Were there real precursors of the Christchurch Earthquake?

With some notes on Earthquake Light

[This report is for those who supplied information to the survey, and will form the basis of a scientific paper. But apologies to the technically minded if parts do not have enough detail. Please contact Neil Whitehead at the email below if there are questions.]

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Abstract

After the M7.1 Darfield earthquake, over 500 reports of events occurring beforehand but thought to be connected were collected. Statistical calculation showed that some real precursors were seen. There were more precursors the day before an earthquake, and within 56 kilometers. Statistical tests showed that pet disturbance minutes before the quake was highly significant, and there was quite good consistency of reaction before aftershocks. Statistical tests showed there were double the usual pets lost/found in Christchurch the week before the quake, and 5x the usual, the day before. There were 30% higher lost/found reports in Wellington for that week. A vet practice experienced about 10x the usual stress-related consultations in that week. Roughly 15% of people in a random dialing survey had possible precursor reports. In the same survey about 1 in 8 pet owners reported a significant reaction from their pet. Thus most pets do not react. Effects on pets were detectable for at least 200km. The type of report is very similar to those reported cross-culturally in Turkey, Japan and elsewhere. The most useful precursor was from the dogs who went berserk a few minutes before the quake, and after being let out, their owners were actually standing in or near a doorway when the quake occurred. Earthquake lights were reported coinciding with the quake, mostly blue/white/green. Some of these were probably electrical arcing but some were definitely from the ground, and the best explanation is intense very low frequency electromagnetic radiation.

Introduction

On the 4th of September 2010 at 4:35:46 am there was a M7.1 earthquake near Darfield, Canterbury, New Zealand. It caused billions of dollars of damage, mostly in Christchurch, but amazingly no lives were lost. This is a record for low fatalities since 1900, for a city of its size, and for an earthquake of M7 or above. Second, but with a much smaller population exposed was the zero fatalities in Fairbanks, Alaska in the 1947 M7.2 earthquake when the population was in the vicinity of 10,000. Third would be the zero fatalities also in Fairbanks for the 1904 M7.3 earthquake when the population was probably about 2,000. This is then a considerable tribute to the improving building codes in New Zealand over the years.

The 1995 Kobe Earthquake (Japan) in contrast was M7.3 (exposed population a few million) caused 6 thousand deaths. Please note it was twice as powerful as the Christchurch quake, because a difference of M0.2 represents about a doubling in earthquake power.

Is it possible to predict earthquakes? In spite of sporadic successes the answer in general is “no”. The most spectacular success was HaiCheng, China 1975. Researchers used several converging lines of evidence to persuade authorities to evacuate the entire city of 1 million people. Next day a disastrous earthquake struck which would have killed tens of thousands. However the same techniques next year in the city of TangShan led to evacuation and no earthquake in the predicted time period. The Chinese claimed some more successes towards the end of the ‘90s. A recent account of their methods which use infrasound, recorded movements of budgies, and crustal strain measurements is given in (Li, Xia, Chen, & Liu, 2008). They admit only medium reliability, which probably means about 70%.

The techniques used in China and elsewhere have included observing animal behaviour, other signs in the biosphere, foreshocks, changes in radon (a natural radioactive gas), changes in water levels, and geophysical tools, such as observing earthquake patterns. However even with all indicators combined there was still a significant failure rate in the predictions.

Possible precursors were summarized in a number of books (Tributsch, 1984), (Rikitake, 2001). The Kobe earthquake resulted in a number of unusual electronic precursors being reported. This led several researchers to speculate about the possible role of electromagnetic radiation from the ground.

This led Professor Ikeya of Osaka University, a geophysicist, to embark on a programme of interdisciplinary research with many students, , and several research colleagues including the authors of this report during the late ‘90s and to about 2005. In general he managed to explain many phenomena before and during earthquakes by invoking electromagnetic radiation produced by piezoelectric effects on minute quartz grains in rock. This was particularly true of his animal research in which he showed the sensitivity of many animals to very low frequency electromagnetic waves. He argued the latter was the common explanation of many observed phenomena rather than subsonic (infrasound) waves. However subsonics cannot be completely ruled out by his work. He showed production of these waves in experiments in which very large presses crushed rock specimens. These very low frequency waves penetrate large thicknesses of rock and can exert their effects on the surface. Subsonics were also generated by rock crushing in experiments done by others independently.

The most sensitive animal was the Japanese catfish, which uses detection of disturbance in electric fields as a signal that its prey is near. Eels were also very sensitive. Professor Ikeya set up a network of aquaria containing catfish in science classes in schools and used cheap CCTV monitors to detect unusual motion in these normally quiescent animals. 20 hours before the Geiyo (Japan) earthquake M6.7 (2001) he detected very

unusual movement, but a year later made another prediction based on the catfish, which was not fulfilled.

A thorough review of the field was published in his book. (Ikeya, 2004).

The above authors (Whitehead, Ulusoy, Asahara, & Ikeya, 2004) also managed to show for the first time that some of the alleged precursors reported by the public were real. (Wadatsumi, 1995) had collected about 1500 of these reports. But of course following the human tendency to see patterns where there are none, many of these were not valid. But could it be possible to distinguish whether some were true? A similar collection from the Izmit earthquake was also assembled. Whitehead and Ulusoy divided the data into classes: 1. Precursors in the ground/water 2. Precursors in the sky/air 3. Animal behaviour changes, 4. Electronic glitches 5. Other precursors. There were quite clear predictions in the literature about these precursors, and they were supposed to be particularly numerous 1 day before the earthquake and 7-10 days before. They were supposed to be much more frequent within 100km.

Of course the difficulty was that it was very likely that members of the public would imagine patterns the nearer they were to the epicenter, and imagine patterns occurring the closer they were in time to the quake.

The authors therefore used the ratio of reports in the various categories as an indicator. The assumption was that any reports mistakenly reported would be generated in about the same ratio a few days before, as the day before, and about the same ratio inside and outside 100km. Any departures from this might indicate some genuine precursors had been reported.

The results (Whitehead et al., 2004; Ulusoy & Ikeya, 2008) essentially confirmed the predictions, though a distance of 80 km as a dividing point was better. Thus in the present study the day before and 7-10 days before were hypotheses to be tested if possible.

Research continues with physical equipment for detecting low voltage changes (e.g. (Ustundag, 2008). This is not easy because much machinery produces these waves. But ultimately it should be more reliable than animal behaviour measurements.

The Christchurch earthquake was an opportunity to test some of the ideas again, under somewhat better conditions that those of Wadatsumi. A website was set up, and a survey using the SurveyMonkey technique, which does most of the hard work. It should be mentioned that designing good questions is about as hard as writing a competent Japanese haiku, though in English! The usual recommendation, to pre-test the interview, was impossible under the time pressures involved.

