OFFICE OF THE PRIME MINISTER'S SCIENCE ADVISORY COMMITTEE

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The Christchurch earthquakes: facts and myths

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What we have all been reminded of so tragically and vividly over the past few months is that the physical landscape of this world is highly active and unstable. We live on the earth's crust which comprises floating plates which are slowly moving; this movement is generated by convection currents arising deep in the earth's core leading to immense energy build-ups where these plates rub up against each other and when eventually something has to give we get a cluster of earthquakes and their associated aftershocks.

Understanding probability, risk and hazards

Earthquake science has immense complexities; indeed it is a classic example of what I call complex rather than linear science. Linear science is can generate certainty; what is the speed of light, are birds the descendants of dinosaurs etc; but in climate change, in much of biology, and within earthquake science we are dealing with something very different. Precision as to any particular event or outcome cannot be achieved, what is likely to happen can only be described in terms of risk and probabilities. Science operates to try and reduce the level of uncertainty so that decisions can be made.

Let me give you a trivial example. When you take an antibiotic for an infection, you do not know for certain it will cure you, it may cause a side effect which has a known probability – rare but finite, it may not work as the bacterium may be resistant which has a certain probability and is influenced by other use of that antibiotic, or it may not work because of a wrong diagnosis – it is a viral infection not bacterial. The doctor and you are effectively considering risk and probability when the antibiotic is described. But just because we describe things in terms of risk and probability does not mean we do not have a clear view of what will happen over time; we know that the incidence of side effects can be described statistically – if we give it to enough people, a predictable proportion will get side effects although we cannot predict whom without additional information.

Every time you go in a car there is a risk of an accident. That is why we require low cost preventative measures such as seat belts and airbags and a warrant of fitness. But using the knowledge generated by science, we have judged the risk of an event to be at a certain level and do not over-engineer the cars and the roads to make every vehicle look like a Sherman tank, which would reduce the risk of injury further but a much greater cost. This is the balancing that all levels of governments do whenever they have to address an issue involving risk or hazard management for example when investing in road engineering, planning ambulance services or in biosecurity services at the border; they rely on estimates of

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probability and the likely impact to elucidate the level of investment to protect citizens, our infrastructure and environment. We need to think about earthquake science in the same light. Over time certain things will happen that we would rather did not. The question is at what frequency and with what severity.

Science does not create policy in resolving these matters but it is an essential element in the formation of appropriate policy options and in understanding the risk/investment relationship. The obligations on the scientist and the scientific advisor, in particular, is therefore to try and present concepts of complexity, risk and probability in a clear, unbiased and matter of fact way so that both the public and policy maker can reach their decisions amongst options which, in the case of earthquakes, is clearly about the level of risk and cost of hazard reduction.

There has been a massive scientific effort since the M7.1 and M6.3 earthquakes. The natural hazards platform led from GNS but involving other CRIs, Universities and the private sector has been of immense value in having many different expertises already aligned and working together prior to the earthquakes. The staff of the University of Canterbury, despite their own situation, has been particularly active. Over the past two weeks my office has been working intensely with the scientific community to ensure that some important understandings are communicated and they are available as a separate paper on this website. There are several points I want to make very clearly as the public needs absolute clarity.

Facts

1. New Zealand earthquake science is as good as it gets. We have a long well respected history, living in such a geologically active landscape. It is well connected to major offshore expertise such as the US Geological survey.

2. New Zealand earthquake engineering science is also world class and has led the world in many life-saving and building-saving innovations.

3. Earthquake science can identify likely regions that will be affected by fault rupture and predict the likely magnitude of the primary quake, but it cannot detail the precise locality of that quake on the fault or its timing; only the probability of whether one will occur.

4. As we have seen both in Christchurch and in Japan the degree of damage caused is not just a factor or magnitude (as reflected in the Richter scale), it depends on where and how deep the quake occurs and the nature of shaking, liquefaction and secondary events such as land-slides, rock-falls, fires and tsunamis.

5. After an earthquake there are general patterns to the cadence of aftershocks that seismologists understand and recognise. They know that they generally tail off in frequency and intensity over some months but the nature of the decline is erratic both in terms of timing and in the pattern of declining intensity. Note that we are dealing with a different type of earthquake fault in Christchurch to Japan: we are not dealing with a plate boundary rupture as occurred in Japan, rather movement on a slip fault. On the latter type of fault, the pattern of aftershocks tends to move and generally effectively radiates out from the initial fault as tension spreads to other parts of the crack or neighbouring cracks.

6. While there is considerable effort going in to understanding more about the Christchurch quake, enough is known now to inform policy makers in terms of risk and probabilities for

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planning for the future. Scientifically there is no reason not to rebuild Christchurch as a vibrant city. However soil degradation means that some sites may not be sensible or economic to rebuild on – the same was the case in the upmarket Marina area after the 1989 San Francisco quake. While aftershocks are distressing and as we have seen, in some situations themselves dangerous, the collective wisdom of the scientific community is reassuring in terms of how the pattern of aftershocks will most likely progress in Christchurch. Unfortunately our population will still get woken at night over coming months, the risk of major impacts is declining progressively.

7. While there was no surface evidence of faults prior to September quake in Canterbury due to the nature of the surface soil, Canterbury was well known to seismologists to have earthquakes, and to have risks of liquefaction. Indeed the cathedral spire has been toppled or damaged by earthquakes some four times prior to its most recent collapse (in 1881, 1888, 1901 and 1922).

8. Most importantly the science suggests that it is absolutely realistic to rebuild Christchurch with a high degree of assurance for its population. While more investigation will help with detailed planning the state of earthquake science and earthquake engineering science provides more than adequate solutions and Christchurch does not have an added risk over other parts of New Zealand because of what has happened.

Dealing with some unfounded concerns

1. Earthquakes are not increasing in frequency. There is an average M8 earthquake in the world about once per year, an average M7 earthquake in the world about every three weeks. In New Zealand we can expect about one average M7 earthquake every 3 years, two magnitude M6 quakes each year and one magnitude M5 every two weeks. Lesser magnitudes are essentially daily occurrences - just look at the GeoNet. Most of these earthquakes do not impact us because of where they occur. Good records over a century show no change in pattern.

2. There is no relationship between the Japan earthquake and the Christchurch series.

3. There is no added risk of a quake on March 20th or any other day. The pattern of declining aftershocks will continue. Inevitably there will almost certainly be aftershocks in Canterbury on that day as there will be today, tomorrow and will be on most days over the next few weeks.

4. There is no scientific controversy about what is going on. Like any complex science, there will be large areas of absolute agreement and academic discourse about detail as clearly we still have much more to learn about our active landscape.

5. The Canterbury series does not change the risk profile on other NZ faults and particularly on the Alpine fault.

Other matters are addressed in the information paper released today.

Finally I want to thank the science community for the enormous effort they have made since the quake. All the science community is united in their wish to help Christchurch through this most difficult of times.

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