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Disasters and Individual Wellbeing

Evidence from Australia

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Research Summary

Why was the research done?

Disaster vulnerability is closely linked to poverty. On the one hand, poorer people are disproportionately more exposed to risks from weather-related events and harsh weather. On the other, vulnerable individuals and households may slide into poverty following disasters as they deplete savings and assets to rebuild their lives. While existing research demonstrates the significant economic and health costs of disasters, less is known about the wellbeing implications. This paper draws on the Household, Income and Labour Dynamics in Australia (HILDA) Survey dataset to provide empirical insights into the wellbeing implications of natural disasters in the lives of Australians, with a particular focus on the role of income.

What were the key findings?

Our analysis revealed two main results. First, disasters have long-running impacts on individual wellbeing. We observed significantly lower life satisfaction and happiness after 18 months. While feelings of social connectedness were higher immediately after a disaster, this feeling declined after about 15 months. Second, we found that wellbeing losses from disasters disproportionately impacted people on low incomes. While the differences are not statistically significant, there is a gap between the wellbeing and happiness of individuals from low-income households who are affected and unaffected by disasters.

What does this mean for policy and practice?

The findings underscore the need for adequate short and long-term support after disasters. Our results on wellbeing effects also underline the important role of organisations involved in disaster recovery to support individuals and families beyond the immediate aftermath. The response and recovery activities in the initial months likely enhance community resilience through increased connection and social interactions. This underscores the need for greater attention to fostering social connectedness in disaster recovery efforts. In terms of policy implications, our findings support the adoption of wellbeing impact as a useful measure to assess disaster severity.

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Disasters and Individual Wellbeing: Evidence from Australia

Introduction

Measures of wellbeing are found to be negatively impacted by some life events, including disasters triggered by natural hazards. Research confirms that disasters not only impose large economic costs but also incur implicit costs related to disruptions in education and work, support for physical and mental health conditions, environmental impact, increase in food and housing costs, and public health consequences among others which were not widely acknowledged in conventional economic costs-benefit analyses until recently (Danzer & Danzer, 2016; Hallegatte et al., 2017). In a similar vein, Jensen and Tiwari (2021) argued that quantification of the impact of disasters underestimates the wellbeing costs, as such evaluation often relies on the costs of mental health support provided to the affected population. Therefore, measuring the subjective wellbeing of the affected population is an increasingly valuable metric to support the current methods of evaluating disaster impacts, reviewing compensation levels and planning recovery efforts (Jensen & Tiwari, 2021). This paper provides empirical insights into the wellbeing implications of natural disasters in the lives of Australians.

Disasters have a multifaceted impact on individuals. This impact includes but is not limited to loss of livelihood, business interruptions, mental health deterioration and severed social connections (Chinn et al., 2022; World Bank & Queensland Reconstruction Authority, 2011). To understand this impact, we focus on three different components of individual wellbeing in our research – life satisfaction, social connectedness and happiness.

Disaster impact is interrelated with socioeconomic inequities that create vulnerability. A large body of research identifies that income is related to people's ability to cope with disasters (Bleemer & van der Klaauw, 2017; Hallegatte et al., 2017; Kerblat et al., 2021). On the one hand, poorer people are disproportionately more exposed to risks from weather-related events and harsh weather (Lankes et al., 2024; Morduch, 1999). On the other, vulnerable individuals and households may slide into poverty following disasters as they deplete savings and assets to rebuild their lives. In this way, disaster vulnerability is closely related to poverty. Moreover, risk management policies and disaster recovery programs are not designed equally as both preparedness and response leave poor people worse off than their counterparts (Tselios & Tompkins, 2019). This is likely to disproportionately affect their wellbeing levels as poor people have less adaptive capacity to cope with exogenous shocks.

Our investigation exploits a rich panel dataset from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. The panel data not only helps control for unobserved individual heterogeneity but also helps

investigate variation in wellbeing over time offering a more comprehensive understanding of the adverse effects of disasters in Australia.

Australia presents an important case study for understanding the wellbeing implications of disasters. The country is the driest continent and has experienced prolonged heat and drought, leading to destructive bushfires that have affected the majority of the country (Abram et al., 2021; Australian Government Department of Climate Change Energy the Environment and Water, 2021). Moreover, Australians are living in an era of more intense and frequent extreme weather events for which they are not prepared. For instance, the bushfires across southeastern Australia in 2019-2020 were unprecedented and termed “Black Summer” (Abram et al., 2021). More recently, people living on the eastern coast of Australia had to cope with multiple back-to-back disasters in 2022. The rain and subsequent floods impacted thousands of households and resulted in \$5.56 billion in insured losses (Climate Council of Australia, 2022). Such weather events and disasters carry damaging consequences for businesses, the environment and communities. The case of Australia is not unique; Benevolenza and DeRigne’s (2019) review of the literature found that natural hazard-induced disasters are also increasing in the United States (US), with significant and disproportionate impacts on the physical and psychological health of vulnerable populations. Therefore, our empirical analyses not only improve our understanding of the wellbeing implications of disasters but also contribute to disaster preparedness and recovery in Australia and overseas.

Disasters and wellbeing

As is widely known, wellbeing is a multidimensional construct. It encompasses many outcomes – feeling good, functioning well, experiencing positive relationships and having a sense of purpose among others (Ruggeri et al., 2020). Research shows that feeling good and functioning well are encapsulated in indicators of subjective wellbeing such as life satisfaction and happiness (Huppert, 2009; Ruggeri et al., 2020). While one’s life satisfaction reflects the cognitive evaluation of their own life, hedonic experiences are also important measures of individual wellbeing (Nikolaev, 2018).

