UNDERSTANDING BEHAVIOURAL RESPONSES TO EARTHQUAKE SHAKING USING INJURY DATA FROM THE 2010/2011 CANTERBURY EARTHQUAKES

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UNDERSTANDING BEHAVIOURAL RESPONSES TO NATURAL HAZARDS

- **Why is it important?**

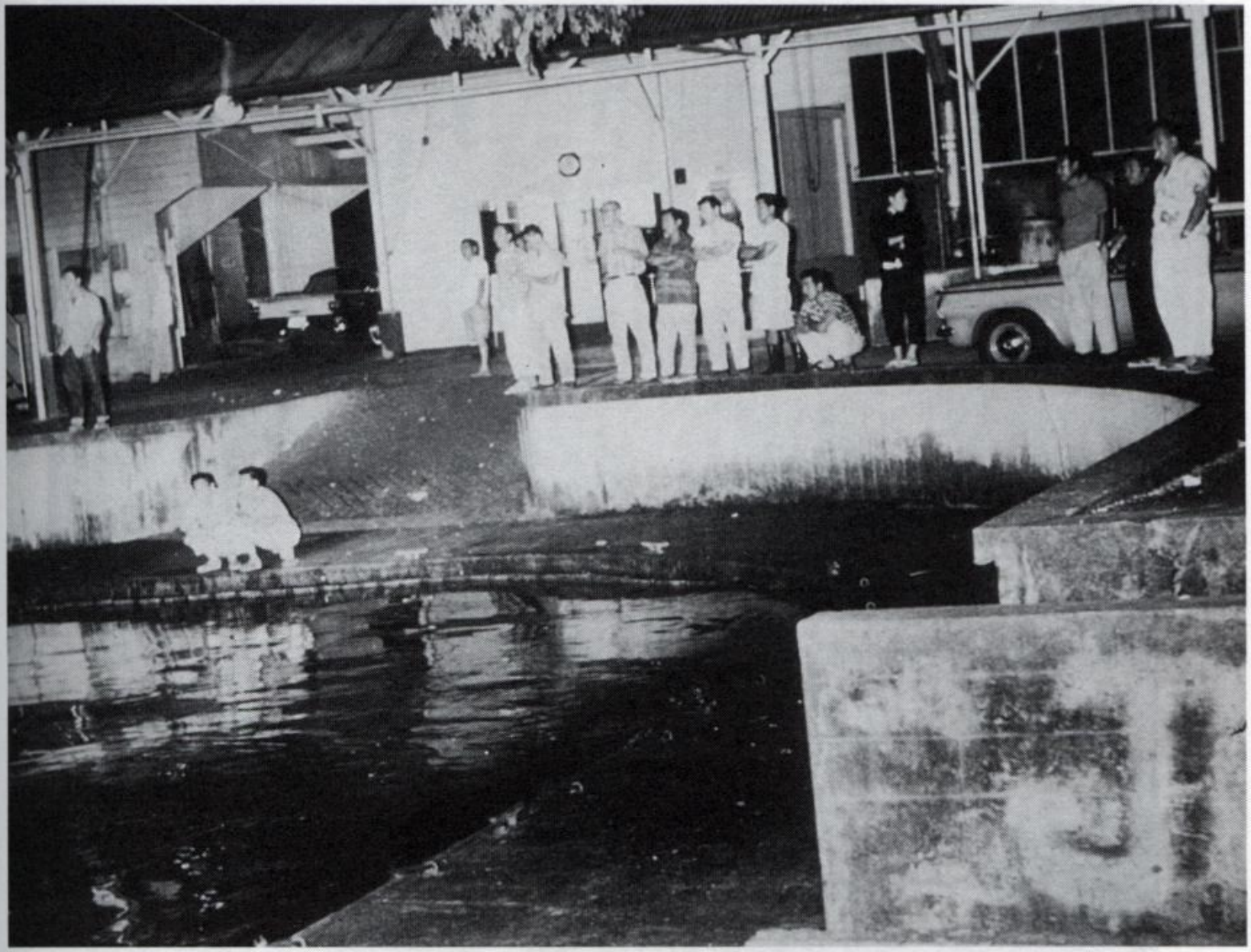
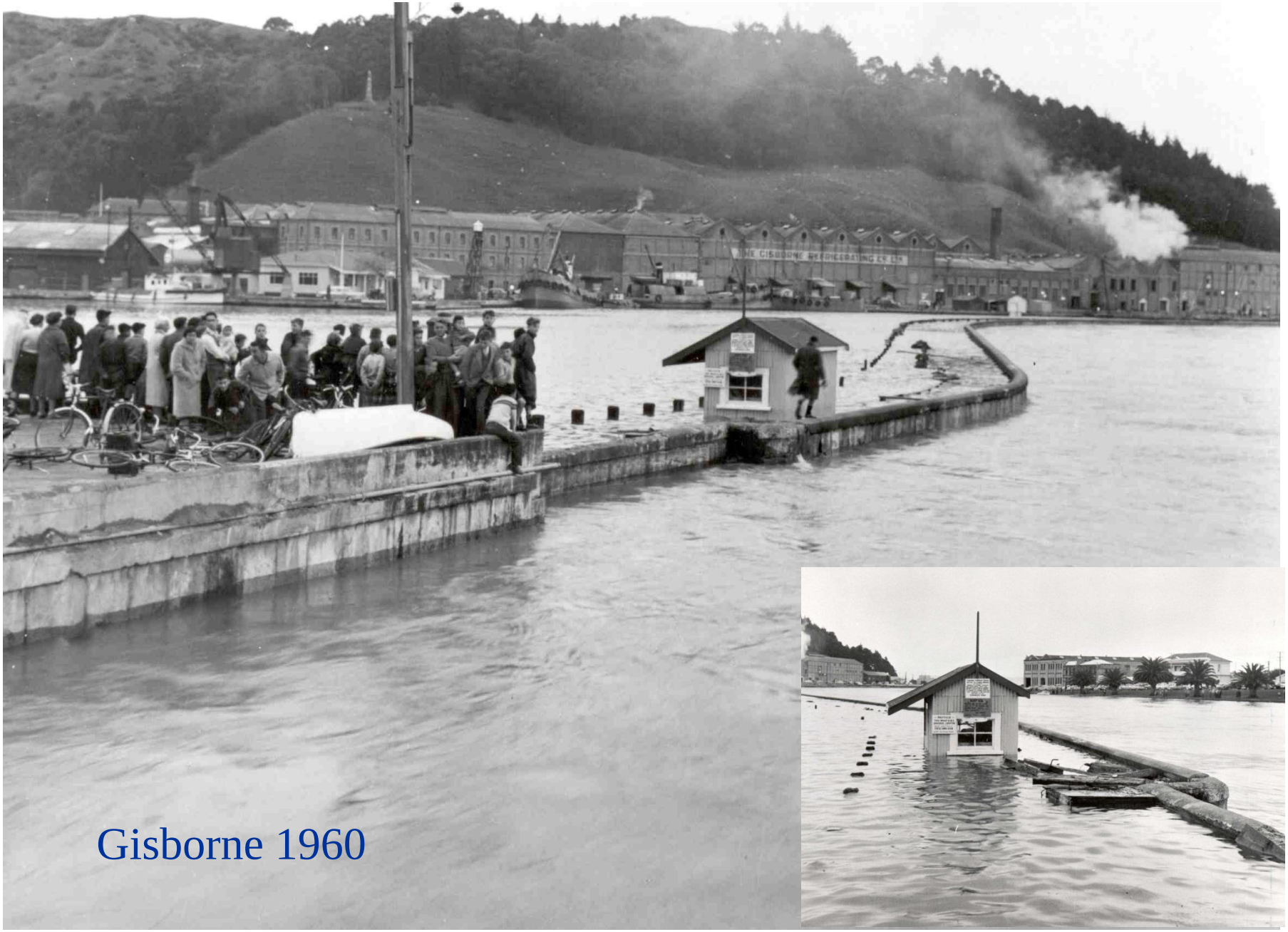


