Japan Earthquake 2011: A Major Setback In Earthquake Prediction?

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ABSTRACT- Japan **was awestruck when a massive 8.9 magnitude earthquake hit the Pacific Ocean nearby Northeastern Japan at around 2:46pm on March 11 (JST) causing damage with blackouts, fire and tsunami. Dr. Vladimir Keilis-Borork and his team had apparent success in predicting the magnitude 8.1 earthquake in Hokkaido, Japan in September 2003. Have they proved less efficient this time than Nostradamus who had apparently predicted the Japan earthquake some 550 years ago? Would the recent Japan earthquake be regarded as a major setback in earthquake prediction? This paper takes an overview of the Japan calamity and its effects on the future of earthquake prediction.**

I.INTRODUCTION

Earthquakes are common in Japan, one of the world's most seismically active areas. The country accounts for about 20 percent of the world's earthquakes of magnitude six or greater. Yet the country was awestruck when a massive 8.9 magnitude earthquake hit the Pacific Ocean nearby Northeastern Japan at around 2:46pm on March 11 (JST) causing damage with blackouts, fire and tsunami. As if it was not enough, the situation soon worsened into the gruesome-Chernobyl-nightmare in Fukuyama nuclear plant. It was indeed an unprecedented catastrophe out of the blue in the last 140 years, and yet, we can be sure that most people will not blame the scientists. There will be no angry editorials; no torrential acid-rains from the sleazy tabloids; no crucifixion & burning of effigies of the earthquake researchers; no anguished criticism; no legislative hearings into what went wrong; and no denouncement from every talk-show worth its name about everything seismologists deserve and every other thing they don't. Despite all this solace, it remains an agonizing fact that scientists did not warn the people of Japan that an earthquake would strike on Friday, and so countless lives that could have been saved were lost.

Dr. Vladimir Keilis-Borork and his team had apparent success in predicting the magnitude 8.1 earthquake in Hokkaido, Japan in September 2003. However, the prediction covered very large area so there was some chance the earthquakes would have happened anyway. As the wounds are still licking, death toll is still being counted, and the disaster data are still pouring in, the debate on the possibility of earthquake predictions shall be continued for a long time to come.

II. HISTORY OF EARTHQUAKE PREDICTION

It remains an interesting fact that any phenomenon which is not properly understood is attributed to holy & mysterious powers. And the same goes true with earthquakes. In Greek mythology, Poseidon was the God of sea and earthquakes, who could cause earthquakes when angry. *Tumu-ra'i-fena*, the Polynesian Goddess, was the one who provided stability to earth on the other hand. The name of the goddess meant: "Foundation of Earthly Heaven."

Though the parapsychological and pseudoscientific methods are not the purview of our research, it remains a recorded fact in parapsychology that Lady Conan Doyle claimed to hear the rumbling of earthquakes over thousands of miles as many as five days preceding an impending earthquake, especially in the quiet of the night. Such

human sensitivity to earth tremors is an unclassified psychic phenomenon. More so, *Conversations with Goethe* (1838) written by Johann P. Eckermann, relates one such account concerning Goethe who had predicted an earthquake two weeks ago, which actually stuck Calabria and Sicily at the very time Goethe called to his valet. If the prophecies of Nostradamus have correctly been understood, he was the one who predicted the recent japan earthquake some 550 years ago (*Century: 1, Quatrain: 46 - Very near Auch, Lectoure and Mirandea great fire will fall from the sky for three nights. The cause will appear both stupefying and marvelous; shortly afterwards there will be an earthquake).*

Japan experiences approximately 400http://en.wikipedia.org/wiki/Japan_Meteorological_Agency_seismic_intensity_scale - cite_note-3 earthquakes every day, although the vast majority are *shindo scale* "0" or less and detectable only using specialist apparatus. The Japanese government embarked on a major earthquake preparedness campaign in the 1970s and 1980s, which some criticized as emphasizing prediction too much over mitigation (Christopher Scholz, March 1997).http://en.wikipedia.org/wiki/Earthquake_prediction - cite_note-18#cite_note-18 It failed to result in a prediction of the Great Hanshin earthquake, which devastated the city of Kobe in 1995. Now they have failed again to predict the recent earthquake, which was triggered 24.4 kilometers beneath the earth at 38.322°N, 142.369°E, approximately 130 km East of Sendai, Honshu, Japan (with the location uncertainty of horizontal +/- 13.5 km as fixed up by the United States Geological Survey). TV pictures showed the tsunami carrying the debris and fires across a large swathe of coastal farmland near the city of Sendai. Bullet trains to the north of the country were halted.

