

## Climate science, economics and politics

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### The science

Twenty-eight years on from the First Assessment Report in 1990, the IPCC's most recent *Special Report on Global Warming* delivers an urgent warning to policymakers that we are reaching the point of no return for mitigating anthropogenic impacts on global warming and associated climate change. The report has divided opinion in Australia and further highlights the discord between climate science, economics and politics nationally.

The report finds that limiting global warming to 1.5°C would now require rapid and unprecedented change in all aspects of society. The report highlights that we are already seeing the consequences of 1°C of global warming through more extreme weather, rising sea levels and diminishing Arctic sea ice.

While 1.5°C may seem a small increase, it is how changes in mean temperatures are related to extreme weather events that is important.

A small increase in the mean temperature also shifts the tails of the distribution, meaning it may impact extreme weather events that are temperature-dependent. However, any relationship between increasing mean global air temperature and extreme weather will be complex, and both peril and location-dependent.

Prof Andy Pitman, from the University of New South Wales and Director of the ARC Centre of Excellence for Climate Extremes, described this in an anecdote to BBC News back in January:

*"the probability works a bit like if you stand at sea level and throw a ball in the air, and then gradually make your way up a mountain and throw the ball in the air again. The chances of the ball going higher increases dramatically. That's what we're doing with temperature."*

As an industry partner of the ARC Centre of Excellence, Risk Frontiers are looking to couple their cat modelling infrastructure to downscaled climate change projections to model the impacts on a peril-by-peril basis for business.

### The economics

A day after the IPCC report was published, the Royal Swedish Academy of Sciences awarded William Nordhaus and Paul Romer the Nobel Memorial prize for economics for their work on climate change and economic growth.

Since the 1970s, Prof. Nordhaus has been warning governments that their economic models were not properly taking into account the impact of global warming. Similarly, Prof. Romer developed the "endogenous growth theory": the notion that countries can improve their underlying performance if they concentrate on supply-side measures such as research and development, innovation and skills. He argues that the creation and spread of ideas - whether that be around climate change or otherwise - is necessary for economic growth.

Understanding the economic costs of climate-related damages is essential to answering the question of how much society should be willing to pay to avert that damage (The Economist, 2018). Prof. Nordhaus' work addresses this issue by modelling the economic harm of carbon emissions, thus allowing him to estimate the likely economic costs of the different IPCC Representative Concentration Pathways (RCPs).

Prof. Romer believes it is perfectly possible for global warming to be kept to a maximum of 1.5°C:

*"Once we start to try to reduce carbon emissions, we'll be surprised that it wasn't as hard as we anticipated. The danger with very alarming forecasts is that it will make people feel apathetic and hopeless. One problem today is that people think protecting the environment will be so costly and so hard that they want to ignore the problem and pretend it doesn't exist."*

### The politics

The IPCC report is published at a time of international discord on climate mitigation, with most scientists acknowledging that the likelihood of achieving a plateau at the proposed 1.5 °C is very small. This is essentially a reflection on the myopic nature of global political institutions, and the opposing long-term nature of the problem at hand.

It also highlights the divisive nature of climate change in Australia. As elsewhere, it has become entangled with political agendas, class, energy and living standards. However, unlike elsewhere, adaptation to climate change has yet to occupy an ongoing, cross-party role in government policy as it has done,



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for example, in Europe. It has exposed an interesting divide between sectors that has come to the fore in recent years – with banking, insurance and industry at large leading the charge in understanding climate change risk and exposures. APRA, the Australian Prudential Regulation Authority, has ensured momentum here when in February 2017 Geoff Summerhayes declared climate change can no longer be considered a future financial risk:

*“While climate risks have been broadly recognised, they have often been seen as a future problem or a non-financial problem. The key point I want to make today, and that APRA wants to be explicit about, is that this is no longer the case. Some climate risks are distinctly ‘financial’ in nature. Many of these risks are foreseeable, material and actionable now. Climate risks also have potential system-wide implications that APRA and other regulators here and abroad are paying much closer attention to.”*

### The bottom line

The global impasse on mitigation efforts only serves to highlight the importance of climate change adaptation

planning and risk management in Australia. We’ll need to continue to adjust to the effects of climate change in the absence of addressing the underlying sources, but, ideally, we’d do both. If we believe the economics of the two most recent Nobel prize recipients, this may not be as costly as we think.

