

# Measuring the Impact of Insurance on Urban Recovery with Light

## The 2010 - 2011 CANTERBURY EARTHQUAKES

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### Research Questions:

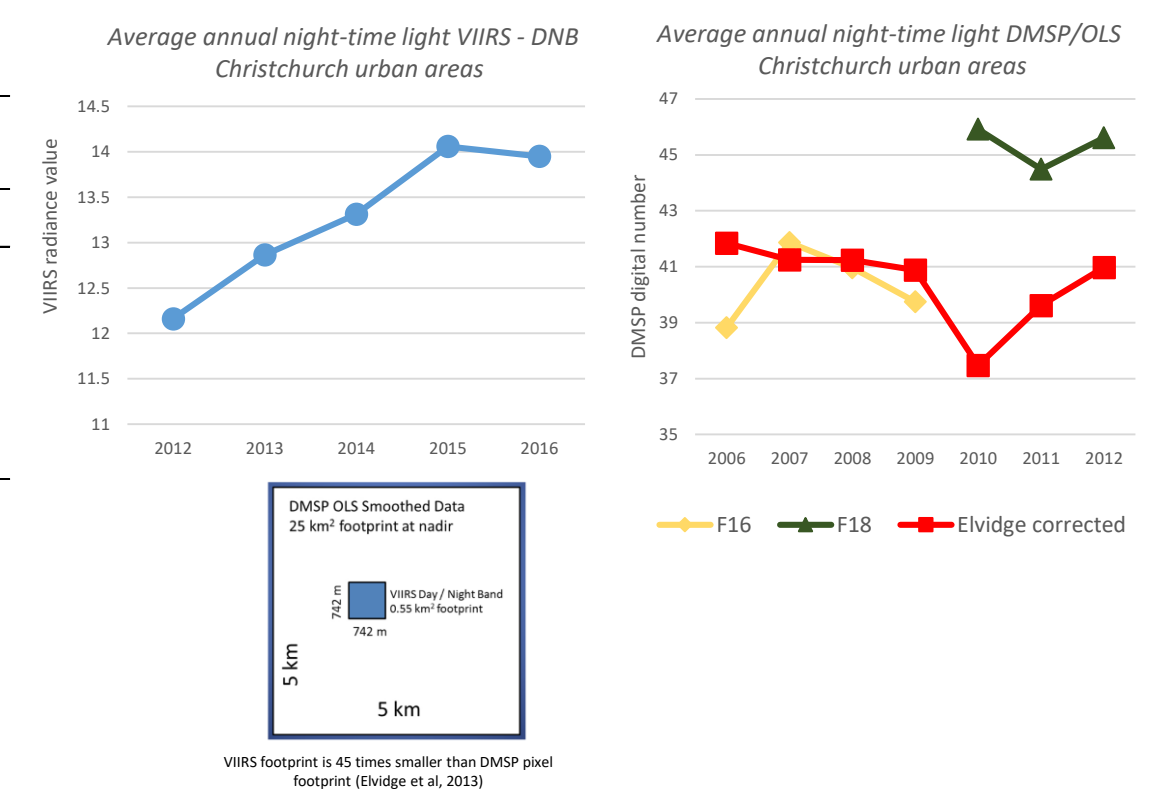
1. Was there a short-term impact of earthquake damage on local economic activity in Greater Christchurch?
2. What were the effects of EQC insurance payments on the recovery of residential areas in Greater Christchurch?
3. Did different aspects of the insurance payments (cash vs. repairs) and their timeliness have any impact on the recovery?

### Descriptive Statistics

Table 1 - Summary statistics of claim payment data

VARIABLES	Building (N = 143,545)		Content (N = 68,324)		Land (N = 73,123)		Total (N = 220,898)	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
Total claim payment (USD)	462,695	696,423	17,347	43,840	60,240	1,424,564	540,284	1,642,358
Total exposed value of the assets (USD)	6,680,840	7,645,051	274,319	520,982	694,532	2,844,193	7,651,877	9,406,143
Proportion of cash paid/total settlement	0.73	0.26	1.00	0.00	0.55	0.41	0.71	0.35
Time to settlement (days)	845	538	489	439	688	514	984	542

Note: Summary statistics of variable "Time to settlement" are calculated at the individual claim level.



