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Effects of climate-related disasters on loneliness, social support, social functioning, and social contacts: longitudinal analyses of impact and recovery

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Climate-related changes and disasters may disrupt relationships and ties. Drawing on 10 years of data from the Household, Income and Labour Dynamics in Australia (HILDA) surveys, we examine the effects of climate-related disasters on loneliness, social support, social functioning, and social contacts with friends and family. By matching respondents who experienced a disaster with a control cohort of similar characteristics before the event, we find being exposed to a climate-related disaster is associated with an increase in loneliness and a decrease in social functioning the year of the event, and up to 2 years afterwards. We also find lower levels of reported social support, with the effect sustained up to 6 years after the event. We further explore whether there may be heterogeneity in the impact, utilising group-based trajectory modelling. We identified three groups that followed distinct trajectories of sociality: a low (19.6%), medium (44.7%), and high social support and connectedness group (35.7%). The low support and connectedness group experienced the most substantial decrease in social support and an increase in loneliness in the year of the event, though followed by gradual recovery over time. Our findings provide further evidence of the heterogeneity in the social impacts of climate change.

Loneliness is an important issue. Much of the existing research has considered its relationship with individual characteristics. However, beyond individual factors, many societal factors may also impact loneliness and social connections. For instance, loneliness has attracted greater attention since the onset of COVID-19 due to the social and physical restrictions that many countries around the world imposed, with a number of studies examining their effects on loneliness[1–3]. Though less examined, climate change and its related impacts may also affect individual loneliness, such as through its impacts on community connectedness and social support.

In this paper, we aim to make several contributions to existing studies on loneliness. Firstly, we examine how experiencing a climate-related disaster may shape loneliness, as well as the sense of social connectedness, social support, and social contact with friends and family. Secondly, by drawing a rich longitudinal dataset, we account for variation in social vulnerability to being exposed to a climate event by matching individuals with similar characteristics before the exposure. This allows us to better estimate the impact of climate events on our outcomes. Thirdly, beyond reporting on an average effect, we further explore whether there may be heterogeneity in the effects. We do so by utilising trajectory modelling, drawing on the longitudinal nature of our dataset. This allows us to develop trajectories of our outcome measures, considering that different groups of individuals may follow different trajectories of loneliness and social connection, even prior to the climate event. This also allows us to examine variation in the experience of the climate event across different loneliness and social groups.

Existing research has shown that being directly impacted by a natural disaster is associated with negative well-being[4]. A unique type of distress, known as solastalgia, is experienced by people impacted by natural disasters[4–7]. Solastalgia is a type of distress associated with environmental change in one's home or community. For instance, Knez et al.[5] and Levinston et al.[4] found that bushfires disrupt the link between well-being and positive place identity, generating solastalgia. This is attributed to the fact that people tend to invest emotionally and cognitively in areas, while natural disasters irrevocably alter the environmental landscape. Viewing irreversible change in

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the community produces distress and is particularly pronounced for groups such as farmers who have a strong place-based identity[8]. This kind of place-based identity is also reported by farmers in regional Australia, who feel solastalgia in the event of droughts[8], and by people impacted by floods, highlighting the incident negatively impacted sense of place and community[6,7].

Exposure to and effects of climate change, however, vary across groups of individuals. People with disabilites[9,10], people with dependents[11,12], rural and regional dwellers[8,13,14], and people with underlying disadvantages[15] are more negatively impacted by natural disasters. Individuals from groups with existing disadvantages before the natural disaster incident also experience greater negative well-being impacts[7,15,16]. Social capital, including connectedness to the community, feelings of belonging, and optimism, is important for natural disaster recovery[15,17,18]. However, individuals belonging to marginalised groups may have a more difficult time accessing social support resources and, as a result, have a harder time recovering from natural disaster-related wellbeing harms[15].

Rural and remote living individuals generally have worse health and greater exposure to natural disasters, which exacerbates the harm experienced[15,19]. For instance, drought has a negative impact on mental health, and the individuals most severely impacted are those working in rural agriculture sectors whose livelihoods are directly affected[13]. However, for all types of employment, living in a drought-affected area is associated with poorer self-reported mental health across professions. Specifically, Ellis and Albrecht[8] found that farmers' wellbeing is significantly linked to the place-bound weather, with good weather having a positive impact on the whole town.