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## Responses to the Lombok Earthquake, 2018 – Rapid Assessment Study

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*The recent earthquake that occurred in Lombok in August, 2018, presented an opportunity to study the responses of those affected in the immediate aftermath of the event. We find that tourists caught up in disasters are uniquely vulnerable. Few followed the encouraged actions of what to do in the event of an earthquake and most were reliant on local residents and tourist operators for advice. This article summarises the earthquake and how people responded and provides some reflections for policy makers.*

### Background

The island of Lombok is located in the Nusa Tenggara Barat Region of Indonesia. It lies on the boundary between the Australian Plate and the Sunda Plate, which has produced numerous powerful earthquakes in the past. The region is a popular tourist destination, with rapidly increasing numbers of visitors since developed countries lifted travel warnings following the 2002 and 2005 Bali bombings and the SARS (severe acute respiratory syndrome) outbreak between 2002 and 2004. Tourism is a major source of income for Lombok and the neighbouring Bali and Gili Islands, with millions of visitors from around the world each year.

The August 5, 2018, Mw6.9 earthquake occurred as the result of shallow thrust faulting on or near the Flores Back Arc Thrust. The earthquake occurred in a subduction plate boundary region where the Sunda and Australia plates converge (USGS, 2018). In the region surrounding the location of the earthquake, there have been six other events of Mw6.5 or larger over the previous century. Four of these are likely to have occurred on the Back Arc Thrust system: a Mw6.5 in the Bali region to the west of Lombok in July 1976 and three events of Mw6.5, Mw6.5 and Mw6.6 in the Sumbawa region to the east of Lombok in November 2007 and November 2009. The Sumbawa earthquakes were associated with several deaths, hundreds of injuries and the destruction of hundreds of houses. This history of recent earthquakes means that locals would have been familiar with the impacts of damaging earthquakes.

The earthquake occurred at a depth of 31.0km, centred at the northern tip of Lombok. The local time was 7:46pm. It was preceded by a main foreshock on July 29, 2018 of Mw6.4, and numerous aftershocks including a Mw5.9 event on August 9, 2018 (USGS, 2018). The earthquake caused severe shaking in Lombok and surrounding islands, including Bali and the Gili Islands, and was felt as far as Sumbawa in the east (Cochrane, 2018) and Trenggalek Regency in the west (Solichah, 2018). Following the earthquake, tsunami warnings were issued: however, the maximum expected height was only half a metre and the warning was later cancelled.



Figure 1: Earthquake location with regional context

Most of those affected by the earthquake were in North Lombok, East Lombok and Mataram City. Reports indicated that there were 392 fatalities, 1,353 injuries and damage to 67,875 houses, 606 schools, six bridges, three hospitals, ten health centres, 15 mosques, 50 prayer rooms and 20 office units (Badan Nasional Penanggulangan Bencana, 2018).

It is important for emergency managers to have an understanding of human behaviour during extreme events so that they can best develop their plans. In an effort to understand the behaviour of tourists and others following the earthquake, researchers from Risk Frontiers conducted a rapid assessment study utilising media analysis containing interviews with survivors. The method involved locating some 120 news articles sourced from a variety of online international, national and local media outlets. From these articles, interviews with 146 people who experienced the earthquake were extracted and analysed to identify damage that occurred and how people behaved during and after the earthquake.

## Results

A significant majority of interviewees were tourists (n=102), who conducted interviews with media outlets from their home countries either remotely or after returning home. Other interviews included local residents (n=20) and expats (n=9), with a further ten not stating where they were from.

At the time of the earthquake, interviewees were located on the island of Bali, approximately 50km to the east of Lombok (n=54); on Lombok (n=40); on the Gili Islands (n=28) and at other locations in the area (n=3). Twenty of those interviewed did not state where they had been at the time of the earthquake.