Research on social connections also deserves more attention as it is an important aspect of individual wellbeing in the aftermath of a disaster. Positive relationships and social connections not only improve mental health but also enhance resilience and constitute an important part of individual wellbeing (Finucane et al., 2021; Haslam et al., 2009; Islam & Walkerden, 2015; Xia & Hudac, 2023). Indeed, social connectedness is an important determinant of communities’ ability to recover from disasters (Aldrich, 2012). Therefore, we focus on three

components of individual wellbeing in this paper as measured by life satisfaction, social connectedness and happiness.

There is growing literature on the impact of disasters on the subjective wellbeing of individuals. Exposure to disasters not only directly affects wellbeing but is likely to lower wellbeing through evacuation, physical and environmental damage, injury and disease, loss of livelihood, loss of community and loss of resources (Frijters et al., 2023; Hickson & Marshan, 2022; United Nations Office for Disaster Risk Reduction, 2022). These stressors lead to poorer mental health, loss of social support, greater anxiety and lower quality of life. For instance, Paul (2011) reported that more than half a million people needed mental health support after Hurricane Katrina in the US. However, mental health support may not fully capture the broader, non-pecuniary impact of disasters on people's lives. Luechinger and Raschky (2009) argued that change in reported life satisfaction is an empirically comprehensive evaluation of the impact of disasters on people. Using this life satisfaction approach, the authors found that historical floods in the period between 1973 and 1998 in 16 European countries had a negative and significant impact on people's reported life satisfaction.

Disasters have negative and long-lasting impacts on the wellbeing of the affected population (Calvo et al. 2015). Some studies have reported contrasting evidence that the negative impact of a disaster is short-lived. In their recent work, Frijters et al. (2023) found that although the wellbeing of people in the US falls in the first few weeks after a disaster, the affected individuals are able to bounce back quickly. In contrast, LaJoie, Sprang and McKinney (2010) found that it took over a year for the wellbeing of Hurricane Katrina evacuees to return to the pre-disaster level. In their study, Luechinger and Raschky (2009) also concurred that subjective wellbeing recovered in under 2 years after the event. The wellbeing impact of the Wenchuan earthquake in 2008 in China, however, lasted for nearly ten years (Wang & Wang, 2023). Overall, these studies argue that subjective wellbeing rebounds after complete recovery and the extent of the damage, response activities, support and completeness of the recovery influence the subjective wellbeing in the recovery period.

Progress is also being made in understanding the association between disasters and wellbeing in Australia. For instance, Shi and Jin (2022) reported statistically significant and negative impact of disasters on life satisfaction. Similar to Luechinger and Raschky (2009), Shi and Jin (2022) used the life satisfaction approach to value the cost of natural hazard-induced disasters in Australia. Using the HILDA Survey data, the authors found that disasters in Australia have a negative impact on people's life satisfaction and that this wellbeing loss is equivalent to a loss of \$162,492 in household income. In their study, Carroll et al. (2009) focused on drought and found a detrimental

impact of drought on the life satisfaction of Australians. Using primary data, Heffernan et al. (2022) reported high rates of anxiety, stress and depression in people affected by the late 2019-early 2020 bushfires in Australia. The authors also found that children in communities affected by the bushfires struggled with behavioural and emotional challenges. Importantly, their study highlights the importance of social connectedness as an important driver of psychological resilience in the aftermath of a disaster and hence a key aspect of subjective wellbeing for affected individuals and households.

We add to this literature by investigating the extent and the duration of the impact of disasters on the life satisfaction, social connectedness and happiness of individuals using large-scale panel data. To do this, we follow Clark et al. (2008) and estimate lead and lag effects. The existing literature helps us build our first hypothesis that disasters have an adverse effect on the individual wellbeing of people in Australia.

H1: Disasters adversely affect individual wellbeing in Australia.

The mixed evidence from existing studies on the long-lasting impacts of disasters does not help us build a clear hypothesis on the long-run impacts of disasters on wellbeing, although the wellbeing implications of disasters are expected to wane with recovery efforts and time.

In related literature, Rentschler (2013) found that poorer households are less able to cope with disasters and require longer recovery periods. Other studies support this finding, indicating that poorer households are more vulnerable to the detrimental impacts of disasters, and this detrimental impact accelerates with disaster frequency and severity (Hallegatte et al., 2017; Hallegatte & Walsh, 2021; Kerblat et al., 2021). This line of research informs our second hypothesis which derives from Hallegatte's unbreakable model (Hallegatte et al., 2017). The model asserts that \$1 in economic loss does not have the same impact on people across different ends of the income distribution. Hallegatte and his coauthors vehemently argued that poorer people are far more affected by the same economic loss than their richer counterparts in the event of a disaster. This is because their income, livelihoods, health and education are at a greater risk, and they are unable to rely on savings or assets to overcome the impacts of disasters. For the same reasons, poorer people when affected by disasters, could also need more time to recover. The unbreakable model shows that income positively correlates with socioeconomic resilience (Hallegatte et al., 2017). Simply put, the risk of wellbeing losses decreases with an increase in income. Therefore, any loss suffered in the aftermath of a disaster is unlikely to have the same wellbeing implications for rich and poor households. Hence, individuals and families at lower income levels are more likely to be affected by wellbeing losses.

