

March 11, 2011, Tsunami-Earthquake of Japan – Was It a Black Swan?

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This article tries to interpret March 11 tsunami-earthquake and ensuing nuclear accident as a Black Swan event, and also tries to find out what messages we should bear in mind in the case of future catastrophe. First, a short introduction of the Black Swan event or theory is made. Then, discussions will be made how well March 11 catastrophe fits to the three conditions of a Black Swan event by taking into account several statistics and specialists' views. The "message" part is weak, partly because the Taleb's original theory itself is not intended to be applied to the kind of problem discussed here. When specialist views are taken from the Internet, their URL's are given at the end of the article so that readers may trace back to the original.

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1. THE BLACK SWAN EVENTS

In 2007, Nassim Nicholas Taleb published a book "The Black Swan" about unpredictable events in which he criticized the risk management methods used by the finance industry and warned about financial crises. He also proposed in the revised version of the book (2010) what he calls a "black swan robust" society, meaning a society that can withstand difficult-to-predict events. The book was described in a review by "Sunday Times" as one of the twelve most influential books since World War II.

Until a Dutch expedition on the Swan River in 1697 discovered black swans in Western Australia, the Old European World presumed that all swans must be white because all historical records of swans reported that they had white feathers. In that context, a black swan was impossible or at least nonexistent.

The Black Swan theory is a metaphor summing up the concept that the event is a surprise (to the observer) and has a major impact. The theory was developed to explain:

1.The disproportionate role of high-impact, hard-to-predict, and rare events that are beyond the realm of normal expectations in history, science, finance and technology.

2.The non-computability of the probability of the consequential rare events using scientific methods (owing to the very nature of small probabilities).

3.The psychological biases that make people individually and collectively blind to uncertainty and unaware of the massive role of the rare event in historical affairs.

Based on Taleb's criteria:

1.The event is a surprise (to the observer).

2.The event has a major impact.

3.After its first recording, the event is rationalized by hindsight, as if it could have been expected (e.g., the relevant data were available but not accounted for).

2. WAS MARCH 11 TSUNAMI A BLACK SWAN EVENT?

In my point of view, March 11 tsunami is a Black Swan event which is outside the realm of regular expectations, because nothing in the past can convincingly point to its possibility. It was a shock to all common observers. The two other fundamental attributes to a Black Swan event are also associated with the catastrophe. Its impact was extreme; and, for many professionals, it seemed explainable and predictable only after the event had occurred.

Wataru Sawamura, a journalist of the Asahi Shimbun, expresses his view on the disaster in his article "Japan, the earthquake and the media." ¹⁾

He summarizes the catastrophe: (1) Unimaginable scale of it all. This was without a doubt the worst disaster in Japan since the Second World War; (2) It was perhaps one of the biggest peacetime challenges faced by any developed nation; and (3) There is no justification for being complacent, and there are many lessons we have learned and continue to learn. Although Sawamura does not use the word “Black Swan,” and his wording is somewhat different from the definition of the Black Swan event by Taleb, Sawamura seems to consider the disaster as a Black Swan as most Japanese people did at the time of its occurrence.

There are people who raise different opinions. One such example was expressed by The Consumer Metrics writers²⁾. They mention that although tsunami damages in general are hard for traditional risk management technologies to handle, the Sendai tsunami is not a “Black Swan event” for two reasons. The tsunamis were, to some extent, anticipated by the Japanese people, whereas it is impossible to even forecast the possibility of Black Swans by definition; and most damage, economic and otherwise, is localized. Noted is the relatively small percentage of Japanese GDP that damage costs represent.

But, what is important is that Taleb himself seems to consider March 11 disaster as a Black Swan event. In his blog, he writes that he received close to 600 requests for interviews on the “Black Swan” of Japan. He refused all, he says, because he thinks for a living & writes books not interviews.

3. HOW DOES THE DISASTER FIT THE BLACK SWAN’S 3 ATTRIBUTES ?

Rarity (or surprise) is the most difficult to be accepted among the three attributes of a Black Swan event, because the north east (i.e. Sanriku) coast of Japan was devastated by several tsunamis in the past. According to A. Suppasri, et al.³⁾, the 600 km Sanriku coast extending from Sendai passing Iwate to Aomori was attacked by a series of great tsunamis since the first historical record in 869 (M8.6), followed by 1611 (M8.1), 1896 (M8.5), and 1933 (M8.4). It is reported that, in this area, an earthquake larger than M8.0 occurs every 100 years and that larger than M8.5 every 1,000 years. Admitting these statistics, the occurrence and the size of the tsunami were an outlier, as they lie outside the realm of regular expectations, because nothing in the past could convincingly point to its possibility.

