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RSIS COMMENTARIES

The Catastrophe in Haiti: A Repeat Lesson for Us all

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The earthquake that devastated Haiti on 12 January 2010 may not be the last that we will see. There are lessons for the whole world as we prepare for more earthquakes in the coming years.

ANOTHER HAMMERING home that we are not living sustainably on our dynamic Earth!
Large disasters developed a doleful cadence through the first decade of the 21st century. First it was India, then Iran, Indonesia, Pakistan and China. And now, in the first month of the century's second decade, it is Haiti. The anguishing post-earthquake scenes of monumental devastation have become all too familiar. In the last half of the last century we built too much, too inadequately, in too many dangerous places, with too little regard for how the Earth works.

Sudden Rupture

Last week's Haiti earthquake was caused by the sudden rupture of a tectonic fault that traverses the entire length of a long peninsula that juts out to the west from the capital city, Port au Prince. The rupture occurred at quite a shallow depth as earthquakes go, and ran for a few tens of kilometers just southwest of the impoverished city of about 2 million. The proximity of the fault rupture and the lack of infrastructural defences conspired to magnify the severity of the catastrophe. The death toll may well exceed the 40,000 each of the 2001 Bhuj and 2003 Bam earthquakes in India and Iran. It could even exceed the nearly 100,000 deaths that resulted from both the 2005 Kashmir and 2008 Lungmen Shan earthquakes in Pakistan and China.

The fault that generated last week's earthquake is well known to geologists as the *Enriquillo-Plantain Garden Fault Zone (EPGFZ)* (see Fig 1, pg 4). It is part of the northern boundary of the Caribbean Plate, which currently moves about 2 cm/yr toward the northeast relative to North America. A pretty predictable neighbour, wouldn't you say? Preliminary seismological data suggest that it was a section of the fault west of the city that ruptured on 12 January. In less than a minute, the mountains south of the fault slipped eastwards by a couple meters, likely over a length of about 70 km.

History amply shows that the EPGFZ had the potential to produce large, destructive earthquakes. Two in the 18th century were particularly well recorded. Moreover, recent measurements of deformation of the region using GPS satellite technology had singled out the fault as a site of dangerously accumulating crustal strain (at a rate of 7 to 9 mm/yr). Warnings of the potential for damaging earthquakes, as well as calls for more detailed scientific study, had been issued in recent years, most recently after small shocks occurred beneath the city in September 2008.

In the second half of the 18th century, it was not just one but two huge earthquakes, only 19 years apart, that razed the colonial town of Port-au-Prince. As related by French Historian Moreau de Saint-Méry, the first one, on 18 October 1751, devastated the whole region between Léogane and Gonaives. It even toppled several buildings in the Spanish harbour of Santo Domingo, more than 250 km to the east, suggesting a fault rupture east of Port-au-Prince. It was followed by strong aftershocks for about two months. Within Port au Prince, only one masonry building did not collapse.

The second earthquake, on the evening of 3 June 1770, was more violent than the first. It turned the reconstructed town into a vast field of ruins, where only aligned trees marked the tracks of former streets. Aftershocks continued for 4 months. Several small shocks that jolted the region in the preceding three years were unrecognised portents of the great earthquake to come.

The Fate of Port au Prince

Why is it that Port au Prince was no more prepared for the 12 January earthquake than it was for the twin events two and a half centuries ago? The answer is quite simple: Just as we humans cannot hear sounds or see colours that are emitted at frequencies beyond what our ears or our eyes have evolved to perceive, we are not naturally attuned to events that happen less frequently than every few decades. We teach our children to look both ways before crossing the street, because cars come by every few seconds or minutes. We regulate the financial markets because financial debacles occur every few decades. But a seismic, volcanic or climatic disaster that might occur every few centuries or millennia or even longer! Should we lose too much sleep over them?

For civilisation's future the answer is most assuredly "yes". We no longer live as a primitive humanity, where our natural senses are adequate for our survival. Our modern civilisation, dependent upon intricate machines and complex economic, political and cultural institutions, will likely not make it without paying attention to the science that has enabled us to extend our "eyes" and "ears" to see and hear the inner working of Earth's tectonics and climate. And once we perceive these dangers, we will need to utilise the powerful "hands" that modern planning and engineering have given us to build safely.

This is particularly appropriate for Port-au-Prince and Haiti. It is quite plausible that the recent earthquake is the beginning of a sequence of such events, analogous but likely not identical to that of the late 18th century. We now know that large earthquakes on long-quiescent, "locked" fault zones commonly trigger one another, and hence cluster in time. It is thus reasonable to suspect that another large earthquake will strike the city in the coming decades, as happened more than two centuries ago. Given the location of the 12 January fault rupture, this second quake will likely emanate from a section of the EPG Fault Zone a bit farther to the east, now pushed closer to the brink of failure by stresses imparted by the sudden slip on the Miragoane-Petionville segment. Cities in a similar fix include Istanbul and Padang, where history has shown that clusters of earthquakes are common and where science has shown that another one is likely within the next few decades.