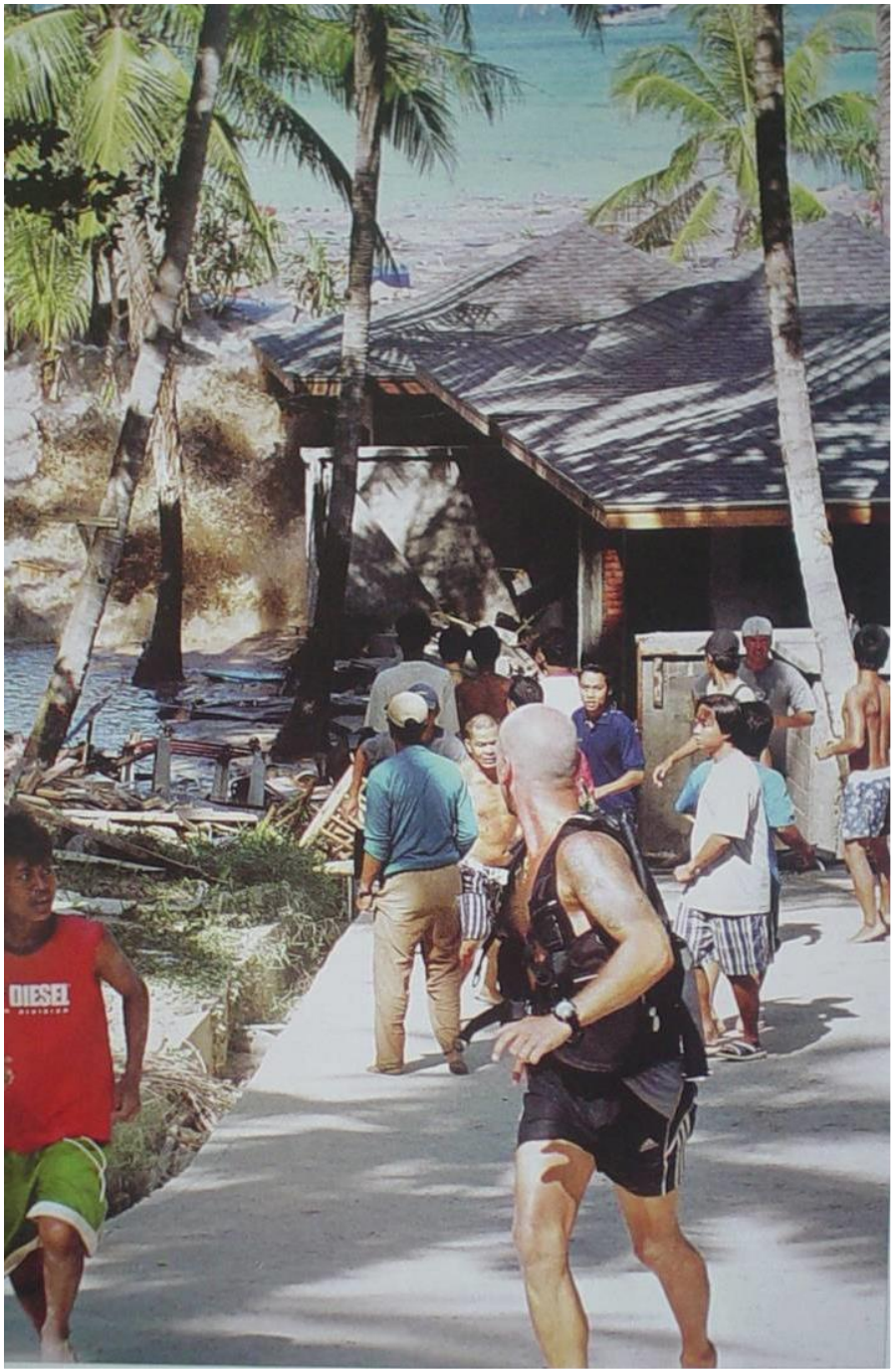
Figure 5.7 Curious Hilo residents await the first wave of the 1960 tsunami.