The interviewees came from a variety of nations, including Australia (n=38), Indonesia (n=25), Britain (n=23), Ireland (n=9), New Zealand (n=8), America (n=7), Singapore (n=5), France (n=4), South Africa (n=3), Canada (n=2), and one interviewee each from Africa (country unstated), Belgium, Denmark, the Netherlands, Malta, Pakistan and Spain. The age of interviewees was captured either by statement in the article or by approximation if a photo was available. Of those interviewed, 99 were categorised between 18 and 60 years old. Three were recorded as above 60 years old, and one was less than 18.

Most interviewees said they were with other adult/s when the earthquake occurred (n=51), or with both children and adult/s (n=24). Ten interviewees said they were with someone but didn't specify their age/s and nine said they were alone.

In relation to their location at the time of the earthquake, interviewees stated that they were at a restaurant (n=29), in a hotel (size not stated) (n=14), at home and awake (n=9), in a single storey hotel (n=8), in a multi storey hotel (n=7), at home and asleep (n=3), in a shop or shopping centre (n=3), at the beach (n=2), on a footpath (n=2), in a car (n=1) or on a boat (n=1).

Consequences the interviewees observed from the earthquake included collapsed buildings (n=45), debris/objects falling (n=25), injuries (n=23), power cuts (n=22), loss of water from swimming pools (n=15), cracked walls (n=13), food shortages (n=11), deaths (n=11), water shortages (n=6), broken glass (n=4), downed cables (n=4), loss of sanitation (n=2), ground subsidence or uplift (n=1), flooding (n=1) and

fires (n=1). Those located in Lombok and the Gili islands observed the most significant damage.

During the earthquake, interviewees most commonly reported, of their own behaviour, that they ran outside (n=43). Others reported that they dropped to the ground as they could not remain standing (n=5), sheltered under a table or bed (n=5), ran outside onto the beach (n=4), moved away from buildings (n=4), sheltered in doorways (n=3), deliberately dropped to the ground (n=2) or moved away from trees (n=2).

During the earthquake, interviewees observed others most commonly either running from buildings (n=44) or screaming (n=37). Other observed behaviours were crying (n=10), moving away from buildings (n=7), caring for others (n=4), running specifically to the beach (n=4), seeking shelter under tables or beds (n=3), holding onto objects or other people (n=3), panicking (n=3), seeking shelter under doorways (n=2), calling or messaging others (n=2) and dropping to the ground (n=1), reporting they could not stand.

Immediately after the earthquake, those interviewed moved to higher ground (fearing a tsunami) (n=29), sought advice on what to do from locals (n=9) or from hotel reception/staff (n=6), gave first aid to the injured (n=4), called or messaged someone (n=4), informed others of tsunami threat levels (n=3), climbed trees (fearing a tsunami) (n=3), searched for family member/s or friend/s (n=3), put on life jackets (fearing a tsunami) (n=2), assisted rescuing trapped person/s (n=2), were themselves incapacitated/requiring treatment (n=2) or extinguished fires (n=1).

Interviewees observed that immediately after the earthquake, others moved to higher ground (n=24), were screaming (n=12), panicking (n=11), caring for others (n=10), running (n=5), assisting the injured (n=5), crying (n=5), remaining on the beach (n=4), calling others (n=4), climbing trees (n=3), searching for others (n=3) or moving debris (n=1).

People said their actions immediately after the earthquake were directed by local residents (n=9), hotel staff (n=9), local authorities (n=3), other tourists (n=2) or by a minister of religion (n=1).

For those interviewees who said they contacted someone, contacts included their parent/s (n=8), other relative/s (n=3), friend/s (n=2), spouse/partner (n=2), children (n=1), authorities (n=1), neighbour/s (n=1) and a stranger (n=1). Six people contacted someone but did not specify who.

