Are Australians "building back better" after the Black Summer fires?

Sonia Akter
Lee Kuan Yew School of Public Policy
National University of Singapore

AARES Federal Webinar

November 3, 2021

Previous Study On ‘Black Summer Fire’

Do fires discriminate? Socio-economic disadvantage, wildfire hazard exposure and the Australian 2019–20 ‘Black Summer’ fires. (Akter & Grafton, 2021)

Link between socio-economic disadvantage and exposure to Black Summer fires

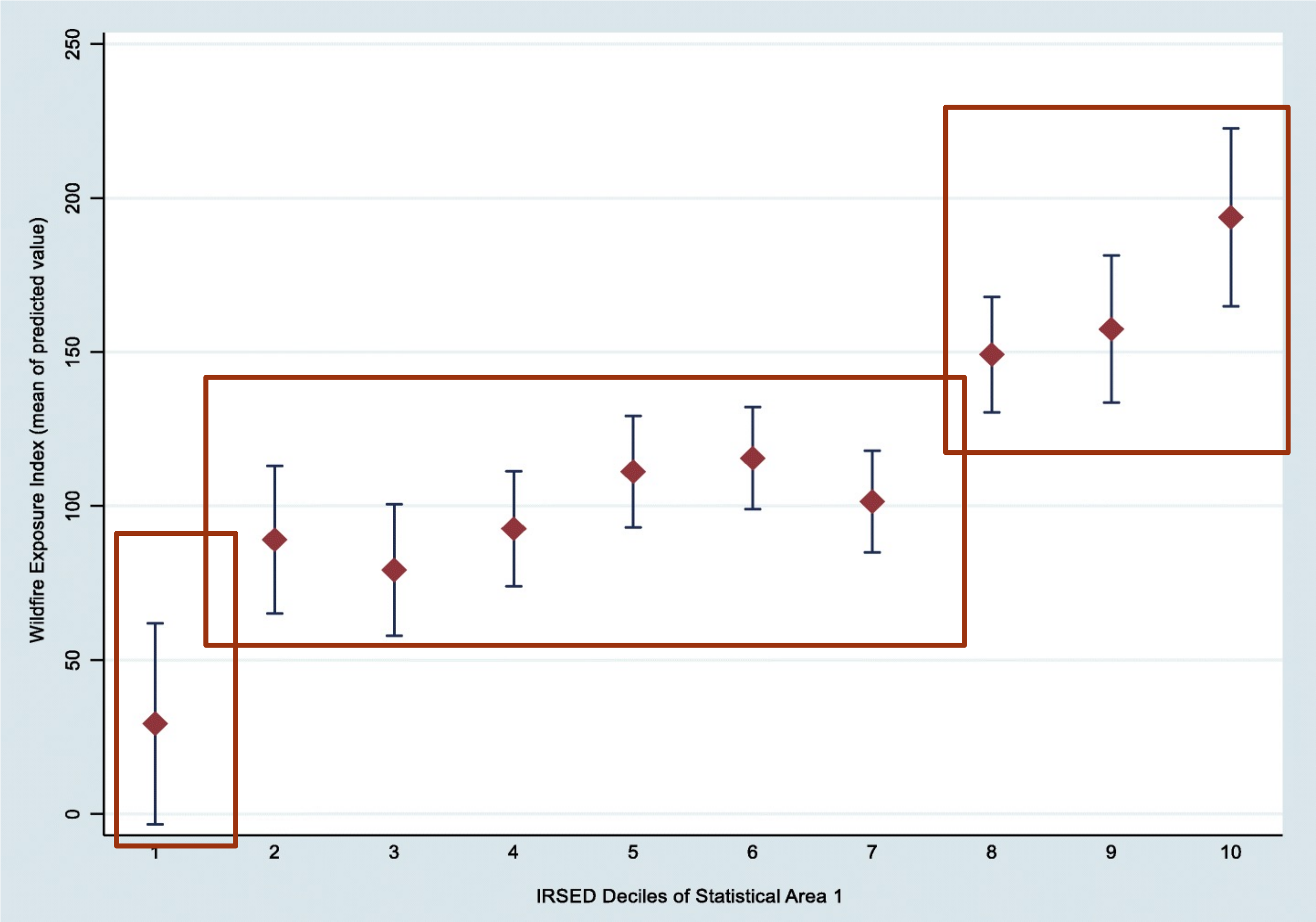
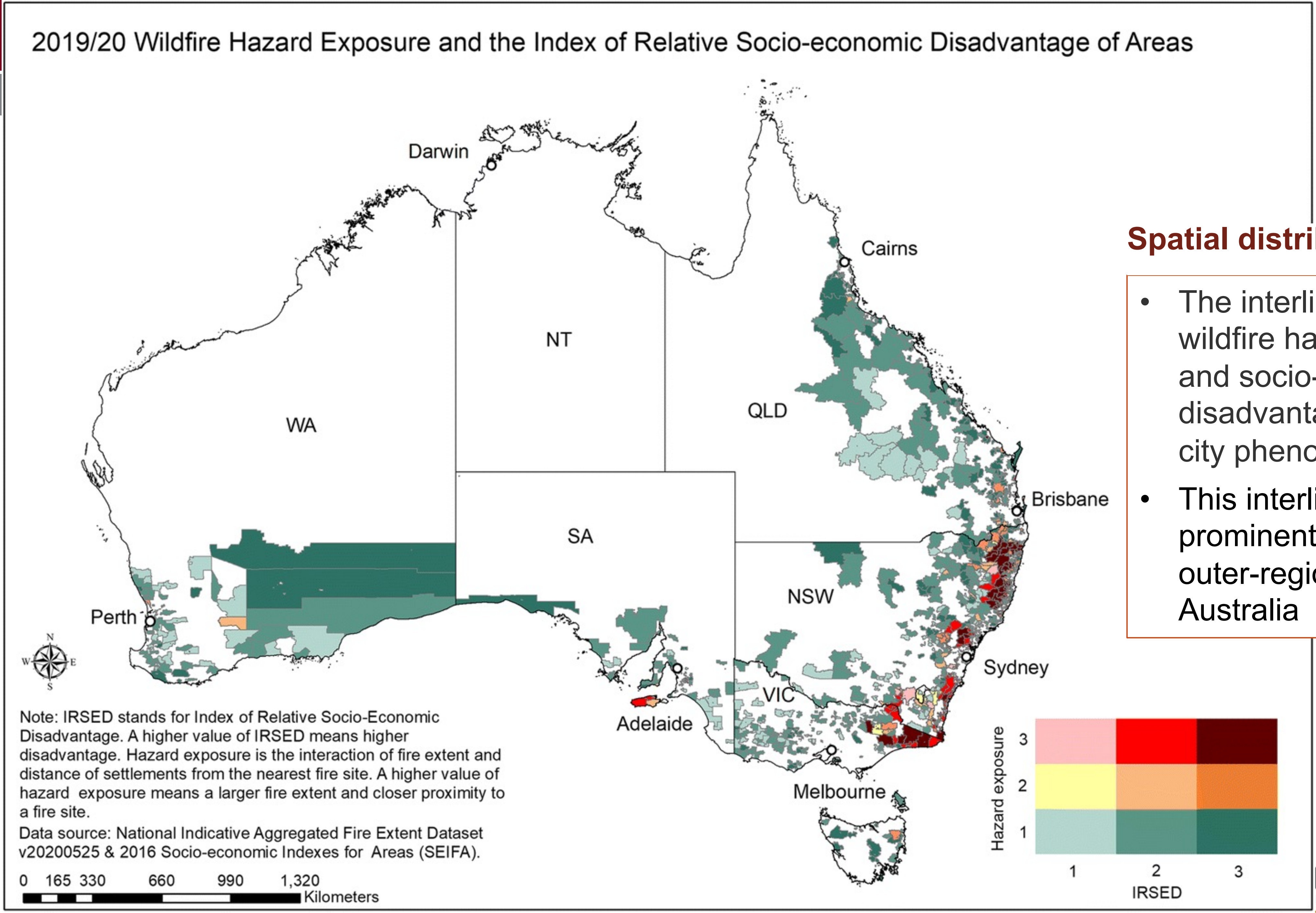