Beyond variation in the exposure to and impacts of climate events, we also know less about the persistence of effects from a longitudinal perspective. Negative well-being persists for many years after natural disaster incidents[6,9,12,20,21]. Alpass et al.[20], Begg et al.[21], Bourke et al.[9] and Prayag et al.[6] found that following the 2010/11 Canterbury earthquakes, well-being recovery takes many years to improve. This was found across all household income levels[21]. Prolonged impact was reported by both people who lived in areas directly affected by the earthquake and those who did not[20]. The longevity of natural disaster impacts was found for bushfires, with de Vet et al.[12] finding that parents still suffered negative physical and mental well-being 4 years after the 2013 Blue Mountains bushfire. For the 2010/11 Queensland Australia floods, Clemens et al.[16] found that about 240,000 (7.1%) respondents were still distressed 2–5 months after the incident. However, Walker-Springett et al.[18] however found that 12 months after a flood in the United Kingdom, respondents' wellbeing returned to pre-flood levels. The differences in these findings occur likely due to the way well-being is measured and potential mitigating factors.

A range of factors determine disaster recovery support. Community connectedness and support are protective factors for well-being during and following disasters[15,17,18,22]. Institutional responses may also promote or impede the community's adaptiveness and consequently result in a more or less distressing experience for impacted individuals through the removal of community-led agency and silencing[18]. At the same time, natural disaster incidents may produce a desire to support others, enhancing social capital and communal coping, which is emphasised as vital for post-disaster recovery[6,7,20]. In addition, while the initial shared experience of a natural disaster brings diverse people together, after the initial impact, Butler et al.[23] and Walker-Springett et al.[18] found that people were not likely to remain close. Community support is a protective factor against worse well-being[15,17,18]; however, it must be in accord with institutional support to mitigate distress[18]. Community relationships formed during natural disaster incidents tend to cease following post-disaster recovery as the shared experience upon which the relationship was formed is removed and differences in disaster impacts exacerbated[18,23]. Impacts tended to be more corrosive to the community in the long term, with divisions such as impacted by the disaster vs non-impacted and insured vs non-insured exacerbating tensions[23].

Results

Sample characteristics pre-disaster

Table 1 presents sociodemographic characteristics of individuals who experienced a climate-related disaster in the year prior to the disaster, before matching (used for group-based multi-trajectory modelling) as well as balanced profiles between exposure and control groups post-matching (used for conditional fixed-effect regressions for matched case–control data). Of the affected individuals, the mean social functioning and social support scores are 79.0 (SD: 25.1) and 1.3 (SD:1.3) respectively. A small proportion experienced loneliness (10.1%) and a majority got together socially with friends/relatives not living with them at least 2 or 3 times a month (73.7%).

Effects of climate-related disasters on social support and connectedness

Table 2 shows that effects of climate-related disasters on social functioning, social support, loneliness and social contact over time. While there were no significant differences in social support and connectedness outcomes between exposure and control groups prior to the disaster, people who experienced a climate-related disaster had a significant decrease in social functioning (disaster year: − 3.99, 95%CI − 5.64, − 2.34; post-disaster year 1: − 2.19, 95%CI − 3.94, − 0.43; post-disaster year 2: − 1.98, 95%CI − 3.72, − 0.23) and a significant increase in the risk of loneliness (disaster year: 0.04, 95%CI 0.01, 0.06; post-disaster year 1: 0.03, 95%CI 0.01, 0.06; post-disaster year 2: 0.03, 95%CI 0.01, 0.05) in the disaster year and 2 years following the disaster year. The effect of climate-related disasters on social support was more sustained over the long term, at around 0.1 point lower than the control group since the disaster. No significant effects of climate-related disasters on social contacts with friends or relatives were observed.