Lessons for Asia

Insofar as this tragic event focuses the world's attention on Haiti, it could well be a last chance to turn things around there. Recall the billions of dollars that poured into Aceh for its reconstruction after the

great 2004 earthquake and tsunami. Those who develop the plans for using the money and the goodwill that will likely continue to pour into Haiti would do well to expect another shock at least as violent within the next few decades. This means that it would be smart to rebuild the physical and the human infrastructure of Port au Prince to be more resilient to another strong shake. An investment in scientific infrastructure would be an important part of that resilience – to measure the strains as they accumulate and understand possible forewarnings.

The lessons of the Haitian earthquake apply here in Asia, as well. We, too, have earthquake-generating faults close to some of our important cities. Istanbul sits just a few kilometers away from a great fault that failed progressively across Turkey throughout the 20th century. The only section of that great fault that has not yet broken is the underwater section nearest that great city straddling the boundary of Europe and Asia. Mandalay, the famous ancient city of northern Myanmar, lies less than 10 km from the Sagaing fault, whose northern stretch has not ruptured since the M ≈ 8 Ava earthquake of 23 March 1839. Myanmar's new capital Naypyidaw straddles a section of the fault that has not broken in recorded history. In Sumatra, Padang is only 40 km from the Sumatran fault -- a fault very similar to Haiti's EPGFZ. Bukittinggi sits virtually atop it and Banda Aceh half way between two of its branches. Wellington, New Zealand, has a similar fault running right through the city. So do the suburbs of Manila. (Figure 2, pg 5)

At the dawn of the second decade of the 21st century, the Haitian tragedy illustrates in exemplary fashion the dangers that supercities, megacities and their hinterlands face from natural hazards: We are largely unprepared, overexposed and naturally disinclined to do things differently. Unless we embrace a new man-Nature paradigm, we are in for an endless litany of what has just happened in Haiti.