The New Zealand Close-up Current Affairs programme agreed to give an interview, (16th September) and in it N.E.Whitehead mentioned the 5 categories, Ground/water, Air/sky/clouds, Animal (biota) behaviour, Electronic, Other (Sundry) and asked people to

visit the website and take part in the survey. These were chosen based on the experience at Kobe and Izmit..

A followup interview with Newstalk ZB on the same day in response to a question encountered people who seemed to have seen "earthquake light" fairly well known to specialists. This was the same time as the quake, but people used the survey format anyhow to report occurrences, and some emailed independently. There was also an article in the Christchurch Press on 2nd October asking for participation.

Over this period there were about 540 responses and over 400 usable items of data to 10th October. Most came from the TV programme. The survey allowed supplying up to three precursors and asked for the category, time, duration, distance (with distances pre-supplied in the survey for major towns), location of observation and event description. Following good survey practice, no mention was made of the distance and specific time hypotheses to be tested, and categories were kept as general as possible.
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A further 34 people were interviewed by random digit dialing, to see whether there were markedly different responses from the survey, and to find an estimate of how often precursor events would be reported. This was out of 118 valid numbers initially dialed, the remainder being faxes, answer phones, some businesses, refusals to take part, engaged signals and no reply. There was a spread across the five categories, not obviously different from the response in the large survey.

The responses which came in after the Christchurch Press article had statistically the same interclass ratios as for the broadcast media response. This showed that there was not a survey bias depending on the type of media.

For the month before the quake Wellington and Christchurch newspapers (Dominion Post and The Press respectively) were surveyed for lost/found animals, and RSPCA files online similarly, which gave Auckland data as well. The aim here was to see whether there were excess strayed animals before the quake, which had been claimed for California. Some local vets were surveyed to see whether there were excess consultations the week before the quake, particularly stress-related. Orama Wildlife Park, Southern Encounter Aquarium and Willowbank were also contacted to check for unusual animal behaviour.

Results

From the telephone survey, 5/34 people reported precursor events evenly divided between the various categories, and not obviously different from the web survey responses, though the sample was very small. This represents about a 15% alleged precursor rate, so people readily make connections of events with a later disastrous event like an earthquake. For animal precursors 1 report out of 8 reported pets reactions to the quake, and another reported subsequent reaction well before aftershocks. This makes such precursors probably moderately common, though the majority of pets will not exhibit them and it's important to say that most pets are not useful to look for precursors.

The result is similar to the Kobe result of 25-33% of pets showing unusual behaviour before the quake.

Of usable replies to the survey, for the statistical tests there were 33 for ground/water, 41 air/sky/clouds, 209 for animals, 24 for electronic and 65 for sundry or "other". Approximate percentages were 9, 11, 56, 6, 18% respectively. Thus rather more than half concerned animals, mainly cats and dogs.

Some respondents, as is common in surveys, volunteered events not directly asked for, in this case occurring during the quake as well. This however gave some useful reports of earthquake lights, or lightning, and these will be reported here.

The typical animal precursor would read something like this: I was woken 5 minutes before the quake by the extreme behaviour of my pet. It has never behaved like this in all the time I have owned it.

A typical ground precursor was a unique noise, particularly various bangs, often from several days before the quake.

A typical sky precursor was strange cloud formations, but also considerable remarking on the "earthquake weather" very still warm weather. These reports did not have the uniqueness of some of the previous signs.

The most typical electronic precursor was TV interference, unusual and sometimes unique.

The most common reported "other" precursor was a feeling of pressure, sometimes manifested as headache (also felt before aftershocks), and a significant number of people felt a very deep vibration for many days before the quake which eased off afterwards.

Discussion

Since this was an internet survey, there were very few responses by letter or phone. This itself could tend to bias the results to the younger people and the computer literate.

In the citations from respondents in this section please be lenient. Replies done in haste still contain various errors even after light editing for obvious errors, However this should not lead to dismissing what they say. Representative responses only are cited, and there are many others at least as interesting. Some interesting texts are not cited because internal details would have allowed identification of respondents.

New Zealand has probably been inhabited by significant numbers of people for only about 600 years, making it the most recently inhabited land in the world for its size. There has been very limited time for a culture to grow up with a long tradition of

precursors to earthquakes, unlike Japan or Iran. However many respondents expressed the New Zealand tradition of "earthquake weather", particularly still and warm weather. This is generally held by scientists to be more folklore than established by stringent criteria. It also seemed to be general knowledge among farmers that farm animals tended to react before earthquakes. This was specially said about the pheasant, and in this case the tradition is international and cross-cultural being known from many places, and in the case of Iran even testified to in an 11th century manuscript. There were hints from the respondents that several suspected stranding of whales was associated with succeeding earthquakes, and perhaps this is a developing tradition, though there is no known statistical association between the two.

The following data are given in summary form only. The full statistical arguments and technical detail will be given in the eventual academic publication. Those who want that detail, can consult the final publication which will also be sent to those on the mailing list. However this may well be a year away, and email addresses change. If you want that final paper and are aware your email is changing please contact the first author to give a new email address.

Lost/Found animals

Data were available for Auckland, Christchurch and Wellington. Auckland data were used as a kind of control. The week before the quake was compared with earlier weeks. The results for both Wellington and Christchurch reached statistical significance ($p=0.05$, using a Chi-squared test) and inspection showed the number reported for Christchurch was double the preceding 4 weeks figures, and 30% higher for Wellington. However there were 13 pets reported missing in Christchurch for the Friday, the day before the quake, which was 5x higher than the mean. The only other day with 13 was 7 days before the quake on the 27th August. This last report gives some limited support to the hypothesis which asserts there are excess precursors 7-10 days before a quake. It is hard to explain why this might be.

This present study therefore presents positive findings contrary to an earlier study in the US which could find no statistical association between animal losses (newspaper ads) and some Californian seismic activity. However that negative study used aftershock records, and the present study uses the quake only.

It suggests there were effects of the quake on animals even in Wellington, and that the distance for effects to halve could be about 250 km but in view of the small numbers of reports involved, this result could well have an error of +-100 km.

Vet records

It was reported prior to the Kobe quake that the week before the quake a vet recorded 3x the usual number of pet consultations. Trying to test this by ringing 6 veterinary clinics in Christchurch gave no discernable reported increase for the week prior to the quake. Nor was unusual animal/fish/eel behaviour reported from Orana Wildlife Park, the Southern

Encounter Aquarium, or Willowbank. Nothing was reported for eels, supposed to be unusually sensitive to impending earthquakes. Nor for eels in holding tanks near lake Ellesmere. However from one suburb a spectacularly different result was reported. Consultations for stress in pets was 10x the usual for the week. This suburb was unusually wealthy and it may be that only inhabitants there could afford the consultations for these less-urgent symptoms.

Bee experiences

It is common for bee-keepers in New Zealand to believe bees are more aggressive before quakes and liable to sting much more. Nothing like this was reported to the association of bee-keepers in the Canterbury region.