Except for an extremely successful short-term prediction by the State Seismological Bureau of China in mid-January of 1975 of an earthquake of magnitude seven-point-three in northeast China which actually struck in the early evening hours of February 4, 1975, the densely populated town of Heicheng – there were dearth of examples of successful predictions. Four other earthquakes were predicted by Chinese scientists during the 1975-76 period, giving a false hope that earthquake prediction was finally possible. Despite all these successes, there was no warning of the 1976 Tangshan earthquake of magnitude seven-point-six, which caused an estimated 250,000 fatalities. This failure put Chinese earthquake prediction research in doubt for several years. In the late 1990s, the Chinese government issued over thirty false alarms,http://en.wikipedia.org/wiki/Earthquake_prediction - cite_note-16#cite_note-16 but claimed successful prediction of the November 29, 1999, M5.4 Gushan-Pianling Earthquake in Haicheng city and Xiuyan city, Liaoning Province.

III. IS EARTHQUAKE PREDICTION REALLY POSSIBLE?

Nothing is certain until it happens. Like the forecasting of floods, famines, and volcanic eruptions, a lot of efforts are being made in the direction of earthquake predictions. There is no dearth of interesting literature available on para-psychological, scientific & pseudoscientific methods of such failed & successful predictions. http://en.wikipedia.org/wiki/Earthquake_prediction - cite_note-4#cite_note-4 In a few cases where fairly accurate predictions were made, the results could not be reproduced subsequently. The natural randomness of earthquakes and frequent activity in certain areas can be used to make "predictions" which may generate unwarranted credibility. These generally leave certain details unspecified, increasing the probability that the vague prediction criteria will be met, and ignore quakes that were not predicted.http://en.wikipedia.org/wiki/Earthquake_prediction - cite_note-5#cite_note-5 Rudolf Falb's "lunisolar flood theory" is a typical example from the late 19th century. Except for scientists like Vladimir Keilis-Borok, earthquake prediction research had been stagnant since the early optimism regarding precursory phenomena was dissipated by negative observations.

Earthquake prediction is much like taking on the stock market; you can see patterns, you have an idea what is going on, but can you make a profit? For stocks it is a purely a matter of money, for a social benefit like earthquake prediction, it is a matter of whether the prediction truly helps anybody. As with so many natural phenomena, earthquakes are the product of what scientists call "complex systems," or systems which are more than the sum of their parts. Complex systems are often stable not because there is nothing going on within them but rather because they contain many dynamic forces pushing against each other in just the right combination to keep everything in place. The stability produced by these interlocking forces can often withstand shocks. But even a tiny change in some internal condition at just the right

spot and just the right moment can throw off these forces just enough to destabilize the system - and the ground beneath our feet that has been so stable for so long suddenly buckles and heaves in the violent spasm we call an earthquake.

Earthquakes were once thought to be random geologic events without cycle or pattern, and in a way they behave a lot like stocks, wind bursts, solar flares, and other events that have properties described by chaos theory. The method of attempting to predict the stock market by direct examination of historic price swings has its adherents, and its detractors. In fact there are fundamental laws working at the smallest to largest scale, and the frequency and size of events correspond to what is called a power law. For stocks, there is a pattern that the number of daily price-swings of 1%, is, perhaps, 8 times the number of days when the swing is 2%, which is eight times the number of days at 4%. Once in a while, there is a major 'stock-quake' with a big swing!

The number of earthquakes and their size generally follow a power law as well (see Zipf's law). Some natural phenomena follow power laws because they are fractal in nature, being self-similar over all scales. As a result of this ubiquity and intrinsic perceptual biases, people generally see 'patterns' or 'things' in any fractal distribution. Thus, the background of stars has its constellations, or one may see a duck in a fluffy cloud. One branch of mathematics that deals with pattern analysis explicitly is called Ramsey Theory.