Many of those interviewed were not from countries which are associated with high earthquake risk. People's previous experiences of earthquakes or education provided in their country of origin may have influenced some responses. This possibility is evidenced by the following responses:

*"Everyone I spoke to just wants to get out but there's not one free seat out of here today. About 90 per cent of us were westerners and we're not trained for how to react in this situation." (Interviewee from a country not prone to quakes) (Darvall and O'Shea, 2018).*

*"It's scary when the ground is buckling under your feet. My partner and I were out of bed and under the table in a flash and we then immediately evacuated the house. When I was a child at school we had earthquake drills. Best training ever." (Interviewee from a quake-prone country) (NZ Herald, 2018).*



Descriptions of interviewees' emotions during and immediately after the quake included feeling fearful (n=37), panicked (n=14), calm (n=9), concerned (n=7), upset (n=5), terrified (n=5), in shock (n=4), apathetic (n=2), surreal (n=2), and other (n=6). Some 83 interviewees did not state their emotions during and immediately after the quake.

Interviewees said they obtained information about tsunami risk from local residents (n=9), the internet (n=6), warning sirens (or the lack thereof) (n=4), social media (n=3), hotel staff (n=2), calling family or friends at home (n=2), other tourists (n=2), local authorities (n=2), observing the ocean (n=2) or overhearing other people (n=2).

Over subsequent days, a significant number of people said they evacuated soon after (n=29). Some stayed to assist rescue, medical or relief efforts (n=11), although these were mainly locals and expats.

The evacuation of tourists from the Gili Islands was said to be chaotic due to the combination of the lack of capacity to evacuate tourists and the fearful state of tourists and locals. There were reports of long waits, pushing and shoving and passage being offered to the highest bidders. Those interviewees who experienced the evacuation described it as:

*"People were just throwing their suitcases on board and I had to struggle to get my husband on, because he was bleeding."* (Embury-Dennis, 2018).

*"We just witnessed one of the boats get completely overfilled with tourists climbing on, with the officials trying to keep them back off the boat, pushing them and shoving them. That boat still hasn't left yet."* (ABC News, 2018).

*"People are punching and hitting each other."* (Osborne, 2018).

## Discussion and conclusion

Many tourist destinations both within Australia and abroad are susceptible to a range of natural hazard risks. For example, some 26 Australians lost their lives during the Asian tsunami in 2004.

Often, many of the elements that make locations aesthetically appealing to tourists are associated with natural hazard risk. For example, warm, shallow seas and sandy islands make idyllic tropical resort getaways, but these places are often at risk from severe weather, while scenic mountain vistas are often the product of tectonic activity which causes earthquakes and volcanism.

Tourists are uniquely vulnerable. Tourists may be unaware of risks present at their destination, lack local support networks and encounter cultural and communication barriers. Research has previously shown that tourists behave differently to locals. During evacuations they tend not to shelter with family and friends, but seek shelter at public evacuation centres, simply return home or find another hotel (Drabek, 1999). Observations from the Lombok disaster support such conclusions: in particular, that many tourists simply leave soon after a disaster and are reliant on locals for direction.

Many of those interviewed ran from buildings or observed others running from buildings. This behaviour is in conflict with actions encouraged by international and local authorities, which promote the actions of drop, cover and hold.

Counter to some research that suggests that people do not panic in the aftermath of disasters (Lorenz et al. 2018), observations from this event show that panic and chaos can occur. This suggests that in more extreme and less predictable events, panic and chaos is likely or that tourists are more likely to panic. Such questions require further exploration.

Promotion of disaster risk by travel agents and tourism operators conflicts with wider tourism promotion. The Australian Department of Foreign Affairs does provide some details about natural hazard risk on its Smartraveller website, although more needs to be done than passively informing travellers. There could be an opportunity to engage with the medical profession and travel health clinics to promote natural hazard risk and safety behaviours at the time travellers seek travel health advice.

Finally, tourists in Australia are not immune from the impacts of natural hazards, as illustrated by the impacts of Cyclone Debbie in the Whitsunday Region. It is important that tourism operators are engaged regarding disaster preparedness and connected with disaster management structures.

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