Farm animals
(Here and subsequently, citations are inset, and the place is given if it is different from Christchurch)

> [3-4pm 3rd September, the Friday the day before the quake:]Animals. 40 sheep in a round cluster beside a tree. After 10 minutes I noticed the sheep still in a circle but they had been moved further over and 35 cattle were now in a close circle around the tree, they were not moving as if waiting for a storm coming. It was strange seeing both types of animals close by each other just silent.

There were several reports of horses extremely agitated before the quake.

> I have 5 horses on my property. All, except one, were fine the evening before the earthquake. This gelding was completely bonkers at dinnertime - he galloped round and round the field bucking and was completely mad. Now I know horses can do this from time to time but it was completely out of character for this guy. He loves his tucker and NEVER runs around like an idiot at dinnertime. I thought it was very strange at the time.

This reinforces the finding that this type of behaviour is a minority reaction in animals

> [Wednesday and Thursday before:] I noticed our pet kune kune pig Lucy Jayne was going crazy running around the paddock and screaming out - very out of character and strange for her. I thought it was because our pet goat had died on the Tuesday and she could smell him or the fact the cows next door had been annoying her but I just kept giving her tit bits to eat and talking to her to try to calm her

> down. After the earthquake I said to my husband I am sure Lucy Jayne sensed or felt something under the ground. She's pretty heavy!!
>
> [Ashburton, Friday afternoon:]every paddock of sheep I drove past had the animals running to or already congregated in the corner of the paddock furtherest from Darfield direction ------ was very odd and drew my attention to it at the time

In this case the sheep tend to react as a flock rather than the unusual individual reacting.

> My six donkeys started braying in the early hours of the morning, don't do that unless something is wrong, prowler etc

Laboratory animals

It had been reported for the Kobe quake that lab animals (mice) whose behaviour was automatically and continuously recorded showed very unusual behaviour a day before the quake. However it was not possible to locate such a colony in Christchurch. The Canterbury University Psychology Department at Ilam, does not monitor its animals in such a way.

Were reported animal precursors real?

There is a difficulty about animal precursors. Owners may report a pet barking at an unusual time, but pets do sometimes bark for no obvious reason. How can one tell whether animal behaviour is really different from normal?

One reasonable criterion may be if the behaviour has never been observed before for that animal. There were many reports in that category.

A statistical test is possible for some of the reports of behaviour immediately prior to the quake. The very first sign to reach people was the primary wave (p-wave), which manifested itself as a remarkable rumble. It was followed several seconds later by the s- or secondary-wave, which produced the shaking. The reports were prior to either of these, by at least several seconds, and more usually several minutes. They cannot be actual reaction to the earthquake vibrations themselves because they are much too early.

Typically owners who reported, were woken from sleep by cat or dog behaviour in the hour preceding the quake, most often in the 0-10 minutes before the quake. There were no less than 57 reports in this hour-class, as compared with 11 spread over the preceeding 12 hours. This latter segment has a mean and standard deviation of 1.4+-0.8 wakeups or equivalent per hour, compared with the extraordinary 57 per hour which is

highly statistically significant. For some reason this final hour before the quake is totally different from all the others, but if it is merely an artifact there seems no reason why an person should consider that last hour as radically different and more likely to contain a precursor than wakeups in the previous 5 hours. There ought to be a more gradual drop-off. This strongly suggests that there is a real phenomenon being reported here.

Amongst the reported data were 16 stories of owners being pawed awake (mostly by cats) and usually on the face, a few minutes prior to the quake. This was usually said to be unique behaviour for the animal, and is hence rather convincing. Many of the remaining 40 reports were of owners woken by extreme barking and the dog wanting out of the house. Both these are usually "look at me" or "please do something" behaviours. For the dogs in 7 cases the owner let the dog out, but was standing in or very near the door when the earthquake occurred. They were inadvertently led to the (probably) safest part of the house, and thus the dog was being an accidental rescuer!

In Kobe similarly dogs particularly tried to make owners go outside with them. Cats similarly bit owners to gain attention.

For dogs and cats in towns, where there were a reasonable number of reports of precursors, the number per 10,000 inhabitants was plotted against the distance from the epicentre. An exponential decrease was seen, in other words the reports per person drop rapidly with distance. This could be due to people unconsciously thinking that events were less likely at larger distances; a depiction of a psychological fact rather than a physical fact. However the distance for the reports to drop to half was 200 km which is consistent with the estimate from the lost pets. It may reflect a falloff of intensity of effect, not just a psychological effect. This would mean that that effects would halve in 200 km, halve again in another 200 km and so on. This suggests effects could be felt by animals over much of New Zealand.

> I read the article on page A10 in today's Press about animal behaviour just before an earthquake. Having learned that animals may display strange behaviour perhaps days before an earthquake I have been prompted to pass on to you the story of Shihad, our son's Staffordshire Bull Terrier bitch. She is a very good friend of our daughter's Miniature Schnauzer, Toby. On Friday 3rd September Shihad escaped from her place ….. in Hornby and an hour or two later she turned up at our daughter's house …. on the far side of Hornby. Shihad's journey would have required her to cross the Main South Road, the Main Trunk railway line and Carmen Road at a very busy time of day. On arriving at Toby's house, Shihad somehow leapt over a six foot fence and then tried to break through a cat door (unsuccessfully) to be with Toby. Shihad has only travelled between the two homes by car and has never walked the route, so it is a mystery to us how she found her way there. Since the 4th

September earthquake we have wondered whether Shihad sensed that an earthquake was imminent and wanted to be with her friend.

Interclass test of precursors

In the previous paper, (Whitehead et al., 2004) there was a new statistical technique used to see if reported precursors were valid. The assumption was that if patterns were seen where there were none, associations where they did not exist, then the ratios of numbers of reports between the classes: ground, air, animal, electronic and "other" should remain constant, depending on psychology rather than actual earthquake precursors. There should be no difference between the ratios for the day before the Kobe earthquake with ratios from earlier time. Similarly ratios should not alter very much with distance. Hence ratios from inside 100 km should not differ much from those outside 100 km. However if there were real precursors, whose effects changed with distance, then the ratios would change. Similarly if there were real precursors close to the quake time, then the ratios would differ from those further away.

The previous work showed that there was a difference between the day before the quake and other days. It showed that there was also a weaker difference between 7-10 days and other times. It showed that there was a difference between reports within about 80 km and reports from outside that. However it was also possible to show that about half the precursors reported were mistaken.

The same tests (using a chisquared test) were applied to the Christchurch data. It seemed that the best test would be to compare the day before the earthquake with the day before that. In the event it was necessary to use the preceeding 3 days of data to compare with the day before to obtain an adequate number of responses. The result was a highly statistically significant difference, only partly due to excess animal reports nearer the quake, precursors being also enhanced in most other categories except "other". Thus there is further support for the hypothesis that the day before the quake contains excess precursors.