H2: The wellbeing of people with greater household incomes is less affected by disasters.

By testing these hypotheses, our paper provides three novel insights: First, by focusing on three different indicators of individual wellbeing i.e., life satisfaction, social connectedness and happiness, we provide a comprehensive understanding of the wellbeing effects of natural disasters. Studying these three indicators gives us a better understanding of how individual wellbeing is impacted in the aftermath of a disaster as previous studies on disaster impacts using panel data have overlooked happiness and social connectedness as critical measures of individual wellbeing. Second, we contribute to existing inconclusive evidence on impact duration by reviewing temporal changes in wellbeing pre- and post-disaster. Third, we dissect the wellbeing impact of people's socioeconomic capacity to cope with and recover from disasters. Specifically, we investigated whether disaster impact on individual wellbeing varied by household income.

Data and Methods

The Household, Income and Labour Dynamics in Australia (HILDA) Survey is a household-based panel study that started in 2001. It surveys over 17,000 people living in Australia each year and collects information on the economic, health and social aspects of their lives. Attrition in the HILDA Survey is comparable to other longitudinal studies such as the British Household Panel Survey (Summerfield et al., 2020).

We used the 2009-2021 waves in our analysis. Since 2009, the HILDA Survey has collected information on whether '*a weather related disaster (flood, bushfire, cyclone) damaged or destroyed your home*' as well as information on how long ago this happened i.e., 0 to 3 months ago, 4 to 6 months ago, 7 to 9 months ago or 10 to 12 months ago. We used the data on whether a weather-related disaster damaged/destroyed a respondent's home as a proxy for being affected by disasters and recoded it as a dummy variable. Akin to Kettlewell et al. (2020), we utilised the information on how long ago the disaster occurred in intervals of 3 months to create dummy variables that represent lag and leads. Importantly, the information collected on wellbeing and disaster from the HILDA Survey data spans years that coincide with different types of disasters in Australia. For example, between 2019-2021, Australia experienced several extreme weather events, including the Black Friday summer bushfires in 2019-2020 and tropical cyclones and floods in Queensland and the Northern Territory in 2015, among several others.

As discussed earlier, our study focuses on three measures of individual wellbeing – life satisfaction, social connectedness and happiness. We are mainly interested in the way in which these measures evolve around the time of a disaster (H1) and if household income impacts this relationship (H2).

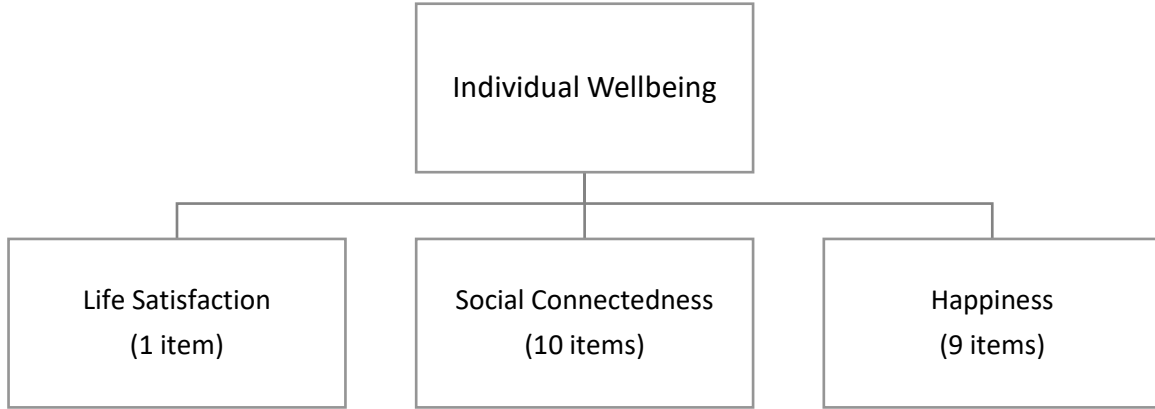
Data on measures of wellbeing is available in the personal and self-complete questionnaires of the HILDA Survey. Life satisfaction is measured by the response to the question '*All things considered, how satisfied are you with your life? Again, pick a number between 0 and 10 to indicate how satisfied you are on a scale of 0 to 10 with higher number denoting greater satisfaction*'.

Social connectedness is an index of 10 variables on social isolation and supportive connections. For instance, 'I often feel very lonely', 'I enjoy the time I spend with the people who are important to me', and 'I seem to have a lot of friends' are measured on 1 (strongly disagree) to 7 (strongly agree) scale and are included in the index on social connectedness. Where an increase in indicators indicates worse outcomes, we reverse-coded the indicators so that higher values denote higher wellbeing. Indicators of mental health and vitality make up the third dimension of personal wellbeing in this paper. It includes nine items such as 'feel full of life', 'felt calm and peaceful', 'have a lot of energy', etc. Table 1A in the Appendix provides a comprehensive list of variables that form the indices for social connectedness and happiness. Following Kettlewell et al. (2020), we refer to this third dimension as happiness.

Such summary indices in the HILDA Survey data have been used by researchers to investigate similar broadly defined outcomes. For example, Qu et al. (2012) focused on people's sense of social isolation and social connection using the same variables that we employ to construct the social connectedness index. The authors also studied the mental health and sense of vitality of HILDA Survey respondents after major life events.