	Exposed population (before matching)		Exposure group (matched)		Control group (matched)	
	%	n	%	n	%	n
Female	52.1	747	52.8	532	52.9	533
Age < 35	31.8	456	23.6	238	22.1	223
Age 35–64	52.5	752	17.3	174	18.3	184
Age > = 65	15.6	224	19.1	192	20.0	201
Australian born	82.5	1182	82.7	833	82.1	827
Main English Speaking	8.9	128	9.1	92	10.5	106
Other	8.6	123	8.1	82	7.3	74
Indigenous people	3.3	47	3.1	31	3.1	31
Couple without children	31.4	450	29.8	300	31.3	315
Couple with children	41.0	588	43.4	437	40.7	410
Lone parent	8.0	115	8.4	85	10.3	104
Lone person	14.7	211	13.7	138	13.4	135
Other household type	4.9	70	4.7	47	4.3	43
Equivalised household income (mean, SD, weekly, '000)	1.04	0.59	1.05	0.60	1.06	0.59
Graduate/postgraduate	21.1	302	21.5	217	23.3	235
High school/advanced certificate	50.1	718	48.8	491	49.1	494
Year 11 or below	28.8	413	29.7	299	27.6	278
Employed	63.6	911	65.2	657	64.3	648
Unemployed	3.9	56	3.5	35	4.6	46
Not in labour force	32.5	466	31.3	315	31.1	313
Received government payments	21.4	307	22.7	229	23.7	239
Long term health condition	32.4	464	31.7	319	33.4	336
Owner	70.7	1012	72.3	728	71.3	718
Private renter	23.4	335	21.6	218	22.6	228
Social renter	2.3	33	2.2	22	1.7	17
Other housing tenure	3.6	52	3.9	39	4.4	44
House (detached or semi-detached)	90.9	1303	91.6	922	92.1	927
Rural regions	48.3	692	46.6	469	46.1	464
Disadvantaged areas (lowest 2 area socioeconomic quintiles)	42.7	612	20.6	207	19.6	197
Social functioning (mean, SD)	79.0	25.1	79.6	24.9	79.8	24.8
Social support (mean, SD)	1.3	1.0	1.4	1.0	1.4	1.0
Loneliness	10.1	144	10.5	106	10.5	106
Frequent social contact	73.7	1043	73.3	738	74.5	750
Observations	1433		1007		1007	

Table 1. Summary statistics at baseline.

Different trajectories of social support and connectedness pre-, during and post climate-related events

The low social support and connectedness group (19.6%) is characterised by a low baseline with high impact. This group shows poorer social support and connectedness prior to the disaster, experienced the most substantial decrease in social functioning and increase in risks of loneliness in the disaster year, though followed by gradual recovery over time. This group also experienced a small impact on social contact. The medium social support and connectedness group (44.7%) exhibits a medium baseline with small impact on social functioning, loneliness, and social support, along with a noticeable decrease in social contact. The high social support and connectedness group (35.7%) had a high baseline with no impact on social functioning, social support, and risks of loneliness, and a small impact on social contact (Fig. 1).

Predictors of social support and connectedness trajectory patterns

Figure 2 presents pre-disaster factors associated with the risk of being in the low to medium social support and connectedness groups relative to the high social support and connectedness group among the exposed population. People at risk of high impacts on social support and connectedness (relative to minimal impact on social support and connectedness) were more likely to be lone parents, those not in the labour force, those with long-term health conditions, social renters, metropolitan residents, and those lacking community attachment, experiencing low levels of area safety, dissatisfied with their neighbourhood, or living in socioeconomically disadvantaged areas prior to the disaster.