A test of the importance of distance was much less convincing. A distance of 80 km was found important for the Kobe and Izmit data. The critical distance for the Christchurch quake would be less and a good estimate might be based on an energy expended of about half the Kobe quake which would suggest a prediction of 63 km. A test gave only marginal statistical significance ($p=0.08$), but the next change in significance occurred with a distance of 56 km ($p=0.029$) and then increased again, so both larger and lesser distances were less significant. There is something about the contrast between distances inside and outside 56 km which is quite significant. 56km happens to be almost the distance of Christchurch from Ashburton.

Birds

A universal observation was birds outside making a tremendous fuss for tens of minutes before the quake but dead silent for ten minutes immediately before. This has been reported from overseas, with the added ominous point that the lone bird left calling is the pheasant, when present.

As in the case of dogs and cats, birds in cages inside went wild a few minutes before the quake.

> [Timaru:]I awoke at 0400 and couldn't get back to sleep so I got up at 0420 and made a coffee and was watching BBC World News.Our daughter's budgie started fluttering her wings in her cage a full 1 minute 30 seconds before the quake struck which at the time I thought to my self "why is she doing that, she's never ever done that before," next minute the quake struck, I got my partner up and we went straight to our daughter's room grabbed her straight out of bed and stood in the door way of her bedroom as the quake continued violently for a minute,,

As in the case of the cats and birds missing the week before the quake, birds seem to have migrated away. This was seen in the Maruia 1929 earthquake. A flock of geese in the Glenhope region increasingly grew restless and did preliminary flights for many days before departing completely before the earthquake in the direction of the Wairau Valley. They had never done these flights before.

Some of the following accounts are from far afield, but may reflect unusual movement of birds.

> Pukeko's are missing out of the paddocks around the Belfast freezing works site and have been since [Friday 3rd 1300h] …. up till 0900hrs today when I drove down Blakes Road Belfast, also the lack of seagulls around the area since Friday …

[Marlborough:]

> Looking out to admire the sunset, when we noticed a large flock of small birds (100+) flying in a south-easterly direction towards Seddon and the coast. These were followed closely by more flocks, varying from approx 30 to 100, then birds in nearby trees joined and followed them. At the end there appeared to be two Canadian geese, which dived twice to the nearby river, then joined the flocks of small birds. There seemed to be an endless procession passing the beautiful sunset. We have seen birds migrating before - but never in such numbers or at this time of year.

[Wanaka:]

We saw a huge number of birds flying South East - we noticed them because it was a flock much larger than anything I've seen before, maybe hundreds of thousands. Not sure what type, perhaps starlings. It was an enormous black cloud of birds and they looked like they were going somewhere (not just circling/playing)

[Christchurch:]

Starlings which normally fly at building - tree height were flying very high late on the Friday afternoon/early evening.

I know this is after the event but driving to school today and going past Travis Wetlands I thought ,yes I remember seeing huge flocks of birds on the Friday afternoon coming home from school. I had never seen so many birds together but thought well it's Spring and maybe migratory birds, but they probably weren't.

[Addington:]

After the first large shake, me and my partner proceeded to go outside and stand in our back lawn as we felt safer there. I noticed a large grouping of birds in our Totara tree. I couldn't tell what type of birds. There are usually birds in this tree but at a guess I would say there were around 60-100 birds. The birds all of a sudden began to spiral upwards from the tree and began to fly around in a anti-clockwise direction. I was quite hypnotised by them and watched them for about 15sec, then a large aftershock hit. I only just remembered this yesterday and was thinking about how the birds maybe felt the vibrations way before I could.

[Friday afternoon:]

I was walking up Rapaki Track (city side of the hills). When I came up to the saddle I noticed a number of birds (100 or so) that I have not seen up on the hills before, but have seen in the city on a daily basis. The birds were in tussock grass alongside the track. As I drew near they took flight. As I kept walking more and more birds (all of the same variety) took flight. Most had been concealed by the grass. By the time they had all taken flight I realised there must have been hundreds upon hundreds of them. I have walked this track regularly over the previous 20 months, usually 3 times per week. I had never seen any of this type of bird up on the hill before. I thought it very unusual. The

birds were brown in colouring and looked similar to the common blackbird. The time was approximately 4.00pm (about 12 1/2 hours prior to the earthquake).

[Dunedin:]

We feed hundreds of birds bread and sugar water from 1 June every year. No birds came to eat or drink on the morning of 3 September which was very unusual. I remember commenting that there must be enough natural food around and that we should stop feeding. On the Saturday morning they were back in full force for breakfast.

My daughter regularly checks her chooks at night, to see if they are all inside the coop. On Thursday evening she checked them at about 20:30 and came back inside the house and reported that the chickens were restless, standing up, ruffling their feathers and making clucking noises. This was the first time ever, as far as we know, that they were not asleep around that time. She did not check the chickens on the Friday night.

The Day before I noticed a duck sitting on the ridge line of a slate roof of my two story house. It seemed very weird to me as duck have webbed feet and I thought it was a very unusual place for a duck to sit. I have photographed it on my phone as I thought it that strange

As my observations are from years back, they don't fit your survey but may interest you anyway.

I grew up in the fairly quakey Bay of Plenty, born 1951, living there until leaving school. We lived on a dairy farm on which no bird shooting was allowed, at about 900feet above sea level. I roamed around very freely and came to recognise that just before a tremor there would be a complete eerie silence pierced only by the call of a solitary pheasant. The call was always a single hoot, not the repetitive call they usually give.

I had forgotten all about this having lived overseas and in Northland for about 20 years, but was reminded about 18 months or so back, (I'm guessing how long ago) when out on my lifestyle property at Motukara, near Chch. It was

> early morning, the birds in our eucalyptus trees were singing their heads off, and suddenly there was total silence and the solitary hoot again, followed by a gentle quake. It took me straight back to my childhood.
>
> During this Sept 4 quake we got under the table for a couple of hours of constant aftershocks, and I commented to my partner when the birds began to sing (no dawn chorus) that maybe the worst was over. Days later I was disturbed one night that there were seabirds on the wing and screeching in the dark at about 9-10pm, plus a lone pheasant call again (we are close to Lake Ellesmere) and later that night (birds silent by then) we had a series of very big aftershocks (night of Thurs 16 I think.)

> Our pet rabbit thumped his foot loudly on the wooden base of his cage for 90 minutes late on the evening before the earthquake. He thumped his foot fast at first then slowed down to a thump a minute for an hour then further apart for the last 30 minutes. This is unusual as there was no other danger around him at the time, and he hasn't thumped his foot in over 6 months since he was much smaller. Our pet cat was sleeping beside his cage as he does every night which never bothers the rabbit.

The percentage of pet reports in the Christchurch quake was 2.5x that in the Kobe quake. It's not clear why, because the percentage of people with dogs (12%) is about the same in each country. There were similar dog reactions reported from Izmit.

Aftershock reactions.