Gisborne 1960

2004 THAILAND

- No official alert BUT
- 22 % felt earthquake
- 70 % saw sea recede
- 55 % heard sounds
- 11 % evacuated



Reasons for evacuating

- Clarity of the threat
- Sources of social influences
- Availability of resources

Riad et al. 1999

"Evacuation behaviour is complex rather than simple, collective rather than individualistic and develops along multiple lines rather than a single path"

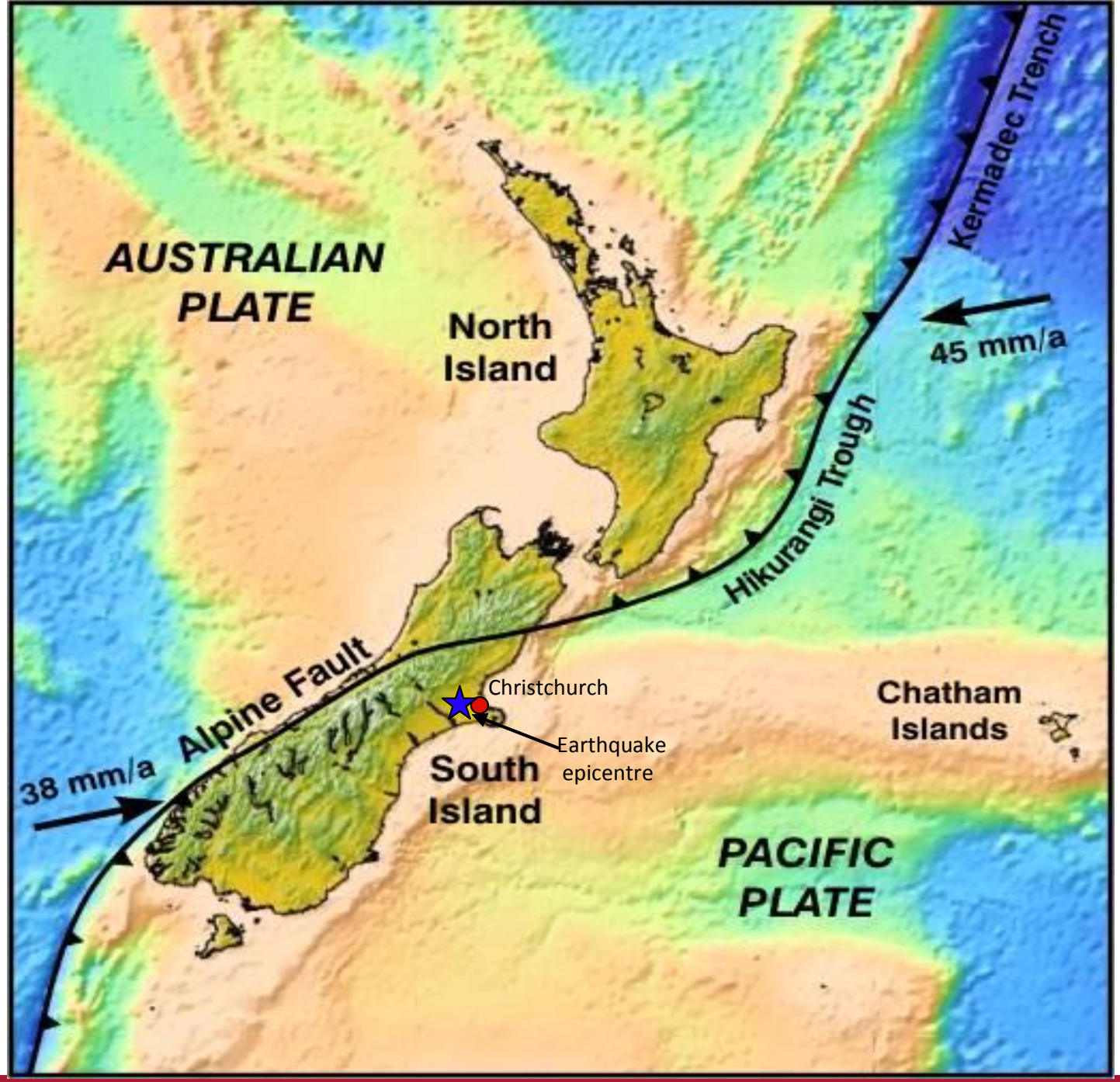
Quarantelli 1985

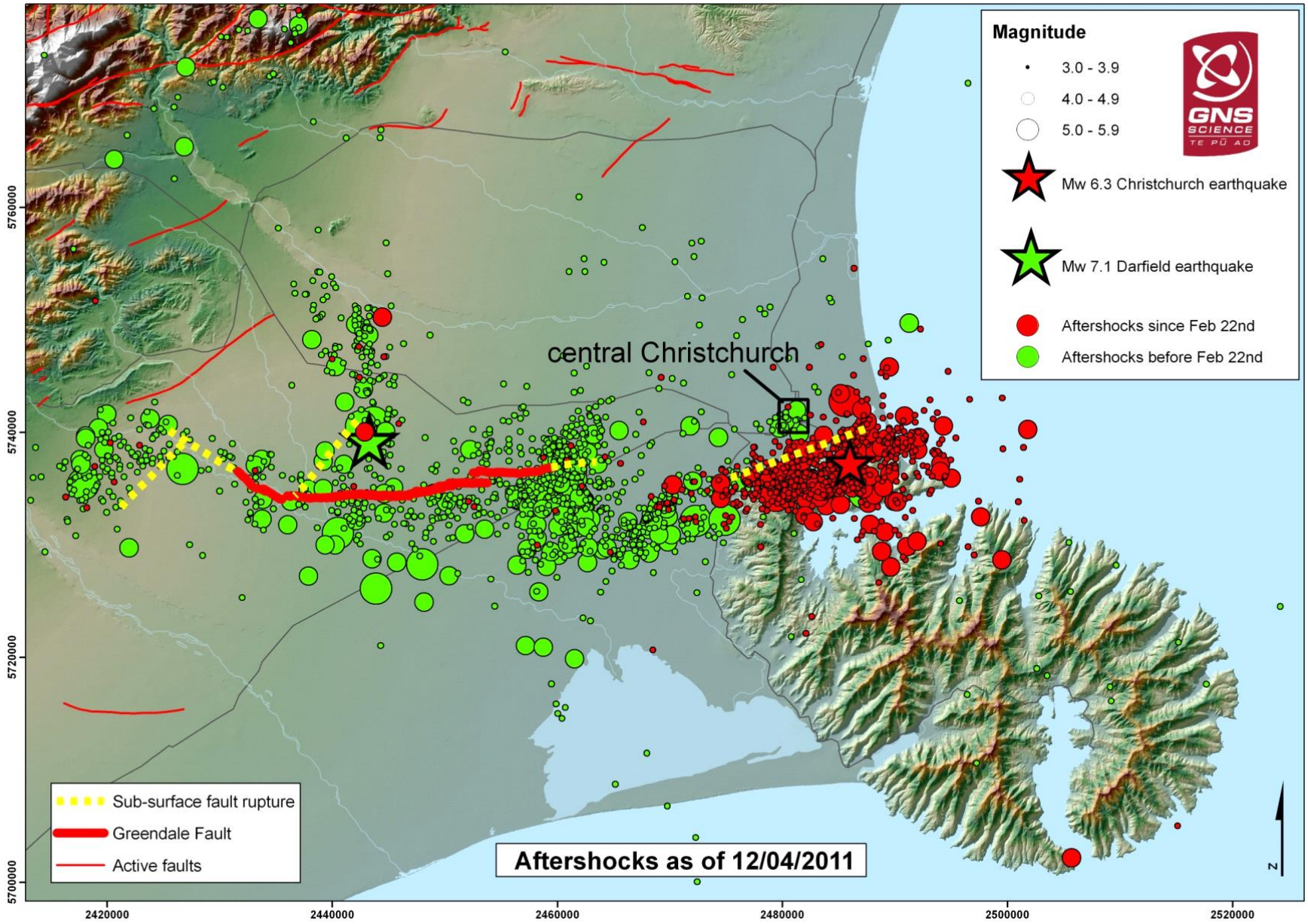
UNDERSTANDING BEHAVIOURAL RESPONSES TO NATURAL HAZARDS

- **Why is it important?**

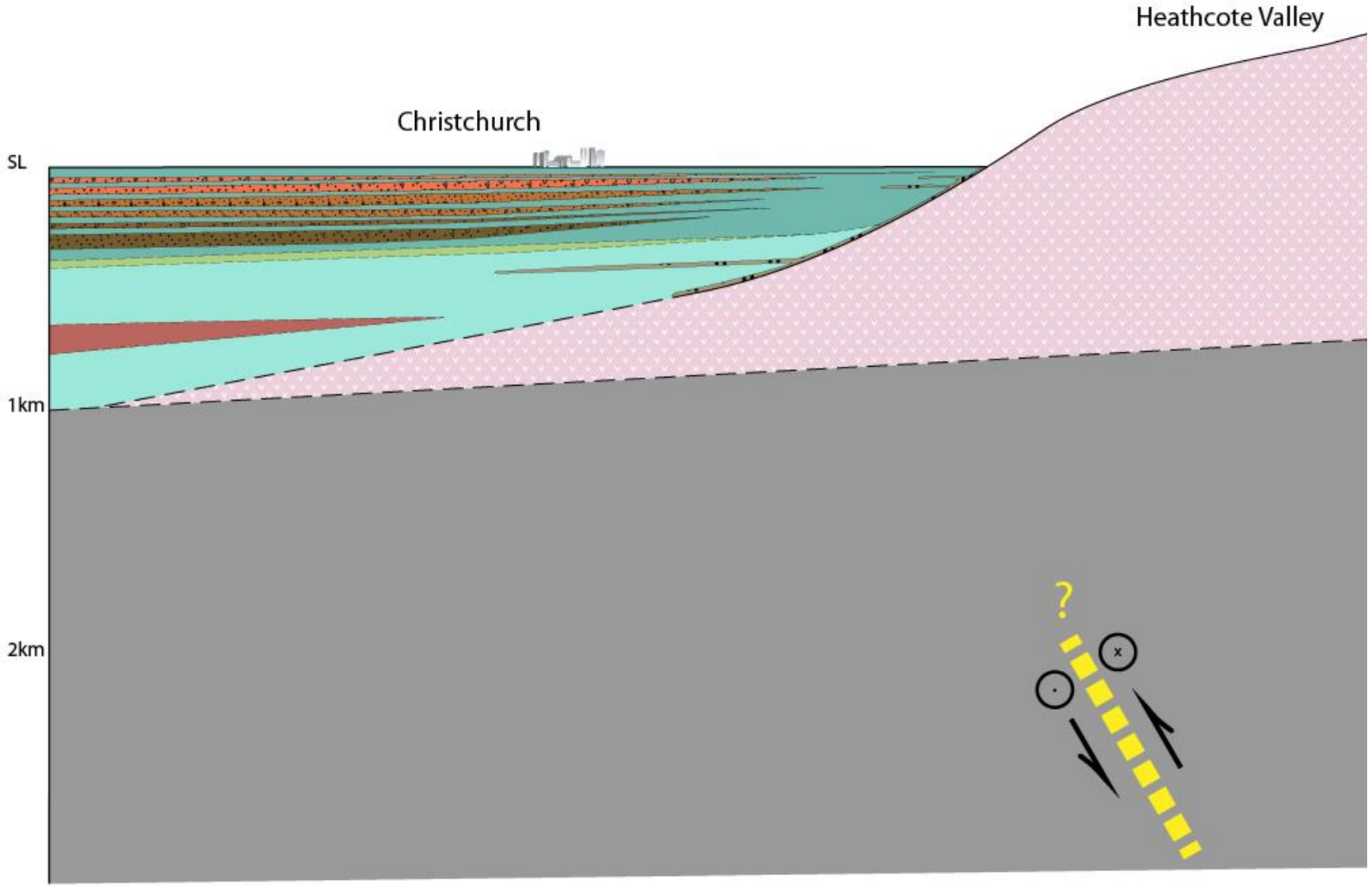

OUTGOING MAIL


a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA
UBC Don't Freak Out Shake Out.
DROP!
COVER!
HOLD ON!
October 18, 10:18 a.m.
The Great British Columbia ShakeOut
IBC | Insurance Bureau of Canada
www.emergency.ubc.ca
www.shakeoutbc.ca


AUSTRALIAN PLATE
North Island
Kermadec Trench
45 mm/a
Hikurangi Trough
Alpine Fault
Christchurch
Earthquake epicentre
Chatham Islands
38 mm/a
South Island
PACIFIC PLATE


Magnitude
3.0 - 3.9
4.0 - 4.9
5.0 - 5.9
GNS SCIENCE
TE PŪ AO
Mw 6.3 Christchurch earthquake
Mw 7.1 Darfield earthquake
Aftershocks since Feb 22nd
Aftershocks before Feb 22nd
central Christchurch
Sub-surface fault rupture
Greendale Fault
Active faults
Aftershocks as of 12/04/2011
N
5760000
5740000
5720000
5700000
2420000
2440000
2460000
2480000
2500000
2520000

A tale of two earthquakes – the Canterbury sequence of 2010-2011


Heathcote Valley
Christchurch
SL
1km
2km
?