	Social functioning		Social support		Loneliness		Social contact	
1 year before disaster	−0.64		−0.05		0.00		−0.01	
	[−2.35	1.07]	[−0.12	0.02]	[−0.02	0.03]	[−0.05	0.02]
Disaster year	**−3.99**		**−0.13**		**0.04**		−0.02	
	[−5.64	−2.34]	[−0.20	−0.06]	[0.01	0.06]	[−0.06	0.01]
1 year after disaster	**−2.19**		**−0.10**		**0.03**		−0.01	
	[−3.94	−0.43]	[−0.17	−0.02]	[0.01	0.06]	[−0.04	0.03]
2 years after disaster	**−1.98**		−0.07		**0.03**		−0.01	
	[−3.72	−0.23]	[−0.15	0.00]	[0.01	0.05]	[−0.05	0.02]
3 years after disaster	−1.44		**−0.11**		0.02		−0.02	
	[−3.20	0.32]	[−0.19	−0.04]	[−0.01	0.04]	[−0.06	0.01]
4 years after disaster	−1.38		**−0.14**		0.02		−0.02	
	[−3.30	0.53]	[−0.22	−0.06]	[−0.00	0.05]	[−0.06	0.02]
5 years after disaster	−1.83		**−0.09**		0.02		−0.01	
	[−3.94	0.29]	[−0.18	−0.01]	[−0.01	0.05]	[−0.06	0.03]
6 years after disaster	−1.97		**−0.20**		0.02		−0.04	
	[−4.27	0.33]	[−0.30	−0.11]	[−0.02	0.05]	[−0.08	0.01]

Table 2. Effects of climate-related disasters on social support and connectedness. Bolded estimates indicate significance at the 5% level.

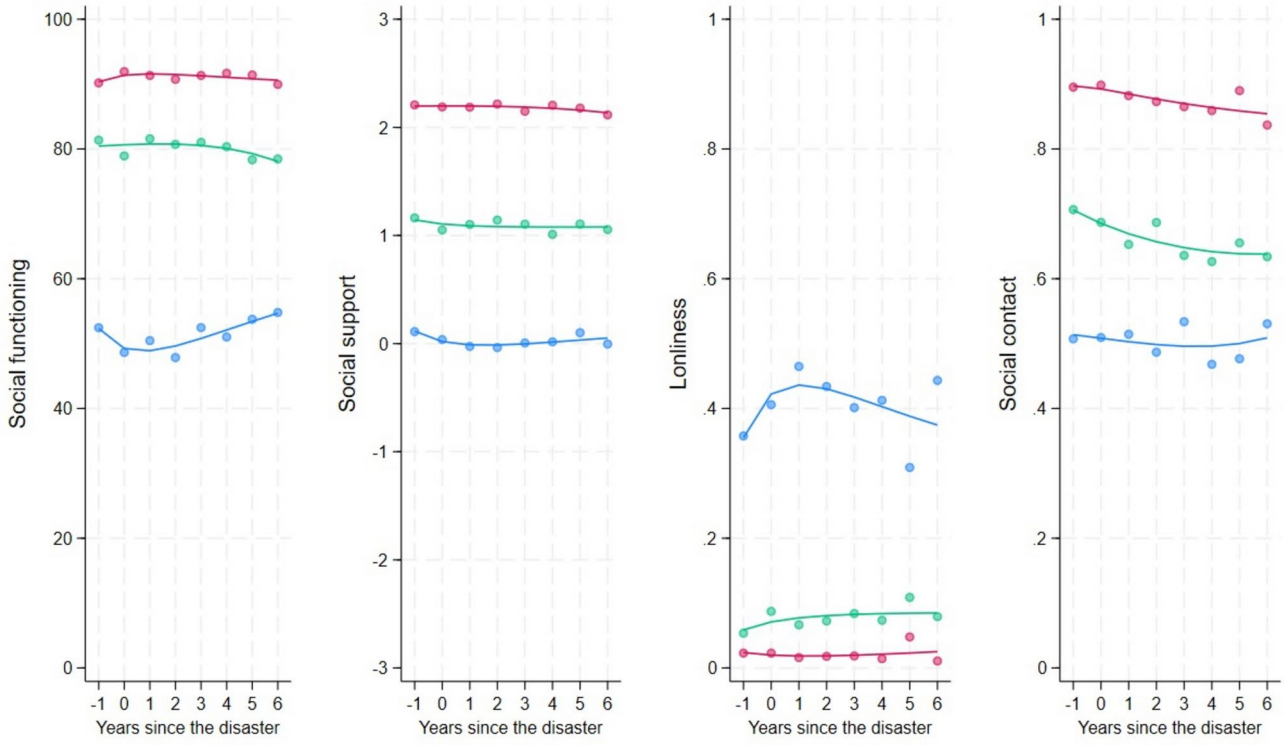

Fig. 1. Different trajectories of social support and connectedness before and after extreme weather events. *Notes* The blue dots indicate the low social support and connectedness group (19.6%), the green dots indicate the medium social support and connectedness group (44.7%), and the red dots indicate the high social support and connectedness group (35.7%).