### Methodology

#### 1. Earthquake Damage and the Loss in Night-time Light

$$Economic\_Loss_{i,t}^{eq} = \alpha + \beta_k Damage_{i,k} + \gamma X_i + \varepsilon_i \quad \text{with}$$

$$Damage_{i,k} = \frac{\sum_k Claim\_payment_{i,k}}{\sum_k Asset\_value_{i,k}}$$

$$Economic\_Loss_{i,t}^{eq} = \Delta NTL_{i,t}^{2010-2011} = \ln(NTL_{i,t,2009}) - \ln(NTL_{i,t,2011})$$

#### 2a. Insurance settlement and Christchurch recovery

$$Economic\_Recovery_{i,t}^{post} = \alpha_i + \tau_t + \beta_k Ins_{i,t,k} + \gamma X_{i,t} + \varepsilon_{i,t} \quad \text{with}$$

$$Ins_{i,t,k} = \ln(\sum_k Claim\_payment_{i,t,k})$$

$$Economic\_Recovery_{i,t}^{post} = \Delta NTL_{i,t}^{Q2,2012-Q3,2016} = \ln(NTL_{i,t}) - \ln(NTL_{i,t-1})$$

#### 2b. Robustness check - Spatial regression

$$SAR) \quad Y_{i,t} = \alpha_i + \tau_t + \rho WY_{i,t} + \beta X_{i,t} + \varepsilon_{i,t}$$

$$SEM) \quad Y_{i,t} = \alpha_i + \tau_t + \beta X_{i,t} + \vartheta_{i,t} \quad \text{where } \vartheta_{i,t} = \lambda W\vartheta_{i,t} + \varepsilon_{i,t}$$

$$SDM) \quad Y_{i,t} = \alpha_i + \tau_t + \rho WY_{i,t} + \beta X_{i,t} + WX_{i,t}\theta + \varepsilon_{i,t}$$

$$SAC) \quad Y_{i,t} = \alpha_i + \tau_t + \rho WY_{i,t} + \beta X_{i,t} + \vartheta_{i,t} \quad \text{where } \vartheta_{i,t} = \lambda W\vartheta_{i,t} + \varepsilon_{i,t}$$

$W$  is referred to the non-negative spatial weighted matrix ( $N \times N$ ) that describes the spatial structure of dependence between AUs. In this study, we employ the row-standardized contiguity weighted matrix. The elements  $\omega_{ij}$  of matrix  $W$  equals to  $1/\text{the number of neighbors of AU } i$  if AU  $i$  and  $j$  share the border, otherwise  $\omega_{ij} = 0$ .

These models include three different types of interaction effects among units:

- (i) Endogenous spatial interaction effects among the dependent variable ( $WY_{i,t}$ );
- (ii) Exogenous spatial interaction effects among the explanatory variables ( $WX_{i,t}$ );
- (iii) Spatial interaction effects among the error terms ( $W\vartheta_{i,t}$ ).

### EQC: New Zealand Earthquake Commission

- Capped insurance to residential buildings, land and contents
  - De facto compulsory addendum to standard fire insurance policies
- => Over 95% NZ residential properties were covered by EQC

#### Insurance settlement post Canterbury earthquakes

- **EQC:** USD 7.2 billion for residential claims
  - Over 460,000 claims involving 167,000 buildings
- **Private insurers:** USD 7.1 billion for commercial and residential claims
  - 26,273 (commercial), 27,617 (over cap), and 63,992 (out of scope)

### Estimation results

Table 3 - Short run economic impact of the earthquakes using the damage ratio variable