Like stocks, the pattern of earthquakes is quite capable of being correlated with anything - once! People have 'associated' the onset of an earthquake with such things as abnormal animal behavior, the weather, earthquake clouds, motion in the level of water wells, etc. Unfortunately, unlike clouds, patterns which might be useful in predicting quakes are not as evident as that rain is more likely when it is cloudy than when it is not. The science of statistics is primarily concerned with discovering patterns and quantifying evidence of associations or correlations in data, regardless of cause. For example, a statistical link may be established between consumption of fatty food and cardiovascular disease, just as there is a statistical link between cigarette smoking and various illnesses.

To be socially useful, earthquake predictions do not have to be ultra precise in magnitude, time and place. Even predictions of a general nature can be quite useful if they are based on scientific principles. For example, the region near the town of Parkfield in California has experienced a magnitude 6 earthquake approximately every 22 years since some time in the 1800s. This led researchers to predict that a similar quake would hit the region in the mid-1980s. Because of the potential value of the scientific data that could be obtained from monitoring seismic data prior to a quake, and because the Parkfield area is relatively quiet - in comparison to most urban areas with respect to man made seismic activity, the region was heavily instrumented with all varieties of monitoring equipment. As it turned out, the predicted quake failed to materialize on the expected fault, however a sizable quake did occur in nearby Coalinga, California in 1983. Perhaps the Coalinga quake released some of the stress on San Andreas Fault near Parkfield, and was in effect a substitute for the missing quake. If that is the case, then one would have expected that the next quake in the Parkfield region would be sometime in the mid 2000s. Indeed another killer quake occurred near Parkfield, this time in San Simeon, California in December 2003. Regrettably, the San Simeon quake of December 2003 produced two fatalities in the town of Paso Robles. It was not until November of 2004 that the expected (but not predicted) Parkfield earthquake arrived, with analysis of the collected data offering no immediately obvious indications that could be used for prediction.

While it might be desirable to be able to predict a specific quake, of a particular magnitude on a given day, the more socially useful predictions in fact are the predictions that a particular geographic region might be especially likely to have a major seismic event within a particular time frame. That is because if it could be determined that a killer quake was definitely going to hit an area, even as vaguely as 'soon', then it becomes possible for regional planners to allocate resources for such projects as urban redevelopment, retrofitting, etc., in those areas where the commitment of a portion of otherwise finite public capital will have the greatest public benefit.

IV. KELLISBOROK'S ALGORITHM OF EARTHQUAKE PREDICTION

The Kellisborok's philosophy can easily be understood by the fact that some disasters and crises are related to each other by more than just the common negative social value we assign to them. For example, earthquakes, homicide surges, magnetic storms, and the U.S. economic recession are all kindred of a sort.

The researchers who developed this framework contend that these four types of events share a

precursory development pattern - a specific change of scale in indicators that can be tracked. They suggest that detecting this pattern could improve crisis prediction.

"Knowing the patterns of extreme events development is pivotal both for predictive understanding of these events and for enhancing disaster preparedness," says Vladimir Keilis-Borok. Adds his colleague Alexander Soloviev of the Russian Academy of Sciences: "A premonitory pattern common to four complex systems of different nature is probably a manifestation of a certain general feature of complex systems."

If we look closely, we find that floods & droughts are not two different events; they are the extreme events of the same phenomenon. To mathematicians who probe complexity, extreme events grow out of the dynamic interplay of indicators representing a complex process. A system may give off signals that deep shift is afoot. A change of scaling is a "premonitory pattern" indicating a coming extreme event. This manifests a shift in pattern - large events that were once infrequent begin to occur closer and closer together (similar to the Doppler's effect as per which the frequency increases as the source comes nearer and nearer).

That systems as diverse as an earthquake, surge in homicides, economic recession and magnetic storm can share a developmental pattern is not as surprising as it may at first seem. Systems are deep as well as dynamic: shift happens - and can, to a large extent, be predicted to save and improve lives.