Figure 1: Wildfire hazard exposure index across socio-economic disadvantage

Lee Kuan Yew School of Public Policy
National University of Singapore



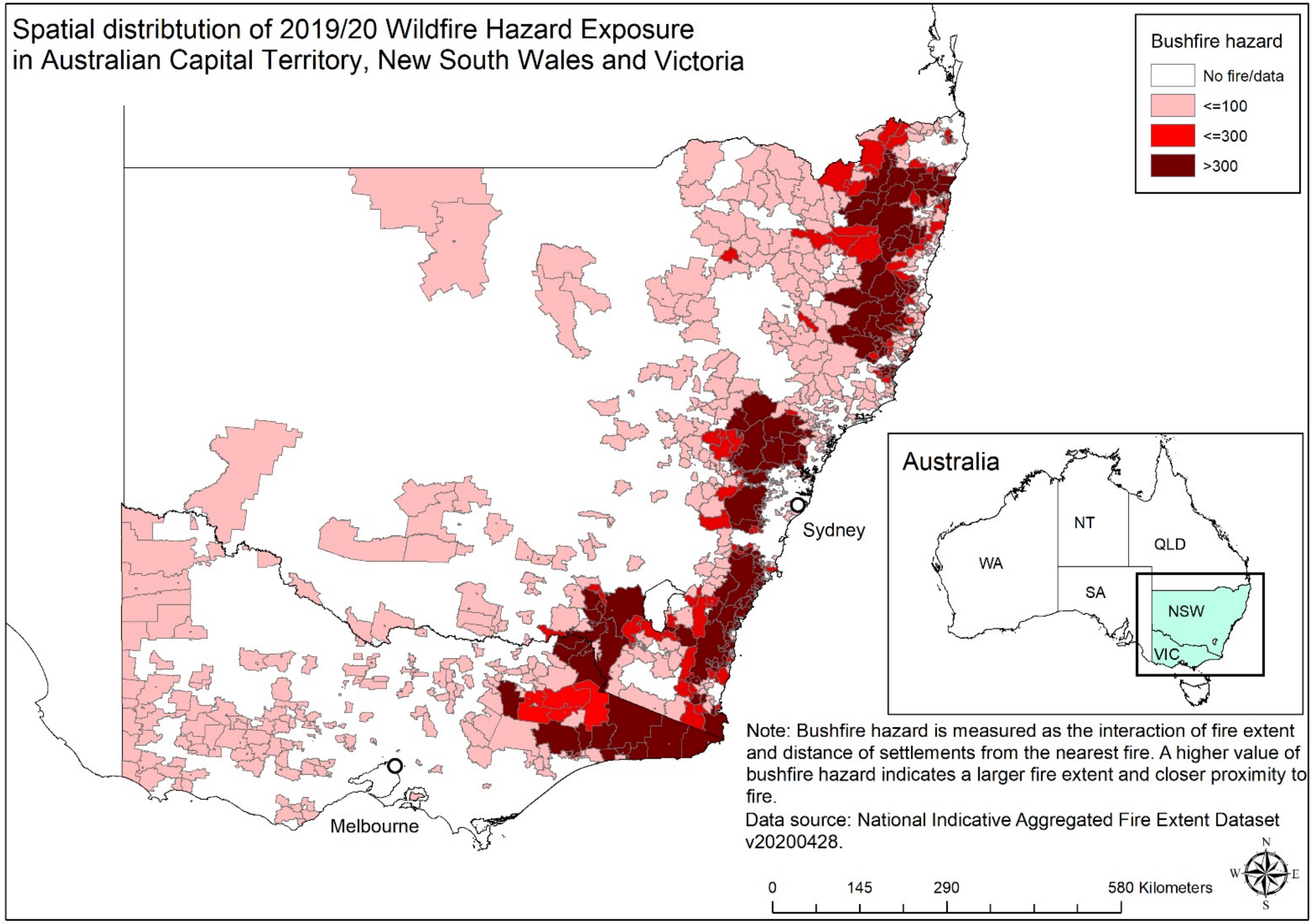
Spatial distribution of the link

- The interlinkage between wildfire hazard exposure and socio-economic disadvantage is not a major city phenomenon
- This interlinkage is most prominent in inner-regional, outer-regional and remote Australia

Lee Kuan Yew School of Public Policy
University of Singapore

The Current Study on ‘Black Summer’ fires Recovery

- This study examines recovery after the ‘Black Summer’ fires in New South Wales (NSW)
- Research questions:
  - Over a year after the ‘Black Summer’ fires, are communities back to where they started from?
  - Does the pace of recovery vary spatially?
  - Is there heterogeneity in recovery across socio-economic disadvantage?
  - Why only NSW?
    - Large area was affected by wildfires
    - Major city and inner regional suburbs were affected



Use of Night-Time Light (NTL) Data for Disaster Recovery

- Advantage of using the NTL data
  - Data collection is quick (in near real-time)
  - Bridges data paucity gaps
  - NTL data has been proven a reliable proxy of GDP and electricity use (Gibson et al., 2021; Beyer et al., 2021)
- Previous studies used NTL data to study impacts and recovery from hurricane, earthquakes, Covid-19 movement restrictions (Gao et al., 2020; Qiang et al., 2020)
- Previous studies present mixed evidence
  - NTL luminosity falls in affected areas because of migration, recession, lack of employment
  - NTL luminosity increases in affected areas because of reconstruction, rebuilding activities

Data and Sources

- Night-time light
  - VIIRS-DNB Cloud Free Monthly Composites (by the National Oceanic and Atmospheric Administration (NOAA))
  - Data frequency: monthly
  - Data coverage: January 2017−March 2021
  - Data granularity: Mesh block (30 to 60 dwellings)
- Other data
  - Forest cover (Department of Agriculture, Water and the Environment, ABARES)
  - Population (Australian Bureau of Statistics)
  - SA1 characteristics (Australian Bureau of Statistics)
- Acknowledgement