The indices for social connectedness and happiness are standardised weighted indices calculated using the 'swindex' module within Stata. Swindex combines multiple indicators to create a summary index using the generalised least-squares method (Schwab et al., 2020). We rescaled indices of social connectedness and happiness so that all three measures of wellbeing are measured on a scale of 0 to 10. Fig. 1 below provides a snapshot of individual wellbeing as a function of the three measures.

Fig. 1 Measures of individual wellbeing



Source: The HILDA Survey (2001-2021)

Using panel data from the HILDA Survey, our model is:

$$Y_{it} = \alpha_i + \beta X_{it} + \gamma Z_i + \delta D_{it} + \varepsilon_{it} \quad (1)$$

In equation (1) above, Y_{it} is the individual wellbeing outcome variable, Z_i is a vector of time-invariant individual characteristics and X_{it} is a set of time-variant individual characteristics including the dummy variables representing the lags and leads. D_{it} is the disaster dummy variable where 1 denotes that a weather-related disaster (flood, bushfire, cyclone) damaged or destroyed the respondent's home in the past 12 months and 0 denotes otherwise. α_i is the unobserved individual heterogeneity and ε_{it} is the error term. This equation tests our first hypothesis (H1).

Equation (2) below tests our second hypothesis (H2) that the wellbeing impact following a disaster varies by household income. It includes household income quartiles and an interaction term between the disaster dummy variable and the household income quartiles.

$$Y_{it} = \alpha_i + \beta X_{it} + \gamma Z_i + \delta D_{it} + \theta H_{it} + \tau D_{it} * H_{it} + \varepsilon_{it} \quad (2)$$

In the above equation, H_{it} denotes the household income quartiles and $D_{it} * H_{it}$ is the interaction term between the disaster dummy variable and household income quartiles. We convert nominal household income to real

household income using data on the Consumer Price Index from the Australian Bureau of Statistics and use equivalised real household income in our analyses. Equivalised household income adjusts total household income relative to the size of the household and the age of its members. To achieve this, we employ the Organization for Economic Cooperation and Development's (OECD) equivalence scale and information on the number and age of household members available in the HILDA Survey data. This equivalence scale, first proposed by Haagenars et al. (1994), assigns a value of 1 to the household head, 0.5 to each additional adult member and 0.3 to each child.

Results

As discussed earlier, the outcome variables life satisfaction, social connectedness and happiness are measured on a scale of 0 to 10. Table 1 below shows the mean of the outcome variables and age of HILDA Survey respondents as well as the percentage of respondents for each category of a categorical variable. The first column lists the summary statistics for those unaffected by disasters whereas the second column lists the same for those affected by a disaster in the previous year.

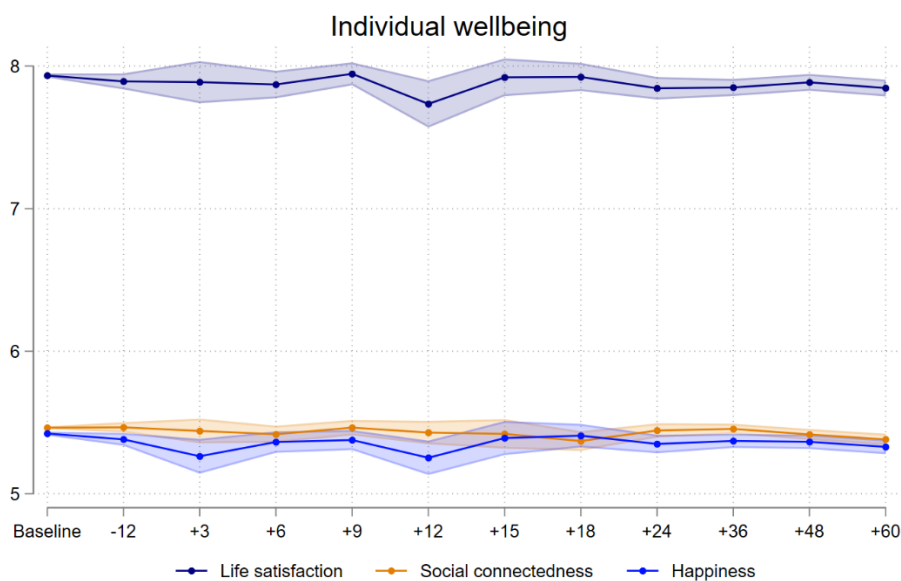
Variables	Unaffected	Affected
Life satisfaction	7.9	7.7
Social connectedness	5.5	5.3
Happiness	5.5	5.2
Age (in years)	45.3	45.2
Female	0.5	0.5
Has a long-term health condition	0.2	0.3
Has child(ren)	0.3	0.3
Is Indigenous	0.03	0.04
<u>Labour market status (%)</u>		
<i>Employed</i>	64.0	62.1
<i>Unemployed</i>	3.8	4.2
<i>Not in the labour force</i>	32.3	33.6
<u>Highest education (%)</u>		
<i>Year 12 or below</i>	41.7	41.6
<i>Diploma or certificate</i>	31.7	36.9
<i>Tertiary</i>	26.6	21.5
<u>Marital status (%)</u>		
<i>Married or in a de facto relationship</i>	64.0	65.6
<i>Separated/Widowed/Divorced</i>	12.8	13.4
<i>Never married</i>	23.1	21.0
<u>Accessibility/Remoteness (%)</u>		
<i>Living in a major city</i>	62.6	44.7
<i>Inner regional</i>	25.4	29.2
<i>Outer regional</i>	10.5	24.2
<i>Remote and very remote</i>	1.5	1.9
<u>Housing (%)</u>		
<i>Own/currently paying off a mortgage</i>	68.8	68.8
<i>Rent</i>	28.6	28.9
<i>Other housing</i>	2.6	2.3
Observations	147,225 (98.5%)	2,244 (1.5%)
Persons	18,657 (91%)	1,853 (9.0%)

