provides a new way of conceptualising and measuring impacts of extreme weather events. Previously, investigations of the impacts of extreme weather events have been limited to the environmental markers, broad associations, qualitative enquiry or psychopathologising understandable effects of extreme weather events. Thus, this research is a novel contribution to the field by offering a more tailored approach to measuring the impacts of extreme weather events.

Psychometric evaluation

These results represent an initial validation of the use of the REvIEW and provide initial evidence for the utility of the scale in differentiating impacts of extreme weather events. The internal consistency contained within the results of the REvIEW provides support for the use of both the total score as an indication of holistic impacts and the subscales individually. These results support the first hypothesis, suggesting that impacts from extreme weather events both cluster globally and within distinct life domains, reflecting varied impacts on livelihood, wellbeing and connection. The second hypothesis related to the stability of the REvIEW. Across two timepoints, participants reported consistent levels of impact for the extreme weather event experienced, providing strong evidence for the stability of the scale. These results provide evidence of strong test-retest reliability for the REvIEW and suggest that impacts can be assessed consistently.

In terms of validity, evidence of convergent validity was provided through a significant, positive association between the REVIEW and post-traumatic stress symptoms and evidence for divergent validity was provided with the lack of association with general wellbeing. The measure was also able to differentiate between known groups. In support of hypothesis four, participants with a higher dependence on the land for their livelihood reported significantly higher impacts from extreme weather events across all factors of the REVIEW compared to participants with lower dependence on the land for their livelihood. Participants residing in rural areas reported higher impacts on livelihood, but not for wellbeing or connection. These results provide support for the ability of the scale to differentiate between known groups and suggest significantly more impacts on livelihood for those in rural areas compared to urban areas, alongside similar levels of impacts on wellbeing and connection for people in both rural and urban locations.

In addition, in support of hypothesis five, higher impact on livelihood was found to be related to lower wellbeing and lower connectedness, and lower wellbeing was related to lower connectedness. These dimensions of impact were associated, providing evidence of convergent validity for the measure and demonstrating that the varied extreme weather impacts are interconnected.

Limitations and directions for future research

While the REVIEW presents a novel measure that addresses a recognised need in assessing the impacts of extreme weather events, there are some limitations in this research. The participants in this sample were drawn from an Australian representative population survey and those who reported having experienced an extreme weather event were presented with the additional questions for this study. Thus, the sample was predominantly from urban, coastal areas with a lower proportion of rural and remote participants. Unfortunately, this reduced the sample size and dimensionality was not able to be assessed, as there were insufficient participants who were dependent on the land for the purposes of validating the Livelihood subscale. Further, this prevented insights from many groups who are especially vulnerable to extreme weather events (e.g. farmers, Aboriginal and Torres Strait Islander Peoples). Future research investigating the impacts of extreme weather events, using the REVIEW, could focus on vulnerable groups such as Aboriginal and Torres Strait Islander communities, farmers and remote regions.

In addition, the participants reported being exposed to a range of extreme weather events and the length of time since the event occurred and the duration of each exposure was varied, limiting the analyses and conclusions. Future research could use the measure to assess the impacts of a specified extreme weather event (e.g. in the event of a flood, fire or drought in one specific area). Gathering evidence of the impacts of distinct events may highlight clusters of impacts that often co-occur for different types of extreme weather events (e.g. floods may have a relatively different pattern of impacts compared to drought). Future research could also use the measure to assess the impact of compound extreme weather events (e.g., drought followed by bushfire), particularly in light of evidence suggesting the negative impact on wellbeing of cumulative stressors in farming populations (Schirmer *et al.*, 2024).

The participants in this preliminary data collection were located in both urban and regional areas and not all participants were dependent on the land. This prevented assessment of dimensionality using factor analysis, as not all participants experienced impacts on the livelihood domain. While dimensionality was not able to be assessed due to these sample characteristics, it is worthy to note that factor analysis is not appropriate for this type of scale anyway, as not all impacts will necessarily occur concurrently or be experienced together. For example, a person who reports stock or crop losses in a drought would not necessarily

lose buildings or infrastructure. Thus, it does not necessarily follow that the occurrence of one impact will be related to other impacts in the subscale and therefore factor analyses are not appropriate for the idiographic and varied impacts, particularly in a sample with mixed exposure to varied types of extreme weather events.

However, this paper presents the development and initial validation of the scale to enable the impacts of various extreme weather events to be assessed within communities exposed. Longitudinal research will be needed to provide evidence of the duration and course of various impacts in communities affected by different extreme weather events and within communities where different sub-population groups (e.g., farmers, young people, older people) may experience impacts differently. Further, validation in varied cultural groups and international locations is needed to assess application in different socio-cultural groups and enable understanding and comparison of the impacts of different extreme weather events globally.

Future development of the REVIEW may include the capacity to measure the impacts of compounding (two or more simultaneous extreme events), cascading (a subsequent sequence of consequences) and cumulative (persisting over time) extreme weather events.

Conclusion

The REVIEW offers an innovative scale to address the gap in existing measures of extreme weather event exposure by offering a quantitative assessment of idiographic experiences and direct impacts of extreme weather events. This scale facilitates the assessment of impacts with exposure and over time, at both individual and community levels, enabling targeted aid and support. Further, this scale was developed and initially validated in the Australian context and includes items that represent place-based attachment, such as connection to the land and distress over landscape changes, recognising how extreme weather events disrupt the integral connection between person and environment, resulting in psychological and emotional disturbance (Ellis and Albrecht, 2017).

Importantly, this scale moves the conceptualisation of psychological responses to extreme weather events away from pathologising mental health issues and towards assessing the impacts, which may reduce stigma and facilitate help-seeking. In conclusion, the REVIEW offers a novel measure to reconceptualise and measure the differential impacts of extreme weather events and facilitates multidisciplinary research and practice relating to understanding and responding to the impacts of extreme weather events.

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