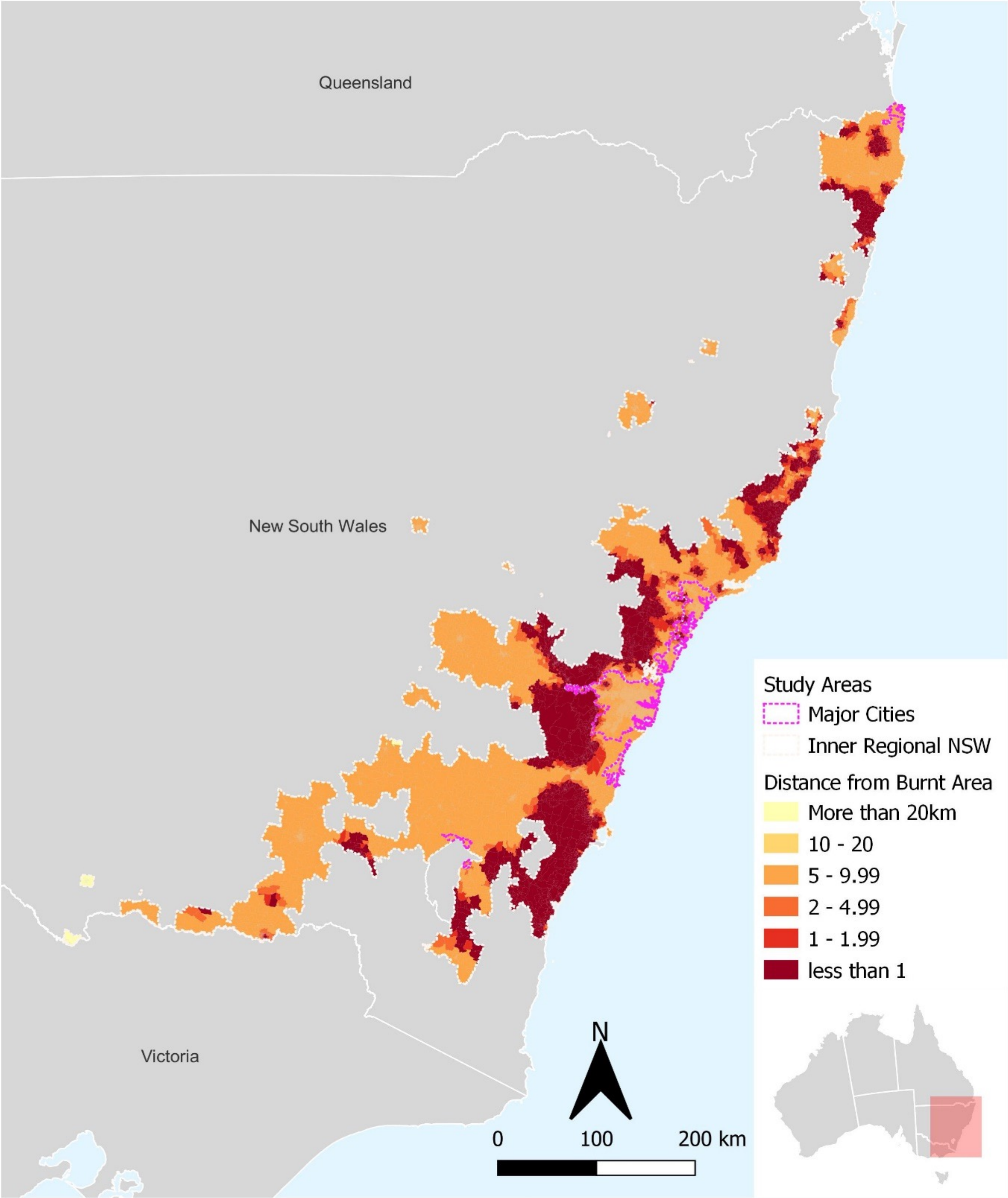
  - The study is funded by the Ministry of Education (MoE) of Singapore
  - All data for this study was generated and collated by Mr. Homer Pagkalinawan.

- Fire extent data
  - Fire Extent and Severity Mapping (FESM) 2019/20 (State Government of NSW and Department of Planning, Industry and Environment, 2020)
    - This dataset represents the 2019/20 fire year including all wildfires >10ha with a fire start date between July 2019 and June 2020
    - Validated data with an accuracy rate>90% for unburnt area

Pixel Value	Severity class	% foliage fire affected
0	Unburnt	0% canopy and understory burnt
1*	Reserved Class	
2	Low	>10% burnt understory >90% green canopy
3	Moderate	20-90% canopy scorch
4	High	>90% canopy scorched, <50% canopy consumed
5	Extreme	>50% canopy biomass consumed

Empirical Strategy: Difference-in-Differences (DiD) method

- The DiD method compares differences in average monthly NTL radiance before and after the wildfire in the affected and unaffected mesh blocks
  - Validity of the findings of a DiD analysis hinges on the satisfaction of the Parallel Trend Assumption
  - Affected and unaffected samples were following the same growth trajectories before the wildfire
- Heterogeneity analysis:
  - (1) Residential versus non-residential; (2) Socio-economic disadvantage
- Data analysis has been conducted separately for
  - (a) major cities (Remoteness Area 1)
  - (b) inner regional NSW (Remoteness Area 2)