CTV Building

Source: Jason Ingham

Data from cities impacted by major earthquakes in several developed and undeveloped countries

	Christchurch (NZ)	Port-au-Prince (Haiti)	Los Angeles (USA)	Bam (Iran)	Kobe (Japan)
Date	22 Feb 2011	12 Jan 2010	17 Jan 1994	26 Dec 2003	17 Jan 1995
Local Time (24 h clock)	12.51	16.53	04.30	05.26	05.46
Magnitude	6.3	7.0	6.7	6.6-6.7	7.2
PGA* (g)	1.8-2.2	<0.1-1.24	1.0-1.78	0.87-0.98	0.82
Urban population affected	450,000	3,000,000	14,500,000	97,000	1,500,000
Urban area affected (km2)	864	38	1,200	19.5	1,800
Population density affected (n/ km2)	520	79,000	12,000	5,000	2,500
Numbers injured	6659	300,000	5000	30,000	>36,000
Numbers killed	182	230,000	72	26,000	5,488

Ardagh et al. *Lancet* 2012 Vol 379: 2109-15


Email
Games
Net Internet

600-700 block of Colombo Street, 22 February

17 killed
1 paralysed

UNDERSTANDING BEHAVIOURAL RESPONSES TO EARTHQUAKE SHAKING USING INJURY DATA

Relative risk by gender and age

	Christchurch	Darfield			Christchurch		
	Population	Total Injuries (n)	Injuries per 10,000	Risk	Total injuries (n)	Injuries per 10,000	Risk
Gender							
Male	168,423	803	47.7	1.0	2525	149.9	1.0
Female	180,012	1453	80.7	1.7	4646	258.1	1.7

Classification of injury context

Primary contexts of injury

Primary immediate: unavoidable causes of injuries that occurred during the main shaking.

Primary action: potentially avoidable causes of injuries that occurred when a person moved during the main shaking.

Aftershock contexts of injury

Aftershock immediate: same as for primary immediate

Aftershock action: same as for primary action

Secondary context of injury

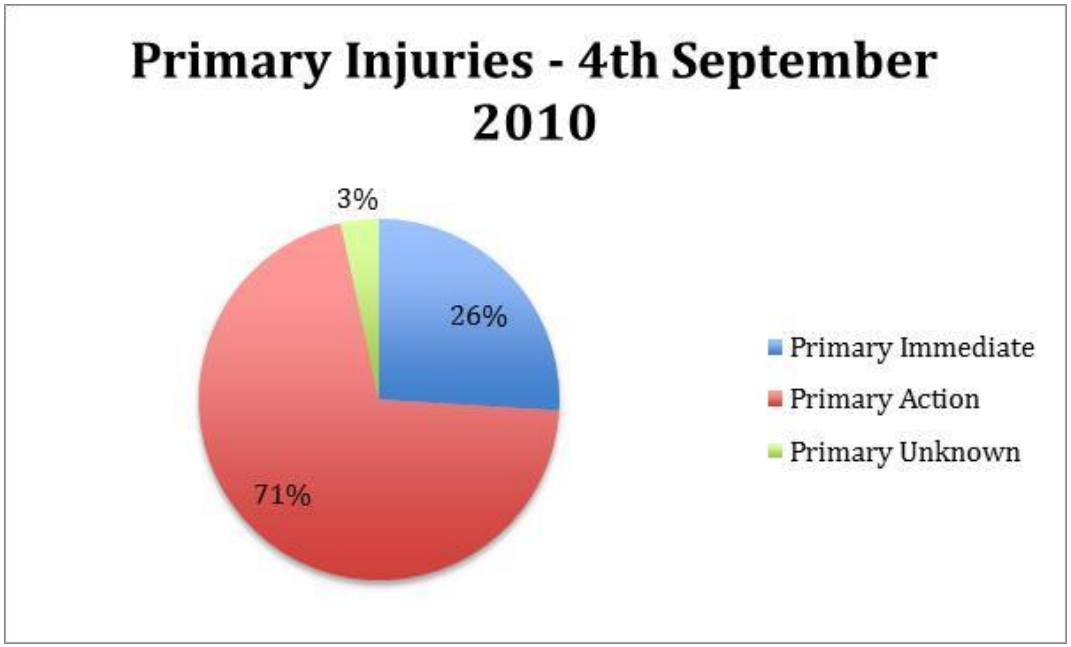
Secondary: any cause of injury that occurred after the shaking had stopped.