Precursors would be most convincing if they occurred not just before the main shock but before aftershocks as well, though the energy in aftershocks has been only about 0.1% of the initial energy. The only type of precursor in which this was reported, was for pets. 7 owners reported pets which persistently reacted before aftershocks as well as before the main shock. In two cases this was seconds before, but mostly it was about 1 minute before, and in a few cases 3, 5 or 10 minutes.

There were three estimates of accuracy "most cases", 80% and 90%.

> Over the whole time since the main quake I have noticed the cat is checking for me before an aftershock and if it is at night she will come and lay beside me in bed. Within 10 or so mins an aftershock happens and that has happened 80%

> of the time. If it is a mild one or nothing that night the cat is away outside

To make this even more convincing, one case involved repeated unusual action:

> Before the large after shocks our dog seemed to know before they happened. She would tap us until we wake up if we were asleep, or she comes right up to us when we're awake before a large aftershock.

Similarities to reports from Izmit and Kobe &c..

There were some quite remarkable similarities to earlier surveys. One strong similarity was people who thought the stars were unusually clear, and "close". One of the authors of the present report had tended to dismiss completely the earlier reports. The stars cannot be literally closer of course, but create that impression somehow in viewers; however the identical language of "closeness" was used even cross-culturally for the earlier surveys.

Before the overseas quakes there were some reports that the moon appeared elongated in the sky. This is so difficult to account for, that there is a tendency to dismiss such a report (even though it was supported by a photograph). However a crescent moon with a similar elongated appearance was reported by one respondent from Christchurch. One proposal to explain this involves formation of a lens effect in the atmosphere under the influence of strong electrostatic fields as described by (Ikeya, 2004), but this requires much more work and research for clarification.

One couple near the mouth of the Waimakariri reported that the river appeared to be at least briefly flowing backwards. This mirrors a report given in Ikeya (2004) for a Japanese earthquake on the Seta River, Kozak's woodcut of the Cumi river flow reversal, (Kozak, 2005) the 1812 New Madrid earthquake in which the direction of the Mississippi briefly reversed (Anonymous, 2010)and there is even a video of the reversal phenomenon from Sichuan associated with an earthquake (ssfounder, 2010). However the tilt required would be high, and although this is also mirrored by a report near Oamaru about unprecedentedly low tide, more research is required, because wind and tides may also create this impression without tilt.

Air/Sky/Clouds

> Was about 430pm, [Friday] we have an ocean view facing NE; looked out and saw two bizarre fan like rainbow clouds; they started at the water and were side by side; taken pictures..never seen anything like it, they may have lasted 1/2 hour or less [one week before quake]

There were many reports of unusual clouds. However everyone saw something different, and it is difficult to give a uniform standard for comparison of cloud formations which

are never associated with quakes. This has been so popular as a possible precursor that there exist associations in Japan to study this but it is not a popular idea amongst scientists because it is difficult to quantify and make objective.

> I was in the Christchurch quake and noticed another phenemenon. Has anyone else heard of a cold wind just prior to the sound of the quake? [many reports of this] We were staying about 6-8 kilometres from Kaiapoi and have one account of a very cold wind then the sound of the quake that followed straight afterward. I have read one more account of a wind just before the quake. What makes this interesting is that there was absolutely no wind that night at all.

Comparison with 1929 Survey

Perrine Moncrieff (Moncrieff, 1930) gave descriptions of the effects of the Maruia (Murchison) earthquake in 1929 following a public newspaper appeal for precursors. She described desertion of houses by mice before the quake (they returned afterwards) one respondent to this 2010 survey also reported this was a precursor in Christchurch. Moncrieff also described a pheasant unusually calling for 20 minutes before the quake (two similar reports in the present survey, though one is very far distant from Christchurch), and a strange clustering of cows for a similar time, also echoed in the present survey from a few respondents. (see section on farm animals)

Hydrological precursors

The Synlait plant near the Rakaia has a 100m deep bore in which the water level is monitored. At 4 am before the quake it showed an increase of 4 m, but there was at the same time some increase anyhow due to winter recharge. Environment Canterbury did not find precursory changes in the bores which they monitor, but at Chertsey a bore requiring pumping under normal conditions produced positively pressured water after the quake. Changes in water levels etc, are very well known both before and after earthquakes.

Three respondents reported unusual silt in usually clear streams before the quake, including in Hagley Park. In a fourth report, one American being punted on the Avon the day before the quake, saw silt and said an earthquake was on its way, but the person punting the American said they never had earthquakes in Christchurch…

Noise Precursors

These were sometimes described as creaking, or sometimes like explosions in the ground, once like a bubble bursting. They were some days before the quake and typical of what is heard overseas.

Electronic precursors

No computer repairers reported excess submitted for repair the week before the quake. No alarm company contacted had experienced undue possibly precursory glitches (though with the cut of electric power there were thousands of alarms triggered during the quake). One company is reported second hand to have experienced excess alarms.

There were 6 reports of TV problems the night before the quake.

> [Friday 4:30-9pm]Television -Full high definition . TV 1 - Picture froze. Tried other channels. The words "No Service" came up. One time it got stuck on a picture of a religious ad of Jesus with no words on it. I said look God is looking at us, after 1 minute we switched it off because it was starting to freak us out, the image stayed with us, just felt like something was different. We are not religious so it was strange.

> The TV lost its signal several times, maybe 6 or 7 times, from 11am ish to 11:30pm ish when we went to bed. It kept displaying "no service" and could only be resolved by turning the TV off and on again. This was the first time this sort of thing had happened and we thought it was weird as the TV is only a couple of months old. Thought maybe it was faulty, but it hasn't happened again since the quake.

> [Friday 1745h]Interference with the digital television signal. The picture pixellated (if that is right word) intermittently but more annoying was sound-picture mismatch to a huge degree whereby at one stage the sound was actors talking (Friends) and the last credits were rolling on the picture. I changed to analogue because it was so out of kilter and could not watch it.

> Immediately after the earthquake I discovered that not only had my watch stopped at 3.17am but so had my clock radio i.e. well before the quake struck. Both were on the bedside table

This is rather persuasively a real precursor.
4 people reported much static electricity in the week before the quake

> Electric shocks (static electricity) before main (week before and almost constant). Also similar before aftershock

> .And one more interesting phenemenon is the electrical current or static electricity prior to the quake. I had a wrap around blanket which I took off just before jumping into bed at around 11.30-12 midnight and the crackling and static electricity coming off that little blanket was very loud and extreme compared to normal. Yes we are starting to understand and predict quakes of this magnitude and it would be great to measure the static electricity to see if there is an unusual hike in current which in this case was about 4-5 hrs prior to the christchurch quake.

One report from a bookstore; static was such that customers' hairdos became bouffant and stickers persistently detached from books

These could accompany the fine settled weather and one wonders if the static electricity excess was a cause of some various electronic glitches reported.

