

Delving into the eye of the cyclone to quantify the causal impacts of natural disasters on life satisfaction

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Household Income and Labour Dynamics Australia (HILDA) Conference

University of Melbourne Thursday 1 - Friday 2 October 2026

Day 1. Session 3A Wellbeing Dynamics. 4.00pm- 5.30pm

Introduction

Natural disasters significantly affect social, health, and economic outcomes, with growing concern about increasing disaster risk

A growing literature links natural disasters to life satisfaction, but robust causal evidence across life satisfaction domains remains limited

Key identification challenge: cross-sectional designs and endogenous disaster exposure measures confound estimates via unobserved individual heterogeneity and residential sorting

Our study resolves these methodological issues: Using over 20 years of longitudinal panel data linked with detailed weather data on cyclones, we asked:

What are the causal impacts of natural disasters on life satisfaction in Australia?

Data

1. Household, Income and Labour Dynamics in Australia (HILDA) survey:

- Nationally representative annual survey tracks individuals over time
- Over 19,000 persons
- Restricted Release 24 (2001-24): Finest geographical identifier at the individual's residential postcode

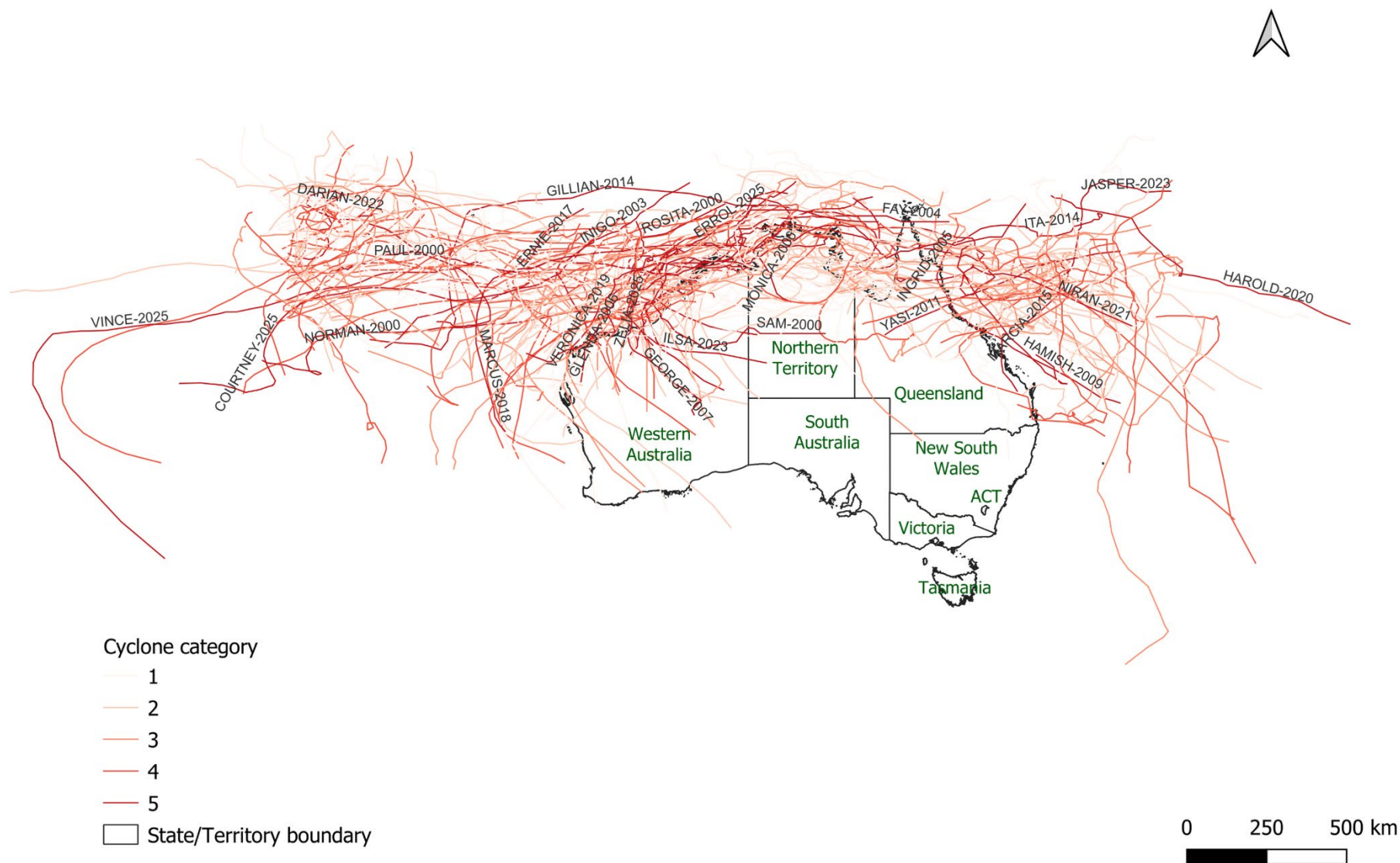
2. Historical cyclone database:

- Obtained from Australia's Bureau of Meteorology
- All tropical cyclones south of the equator between longitudes 90E and 160E
- Each cyclone: track (i.e., longitude, latitude, and time) and wind speed

Connecting the two datasets:

- Matching the cyclone's track and timing with the individual's residential postcode centroid and precise interview date

Figure 1: Tropical cyclone hit map between 2000 and 2025



Note: Only the names and years of Category 5 cyclones are listed.

Descriptive analysis

- 8,817 observations (6,020 individuals) experienced at least one cyclone within 100 km; 3.9% of the sample was exposed
- Cyclone-exposed individuals were younger, less educated, more likely to live in rural areas, and resided in lower socio-economic regions
- Descriptive statistics indicate significant differences in life satisfaction outcomes between exposed and unexposed groups
- These pre-existing differences highlight the need for individual fixed-effects models to identify the causal impact of cyclones on life satisfaction

Table 1: Sample means of key variables by cyclone exposure

	Affected by any cyclone	Unaffected	Affected - Unaffected (1) - (2)
	(1)	(2)	(3)
Age (years)	44.146	45.023	-0.877***
Year 12 ^(a)	0.159	0.152	0.008*
Vocational or Training qualification ^(a)	0.401	0.358	0.043***
Bachelor or higher ^(a)	0.170	0.186	-0.016***
Household size	2.849	2.889	-0.04**
Major city ^(a)	0.336	0.611	-0.275***
Local area unemployment rate (%)	4.989	5.028	-0.039***
Local area SEIFA decile	5.154	5.450	-0.296***
Overall life satisfaction	7.961	7.926	0.035**
Employment opportunity satisfaction	7.167	7.092	0.075***
Financial situation satisfaction	6.703	6.602	0.101***
Home satisfaction	8.009	8.031	-0.022
Community satisfaction	6.764	6.779	-0.015
Neighbourhood satisfaction	7.875	7.891	-0.016
Personal safety satisfaction	8.320	8.239	0.081***
Health satisfaction	7.240	7.266	-0.026
Observations	8,817	215,474	

Note: “Affected” if facing any cyclone within 100 km from its eye last year. ^(a) indicates a binary variable. Figures are sample means. 6

Empirical model

$$Y_{ipt} = \alpha + \sum_{L=0}^k [Z_{ip(t-L)} \beta_L] + X_{ipt} \gamma + \lambda_t + M_{it} + \delta_p + \pi_i + \varepsilon_{ipt} \quad (1)$$

Y_{ipt} – **Outcomes:** Overall life satisfaction and selected domains, at survey time

Z_{ipt} – **Cyclone exposure measure:**

- Categorical variable: Unaffected (comparison group), 1 (weakest) to 5 (strongest), using BOM's suggested cutoffs on maximum mean wind speed
- Distance from the cyclone eye: 40 km and 100 km
- Cyclone exposure in residing postcode 12 months prior survey date

X_{ipt} – **Time-varying variables:** Age (and its square), education levels, household size, major city residency, regional unemployment, and SEIFA

Month (M_{it}), Year (λ_t), Postcode (δ_p) dummies

Unobserved, time-invariant individual characteristics (π_i)

Empirical model (cont.)