VARIABLES	Dependent variable: Change in night-time light between 2010 and 2011											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Damage ratio	0.559*** (0.186)	0.416** (0.171)	0.953*** (0.401)	0.757*** (0.367)	0.379 (0.389)	0.379 (0.389)	0.016 (0.051)	-0.006 (0.068)	0.747 (0.493)	0.474*** (0.181)	0.343** (0.162)	0.912*** (0.415)
Household Income		0.008 (0.037)	0.003 (0.045)		0.007 (0.036)	0.007 (0.036)		0.012 (0.038)	-0.025 (0.049)		0.007 (0.037)	-0.000 (0.041)
Night-time Population		0.018 (0.012)	0.017 (0.012)		0.019 (0.012)	0.019 (0.012)		0.019 (0.012)	0.021* (0.012)		0.019 (0.012)	0.017 (0.012)
Number of Bedrooms		-0.060 (0.094)	-0.019 (0.119)		-0.071 (0.092)	-0.071 (0.092)		-0.093 (0.092)	0.023 (0.144)		-0.061 (0.092)	-0.011 (0.114)
Area square Km		0.006 (0.008)	0.005 (0.008)		0.006 (0.008)	0.006 (0.008)		0.006 (0.009)	-0.012 (0.018)		0.005 (0.008)	0.003 (0.009)
Constant	-0.086*** (0.016)	-0.237 (0.312)	-0.251 (0.367)	-0.076*** (0.016)	-0.210 (0.301)	-0.210 (0.301)	-0.052*** (0.008)	-0.228 (0.309)	0.011 (0.015)	-0.079*** (0.015)	-0.224 (0.305)	-0.221 (0.335)
Observation	158	158	158	158	158	158	158	158	158	158	158	158
R-squared	0.045	0.097	0.058	0.022	0.079	0.079	0.000	0.074	0.031	0.037	0.093	0.043
IV			40.349				35.301					22.328

\*\*\*/\*\*/\* indicating the significance levels of respectively 1%, 5% and 10%. AU cluster - robust standard errors are shown in parentheses. All regressions are estimated with OLS. IV is the robust Kleinbergen-Paap  $\rho$  Wald F statistic for test of weak instruments. IV regressions have overidentification's p-value approximately equal to zero, except for land regression.

Table 5 - Economic recovery following the earthquakes (Claim payment) - Direct and Indirect effects

VARIABLES	Dependent variable: Quarterly change in night-time light															
	SAR				SAC				SEM				SDM			
	Building	Content	Land	Total	Building	Content	Land	Total	Building	Content	Land	Total	Building	Content	Land	Total
<b>Direct effect</b>																
Insurance payment	0.434*** (0.161)	-0.057 (0.078)	0.136*** (0.052)	0.491*** (0.178)	0.389** (0.167)	-0.051 (0.078)	0.122** (0.050)	0.422** (0.186)	0.456*** (0.157)	-0.061 (0.076)	0.130*** (0.046)	0.536*** (0.173)	0.387** (0.172)	-0.063 (0.077)	0.132** (0.052)	0.421** (0.184)
Settlement time	0.0336 (0.0432)	0.0140 (0.0268)	0.0153 (0.020)	0.0122 (0.046)	0.00239 (0.0449)	0.002 (0.028)	0.012 (0.020)	-0.014 (0.050)	0.062 (0.044)	0.032 (0.025)	0.015 (0.022)	0.042 (0.045)	0.016 (0.042)	0.013 (0.027)	0.013 (0.020)	0.001 (0.045)
Prop. Cash settlement	0.444** (0.190)		-0.0454 (0.0892)	0.449*** (0.171)	0.508*** (0.185)	-0.055 (0.169)	0.501*** (0.189)	0.277 (0.199)		-0.0330 (0.0922)	0.292 (0.182)	0.485** (0.195)		-0.048 (0.087)	0.444** (0.177)	
Ins. payment* Settlement time	-0.469*** (0.148)	0.034 (0.077)	-0.125** (0.049)	-0.513*** (0.163)	-0.420*** (0.160)	0.038 (0.079)	-0.112** (0.048)	-0.443** (0.176)	-0.490*** (0.143)	0.024 (0.072)	-0.119*** (0.044)	-0.558*** (0.157)	-0.417*** (0.161)	0.030 (0.077)	-0.118** (0.049)	-0.440*** (0.170)
<b>Indirect effect</b>																
Insurance payment		0.332** (0.136)	-0.044 (0.061)	0.104** (0.043)	0.376** (0.150)	0.663* (0.361)	-0.087 (0.150)	0.194** (0.092)	0.715* (0.402)			-0.208 (0.583)	0.088 (0.285)	0.045 (0.096)	-0.627 (0.525)	
Settlement time		0.026 (0.034)	0.011 (0.021)	0.018 (0.016)	0.010 (0.036)	0.002 (0.084)	-0.001 (0.057)	0.020 (0.038)	-0.0284 (0.0957)			-0.388*** (0.149)	-0.247*** (0.094)	-0.005 (0.073)	-0.382*** (0.135)	
Prop. Cash settlement		0.338** (0.156)		-0.0318 (0.0677)	0.343** (0.141)	0.896* (0.489)		-0.0852 (0.156)	0.880* (0.472)			1.665*** (0.588)		-0.243 (0.290)	1.465** (0.583)	
Ins. payment* Settlement time		-0.358*** (0.129)	0.0273 (0.060)	-0.096** (0.041)	-0.393*** (0.142)	-0.718** (0.363)	0.0695 (0.156)	-0.179** (0.089)	-0.752* (0.396)			0.740 (0.591)	0.093 (0.277)	-0.041 (0.093)	0.668 (0.535)	