Analysis Sample

- Affected (treatment) sample:
  - (1) all directly affected mesh blocks; (2) all directly affected but severely burnt mesh blocks (3) all mesh blocks within 2 km radius of a fire; (4) all mesh blocks with 5 km radius of a fire
- Unaffected (control) sample (inclusion criteria):
  - (1) all mesh blocks located within the same SA1 (or SA2) & within 5 (or 10) km radius of the directly fire affected mesh blocks; (2) all mesh blocks with forest cover

Main Empirical Specification

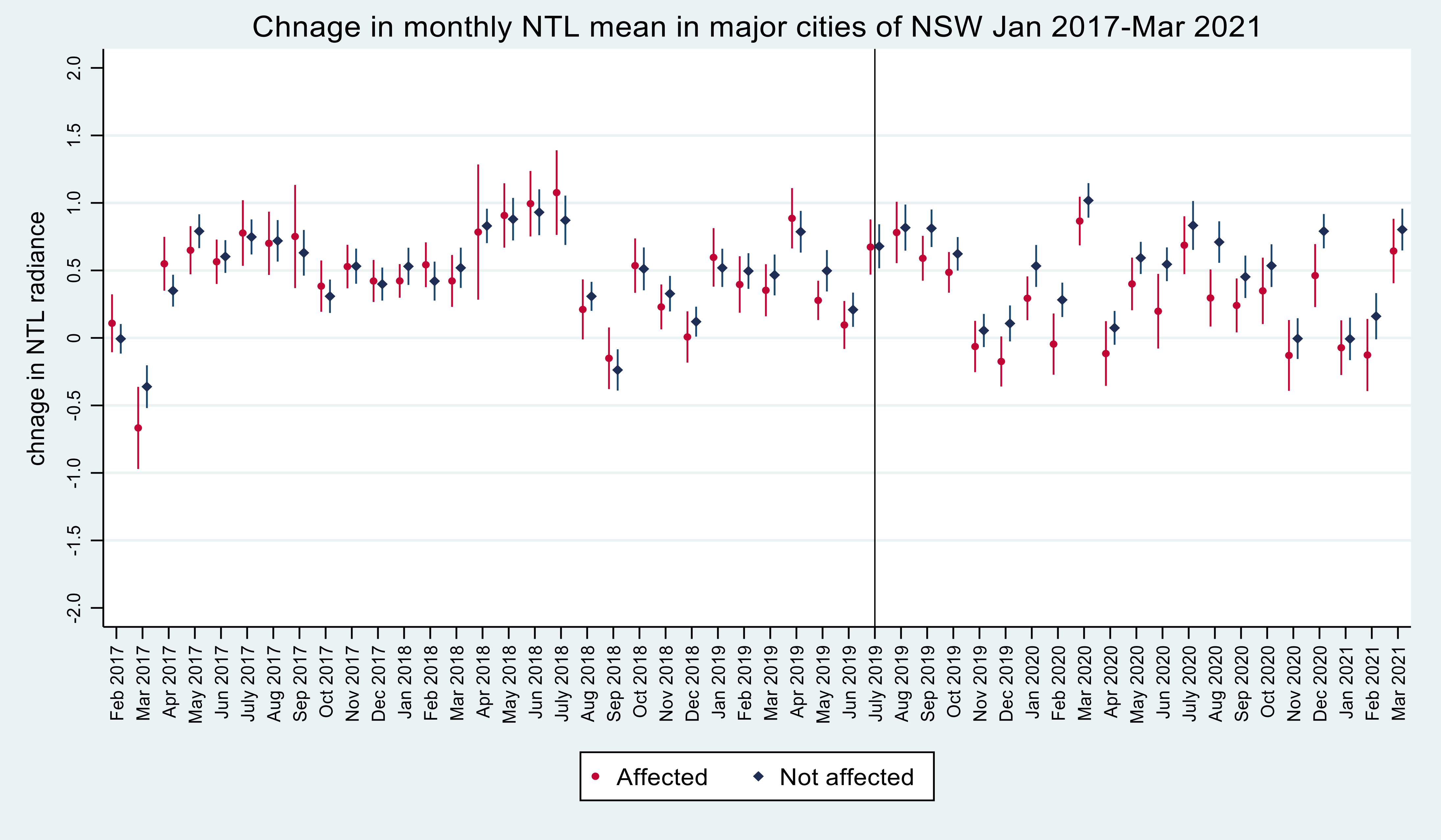
$$NTL_{imy} = \beta_0 + \beta_1 Treatment_i + \beta_2\, Post_{my} + \boldsymbol{\beta_3} Post_{my} X Treatment_i + \gamma_{my} + \lambda + \varepsilon_{imy} \qquad (1)$$