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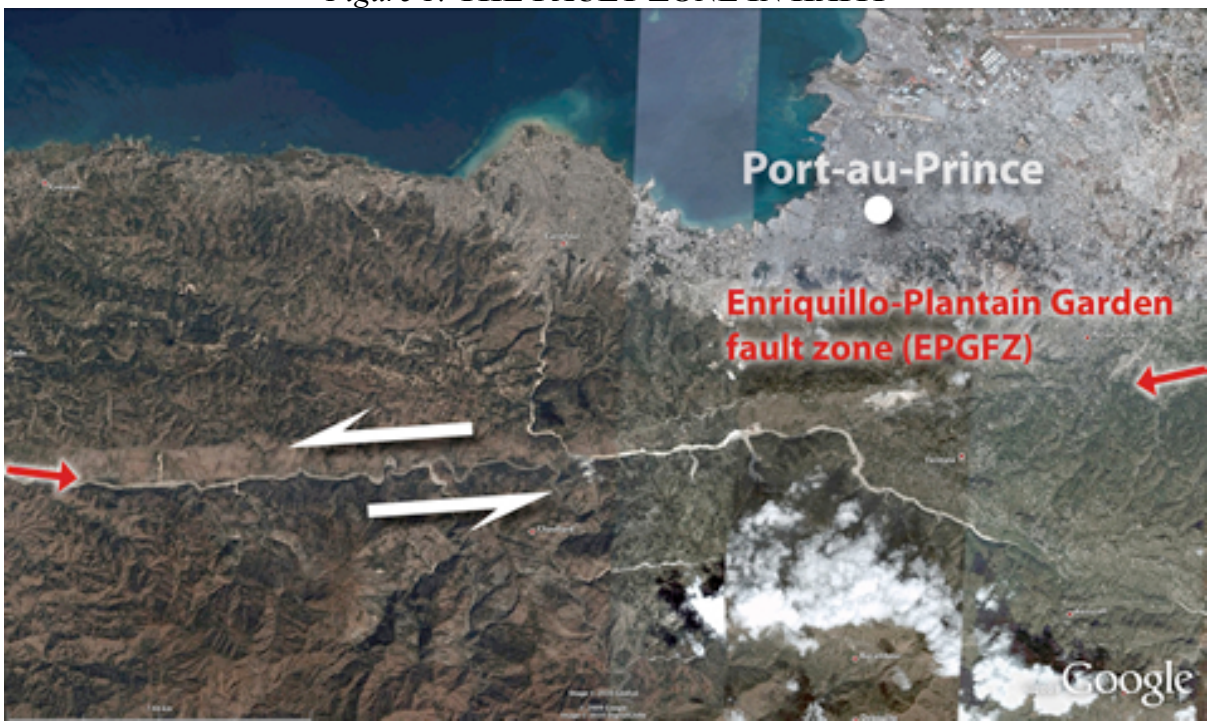
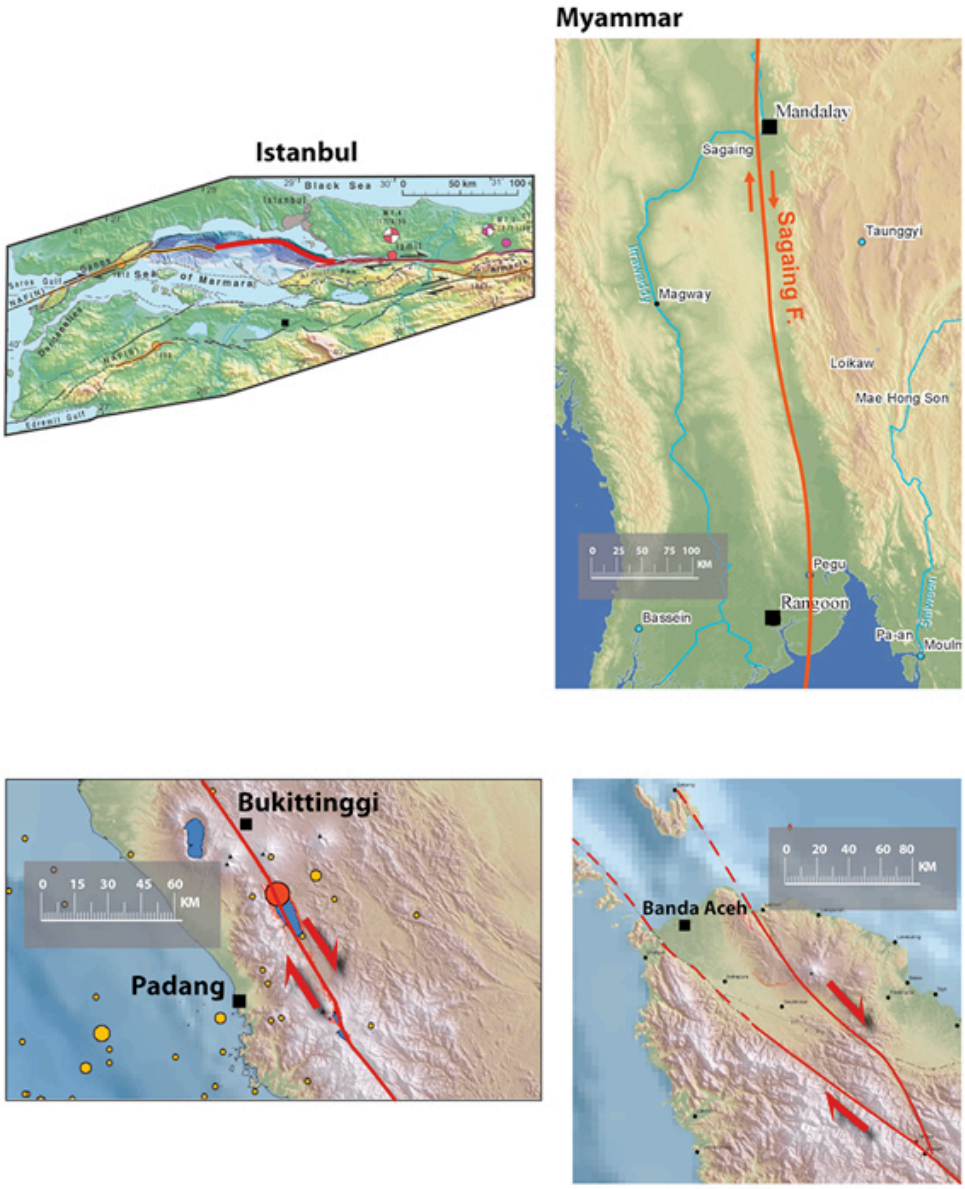
Figure 1: **THE FAULT ZONE IN HAITI**



The EPGFZ is clearly visible (between the arrows) in satellite imagery on Google Earth. The large white arrows indicate the sense of motion of the fault. The block north of the fault moves west relative to the block on the south. We call this type of fault a left-lateral (or sinistral) fault, because an observer looking across the fault from one side would see the other side of the fault move left during a big earthquake.

Figure 2: **CITIES WITH SIMILAR SEISMIC SITUATIONS**



Many of the world's cities are in a seismic situation akin to that of Port au Prince. Turkey's Istanbul is only a few kilometers from the North Anatolian fault, a right-lateral (dextral) fault. All of this 2000-km long fault has slipped in large, destructive earthquakes in the past century, except the underwater section nearest Istanbul. In Indonesia, Sumatra's Bukittinggi and Padang lie close to the Sumatran fault, but fortunately the nearest sections ruptured in the early to mid-20th century. The two strands that embrace Banda Aceh, however, have not broken in historical time and may be posed for a large earthquake. In Myanmar, Mandalay, Yangon (formerly known as Rangoon) and Napidaw are near the Sagaing fault, parts of which have not broken for more than a 140 years.