\*\*\*/\*\*/\* indicating the significance levels of respectively 1%, 5% and 10%. AU cluster - robust standard errors are shown in parentheses. All regressions are estimated with AU and quarter fixed effect.

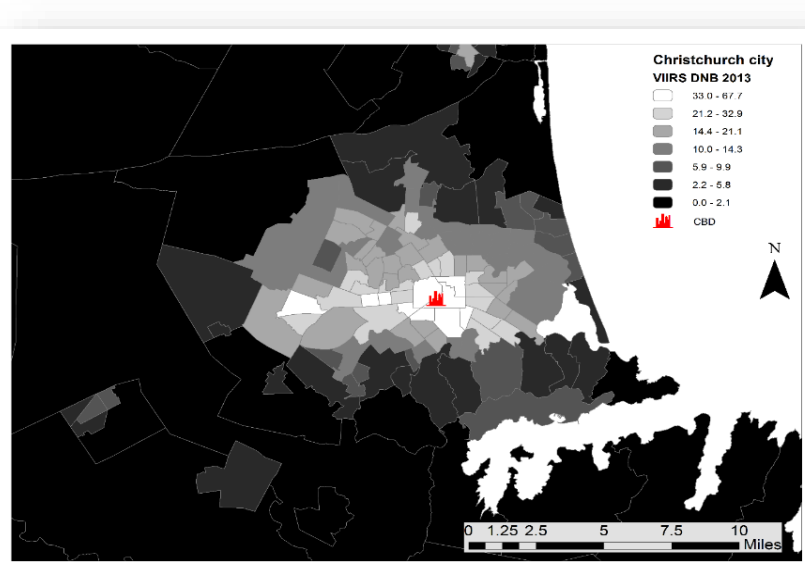
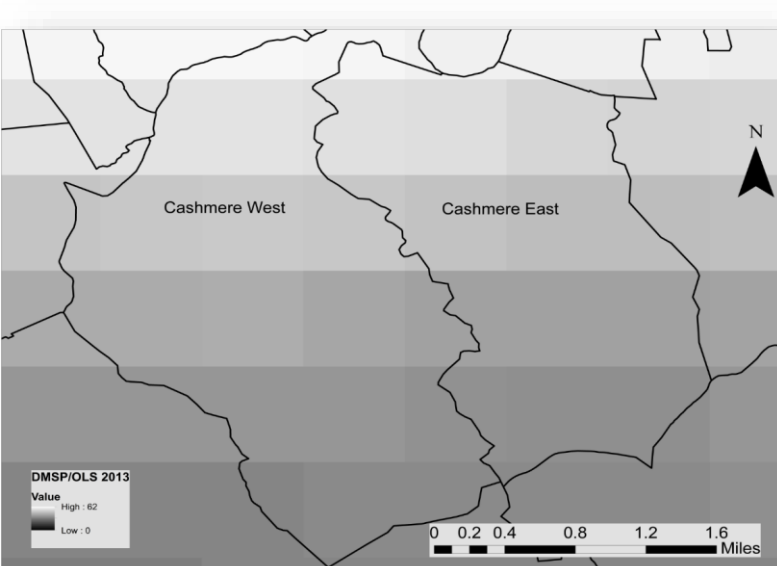
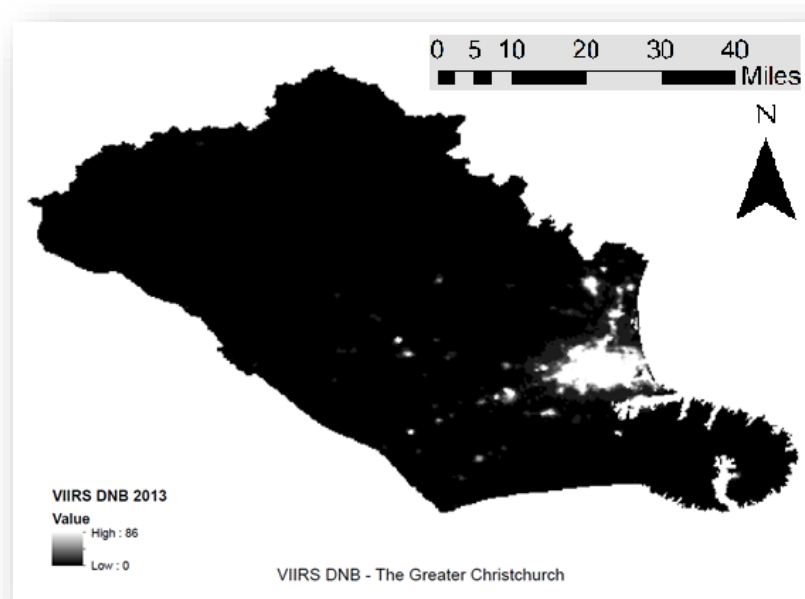
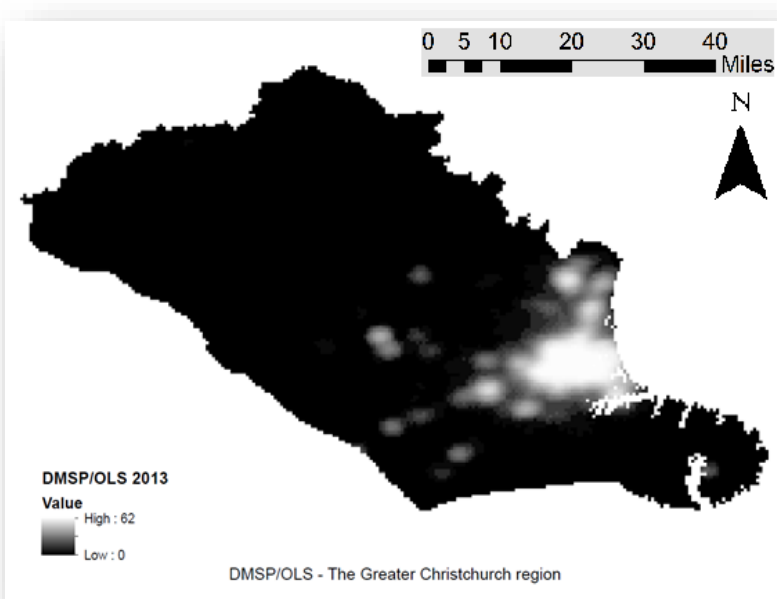
### Night-time light imagery

#### Nightlight intensity

- Indicator of economic activity
- Available to use in greater spatial detail and higher frequency than macro-economic statistics

#### Change in nightlight

- Capture disaster impact and recovery process
  - Bertinelli & Strobl, 2013; Elliott et al., 2015; Mohan & Strobl, 2017; Tanaka et al., 2000
- Few papers use nightlight to estimate earthquakes' impact and recovery
  - Gillespie et al. (2014) using household survey in Sumatra after its earthquake, tsunami and reveal the link between night-time brightness and spending per capita at community level.



Example of area unit polygons in south Christchurch and the DMSP/OLS light intensity pixels

Average annual night-time light in 2013 at the area unit level

### Conclusions and Policy Implications

- Earthquake damage significantly reduced the nightlight radiance in the immediate aftermath of the earthquakes, but the amount of lights bounced back and even increased in the years that followed.
- Building and land claim payments by the EQC contributed significantly to local residential recovery in the years following the earthquakes.
- However, prolonged delays in settling claims reduced the benefits of these insurance payments.
- Cash payments were more conducive to faster recovery for building claims while we found no conclusive finding for the effect of land remediation cash payments.
- We find positive spillover effects of insurance payout and cash payment for the recovery of surrounding areas (justifying public subsidies to the insurance program).