- NTL_{imy} is the mean of monthly NTL luminosity for mesh block i, month m, and year y
- $Treatment_i$ is a dummy variable
  - =1 if mesh block i is categorized as affected
  - =0 if mesh block i is categorized as unaffected and fulfils inclusion criteria
- $Post_{my}$ is a dummy variable (=1 for June 2020 to March 2021; =0 for all months and years before July 2019) [July 2019 to June 2020 are excluded]
- γ_{my} is time (year-month) fixed effects
- λ is SA3 fixed effects
- ε_{imy} is robust error term clustered at the mesh block level
- Sample selection criteria used for main specification:
  - Affected and unaffected mesh blocks are located within the same SA1
  - Have forest cover
  - Located within 5 km radius of a fire

Lee Kuan Yew School of Public Policy
National University of Singapore

Results (1): Average change in luminosity in fire affected and unaffected mesh blocks in major cities of NSW

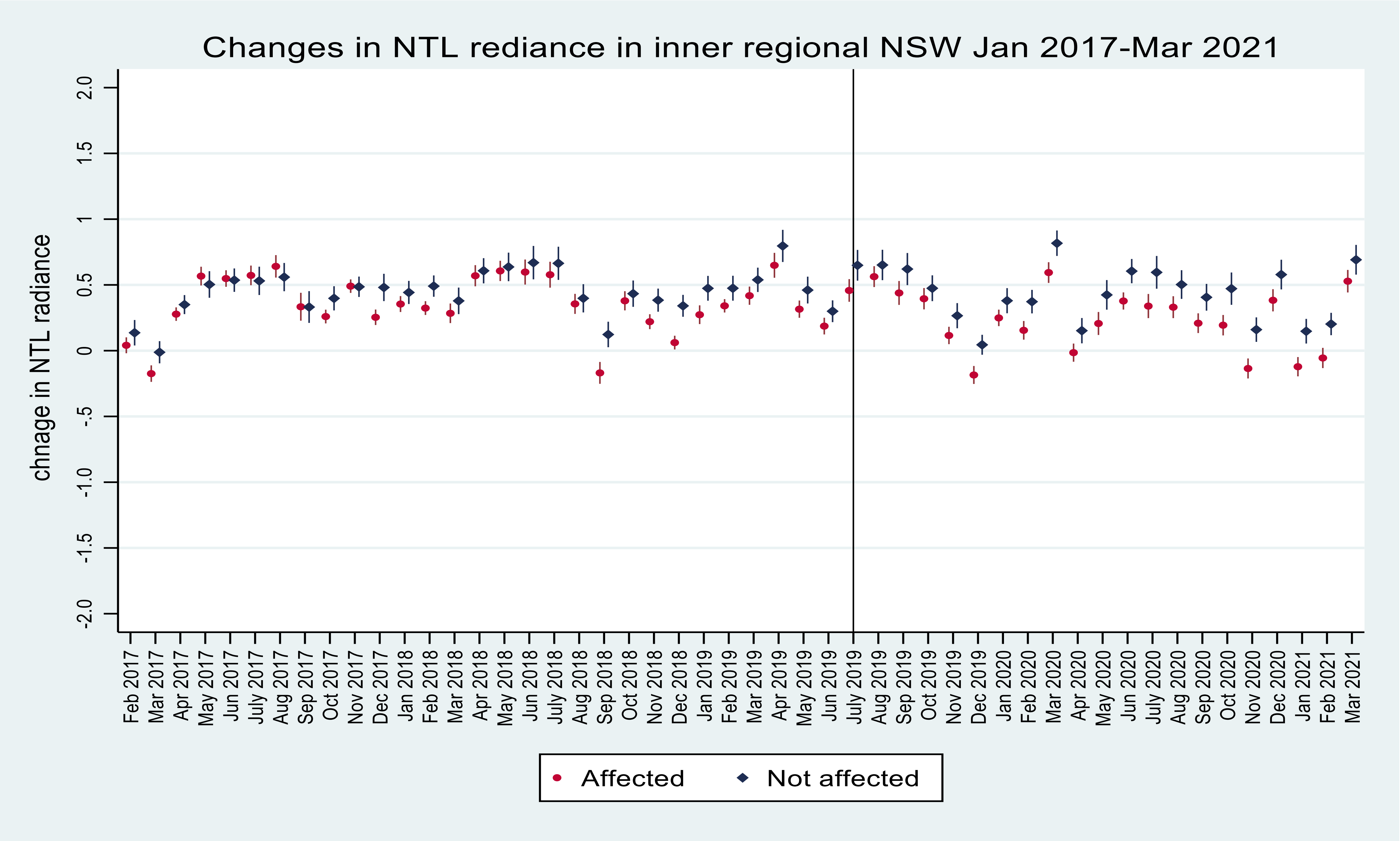
	Luminosity (1)	Luminosity (2)	Luminosity (3)	Luminosity (4)	Luminosity (5)
$\beta_3 Post_{my} X Treatment_i$	−0.219**	…	−0.119*	−0.208	−0.474
	(0.092)	…	(0.065)	(0.153)	(0.410)
$\beta_3 Post_{my} X Treatment(Severe)_i$	…	−0.299**	…	…	…
	…	(0.119)	…	…	…
$\beta_2 Post_{my}$	0.810***	0.799***	0.846***	1.031***	1.055***
	(0.073)	(0.072)	(0.074)	(0.169)	(0.067)
$\beta_1 Treatment_i$	−0.699*	−0.365	−0.460*	−1.311**	−0.202**
	(0.400)	(0.776)	(0.277)	(0.576)	(0.089)
β_0 (control group baseline mean)	14.600***	14.580***	15.050***	14.880***	11.530***
	(1.434)	(1.433)	(1.459)	(1.532)	(0.774)
SA3 fixed-effects	Y	Y	Y	Y	Y
Month fixed-effects	Y	Y	Y	Y	Y
Year fixed-effects	Y	Y	Y	Y	Y
Observations	38,610	38,610	38,610	43,909	88,610
R-squared	0.220	0.218	0.220	0.176	0.178
Treatment sample includes mesh blocks	directly affected	Moderately, highly or extremely affected	≤2km from directly affected	≤5km from directly affected	directly affected
Control sample includes mesh blocks	(a) within 5 km (b) in same SA1	(a) within 5 km (b) in same SA1	(a) within 5 km (b) in same SA1	(a) within 10km (b) In same SA1	(a) within 10km (b) in same SA2
Parallel Trend Assumption is met	Yes	Yes	Yes	No	No