Note: Female, has a long-term health condition, has child(ren), is Indigenous are dummy variables coded as 1 when true and 0 otherwise. The summary statistics for these dummy variables denote the proportion of respondents. Other housing includes those who live rent-free or have life tenure.
 Source: The HILDA Survey (2009-2021)

There are a total of 20,510 respondents in our analytical sample. 9% of the respondents were affected by a disaster in the years before the HILDA interviews. The pooled mean of the variables that capture individual wellbeing is slightly lower for people unaffected by disasters than those whose homes were destroyed by a disaster. The age and proportion of respondents who are female, have a long-term health condition, have child(ren) and are Indigenous are similar across the affected and unaffected subgroups. The housing situation is also similar for both of these subgroups. We observed that 44.7% of those affected by disasters are living in major cities compared with 62.6% of those who were unaffected. A greater proportion of those affected are also living in outer regional areas (24.2% vs 10.5%).

To understand the short and long-run impact of disasters on wellbeing, we plot individuals' wellbeing against time since their homes were damaged or destroyed in a disaster in Fig. 2. The coefficients for -12 show the individual wellbeing levels measured 12 months before the disaster and +3 denotes the life satisfaction, social connectedness and happiness measured 0-3 months after the disaster. Similarly, coefficients corresponding to +24 and +36 reveal the wellbeing measured 13-24 months and 25-36 months after the disaster, respectively. We include those who were unaffected by disasters as a starting point.

Fig. 2: Unconditional effects of disaster on individual wellbeing with 95% confidence intervals



Note: Coefficients are plotted for those unaffected by disasters and those affected by using random effects specification with cluster-robust standard errors. The x-axis represents months pre- and post-disaster events.
 Source: The HILDA Survey (2009-2021)

Fig. 2 shows that the strongest impact on happiness appears at the time of the disasters i.e., in the first 0-3 months and then 10-12 months later. In contrast, social connectedness declines 15 months after the disaster but returns to earlier levels. We observed slightly lower life satisfaction after the disaster but a steeper decline occurs in the 10-12 months period. While life satisfaction increases in the next few months, we note another downturn 18 months after the disaster. Across all three measures, there are some signs of long-term adverse effects of a disaster although there are quick upturns after steep declines.

We also observed some anticipatory effects of disaster on life satisfaction and happiness i.e., the adverse effects of disasters on wellbeing precede the destruction of homes and related impact on material wellbeing. This is not surprising as other studies have found evidence of anticipatory impact of disasters. For example, communities living in areas of high bushfire risk report higher psychological distress and anxiety during bushfire season (Heffernan et al., 2022). Similarly, communities along the coastlines in Australia are often at the frontline of meteorological disasters such as storms and tropical cyclones.

Table 2 below displays results from the regression analyses of individual wellbeing. Column 1(a) shows the coefficients from the correlated random effects model of life satisfaction. Columns 1(b) and 1(c) list the coefficients for social connectedness and happiness, respectively. All models include sociodemographic characteristics such as age, labour market status, highest education level and marital status among others.

Variables	1(a) Life Satisfaction	1(b) Social Connectedness	1(c) Happiness
Age	-0.03*** (0.00)	-0.00 (0.00)	0.02*** (0.00)
Sex (Reference group: Male)			
Female	0.01 (0.02)	0.18*** (0.01)	-0.26*** (0.01)
Labour market status (Reference group: Employed)			
Unemployed	-0.20*** (0.02)	-0.04** (0.01)	-0.05** (0.02)
Not in the labour market	-0.00 (0.01)	0.03*** (0.01)	-0.02+ (0.01)
Highest education (Reference group: Year 12 or below)			
Diploma or Certificate	-0.15*** (0.02)	-0.08*** (0.01)	-0.08*** (0.02)
Tertiary	-0.13*** (0.02)	-0.03 (0.02)	-0.07** (0.02)