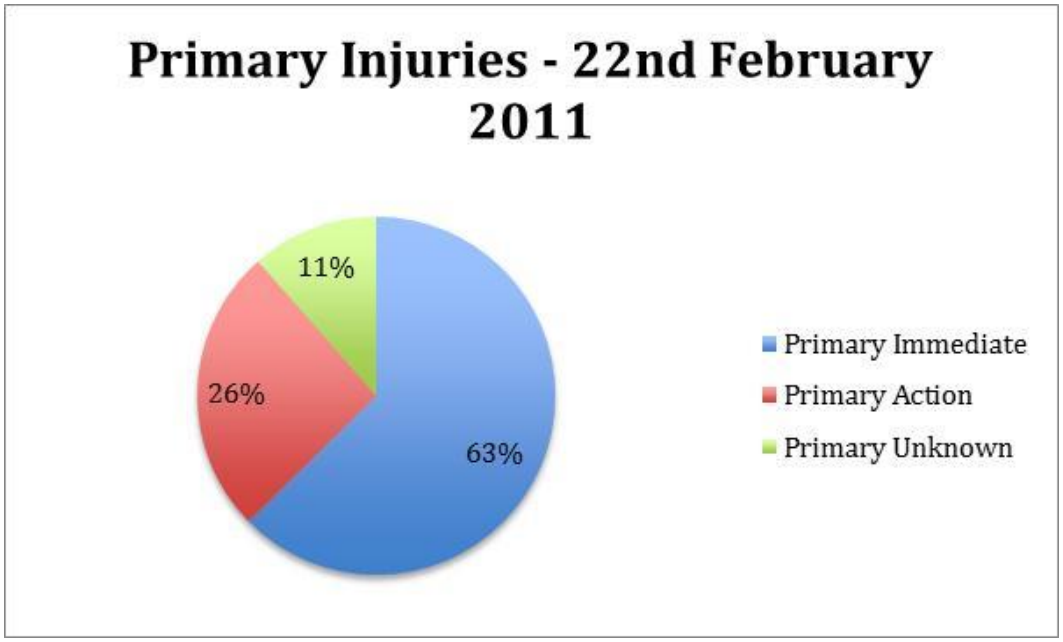
Relative risk by gender and age

	Christchurch	Darfield			Christchurch		
	Population	Total Injuries n	Injuries per 10,000	Relative risk	Total injuries n	Injuries per 10,000	Relative risk
Under 5	21,477	15	7	1	66	30.7	1
5-9	21,396	12	5.6	0.8	41	19.2	0.6
10-14	22,797	31	13.6	1.9	86	37.7	1.2
15-19	25,875	62	24	3.4	241	93.1	3
20-24	27,597	68	24.6	3.5	359	130.1	4.2
25-29	22,506	81	36	5.2	371	164.8	5.4
30-34	24,858	145	58.3	8.4	433	174.2	5.7
35-39	26,310	224	85.1	12.2	636	241.7	7.9
40-44	26,091	240	92	13.2	674	258.3	8.4
45-49	25,008	304	121.6	17.4	784	313.5	10.2
50-54	21,927	274	125	17.9	821	374.4	12.2
55-59	20,313	197	97	13.9	644	317	10.3
60-64	15,084	175	116	16.6	554	367.3	12
65+	47,196	428	90.7	13	1461	309.6	10.1

Context of injury

	Darfield n (%)	Christchurch n (%)
Primary Immediate	377 (16.7)	3129 (43.6)
Primary Action	1025 (45.4)	1293 (18.0)
Primary Unknown	50 (2.2)	574 (8.0)
Secondary (including clean-up)	499 (22.1)	1881 (26.2)
Aftershock Immediate	165 (7.3)	172 (2.4)
Aftershock Action	134 (5.9)	103 (1.4)
Aftershock Unknown	6 (0.3)	19 (0.3)


Primary Injuries - 4th September 2010
3%
26%
71%
Primary Immediate
Primary Action
Primary Unknown


Primary Injuries - 22nd February 2011
11%
26%
63%
Primary Immediate
Primary Action
Primary Unknown

Mechanisms of Injury

	Darfield		
	Female	Male	Total
Cause	n (%)	n (%)	n (%)
Fall/Trip	422 (29.0)	207 (25.8)	629 (27.9)
Cleanup	150 (10.3)	170 (21.2)	320 (14.2)
Projectile	126 (8.7)	82 (10.2)	208 (9.2)
Helping Others	110 (7.6)	60 (7.5)	170 (7.5)
Children	98 (6.7)	45 (5.6)	143 (6.3)
Ground damage	61 (4.2)	45 (5.6)	106 (4.7)
Glass	45 (3.1)	37 (4.6)	82 (3.6)
Masonry	20 (1.4)	37 (4.6)	57 (2.5)
Animals	11 (0.8)	6 (0.8)	17 (0.8)

Mechanisms of Injury

	Christchurch		
	Female n (%)	**Male** n (%)	**Total** n (%)
Fall/Trip	1282 (27.6)	588 (23.3)	1870 (26.1)
Projectile	726 (15.6)	374 (14.8)	1100 (15.3)
Ground damage	356 (7.7)	331 (13.1)	687 (9.6)
Cleanup	251 (5.4)	371 (14.7)	622 (8.7)
Glass	141 (3.0)	70 (2.8)	211 (3.0)
Masonry	70 (1.5)	91 (3.6)	161 (2.3)
Helping Others	83 (1.8)	55 (2.2)	138 (1.9)
Children	91 (2.0)	17 (0.7)	108 (1.5)
Animals	14 (0.3)	11 (0.4)	25 (0.4)

Christchurch quake - Clinical Characteristics of injuries incurred in first 24 hours

Injury Type	Total injuries	Male	Female	Ratio
	n	n (%)	n (%)	F:M
Soft Tissue Injury	4748	1369 (29%)	3379 (71%)	2.47
Laceration	816	302 (37%)	514 (63%)	1.70
Fracture/Dislocation	414	127 (31%)	287 (69%)	2.26
Dental Injury	138	54 (39%)	84 (61%)	1.56
Concussion	58	15 (26%)	43 (74%)	2.87
Pain Syndromes	57	10 (18%)	47 (82%)	4.70
Foreign Body	45	15 (33%)	30 (67%)	2.00
Burns	38	22 (58%)	16 (42%)	0.73
Other	345	118 (34%)	227 (66%)	1.92

Christchurch quake- first 24 hours
Accident location and external cause of injury

	Total injuries	Male	Female	Ratio
	n	n (%)	n (%)	F:M
CTV				
Workplace Address	687	339 (49%)	348 (51%)	1.03
Deaths	115	25 (22%)	90 (78%)	3.60
PGC				
Workplace Address	441	198(45%)	243 (55%)	1.23
Deaths	18	8 (44%)	10 (56%)	1.25
Actions taken				
Passive	3129	915 (29%)	2214 (71%)	2.42
Action	1293	365 (28%)	928 (72%)	2.54
Cleanup	622	371 (60%)	251 (40%)	0.68
Aftershocks	294	99 (34%)	195 (66%)	1.97
Other/Unspecified	1833	775 (42%)	1058 (58%)	1.37

Christchurch quake- first 24 hours
Accident location and external cause of injury