But complex systems aren't found only in the natural world. Human systems are often complex systems. Economies and elections, for example, are complex systems. "In fact, human systems may be even more unpredictable because the raw material of those systems isn't mere stuff. It's people. And since people can see, think, and talk to each other, a whole new level of complication and unpredictability is introduced," wrote Dan Gardnear in Ottatwa Citizens. Recently Keilis-Borok has, in collaboration, used some of his techniques to make socio-economic predictions with notable success. For example, in his work with Allan Lichtman, he used the mathematics of pattern recognition to correctly predict the popular vote winner of presidential elections in the United States from 1984 to 2008 as well as correctly predicting 128 out of 150 US mid-term Senatorial elections since 1986. He has also applied the method to predicting rises in murder rates in Los Angeles, recessions, spikes in unemployment and, most recently, terrorist attacks.

V. SUMMARY & CONCLUSION:

Despite being the successes in a few predictions of complex systems, no prediction could be made of most of the earthquakes; the eruption of unrest in the Middle East; the global financial crash of 2008; the 9/11 attacks; the collapse of the Soviet Union; and the Iranian revolution. In every case, there was widespread failure to see the event coming. Like seismologists, the best we can hope for is an understanding of the possibilities and probabilities. Often, that will be enough to make a big difference. We may not be able to predict earthquakes but we can create building codes that dramatically reduce damage and fatalities - as they undoubtedly did in Japan. The loss of properties in Japan was less due to earthquake and more due to tsunami. What we need to address more seriously now is the security and safety of nuclear power plants, which Japan has miserably failed to ensure till these lines were being written. Similarly, the few economists who "called" the crash of 2008 may not have delivered time-and-place warnings, but they did see that the apparent stability of the financial system belied potentially dangerous forces beneath. Had we regulated accordingly, things may have turned out very differently.

As scientists like Vladimir Kellisborok study earthquakes, people can rest assured that scientists are doing everything possible to understand and monitor how the earth works and to reduce earthquake risk as the accurate predictions would serve as a reminder for vigilance in earthquake-prone areas. If any of the prediction methods is eventually shown to work, it will demonstrate that the Earth's crust contains information about upcoming large shocks. This would be an important finding, and would spur additional research that might someday lead to societally useful predictions.

REFERENCES:

[1] Variations of Trends of Indicators Describing Complex Systems: Change of Scaling Precursory to Extreme Events, Vladimir Keilis-Borok (University of California, Los Angeles) and Alexandre Soloviev (International Institute of Earthquake Prediction Theory and Mathematical Geophysics, Russian Academy of Sciences) appears in the (J.) *CHAOS.*

[2] Geometric Incompatibility in a Fault System, Andrei Gabrielov, Vladimir Kellis-Borok, & David D. Jackson, Earthquake Prediction: The Scientific Challenge (National Academy of Sciences Colloquium, United States), 1996, pp. 3838-3842.

[3] Nonlinear Dynamics of Lithosphere and Earthquake Prediction, Volume 2002, Dr. Vladimir Kellis Borok & Dr. Alexandra A. Soloviev, ISSN 0172-7389, ISBN 3-540-43528-X, Springer-Verlag Berlin Heideberg New York.
[4] Earthquake Prediction: A Review, S. S. Rathore and S. V. Shende, Technologia 2010, MPCCET, Bhilai, 24-25, Feb 2010.
[5] Earthquake Prediction & Early Warning System: A Classic & Contemporary Review, S. Rathore and S. V. Shende, International Conference at GIT, Kurukhestra, 2010.
[6] Recent Advances in Earthquake Prediction: A Review & Recapitulation, S. S. Rathore and S. V. Shende, NECTAS-2011,Saraswati College of Engg.,Kharghar,Navi Mumbai.
[7] Earthquake Early Warning Systems: Performance & Prospects, S. S. Rathore and S. V. Shende, Proc. National Conference on Advances in Concrete Technology, Lakshmi Narain College of Technology, Bhopal, 26th – 27th March, 2010, pp. 105 - 108.
[8] Whatever Happened to Earthquake Prediction?, Christopher Scholz, March 1997.

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