Discussion

Climate change is impacting citizens around the world. While there is increasing research on its impact on mental health, our study contributes by considering its effect on loneliness and a range of social outcomes. Drawing on a rich, longitudinal dataset, we demonstrate that being exposed to a climate-related disaster is related to increases in loneliness, and decreases in social functioning and reported social support. Interestingly, we do not find effects on social contact, suggesting that having experienced a climate event may shape people's

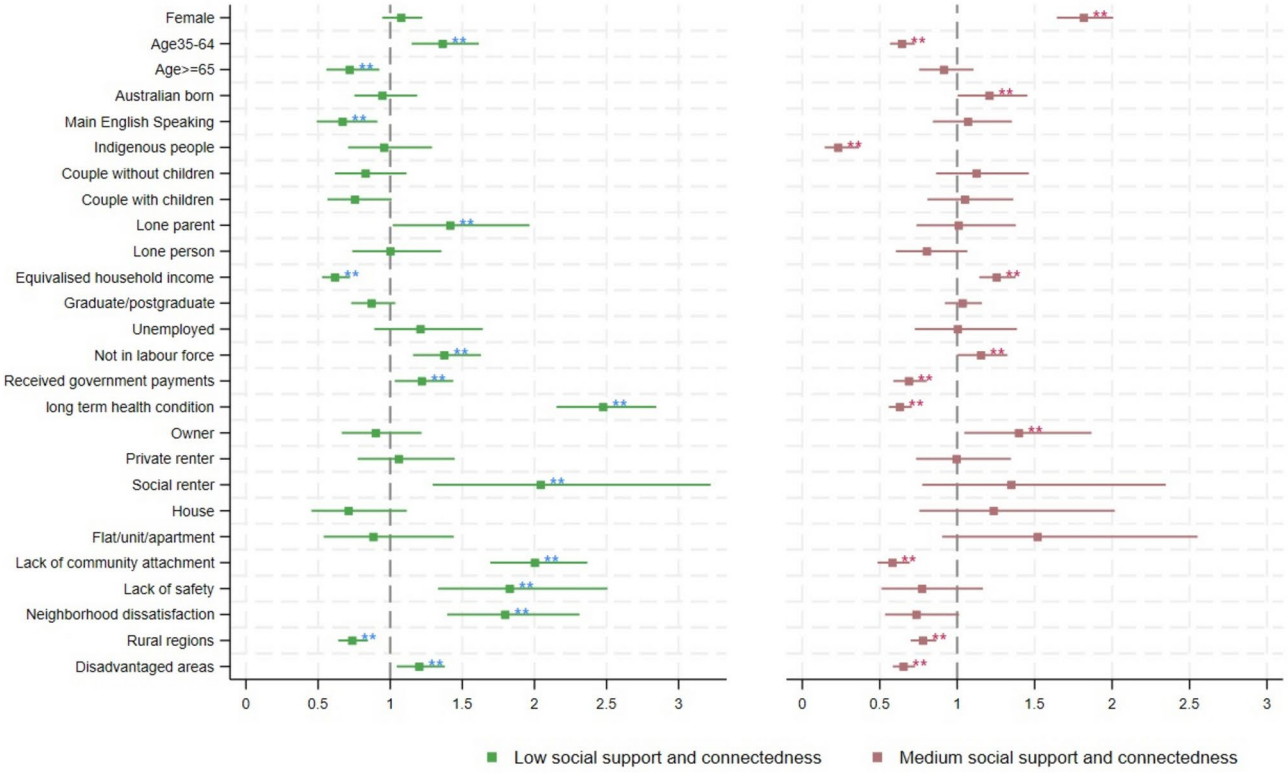

Fig. 2. Predictors of social support and connectedness trajectory patterns. *Notes* Relative risk ratios and 95% CI are displayed. High social support and connectedness is used as the reference group. ** significant at the 5% level.