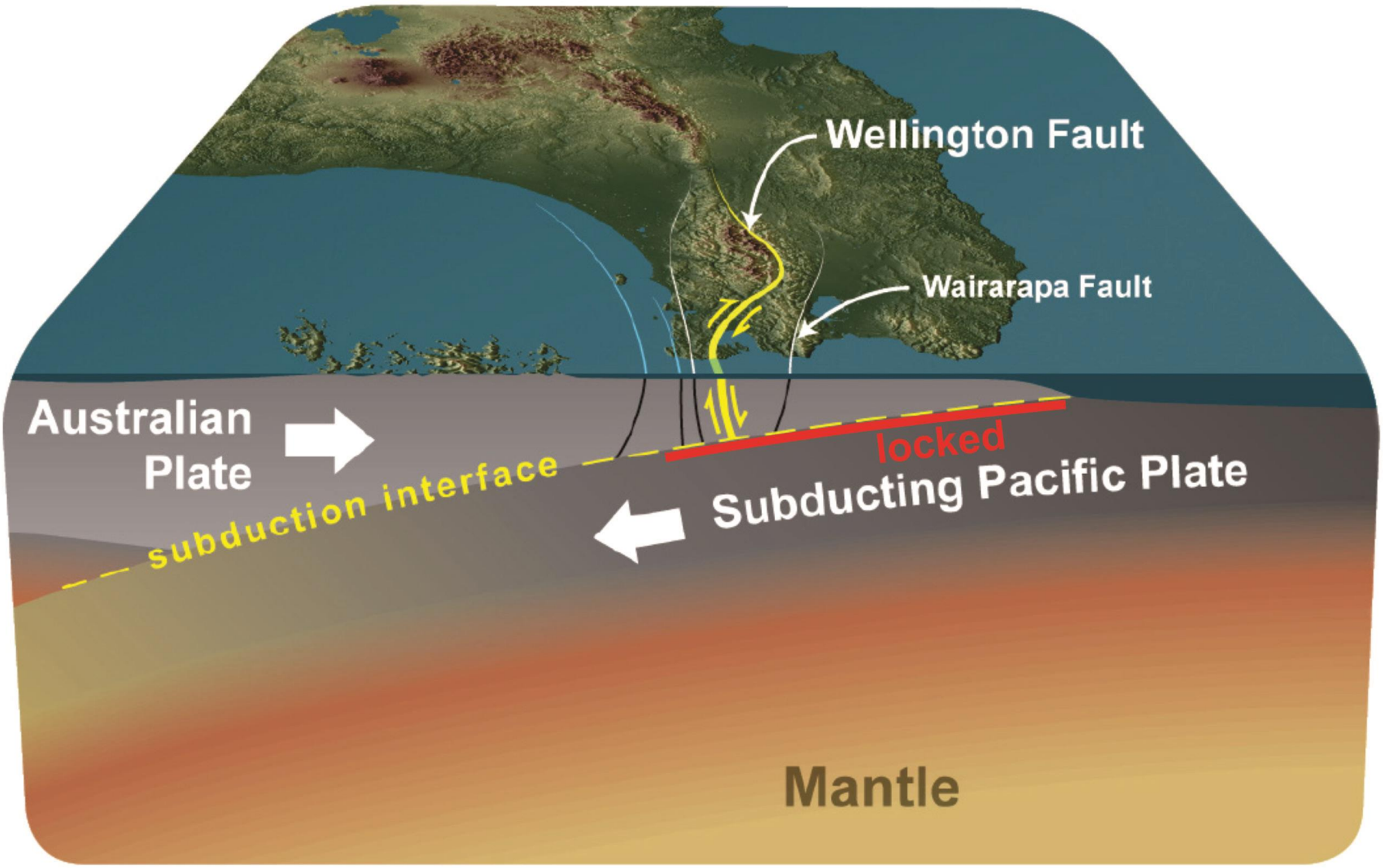
	Total injuries	Male	Female	Ratio
	n	n (%)	n (%)	F:M
Accident Scene				
Home	3392	1002 (30%)	2390 (70%)	2.39
Commercial/Service	1549	444 (29%)	1105 (71%)	2.49
Location				
Road/Street	399	143 (36%)	256 (64%)	1.79
Industrial Place	228	112 (49%)	116 (51%)	1.03
School	140	34 (24%)	106 (76%)	3.12
Place of Recreation or Sport	80	21 (26%)	59 (74%)	2.81
Place of Medical Treatment	45	8 (18%)	37 (82%)	4.63
Other/Not Obtainable	826	268 (32%)	558 (68%)	2.08

- **Gender differences were significant and causes are varied. Further work is need to explain them.**

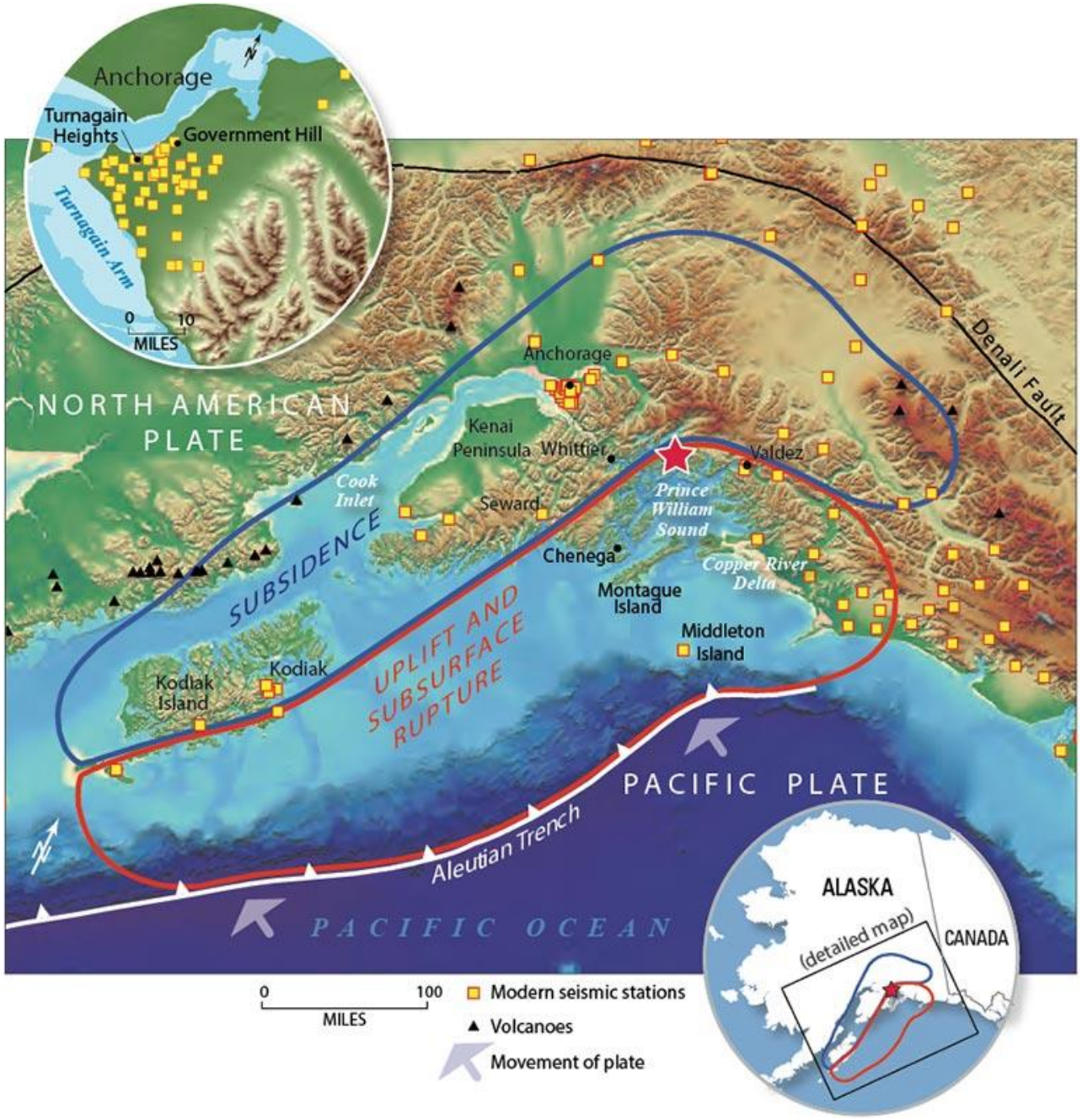
- **In general, improved building codes, strengthening buildings and securing fittings will reduce future earthquake deaths and injuries.**