Sample: Individuals

- Aged 15 or over
- Resided in states/territories impacted by at least one cyclone during 2000-24: WA, NT, QLD and NSW
- Appeared at least twice during the study period

Estimation method:

- Individual Fixed Effects OLS
- Standard errors clustered at the postcode level

Main regression results

- Only the most severe Category 5 cyclones significantly reduce overall life satisfaction, community satisfaction, personal safety, and health satisfaction
- Impacts are stronger for individuals located closer to the cyclone eye, indicating a clear distance-decay effect
- Exposure to less severe cyclones is associated with higher community and neighbourhood satisfaction, consistent with increased social cohesion following disasters

Table 2: Impacts of cyclone exposures on life satisfaction

Distance to cyclone eye:	40km	100km	40km	100km	40km	100km	40km	100km
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A:	Overall life satisfaction		Employment opportunity satisfaction		Financial situation satisfaction		Home satisfaction	
Category 1-2	0.10***	0.04**	0.01	0.03	0.06	-0.01	-0.05	-0.02
	[0.03]	[0.02]	[0.07]	[0.04]	[0.06]	[0.03]	[0.05]	[0.03]
Category 3-4	0.02	-0.00	0.05	0.03	-0.06	-0.05*	-0.04	-0.02
	[0.03]	[0.02]	[0.05]	[0.04]	[0.04]	[0.03]	[0.04]	[0.03]
Category 5	-0.10**	-0.07**	-0.03	-0.03	-0.02	-0.01	-0.05	-0.01
	[0.04]	[0.03]	[0.08]	[0.06]	[0.06]	[0.05]	[0.06]	[0.04]
Observations	224,221	224,221	176,341	176,341	224,036	224,036	224,167	224,167
No of unique persons	23,501	23,501	21,954	21,954	23,488	23,488	23,502	23,502
Mean dependent variable	7.93	7.93	7.10	7.10	6.61	6.61	8.03	8.03
Panel B:	Community satisfaction		Neighbourhood satisfaction		Personal safety satisfaction		Health satisfaction	
Category 1-2	0.03	0.07**	-0.02	0.03	0.01	0.02	0.02	0.01
	[0.06]	[0.03]	[0.05]	[0.03]	[0.04]	[0.02]	[0.05]	[0.02]
Category 3-4	0.06	0.06**	0.08**	0.05*	-0.00	0.02	-0.01	-0.00
	[0.04]	[0.03]	[0.04]	[0.02]	[0.03]	[0.02]	[0.04]	[0.02]
Category 5	-0.11*	-0.08	-0.08	-0.03	-0.13**	-0.03	-0.10*	-0.09**
	[0.06]	[0.05]	[0.06]	[0.05]	[0.05]	[0.04]	[0.05]	[0.04]
Observations	223,772	223,772	223,984	223,984	224,161	224,161	224,244	224,244
No of unique persons	23,476	23,476	23,489	23,489	23,506	23,506	23,505	23,505
Mean dependent variable	6.78	6.78	7.89	7.89	8.24	8.24	7.26	7.26

Note: Results from individual FE model (1).

Dynamic impacts

- Category 5 cyclones reduce life satisfaction both immediately and over time
- Community and personal safety satisfaction remain lower one year after exposure
- Employment opportunity, community, neighbourhood, and personal safety impacts persist for up to two years
- Evidence points to significant delayed and persistent wellbeing effects of severe cyclones beyond the disaster period itself

Table 3: Dynamic impacts of category 5 cyclone exposure

Satisfaction outcome:	Overall life satisfaction	Employment opportunity satisfaction	Financial situation satisfaction	Home satisfaction	Community satisfaction	Neighbourhood satisfaction	Personal safety satisfaction	Health satisfaction
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Concurrent								
Current	-0.08** [0.03]	-0.04 [0.06]	-0.00 [0.05]	-0.01 [0.04]	-0.09* [0.05]	-0.03 [0.05]	-0.03 [0.04]	-0.09** [0.04]
Observations	224,221	176,341	224,036	224,167	223,772	223,984	224,161	224,244
No of unique persons	23,501	21,954	23,488	23,502	23,476	23,489	23,506	23,505
Panel B: One-year lagged								
Current	-0.10*** [0.04]	-0.08 [0.07]	-0.05 [0.05]	-0.04 [0.05]	-0.10** [0.05]	-0.06 [0.05]	-0.03 [0.04]	-0.11*** [0.04]
One-year lagged	0.01 [0.04]	-0.09 [0.07]	-0.02 [0.05]	-0.06 [0.05]	-0.09* [0.05]	-0.07 [0.04]	-0.08** [0.04]	-0.01 [0.04]
Observations	196,908	152,974	196,789	196,847	196,532	196,701	196,841	196,920
No of unique persons	18,773	17,402	18,772	18,776	18,766	18,771	18,774	18,777
Panel C: Two-year lagged								
Current	-0.10*** [0.04]	-0.09 [0.07]	-0.05 [0.06]	-0.04 [0.05]	-0.09* [0.05]	-0.07 [0.05]	-0.03 [0.04]	-0.12*** [0.04]
One-year lagged	0.01 [0.04]	-0.10 [0.07]	-0.03 [0.05]	-0.06 [0.05]	-0.10* [0.05]	-0.07 [0.05]	-0.10** [0.04]	-0.02 [0.04]
Two-year lagged	-0.00 [0.03]	-0.15** [0.07]	-0.06 [0.05]	-0.02 [0.05]	-0.08* [0.05]	-0.13*** [0.04]	-0.07* [0.04]	-0.01 [0.04]
Observations	176,256	135,764	176,176	176,197	175,927	176,066	176,197	176,265
No of unique persons	16,587	15,308	16,585	16,586	16,573	16,576	16,587	16,587