Has long-term health condition (Reference group: No)			
Yes	-0.17*** (0.01)	-0.04*** (0.01)	-0.20*** (0.01)
Marital status (Reference group: Married or in a de facto relationship)			
Separated/Widowed/Divorced	-0.30*** (0.03)	-0.06*** (0.01)	-0.09*** (0.02)
Never married	-0.20*** (0.02)	-0.03* (0.01)	-0.01 (0.02)
Has children below 14 years of age (Reference group: No)			
Yes	-0.01 (0.01)	-0.06*** (0.01)	-0.04*** (0.01)
Is Indigenous (Reference group: No)			
Yes	0.18*** (0.05)	-0.11*** (0.03)	-0.06 (0.04)
Accessibility/Remoteness (Reference group: Major city)			
Inner regional	0.09*** (0.02)	-0.02+ (0.01)	0.04* (0.01)
Outer regional	0.13*** (0.03)	-0.04* (0.02)	0.05* (0.02)
Remote and very remote	0.13* (0.05)	0.01 (0.03)	0.13** (0.05)
Housing (Reference group: Own/Currently paying mortgage)			
Renting	-0.12*** (0.01)	-0.03*** (0.01)	-0.03** (0.01)
Others	-0.07** (0.03)	-0.02 (0.02)	0.01 (0.02)
Home destroyed by flood, cyclone or bushfire (Reference group: No)			
Yes	-0.09 (0.07)	-0.09+ (0.05)	-0.05 (0.05)
Wellbeing measured 12 months before disaster	-0.01 (0.03)	0.02 (0.02)	-0.02 (0.02)
Wellbeing measured 0-3 months after disaster	0.08 (0.10)	0.13* (0.06)	-0.06 (0.08)
Wellbeing measured 4-6 months after disaster	0.02 (0.08)	0.07 (0.05)	-0.01 (0.06)
Wellbeing measured 7-9 months after disaster	0.06 (0.08)	0.11* (0.05)	-0.02 (0.06)
Wellbeing measured 10-12 months after disaster	-0.04 (0.10)	0.08 (0.06)	-0.11 (0.07)
Wellbeing measured 13-15 months after disaster	-0.02 (0.08)	-0.02 (0.06)	0.05 (0.06)
Wellbeing measured 16-18 months after disaster	-0.03 (0.05)	-0.07* (0.04)	-0.01 (0.04)
Wellbeing measured 19-24 months after disaster	-0.08* (0.04)	0.01 (0.03)	-0.08* (0.03)
Wellbeing measured 25-36 months after disaster	-0.07* (0.03)	0.03 (0.02)	-0.06* (0.02)
Wellbeing measured 37-48 months after disaster	-0.04 (0.03)	-0.03 (0.02)	-0.03 (0.03)
Constant	7.88*** (0.08)	5.57*** (0.05)	5.58*** (0.07)
Overall R-squared	0.07	0.07	0.16
Observations	149,469	149,469	149,469
Persons	20,510	20,510	20,510

Note: + p<0.1, * p<0.05, ** p<0.01, *** p<0.001 Robust standard errors are in parentheses. All the models control for response waves, SEIFA index and mean of the time-varying variables.
Source: The HILDA Survey (2009-2021)

The regression results in Table 2 reveal how individual wellbeing varies with and after disaster events (H1). As explained earlier, the dummy variable ‘home destroyed by flood, cyclone or bushfire’ captures the wellbeing impact of disasters on affected individuals vis-à-vis those whose homes were not affected. We found a negative relationship between disasters and all three measures of individual wellbeing. However, only the negative association between social connectedness and disasters is significant at the 10% level.

The coefficients for the dummy variable ‘wellbeing measured 0-3 months after disaster’ reflect the wellbeing impact immediately after the event as wellbeing is measured in the first three months after the disaster has occurred. We found a positive and statistically significant association between disasters and social connectedness in the first 3 months. We observed this positive relationship throughout the first year after the disaster, but it is not always statistically significant. In the second year, social connectedness is negatively impacted by disasters in the 16-18 months. This association is statistically significant.

Happiness scores are negatively affected by disasters in Australia. We observed a statistically significant and negative association between disaster and happiness in the 19–36-month period. In terms of the length of impact, we also found that life satisfaction is significantly lower in the same period i.e., between 19-24 months and 25-36 months. In terms of sign and magnitude, the impact of disasters on life satisfaction and happiness scores is similar in these recovery periods.

As the literature has established, individual wellbeing varies by socioeconomic characteristics. Female respondents report significantly higher social connectedness compared to male respondents. However, happiness scores are significantly lower for females than males. Age has a statistically significant and negative association with respondents’ evaluation of their own lives but has a significant and positive relationship with reported happiness. Those with higher levels of education as well as those who are unemployed report lower levels of individual wellbeing than those who completed Year 12 (or lower level) and employed respondents, respectively. People in regional and remote areas have higher life satisfaction and happiness scores but lower social connectedness compared with those in major cities. Housing also significantly impacts individual wellbeing as renters report lower life satisfaction, social connectedness and happiness scores than homeowners or those currently paying their mortgage.

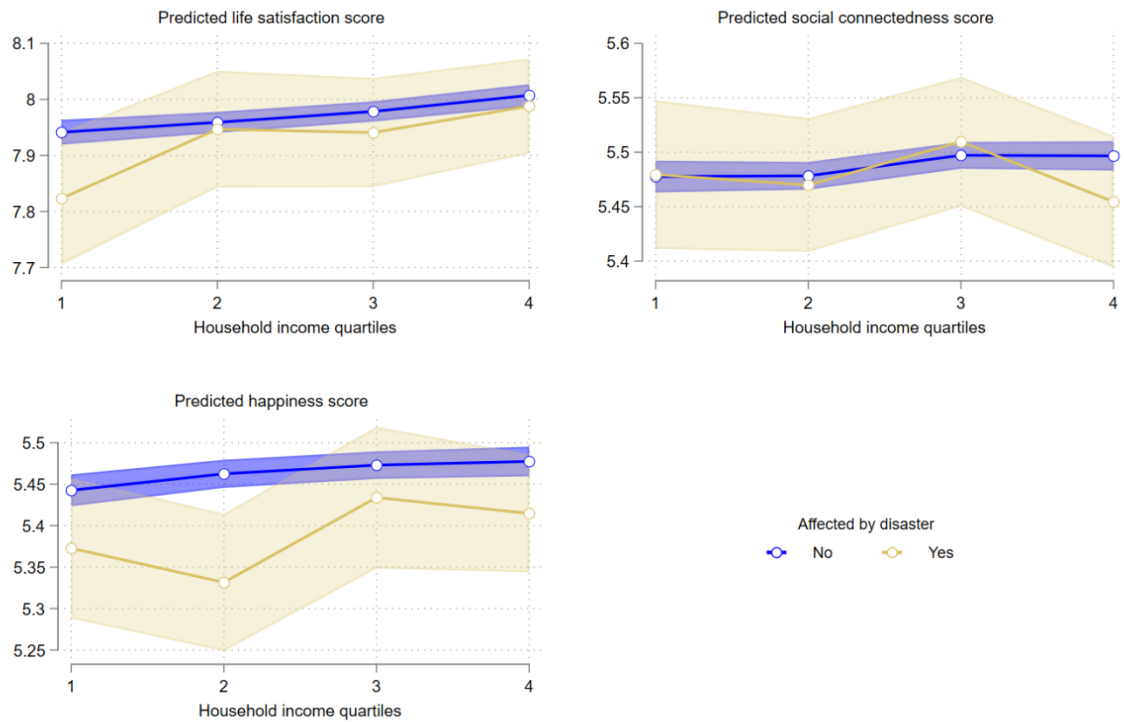
Next, we test our second hypothesis (H2) and include real equivalised household income in our estimation. The key results from the analyses including the interaction terms between household income quartiles and disaster (see Equation 2) are presented below in Fig. 3. It plots the interaction terms for each of the measures of individual