views on their relationships, rather than actual social behavior. We also demonstrate that the effects on the outcomes extend beyond the year of the event and persists for several years afterward. Furthermore, we demonstrate heterogeneity in the impact by utilising group-based trajectory modelling. We showed that there were three groups who followed distinct trajectories of sociality and that the impact was more severe for the most vulnerable group. Thus, it provides evidence of the heterogeneity in the social impacts of climate change. Our findings are consistent with prior research, demonstrating that individuals who were more disadvantaged were more negatively impacted by climate disasters[7,15,16]. However, we advance existing studies by utilising more robust methods, demonstrating the impact longitudinally, and examining how long loneliness and social outcomes are affected and persists after climate events.

Though we have contributed to existing research on exposure to climate events and loneliness, our study is not without limitations. Firstly, we are limited by the measures available to us in the dataset. For instance, we utilised a single item on loneliness. Future research drawing on a comprehensive loneliness scale might be useful. We were also restricted to the item on whether the respondent had experienced a climate-related disaster (flood, bushfire, or cyclone) that damaged or destroyed their home. Arguably, this is a severe measure of being impacted by climate change, and it is possible that individuals are affected without damage to their homes. Future research drawing on datasets that contain other forms of measuring the impact of climate events would be useful. Our data also draws on an Australian dataset, which may be limited in terms of generalisability. Future research drawing on data from other countries would also be valuable. Given the frequency and ongoing impact of climate change, understanding its effects of social outcomes, including loneliness, would be increasingly valuable. This will have scientific value but could also potentially help inform interventions that could mitigate their impacts.

Data/methods

Data

Data is drawn from 10 years of a nationally representative, longitudinal study collected from 2009 to 2019 as part of the Household, Income and Labour Dynamics in Australia (HILDA) survey. The data is public available upon an application and approval for data access (https://dataverse.ada.edu.au/dataverse.xhtml?alias=hilda). With a stratified multistage clustered sampling design, the HILDA survey interviews more than 10,000 Australians annually and contains rich information on demographic, economic, and psychosocial status, as well as occurrences of major life events, including climate-related disasters. The sample includes de-identified individuals who were observed for at least 1 year before the disaster and 3 years after the disaster to allow for the control of baseline characteristics and sufficient follow-up.

Outcome measures

Social capital outcomes are measured in four ways including social functioning, social support, loneliness, and social contact. First, social functioning as part of the 36-Item Short Form Survey (SF-36) is used to measure interference with social activities due to physical health or emotional problems. It is on a scale from 0 to 100, with higher values indicating better functioning. Second, social support is constructed following Flood[24] based on responses to 10 questions on a 7-point scale related to accessible social ties, including (1) People don't come to visit me as often as I'd like, (2) I often need help from other people but can't get it, (3) I seem to have a lot of friends, (4) I don't have anyone I can confide in, (5) I have no one to lean on in times of trouble, (6) There is someone who can always cheer me up when I'm down, (7) I often feel very lonely, (8) I enjoy the time I spend with the people who are important to me, (9) When something's on my mind, just talking with the people I know can make me feel better, and (10) When I need someone to help me out, I can usually find someone. These questions are converted to a range from −3 to 3 scale and averaged across the 10 items, with higher values indicating higher support. Third, loneliness is measured using a binary variable based on how much the respondent agreed or disagreed with the statement "I often feel very lonely", with 1 indicating very lonely (scoring 6–7) and 0 not/less lonely (scoring 1–5). Fourth, the measure on social contact is constructed using the information on how often the respondent got together socially with friends/relatives not living with them, with 1 indicating frequent social contact (at least 2 or 3 times a month) and 0 less frequent social contact (at most about once a month).

Exposure measure

HILDA contains a binary variable to indicate if a respondent has experienced a climate-related disaster (flood, bushfire, or cyclone) that has damaged or destroyed their home. A total of 2003 people in the sample reported experiencing home damage from climate-related disasters between 2009 and 2019. Those without at least one observation recorded prior to their experience of a disaster were excluded to allow for matching with a control group, giving a sample of 1443 people.

