Geohazards

Animals and earthquakes (*February 2007*)

Dating back to 373 BC Greece, anecdotes of animals' strange behaviour shortly before earthquakes and tsunamis are common. The best known case of such behavioural oddities being used to counsel evacuation is from Liaoning Province in China, when the city of Haicheng was alerted to the magnitude 7.3 earthquake of 4 February 1975. Over 2000 people died, but in July of 1976 a similar earthquake struck Tangshan in Hebei Province. Such signs of animal distress were ignored there and up to a quarter of million people perished. Chinese seismologists have since taken the animal lore on board. *New Scientist* recently included an article on why that might be a rational measure (Kaplan, M. 2007. Beastly powers. *New Scientist*, 12 February issue, p. 34-37; DOI: 10.1016/S0262-4079(07)60419-9).

Positive evidence that dogs may sense impending quakes comes from an unrelated study to ascertain if there is a canine form of Seasonally Affective Disorder. Canadian dog owners in Vancouver voluntarily rated their pets' anxiety and activity levels twice weekly for a year, but no sign of changes attributable to season turned up. There was, however, one day in which almost half the dogs were more active and more anxious than usual: 27 February 2001. A day later the British Columbia coast was shaken by a magnitude 6.5 earthquake, fortunately without major damage or casualties.

A possible reason why the dogs became edgy is their range of hearing, which extends from low to very high frequencies, well beyond that of humans and most other animals. The researcher found that fewer dogs with floppy ears seemed to anticipate the quake than those with pricked-up ears, and small-headed dogs seemed especially sensitive too. A few hours before the 26 December 2004 tsunamis, normally placid buffaloes on a beach in Thailand suddenly stampeded inland: bovids also have hearing ranges that extend to high frequencies. Despite reports of similar behaviour by wild elephants in Sri Lanka before the tsunamis struck, none were confirmed: elephants hear only very low frequencies. Despite what seems to be good evidence that dogs with pricked-up ears and tiny heads did sense something a day before the British Columbia earthquake, seismologists are not inclined to believe it was high-frequency sound waves – if they couldn't pass through a dog ear how could they pass through a few hundred kilometres of rock? Low-frequency sounds do travel huge distances, and Chinese anecdotes centre on snakes that are very sensitive to these but not higher frequencies. The Nanning Seismic Bureau has webcams that continually monitor snake farms, any sign that they attempt frantically to escape their pens raises an alarm for the district.

Without a satisfactory explanation for the evidence of animals' seismic sensitivities, scientific scepticism is high; yet so it was for Wegener's ideas on continental drift…

Signs of ancient tsunamis (*July 2007*)

Since the catastrophic Indian Ocean tsunami of 26 December 2004 everyone is aware of the frightening effects of submarine earthquakes; or at least they should be. A variety of coastal features in its aftermath gives potential guides to previous, unrecorded events. Four

hundred years ago, on January 30 1607, more than 2000 people perished in the lowlands surrounding the Bristol Channel of the UK; Britain's largest recorded environmental disaster. Reports consistently mention a large wave and water surge on a fine day with low winds. It inundated more than 500 km^2 along almost 600 km of coast, and was almost certainly a tsunami, although its cause is unknown. Confirmation comes from a variety of coastal features around the Bristol Channel that match those of known tsunamis (Bryant, E.A. and Haslett, S.K. 2007. Catastrophic wave erosion, Bristol Channel, United Kingdom: impact of tsunami. *Journal of Geology*, v. **115**, p. 253-269; DOI: 10.1086/512750).

Imbricated boulders near Porthcawl, South Wales (Credit: Bryant & Haslett 2007; Fig. 10)

Telltale signs are large boulders showing evidence of transportation, in the form of imbrication; sculpturing of bedrock on wave-cut platforms; and occasional wholesale erosion of coastal areas. All are present around the Bristol Channel and help confirm the origin of the 1607 disaster. More important, this confirmation helps identify other areas of coast that have in the recent past been exposed to tsunamis, and might be again. The firths (sea-inlets) of eastern Scotland each contain large tracts of sand flats, often containing bones of stranded whales and other large marine mammals. In places, the sands abut hillsides standing well above sea-level. Firths are not prone to storm waves, but lie the Bristol Channel are funnel shaped so that waves produced by sea-bed disturbances would be amplified. In 1988 these features were ascribed to tsunamis generated by submarine landslides off the Atlantic coast of Norway, around 7 ka ago. Despite being far from any major tectonic boundary, Britain is as prone to tsunami disaster as any maritime country.

Tsunamis: is there worse to come in the Bay of Bengal? (*November, 2007*)

Since the catastrophic tsunamis of 26 December 2004, attention has focussed on further major earthquakes off the Sumatran coast. In fact there have been two of large magnitude in that stretch of the Indian Plate's subduction system since 2004, in places predicted from

the stress perturbation by that of 2004 (see *Yet more Indian Ocean earthquakes? Sadly, yes* May 2005). Fortunately, large tusumais did not spread from their epicentres, but there were fatalities. The subduction zone swings from NW-SE off Sumatra to N-S towards the north, parallel to the coast of Myanmar (Burma), where is dominated by dextral strike-slip movements to accommodate driving the Indian sub-continent into Asia. Widely regarded as not likely to pose any substantial threat, partly from ignorance of the tectonics of western Myanmar, it now seems to pose a major risk after all (Cummins, P.R. 2007. The potential for giant tsunamigenic earthquakes in the northern Bay of Bengal. *Nature*, v. **449**, p. 75-78; DOI: 10.1038/nature06088).

On 2 April 1762 the Arakan coast of what was then Burma experienced an earthquake that later investigation showed to have involved elevation changes in the shallow sea of up to 7 m. That seems sufficient to generate tsunamis, and Cummins has estimated how large those may have been after the Arakan earthquake, and how they may have propagated across the northern Bay of Bengal. As several subduction zone systems have demonstrated, stress build up with continual plate movement leads to episodic earthquakes. Indeed, anecdotal evidence from local in the Arakan area indicates some awareness of periodic seismic events, roughly every century. The 23 mm per year motion of this part of the Indian plate may suggest that is an overestimate of the repeat frequency. Nonetheless, the Earth's most densely populated lowlands – the Ganges-Brahmaputra delta plains, home to 60 million people living less than 10 m above sea level – and the cities of Chittagong, Dhaka and Kolkata are potentially at risk from future tsunamis.

See also: Kerr, R.A. 2007. Continuing Indonesian quakes putting seismologists on edge. *Science*, v. **317**, p. 1660-1661; DOI: 10.1126/science.317.5845.1660.