wellbeing i.e., life satisfaction, social connectedness and happiness. The full regression results are presented in Table 1B in the Appendix.

In the figure below, the x-axis plots the household income quartiles where 1 denotes the lowest-income quartile and 4 denotes the highest-income quartile. The yellow line reflects the predicted scores for those affected by disasters and the blue line shows the different wellbeing scores for those unaffected by disasters. Expectedly, confidence intervals are larger for the former group since fewer people were affected by disasters in our sample.

People in the lowest-income quartile report lower life satisfaction scores if they are affected by disasters than those who remain unaffected. For people in the medium and highest-income quartiles, the life satisfaction scores are similar for both groups – the disaster-affected individuals and the rest of the sample. Those in the lowest and medium-lowest income quartiles when affected by disasters also report lower happiness scores in the HILDA Survey with the difference in happiness scores for the medium-lowest group being statistically significant. While the happiness scores of the affected individuals are lower than those unaffected in the medium-highest and highest-income quartiles, the difference is not statistically significant. We do not observe any discernible trend for social connectedness for different income groups. It suggests that the relationship between disasters and social connectedness is not moderated by income.

Fig. 3 Predicted individual wellbeing for different household income quartiles



Note: The shaded areas in the subplots are 95% confidence intervals of predicted wellbeing scores.
 Source: The HILDA Survey (2009-2021)

Discussion

The analysis in this paper reveals two main results. First, disasters have long-running impacts on individual wellbeing. Like Jensen and Tiwari (2021) and Heffernan et al. (2022), we found that social connectedness was higher immediately after a disaster. Although people experience an increase in social connectedness in the first few months after a disaster, it declines around 15 months later. This immediate increase followed by a decline in social connectedness later could be explained by the nature of response and recovery support from government agencies, non-government organisations, community members and volunteers. We also observed significantly lower life satisfaction and happiness after 18 months for individuals whose homes were damaged or destroyed by a disaster. Despite the long-run effect of disasters on life satisfaction and happiness, it is highly likely that wellbeing scores improve after complete recovery as we did not find any significant difference in individual wellbeing in the fourth year post-disaster. This resonates with conclusions drawn from earlier studies. Calvo et al. (2015), for example, found no difference in the happiness levels of women pre-disaster and four years post-disaster.

The findings for the first hypothesis (H1) are in line with our expectations. Specifically, our findings on social connectedness could possibly be explained by the timing and planning of disaster recovery activities, although verifying this with our available data is not feasible. In the aftermath of a disaster, several modes of formal and informal support, including support workers and volunteers, are reflected in the improved social connections in the first few months after a disaster. This coming together of different government agencies, non-government organisations and volunteers helps those affected to cope with and recover from disasters and mitigate negative impacts on wellbeing. Moreover, there has been an increase in focus on social capital and networks in disaster-related studies as a coping mechanism or recovery tool (Butler et al., 2016; Heffernan et al., 2022). Social connections are critical in not only supporting recovery activities but also in supporting resilience to future disaster events (Albrecht, 2018; Butler et al., 2016).

Second, we report how Australians' wellbeing in the aftermath of a disaster was affected by their household incomes. The wellbeing losses from disasters disproportionately impacted people on low incomes. While the differences are not statistically significant, there is a gap between evaluative wellbeing and happiness of individuals from low-income households who are affected and unaffected by disasters. This gap in happiness scores is also noted for individuals in the medium-lowest income group where it is significant and to some extent for those in the medium-highest and highest-income quartiles. While the social connectedness of those affected by disaster and others does not significantly vary by income, this is not surprising as Bianchi and Vohs (2016) found that frequency and type of social connection could change with income. However, the social connectedness of disaster-affected individuals could vary for different demographic groups and in turn affect recovery for specific groups. In all, we did not find convincing evidence in favour of our second hypothesis as the wellbeing of people from high-income households affected by disasters is not significantly different from that of affected individuals from high-income households.