> Our clock went into reverse on Tues 31 Aug, ran normally for a few hours on Wed. 1st Sept & stopped completely either late pm on 1st or early am 2nd. Earthquake happened @ 4.35 Sat 4th Sept.

This was not a visible backwards movement in the figures of this digital clock but erratic backward jumps. A visible backward movement in the second-hand of a quartz clock before the Kobe quake as shown by Prof. Ikeya could have been caused by static electrical interaction with the integrated circuits involved.

The best common explanation for these is static electricity fluctuations rather than subsonics or other causes. The supposed very low frequency electromagnetic waves could have been involved.

Human responses

In the "other" category there were many respondents who reported various experiences they thought were connected to the later earthquake. These ranged from those usually classified as "psychic" to physiological symptoms. These types of experiences are usually reported in this type of retrospective survey. The most convincing are those which led to respondents taking unusual action in the day before the quake:

> I was hunting in mountains for deer, all set to stay the night and keep hunting on Saturday. After dark I had a real fear that my family was in danger, packed up my gear walked out in the dark, drove back to Christchurch stopping to have a quick snooze on the way, all the time thinking this is

> crazy, I have been planning this hunting trip for weeks, got home went to bed (wife very surprised to see me back two days early) couple hours later earthquake!
>
> Just after 12am on Saturday 4th September I was just starting to go to sleep when I heard glass breaking. It sounded like window glass being smashed... many windows. It was very loud and I lay in my bed terrified. I felt so scared I froze for a good few minutes. After it stopped I got the courage to get out of bed but couldn't see anything by peeping through the curtains. I was too scared to go outside. I waited for the sound of sirens as the noise was very loud and seemed to go on for a long time and I couldn't believe I was the only person to hear it. But no sirens came. I finally went back to bed and drifted in and out of sleep until I was shaken awake by the big earthquake. My flatmate and I both came running into the hall when the earthquake struck then went and sat in the lounge to calm down when it stopped. I asked him if he heard the breaking glass last night - it was so loud - but he didn't hear a thing. Later that morning we went to check on our neighbours but no one had had their windows broken. My flatmate believes I had a premonition about the earthquake coming and the damage it would do. I am very sensitive and have "known" things before they've happened before... but nothing as huge as this. I still feel scared when I think about it, it actually scared me more than the earthquake!
>
> [The day before the quake:]
>
> This is an account my daughter gave me, she works with severe dementia patients at Princess Margaret hospital, all day they were very upset, out of the ordinary upset, I think 4 had to be put in secure rooms, a number had to be placed in chairs that they couldn't get out of, the Dr there said it was the worst day he had had in all his time working there.

A similar story was reported by a respondent for the Lake Alice mental hospital before a historic earthquake

Some people say they can feel continuous very deep vibration in many locations, and this was connected by them with the earthquake

> I have been hearing deep pulsing/buzzing noise when it is quiet at night. (A bit like a helicopter or airplane a long,

> long way away.) It is so deep I can almost feel rather than hear it. I have turned everything electrical off in the house and could still hear it. The rest of my family can't hear it. When I go outside I can't hear it. It stops and starts and often wakes me up in the night suddenly. I thought it was tinnitus so had my hearing checked by an audiologist who said my hearing is very good and that maybe I could hear things other people can't hear. A week or so ago I was talking to my neighbour and mentioned the noise and she said she has been hearing it too, and so has several of her women friends, and their families also think they are imagining it. Since the earthquake it has almost stopped although I do hear it still sometimes. I wonder if it is something to do with the earthquake although it was over several months rather than just before it.

3 respondents reported intense feelings of itchiness before the earthquake, but had not connected this to the earthquake until they had heard it mentioned on TV in connection with animals.

There is little research on these areas, but the conclusion might be that whatever is disturbing animals may be disturbing some humans in various ways too.

A very interesting response came from a NZ Army man who has seen service in Iraq, and remarked he usually woke significantly before both the quake and aftershocks, which perhaps mirrored his training to be hyper-alert to threat.

What could be disturbing animals before a quake?

Candidates could be, subsonics (infrasonics) or very low frequency electromagnetic (EM) waves. Both these travel very long distances indeed. Magnetic fields also could penetrate the kilometers of rock, but would have seriously disturbed the power grid, and loggers (electronic recorders) show that did not happen until the quake. Both infrasonics and the EM waves are generated before and during rock crushing. Both are known from laboratory experiments to affect animals (though the hearing range of humans and animals is not very different). The subsonics might account for the feeling of pressure experienced by many residents. The subsonics are not known to affect electronic appliances. (consider for example, a rock concert!), but the EM waves do. In their earthquake prediction research the Chinese prefer to investigate infrasonics but the Japanese and Turks have concentrated more on the EM waves. Both might be involved.

How feasible would earthquake prediction be based on people's experiences in Christchurch?

The answer is "not very".

The most convincing and specific precursors were only a few minutes before the quake. There is some value in these, even lifesaving value. The 7 reports of owners responding to their pets by being very near or in a doorway at the time of the quake, shows that the watchdog function still has some relevance today. The lesson is: if your pet goes berserk at an inconvenient time, be inclined to humour this – it could save your life.

What value would precursors be the day before? Mainly we think heightened alert-status. It is certainly not possible to strengthen buildings in a short time-frame, but it is always worthwhile to think whether a house has hazards which can be avoided with a simple fix such as anchoring ornaments in a semipermanent fashion.

It is always worth thinking about emergency supplies as civil defence authorities emphasise, and in the long term replacing brick chimneys, and adhering to building safety codes. Retrofitting of buildings is very expensive, but probably potentially saves many lives.

The accounts of lost pets peaking before the quake may be somewhat useful but has limits. It could not have been predicted from the 5x rate on the Friday before the quake that an earthquake would be the next day – indeed there was an identical figure a week earlier. And if one saw a peak, would there be an even higher peak the next day? And so on?

A major problem would be coverage. In the present study, only major cities had enough pets for a sufficient number of reports. Even minor cities did not. For clinic details, only vet clinics in wealthy suburbs could be indicators, which makes them a minority in a minority of locations.

Pets vary. The majority show no useful precursory detection. It is not clear a priori which ones are useful and which are not. At a guess dogs encouraged in their watchdog function might be more useful.

Earthquake light.

This is well known as something accompanying earthquakes. Although scientists gave reports little credence in the past, photographs and videos finally provided clear evidence. Many witnesses from Christchurch reported this and a few accounts gave significant new information. Because this is so unusual we give many reports in full. We would be delighted to receive further reports! Even if they repeat what we give below. Ideally we would like to know very precise timing – how long before the quake was the light? And in which direction? How many flashes were there? What was the colour? Did you see anything coming from the ground? Did you see light before or with an aftershock? Did you see a glow?

> Driving to ChCh from Darfield at 9.30pm on Friday
> 03/09/10 (the night of the Quake). Saw a strange halo / ark

> of light over the city of Chch. It was Blueish I guess. Don't know how long it went on as I was concentrating on driving. Not too sure if connected to Quake but did seem odd at the time.