Chnage in monthly NTL mean in major cities of NSW Jan 2017-Mar 2021
chnage in NTL radiance
2.0
1.5
1.0
0.5
0
-0.5
-1.0
-1.5
-2.0
Feb 2017
Mar 2017
Apr 2017
May 2017
Jun 2017
July 2017
Aug 2017
Sep 2017
Oct 2017
Nov 2017
Dec 2017
Jan 2018
Feb 2018
Mar 2018
Apr 2018
May 2018
Jun 2018
July 2018
Aug 2018
Sep 2018
Oct 2018
Nov 2018
Dec 2018
Jan 2019
Feb 2019
Mar 2019
Apr 2019
May 2019
Jun 2019
July 2019
Aug 2019
Sep 2019
Oct 2019
Nov 2019
Dec 2019
Jan 2020
Feb 2020
Mar 2020
Apr 2020
May 2020
Jun 2020
July 2020
Aug 2020
Sep 2020
Oct 2020
Nov 2020
Dec 2020
Jan 2021
Feb 2021
Mar 2021
Affected
Not affected

Results (2): Average change in luminosity in fire affected and unaffected mesh blocks in inner regional NSW

	NTL Luminosity	NTL Luminosity	NTL Luminosity	NTL Luminosity
	(1)	(2)	(3)	(4)
$\beta_3 Post_{my} X Treatment_i$	−0.140***	−0.107***	−0.096***	−0.126***
	(0.030)	(0.034)	(0.028)	(0.026)
$\beta_2 Post_{my}$	0.678***	0.683***	0.682***	0.667***
	(0.040)	(0.045)	(0.037)	(0.034)
$\beta_1 Treatment_i$	−0.276*	0.067	0.535***	−0.291**
	(0.157)	(0.176)	(0.151)	(0.141)
β_0 (control group baseline mean)	1.620***	1.389***	1.823***	2.260***
	(0.429)	(0.439)	(0.434)	(0.414)
SA3 fixed-effects	Y	Y	Y	Y
Month fixed-effects	Y	Y	Y	Y
Year fixed-effects	Y	Y	Y	Y
Observations	201,552	201,552	246,899	274,645
R-squared	0.046	0.046	0.043	0.061
Treatment sample includes mesh blocks	directly affected	≤2km from directly affected	≤5km from directly affected	directly affected
Control sample includes mesh blocks	(a) within 5 km (b) in same SA1	(a) within 5 km (b) in same SA1	(a) within 10km (b) In same SA1	(a) within 10km (b) in same SA2
Parallel Trend Assumption is met	Yes	Yes	Yes	Yes


Changes in NTL rediance in inner regional NSW Jan 2017-Mar 2021
chnage in NTL radiance
2.0
1.5
1
0.5
0
-.5
-1.0
-1.5
-2.0
Feb 2017
Mar 2017
Apr 2017
May 2017
Jun 2017
July 2017
Aug 2017
Sep 2017
Oct 2017
Nov 2017
Dec 2017
Jan 2018
Feb 2018
Mar 2018
Apr 2018
May 2018
Jun 2018
July 2018
Aug 2018
Sep 2018
Oct 2018
Nov 2018
Dec 2018
Jan 2019
Feb 2019
Mar 2019
Apr 2019
May 2019
Jun 2019
July 2019
Aug 2019
Sep 2019
Oct 2019
Nov 2019
Dec 2019
Jan 2020
Feb 2020
Mar 2020
Apr 2020
May 2020
Jun 2020
July 2020
Aug 2020
Sep 2020
Oct 2020
Nov 2020
Dec 2020
Jan 2021
Feb 2021
Mar 2021
Affected
Not affected