To summarise, our main results show that disasters can have long-lasting effects on people's wellbeing. Our research also reveals people's resilience in the aftermath of a disaster as they return to pre-disaster levels of wellbeing in a few years. The findings also underscore the need for adequate short and long-term support after disasters. Our results on wellbeing effects also underline the important role of organisations involved in disaster recovery to support individuals and families beyond the immediate aftermath. The response and recovery activities in the initial months likely enhance community resilience through increased connection and social interactions (Heffernan et al., 2022). This underscores the need for greater attention to fostering social connectedness in

disaster recovery efforts. In terms of policy implications, our findings support the adoption of wellbeing impact as a useful measure to assess disaster severity (De & Thamarapani, 2022; Jensen & Tiwari, 2021).

People respond to and recover from disasters in different ways. Further analysis could help reveal at-risk populations who are in need of adequate support following a disaster. A limitation of using the 'home damaged or destroyed by weather events' variable as a proxy measure of disaster is that it excludes people who may have been affected by a disaster but whose homes remained intact. As a result, our sample is restricted to those severely impacted by disasters and we are unable to investigate the wellbeing implications of disaster for those whose homes sustained minimal or no damage in the disaster. A more inclusive definition could help describe the varied impact of disasters in Australia. Future research should also focus on the impact of drought on the material and subjective wellbeing of people. While drought may not damage houses, it can still adversely affect households.

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Appendix

Table 1A: Measures of social connectedness and happiness in the HILDA Survey

Indices	Variables
Social connectedness	People don't come to visit me as often as I would like I often need help from other people but can't get it I seem to have a lot of friends I don't have anyone that I can confide in I have no one to lean on in times of trouble There is someone who can always cheer me up when I am down I often feel very lonely I enjoy the time I spend with the people who are important to me When somethings on my mind, just talking with the people I know can make me feel better When I need someone to help me out, I can usually find someone
Happiness	Vitality: Feel full of life Vitality: Have a lot of energy Vitality: Felt worn out Vitality: Felt tired Mental Health: Been a nervous person Mental Health: Felt so down in the dumps nothing could cheer you up Mental Health: Felt calm and peaceful Mental Health: Felt down Mental Health: Been a happy person

Table 1B: Coefficients from Correlated Random Effects Estimation of Life Satisfaction, Social Connectedness and Happiness including Household Income

Variables	1(a) Life Satisfaction	1(b) Social Connectedness	1(c) Happiness
Age	-0.03*** (0.00)	-0.00 (0.00)	0.02*** (0.00)
Sex (Reference group: Male)			
Female	0.01 (0.02)	0.18*** (0.01)	-0.26*** (0.01)
Labour market status (Reference group: Employed)			
Unemployed	-0.19*** (0.02)	-0.04** (0.01)	-0.05** (0.02)
Not in the labour market	0.00 (0.01)	0.03*** (0.01)	-0.02 (0.01)
Highest education (Reference: Year 12 or below)	0.00	0.00	0.00
Diploma or certificate	-0.15*** (0.02)	-0.08*** (0.01)	-0.08*** (0.02)
Tertiary	-0.14*** (0.02)	-0.03+ (0.02)	-0.07** (0.02)
Has long-term health condition (Reference group: No)	0.00	0.00	0.00
Yes	-0.17*** (0.01)	-0.04*** (0.01)	-0.20*** (0.01)
Marital status (Reference group: Married or in a de facto relationship)			
Divorced/Widowed/Separated	-0.30*** (0.03)	-0.05*** (0.01)	-0.09*** (0.02)

Never married	-0.19*** (0.02)	-0.03* (0.01)	-0.01 (0.02)
Has children below 14 years of age (Reference group: No)			
Yes	-0.00 (0.01)	-0.06*** (0.01)	-0.04*** (0.01)
Is Indigenous (Reference group: No)			
Yes	0.18*** (0.05)	-0.11*** (0.03)	-0.06 (0.04)
Accessibility/Remoteness (Reference group: Major city)			
Inner regional	0.09*** (0.02)	-0.02+ (0.01)	0.04** (0.01)
Outer regional	0.13*** (0.03)	-0.04* (0.02)	0.05* (0.02)
Remote and very remote	0.13* (0.05)	0.00 (0.03)	0.13** (0.05)
Housing (Reference group: Own/Currently paying mortgage)			
Renting	-0.11*** (0.01)	-0.03** (0.01)	-0.03* (0.01)
Others	-0.07* (0.03)	-0.02 (0.02)	0.01 (0.02)
Home destroyed by flood, cyclone or bushfire (Reference group: No)			
Yes	-0.12* (0.06)	0.00 (0.03)	-0.07 (0.04)
Equivalised household income (Reference group: Lowest quartile)			
Medium-lowest	0.02 (0.01)	0.00 (0.01)	0.02* (0.01)
Medium-highest	0.04** (0.01)	0.02* (0.01)	0.03** (0.01)
Highest	0.07*** (0.01)	0.02* (0.01)	0.03** (0.01)
Home destroyed#Equivalised household income (Reference group: Yes#Lowest)			
Yes#Medium-lowest	0.11 (0.08)	-0.01 (0.05)	-0.06 (0.06)
Yes#Medium-highest	0.08 (0.08)	0.01 (0.05)	0.03 (0.06)
Yes#Highest	0.10 (0.07)	-0.04 (0.05)	0.01 (0.06)
Constant	7.83*** (0.08)	5.56*** (0.05)	5.55*** (0.07)
Overall R-squared	0.07	0.07	0.16
n	149,469	149,469	149,469
N	20,510	20,510	20,510

Note: + p<0.1, * p<0.05, ** p<0.01, *** p<0.001 Robust standard errors are in parentheses. All the models control for response waves, SEIFA index and mean of the time-varying variables.

Source: The HILDA Survey (2009-2021)