This is in the precursor category rather than during the quake.

Philip Duncan of Weatherwatch (http://www.nzherald.co.nz/christchurch-earthquake/news/article.cfm?c_id=1502981&objectid=10673092) published the following:

> When I was in the big Christchurch quake two Saturday's ago I noticed three or four brilliant blue flashes that lit up the sky (but didn't light up the city itself, as normal lightning would do). My first instinct was that it was power transformers exploding.
>
> However on reflection I realised the lights were simply too bright and lit up too much of the night sky.

There were many responses and comments about this, and also many sent in to the survey site by respondents. Many react to previous comments. Some of the particularly interesting ones from the combined set follow.

> [Nelson all week before:] Very strange green light; distant trees, hills stood out very clearly; a strange stillness.

> I was outside on the back lawn at my house in Wigram. I had returned from Europe only 36 hours earlier and suffering jet lag - hence why I was up at 0430! Everything was unbelievably quiet - no sound from any animal, human or even any wind to speak of. The sky was crystal clear with as many stars out as I have ever seen. It was unseasonably warm for that time of morning at that time of year. As I surveyed the skyline a huge flash of bright white light - very similar to sheet lightning- flashed across the sky from South to North. As soon as it had flashed the rumbling began and the quake hit. This phenomenon happened again in the middle of the quake and the quake subsequently felt to intensify after the second flash of 'lightning' had occurred. [The quake had two major shocks within it].

> Just before the quake I noticed that there was interesting colours in the sky, this then moved on to some very low frequency vibrations and then there was what looked to be a large lightning bolt and then the big quake started. I did

some research after seeing this online and found that the HAARP site was running full power around this time and I was surprised to see that this was the same for the Chile earthquake and also another 2 earthquakes.

[Rolleston 6-9pm 3rd:]Blue light towards Darfield

If you're looking for another eyewitness to the flashes you have two more here. I live up in Westmorland and because my bedroom is impossible to see into often sleep with the curtains open so I can look at the pretty lights at night. We saw several flashes out to the west side of the city but because it was about the time the power cut out I also thought it was transformers shorting or the insulators on the pylons shifting and causing short circuits.

I have seen exactly that, at least 3 all in about 2 kilometers of each other and maybe 5 kilometers west of Parklands. I was deciding whether I should jump out the window when I looked up from the first bright flash and observed the next two, one of which I swore had an arc of lightning leading to it. Until a friend pointed out this article I just assumed it was transformers blowing up as the power went out at the same time and all the light came from the ground. The one I got a good look at made an amazing amount of light in the form of a sphere on the ground.

My wife and I saw these lights too and like you, we first thought it was caused by electricity equipment exploding, but the lights were far too bright and lit up the sky exactly like a strong thunderstorm. Except there were no clouds and the light seemed to originate from the ground. We live on Dyers Pass and could see flash after flash in the direction of the airport. When we listened to the radio later, a lady recounted her quake experience and also mentioned these bright lights. I guess we can consider ourselves lucky to have witnessed this phenomena and lived to tell the tale.

I definitely saw the lights (looked a lot like lightning), freaked me right out coz I thought OMG not a storm as well. We live in Broadoaks, Cashmere and what I saw was a blue red colour flash backwards & forwards across the

sky and yes you're right only in the sky. Very very frightening experience, keep safe everyone

On Saturday night of the big quake my wife and I spoke with a work friend who said he was out driving at 4:35am when he saw numerous blue flashes in the sky. I was skeptical about what he had seen until the following night. My wife and I were driving back from Blenheim home to Christchurch when just south of Amberley we both saw two blue flashes in the sky ahead of us. One slightly to the left and the later one to the right. A definitive earthquake phenomenon in our opinion.

This last was therefore more associated with the aftershocks than the main quake,.

The Lyttelton Road Tunnel cameras caught blue flashes after the quake - maybe these are examples of Earthquake Lightning? [The authorities confirm there was security camera records]

I live in Tai Tapu, about 15 ks from chch as the crow flies.and I saw the lights over Christchutch mid quake from my bedroom window. … I jumped out of bed and saw massive flashes of white/blue lights from the city. For a split second I thought chch had been bombed. I will never forget those images and those ghastly first few moments.

I went outside straight after quake to listen to car radio for tsunami warnings, the aftershocks were bouncing car all over the drive way, just as I got in car I saw blue lightning both in the east and western skies. Thought Armageddon had arrived.

The red colour made me think the whole of christchurch had blown up. It was like a fire red, that you would see in a distance only it was right across the sky in a line.
I think there were 2 flashes close together. There was the light of the sky above that. We have trees in our yard and I can say it was bright enough to see through them.
That brightness frightened me as if we were next to blow up. The noise was a cracking noise very loud. I yelled at my husband the city is blowing up. Then realized it was an earthquake. I am sorry I cannot describe it better than that.

One respondent in a very good position to see what was happening relayed the following unique account:

> Hi. I am 65 years old. I have been driving for 50 years.
>
> I was driving into Christchurch on the morning of the quake. I was placed on the motorway at the point where the road divides into two, and I southbound, towards Christchurch. Speed, exactly 100 ks. One car behind me by about 500 metres, and a large truck about 1 mile behind. No one else around.
>
> I observe silly things, for example, on the way *out of town*, I observed a vehicle heading west along the north shore of the Waimak, below the bridge, the vehicle had its hazard lights flashing. Time 4.21 am.
>
> 4.35am. The sky lit up with an incredible lighting display. I knew it was an aurora. I know what causes an aurora. Radiation interacting with the magnetic field of the planet.
>
> To my left, east, the flashing dark green to light green as it moved away from me. To my right, west, light blues to dark blue. The display was 'sheeting'. I have seen auroras on TV, and that is what it was. This was not lightning.
>
> My car clock clicked over 4.36am, just seconds into the aurora, and the car lurched and tipped and shuddered. The force was enough to have tipped my car over, but due to experience I managed to steer into the shudders. The lights of the motorway were still on. 'Rivulets', or riggles, were flashing towards me from the south west, like a giant spider web, or 'radials', and the motorway was drifting from side to side. I would guess that the centre of the spiderweb would have been around Springfield. Two 'rivulets' flashed passed me on either side, straight into Kaiapoi which was on my immediate left, east. The lighting display suddenly became incredibly intense, and was not 'in the distance', it was all around me. Then with the violent shuddering of the car, there was a HUGE flash of brilliant white light, and the display vanished, and the whole city sank into blackness. It

was gone. No light anywhere. The driver behind me must have stopped because I didn't notice him again.

My first impression was that there had been an atomic explosion. I believe that the aurora was caused by intense radiation, hence my instinctive belief that the city had been subject to some kind of atomic explosion.