Exposure and control groups

To investigate the impact of a climate-related disaster on social support and connectedness, control cohorts who shared similar characteristics before the disaster were randomly sampled from respondents who never experienced a climate-related disaster that damaged or destroyed their home during 2009 and 2019 based on a series of covariates measured one-year prior to the disaster experience. These matching covariates include gender, age groups, country of birth, Aboriginal and Torres Strait Islander status, education, urbanness, area socioeconomic quintiles (according to the index of relative socio-economic advantage and disadvantage), household structure, equivalised household income, employment status, long-term health condition, government payment status, tenure types, dwelling types, area mean housing prices, social support and connectedness measures, 13 region indicators (according to the Australian Statistical Geography Standard Greater Capital City Statistical Area 2011), and 8 climate zone indicators (according to the National Construction Code).

Each exposed cohort who experienced the disaster at different years was matched to a control cohort with similar demographic, socioeconomic, housing, health, neighbourhood, location, and climate characteristics (see above matching covariates) 1 year before the disaster. Exposed and control cohorts were dynamically matched using one-to-one nearest neighbour matching within a calliper of 0.2 of the standard deviation of the logit of the propensity score without replacement. Once included in a cohort, these individuals were excluded from being selected as controls in subsequent matchings. After matching, the analytical sample at baseline comprises of 1388 people from the exposure group and 1388 from the control group. After excluding individuals who were exposed to disaster after 2016 to allow follow-up of at least 3 years after disaster, a total of 2014 individuals including 1007 exposed and 1007 unexposed. Around 90% of individuals are observed for at least 8 years in the sample. The matching scheme is described in Appendix Table A1 and the matching outcome is reported in Appendix Figure A1. Results on standardised mean differences show significant improvement in the balance of covariates between exposed and control cohorts.

Statistical analysis

To examine the impact of climate-related disasters on social support and connectedness, conditional fixed-effect regressions for matched case–control data were used[25]. A range of baseline sociodemographic characteristics that have been identified in the literature as key determinants of social vulnerability to climate change[26] including gender, age groups, country of birth, Aboriginal and Torres Strait Islander status, education, urbanness, area socioeconomic quintiles, household structure, equivalised household income, employment status, and long-term health condition, along with climate zones and year indicators were controlled for. Matched exposure and control groups with covariates adjusted enables double robustness estimation. Clustering robust standard errors are applied.

To identify latent distinctive trajectories of individual social support and connectedness before and following extreme weather events among those exposed, group-based multi-trajectory modelling was performed. The approach defines a finite number of clusters of individuals following similar trajectories over time across multiple indicators of social support and connectedness[27]. Censored normal models (for social functioning and social support measures) and logistic models (for loneliness and social contact measures) were used to estimate trajectories of social support and connectedness outcomes, allowing for cubic functions for each group trajectory. For the model specification, trajectory models with different numbers of groups for each outcome and four outcomes collectively were estimated and assessed. To identify the distinct features of the data, the selection of the number of groups was based on model fit, parsimony, and representation of trajectories for each outcome in the multi-trajectory model, drawing on the Bayesian Information Criterion (BIC) to determine model fit,

including entropy statistics (>0.80) to consider confidence in group membership classification, as well as the average posterior probabilities (closer to 1) to assess precision of group selection, allowing a sufficient sample size (≥10%) to constitute each group[27,28]. Through the selection process (Appendix Table A2), the BIC statistics improved as the number of groups increased but by a much smaller margin after the three-group model. The three-group multi-trajectory model had higher entropy scores and average posterior probabilities than the models with more than three groups, and the models with more than three groups did not include a group substantively distinct from those with three groups. The three-group multi-trajectory model also preserved the distinctive trajectories revealed in the individual trajectories for each outcome measure. Consequently, the selection process identified a three-group multi-trajectory model.

Analyses were conducted using the 'traj' and 'xtreg' commands for the trajectory modelling and effect estimates in Stata SE 18.0.

Data availability

The HILDA data is available through the Dataverse website. (https://dataverse.ada.edu.au/dataverse.xhtml?alias=hilda).

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Competing interests

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