Results (3): Average change in luminosity in fire affected and unaffected mesh blocks in Major Cities of NSW Residential vs Non-residential

	NTL Luminosity	NTL Luminosity	NTL Luminosity
	(1)	(2)	(3)
$Post_{my} X Treatment_i X Residential_i$	−0.314*	…	−0.203
	(0.186)	…	(0.132)
$\beta_3 Post_{my} X Treatment(Severe)_i$	…	−0.704**	…
	…	(0.295)	…
Observations	38,610	38,610	38,610
R-squared	0.220	0.218	0.220
Treatment sample includes mesh blocks	directly affected	directly affected	≤2km from directly affected
Control sample includes mesh blocks	(a) Within 5 km (b) In same SA1	(a) Within 5 km (b) In same SA1	(a) Within 5 km (b) In same SA1
SA3 fixed-effects	Y	Y	Y
Month fixed-effects	Y	Y	Y
Year fixed-effects	Y	Y	Y

Results (4): Average change in luminosity in fire affected and unaffected mesh blocks in Major Cities of NSW Socio-economic disadvantage vs advantage

	NTL Luminosity	NTL Luminosity
	(1)	(2)
$Post_{my} X Treatment_i X Disadvantage_i$	−0.235	−0.251
	(0.175)	(0.172)
Observations	38,610	48,259
R-squared	0.225	0.250
Treatment sample includes mesh blocks	directly affected	≤2km from directly affected
Control sample includes mesh blocks	(a) Within 5 km (b) In same SA1	(a) Within 5 km (b) In same SA2
SA3 fixed-effects	Y	Y
Month fixed-effects	Y	Y
Year fixed-effects	Y	Y

Results (6): Average change in luminosity in fire affected and unaffected mesh blocks in inner regional NSW Socio-economic disadvantage vs advantage

	NTL Luminosity	NTL Luminosity
	(1)	(2)
$Post_{my} X Treatment_i X Disadvantage_i$	−0.088	…
	(0.059)	…
$Post_{my} X Treatment_i X HighDisadvantage_i$	…	−0.126*
	…	(0.070)
Observations	201,552	201,552
R-squared	0.050	0.060
Treatment sample includes mesh blocks	directly affected	≤2km from directly affected
Control sample includes mesh blocks	(a) Within 5 km (b) In same SA1	(a) Within 5 km (b) In same SA1
SA3 fixed-effects	Y	Y
Month fixed-effects	Y	Y
Year fixed-effects	Y	Y

Conclusions from Preliminary Findings

- Luminosity scores among the affected communities in major cities and inner regional NSW have dropped after the black summer fires
- The decline in economic activities in fire affected inner regional NSW is relatively higher compared to major cities (10% vs 2%)
  - May be because of COVID
- Spillover effects seem very limited
- Variation is coming mostly from residential areas
- Socio-economic disadvantage seems to have played a role in the slow recovery
    - More granular socio-economic disadvantage data is necessary to draw conclusion with greater confidence
- Next steps:
  - Expand data collection (March-December 2021)
  - Clean up the monthly data
  - Use cleaned yearly data for robustness checking

Reference list

- Akter, S., & Grafton, R. Q. (2021). Do fires discriminate? Socio-economic disadvantage, wildfire hazard exposure and the Australian 2019–20 ‘Black Summer’ fires. *Climatic Change*, 165(3), 1−21.
- Beyer, R. C., Franco-Bedoya, S., & Galdo, V. (2021). Examining the economic impact of COVID-19 in India through daily electricity consumption and nighttime light intensity. World Development, 140, 105287.
- Gao, S., Chen, Y., Liang, L., & Gong, A. (2020). Post-earthquake night-time light piecewise (PNLP) pattern based on NPP/VIIRS night-time light data: A case study of the 2015 nepal earthquake. Remote Sensing, 12(12), 2009.
- Gibson, J., Olivia, S., Boe-Gibson, G., & Li, C. (2021). Which night lights data should we use in economics, and where?. Journal of Development Economics, 149, 102602.
- Klomp, J. (2016). Economic development and natural disasters: A satellite data analysis. *Global Environmental Change*, *36*, 67-88.
- Qiang, Y., Huang, Q., & Xu, J. (2020). Observing community resilience from space: Using nighttime lights to model economic disturbance and recovery pattern in natural disaster. Sustainable Cities and Society, 57, 102115.