I was careful to check each bridge for tell-tale cracks, but they seemed at a rapid glance to be OK. When I drove over the Chaney's Overbridge it was not damaged. The lane under the bridge was not in the range of my headlights. But the motorway on both sides of the overbridge was dead flat at that time. The damage to the area must have occurred AFTER the intitial shock.

The first lights I saw were at Countdown in Northlands, and it occurred to me they would have a generation backup system. Lights on the west side of Papanui Road flickered here and there, but Merivale was in darkness. I usually stop at Paul's coffee shop, and I paused there to check he was OK, but his blind was down, so I assumed he was not at work yet.

And further (recapitulation):

The light display appeared first, then maybe a second later I felt the car jolt. My car was kicked to my left, as if the front right wheel had been hit, then the next bump was the other way.

The lighting moved away from me, or appeared to move away, to the south west. As the colours changed they moved away, or, as they moved away the colours changed. Greens on my left, east, blues on my right, west. The brilliant white light was directly over the city. The range of the light extended right out to sea, east, into the whole distance I could see. I was 'inside' the light. [and it was hugging the ground, about car height].

I am not initiated to say, but I suspect we might eventually find that the greatest shock of the earthquake was actually out to sea. Is it possible to check for huge cracks in the sea bed?

The spiderweb effect was the movement of the earth itself. If you could imagine a flat concertina. The radials [=

> rivulets, earlier] advanced across the road in front of me, from southwest to northeast, and they moved as fast as I could take in the spectacle. The radials were not uniform in that I saw some which appeared to be behind/ahead of others. Each radial, and I am trying be helpful, was each, ker-bump, and a ker-bump, with me travelling south at 100ks per hour. On each side of each radial, the road moved in opposite directions, like a push-pull effect. As I passed over each radial, the car lurched the other way. Each radial looked strangely like the pictures of gophers burrowing along, where they leave a little upraised trail. But there were no open cracks as appeared later. I would guess that the motorway was swaying inside a channel of about one metre overall in the distance I could see. The lights of the motorway were still on until the last tremor. The lights of the city vanished basically simultaneously with the aurora.
>
> If the earthquake was somewhat 'selective' in it's destruction, I am guessing that anything directly over each radial got a hell of a hiding, but in between the radials, much less destructive.

An important feature of the above is the coincidence of the light with earthquake pulses as they traversed the ground. This ground display was not power lines arcing. Also it is worth noting that the light was actually slightly in advance of the first shock, (later estimate 5 seconds) whereas logger records show voltage disturbances on HV lines took at least 10 seconds to be initiated. This says there was distinct green and blue appearances before any arcing occurred. The white flash towards Christchurch coincident with the failing of lights is much more likely to be arcing. The auroral appearance suggests ionization of the nitrogen and oxygen in air.

The colours described in the flashes are quite variable, but have the following numbers of reports:

Blue 1 (to Darfield, glow) 3 2(hour precursor glow) 1 (post quake)
Blue and White 4
Red 1
Orangey-red 1 (brooklands) 1 (Burwood to E)
Yellow-orange 1
White alone 6
Green alone 2(glow) 1
Blue green and White 1
Red Blue (Broadoaks) 1
Unspecified 8

This is complicated. Glows are reported, flashes are reported, both pre and post quake. White seldom pre or post, but at the very end of the shake. This could be aluminium arcing, except observers insist it was far too bright.

Quite clear is the description of some people that light came from the ground. The description of a sphere may mean a hemisphere.

The blue green colours may have been partly electrical, but some definitely preceded shorting. They are typical of the ionization of oxygen (green) and nitrogen (blue). The red colours are much more obscure. It rather seems as though there is some consensus that bluer colours were towards the epicenter and greener colours further away, towards the east. Some careful observers think there were at least 6 flashes during the quake.

From Early NZ accounts we read about Wellington ((Grayland, 1957) "Following the shock on October 17 [1848] (3.40 p.m.) the sky in the evening to the north was seen to be lit up, as if by some distant fire. This gave rise to a suggestion that Tongariro might have burst into operation – " (Footnote in the above reference: I myself witnessed the green light-flashes which occurred simultaneously with the earthquake in Wellington in June 1942).

Later we note (Hutton, 1888) for the earthquake at Aimuri 1st September 1888 "At Reefton, in the early morning and in the evening of the 1st September, a "luminous appearance" is reported to have been seen in the eastern sky in the direction of Christchurch, and it was again highly visible on the evening of the 8th September. In Dunedin, on the evening of the 1st September, an extraordinary glow was observed in the western sky, noticeable until after midnight, and it travelled southwards. I mention these things, but I do not think that they were in any way connected with the earthquake. (p288)"

Later commentators might not be so sure.

An electromagnetic explanation seems possible.

Summary

Some new science has come out of the survey you all helped with. The statistical foundation for saying animals in particular and other phenomena to a lesser extent, are predictive is much sounder than before. The data were gathered in a more sociologically rigorous fashion than before. There is new support for the idea that pets go missing unduly in the week before a large quake and this effect may exist for a few hundred kilometers radius. There is further confirmation that earthquake light may come from the ground rather than the sky, and some exists independent of electrical arcing. However because no lives were lost in Christchurch, it appears that adherence to sound building codes may well have the most effect. We must ask "Does prediction have a future?!" and cannot yet say…….

Afterword

. i tried to sleep but i was too scared. how dare the earthquake damage my hometown... Thank-you Sarrah

Acknowledgments

The 500 plus people who took part in this survey deserve considerable thanks. It takes time to fill in a survey, particularly when unexpected features of experienced events make it hard to adjust their description to the question form, and some may have been more used to texting. We thank those who described precursors to the aftershocks which added significantly to the overall picture. Thanks further to those people who mentioned aspects which were able to be followed up by contacting various companies and organizations. Thanks to those people who emailed giving descriptions from other earlier earthquakes. Some of those are striking, and are mentioned in the text. We also thank those people who volunteered personal information even though it sounded rather strange, and questionable to them. Their courage has led to a much more accurate understanding, and we would like to reassure them that similar descriptions came from the precursors to the Kobe and Izmit earthquakes.

Thanks to the people contacted by random dialing, who agreed to answer questions particularly about precursors and pets. Also various people like computer service representatives, alarm monitoring service personnel, veterinary service personnel, personnel from the Orana Wildlife Park, Southern Encounter Aquarium and Willowbank.

Thanks to Colin Todd who alerted us to the possibilities of online surveys via SurveyMonkey and with Briar Whitehead, rapidly facilitated a website, Kristina Irving who collected crucial information about Christchurch vets, Robin Hodge who alerted us to a similar fascinating survey of public opinion about the Maruia (Murchison) earthquake in 1929, Lois Whitehead for locating NZ historical accounts of earthquake light, the Close-Up team who were unfailingly efficient, the NewstalkZB team likewise, David Williams of the Christchurch Press, Bill Wilson Orion Network for voltage logger data. Penny Hargreaves for research on bees. Lucy Bowker of Synlait and David Scott of ECAN for hydrological information.

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