- **However, the high rate of action injuries earthquake suggests that further education is needed to promote appropriate actions during and after earthquakes.**

Wellington's Earthquake Setting



Wellington's Earthquake Setting

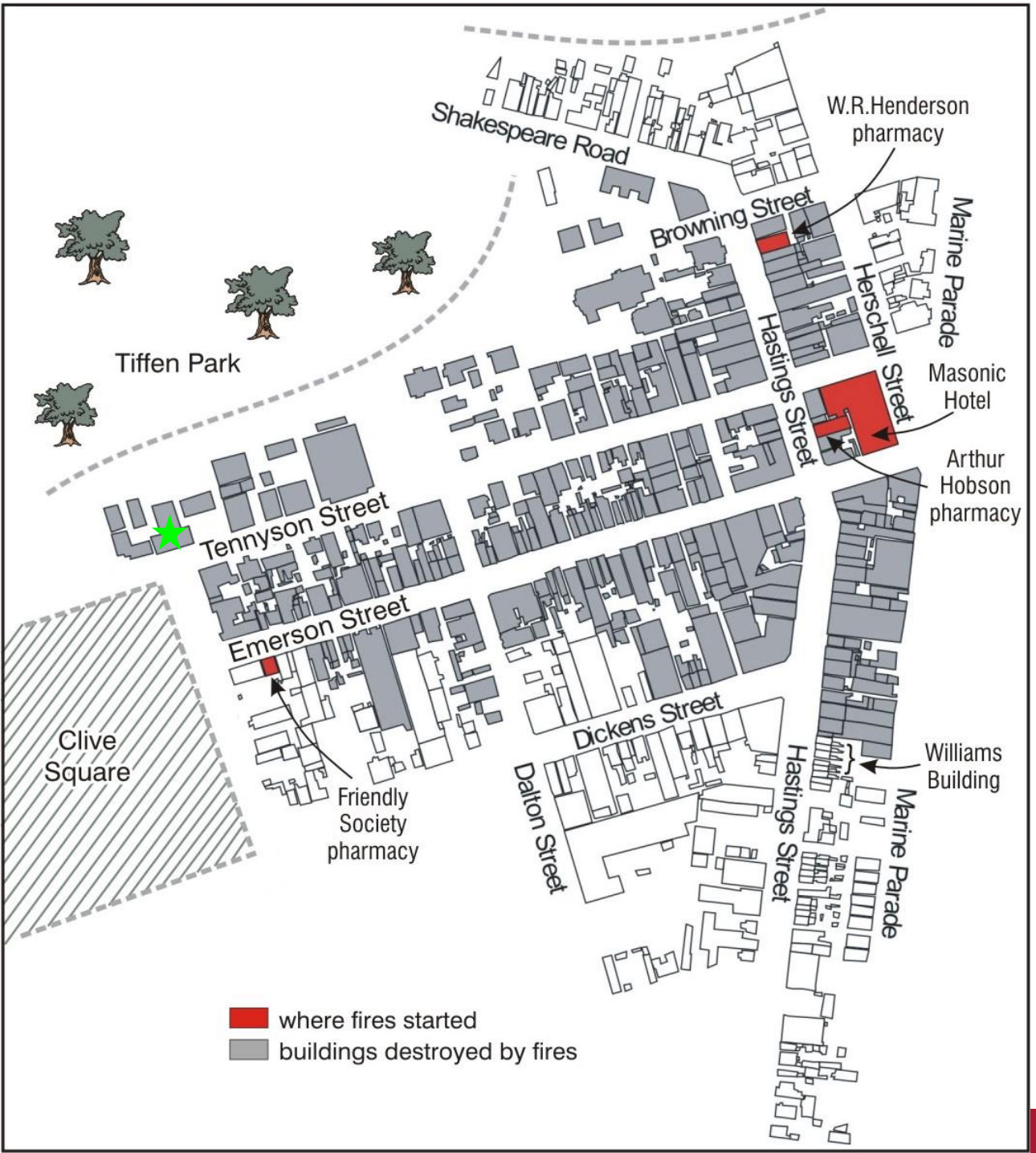

Anchorage
Turnagain Heights
Government Hill
Turnagain Arm
0
10
MILES
NORTH AMERICAN PLATE
Anchorage
Kenai Peninsula
Whittier
Valdez
Denali Fault
Cook Inlet
Seward
Prince William Sound
SUBSIDENCE
Chenega
Copper River Delta
Montague Island
Middleton Island
UPLIFT AND SUBSURFACE RUPTURE
Kodiak
Kodiak Island
PACIFIC PLATE
Aleutian Trench
PACIFIC OCEAN
0
100
MILES
Modern seismic stations
Volcanoes
Movement of plate
ALASKA
(detailed map)
CANADA

Tsunamis washed many vessels into the heart of Kodiak

Photo Credit: U.S. Navy on March 30, 1964

Napier in the 1880's (view to the south)

Napier


Shakespeare Road
W.R.Henderson pharmacy
Browning Street
Marine Parade
Herschell Street
Hastings Street
Tiffen Park
Masonic Hotel
Arthur Hobson pharmacy
Tennyson Street
Emerson Street
Clive Square
Friendly Society pharmacy
Dickens Street
Dalton Street
Williams Building
Hastings Street
Marine Parade
where fires started
buildings destroyed by fires


Hastings St Napier
D·S·L