Note: Results are from individual FE model (1).

Robustness checks

- Results are robust across alternative samples, controls, and estimation methods
- Individual fixed effects are critical for obtaining unbiased estimates
- No evidence that future cyclones affect current wellbeing (falsification test)
- Placebo randomisation tests strongly support a causal interpretation of cyclone impacts on life satisfaction

Economic implications

- Cyclone impacts are broadly comparable in magnitude to Black Saturday bushfires/wildfires, but show wider and more persistent domain-level effects
- Unlike prior bushfire/wildfire evidence, cyclones significantly affect health and other wellbeing domains
- Estimated wellbeing losses translate into meaningful income-equivalent reductions ($\approx 1.4\% - 6.5\%$)
- Results highlight substantial economic and welfare costs of severe cyclone exposure

Table 4: Economic implications of the cyclone impacts on life satisfaction

Satisfaction outcome:	Overall life satisfaction	Employment opportunity satisfaction	Financial situation satisfaction	Home satisfaction	Community satisfaction	Neighbourhood satisfaction	Personal safety satisfaction	Health satisfaction
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Current category 5 cyclones	-0.10*** [0.04]	-0.10 [0.07]	-0.06 [0.05]	-0.05 [0.05]	-0.09* [0.05]	-0.07 [0.05]	-0.03 [0.04]	-0.12*** [0.04]
One-year lagged category 5 cyclones	0.01 [0.04]	-0.11 [0.07]	-0.04 [0.05]	-0.06 [0.05]	-0.10** [0.05]	-0.07 [0.05]	-0.10** [0.04]	-0.02 [0.04]
Two-year lagged category 5 cyclones	-0.00 [0.03]	-0.15** [0.07]	-0.07 [0.05]	-0.03 [0.05]	-0.08* [0.05]	-0.13*** [0.04]	-0.07* [0.04]	-0.01 [0.04]
Equivalised HH disposable income (in natural log)	0.04*** [0.01]	0.11*** [0.01]	0.18*** [0.01]	0.04*** [0.01]	-0.00 [0.01]	0.02*** [0.01]	0.04*** [0.00]	0.04*** [0.01]
Observations	176,137	135,663	176,059	176,078	175,809	175,947	176,078	176,148
No of unique persons	16,578	15,298	16,576	16,577	16,565	16,567	16,578	16,578
Mean of dep. variable	7.92	7.15	6.72	8.03	6.81	7.89	8.24	7.19

Note: Results are from individual FE model (1).

Heterogenous impacts

- Cyclone impacts vary substantially across demographic, household, and regional characteristics, indicating significant heterogeneity in vulnerability
- Negative effects are generally strongest for males, younger individuals, and those without prior residential insurance coverage
- Rural, coastal, and historically cyclone-prone communities experience larger declines in overall life satisfaction following severe cyclones
- Residents of historically cyclone-free areas experience particularly large reductions in financial and home satisfaction, highlighting the importance of disaster preparedness and resilience

Summary of main findings

- First causal evidence on cyclone impacts on multiple life satisfaction domains in Australia using individual fixed-effects and exogenous exposure measures
- Only severe Category 5 cyclones significantly reduce overall life satisfaction, with broader negative effects on community, health, and related domains
- Welfare impacts are economically meaningful, equivalent to an income loss of ~1.4%–6.5% and comparable to major disasters such as the 2009 Black Saturday Bushfires
- Results are robust to extensive sensitivity tests and show clear heterogeneity by gender, age, insurance, and other characteristics, with policy-relevant distributional effects



QR code to working paper

Thank You!

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