Then, how big was the impact of the disaster? According to the National Police Agency (as of July

11, 2012) the numbers of the dead and the missing are 15,867 and 2,909 respectively, whereas those caused by the 1995 Kobe earthquake were 6,434 and 3, respectively. The Cabinet Office, by summing up various kinds of direct losses, estimated the monetary loss as about 17 trillion Yen as of June 2011. The same Office later made a more general estimate of 16-25 trillion Yen. Japan’s Gross Domestic Product for 2010 was 511 trillion Yen, indicating that the monetary loss was something between 3.1% and 4.9% of the real GDP. Economic loss is difficult to estimate, and the number may greatly vary if total withdrawal from nuclear power would realize. Did these numbers give a real impact to Japanese people?

Rarity and impact is both relative. For most Japanese March 11 tsunami was generally endowed with these two conditions of the Black Swan. However, there is another important element related to the catastrophe still haunting every corner of Japan - the Fukushima nuclear issue which has made March 11 tsunami truly a Black Swan. The accident was a great surprise and has given the most serious impact on Japanese people.

Andrew DeWit (Professor of the Political Economy of Public Finance, School of Policy Studies, Rikkyo University, Japan, and an Asia-Pacific Journal coordinator) discusses the effect of Fukushima meltdowns on Japanese economy and policy in his worth-reading article, “Fallout from the Fukushima Shock: Japan’s Emerging Energy Policy.”⁴⁾

He claims that Japan’s March 11 disaster is the costliest natural catastrophe in human history, and that it will be matched by history’s most expensive rebuild. The tragic March 11 earthquake, tsunami and its continuing nuclear crisis struck in the midst of the world’s unfolding financial, economic, environmental and energy crises, and in the most rapidly aging society in the case of Japan. The Fukushima nuclear shock is drastically reshaping Japan’s energy policy and politics.

Prior to March 11, the emphasis on nuclear power was largely accepted in the Japanese public debate as the only reasonable option. Against the backdrop of climate change, geopolitical risks, and other undeniable realities, nuclear power was deemed the rightful pillar of the “best energy mix.” Nuclear was considered as 1) the cheapest source of power, 2) among the best for achieving a low-carbon society, and 3) ideal for building energy self-sufficiency, through recycling of nuclear waste in a plutonium economy. Nuclear was also seen as the main engine of a public-private “All Japan” export drive into expanding global markets for energy and environmental infrastructure.

But, DeWit observes that Fukushima has transformed the Japanese public's (rather resigned) acceptance of nuclear power into strong opposition. He refers to the public opinion poll, released by the national broadcaster NHK on November 4, which indicates that about 70% of respondents want reduced reliance on, or even a complete withdrawal from, nuclear power.

He says that Japan's central bureaucracy itself is confused as can be seen from "Energy White Paper 2010" released by the Ministry of Economy, Trade and Industry (METI) of Japan. The METI's white paper released on October 28, 2011 marks an explicit and official retreat from the policy of centering the energy economy on nuclear. By contrast, the previous year's "Energy White Paper 2009" was confident of moving forward on nuclear recycling, new plants, the expansion of human resources for a burgeoning industry, and so on. But the 2010 report admits that continuing with this aggressive policy, one which has been especially pronounced since 2004, will be extremely difficult. Public-sector investment in the long-range goal of building the nuclear economy is being withdrawn, particularly the ambitious plans for new reactors. According to DeWit, the retreat from nuclear power is already generally understood as unavoidable, although nobody knows whether the decision is right or not.

Taleb in his blog offers thoughtful insights into Fukushima under the title of "Time to understand a few facts about small probabilities - Criminal stupidity of statistical science."⁵ He argues as follows, "The Japanese Nuclear Commission had the following goals set in 2003. The mean value of acute fatality risk by radiation exposure resultant from an accident of a nuclear installation to individuals of the public, who live in the vicinity of the site boundary of the nuclear installation, should not exceed the probability of about 1×10^{-6} . I spent the last two decades explaining why we should not talk about small probabilities in any domain. Science cannot deal with them. It is irresponsible to talk about small probabilities and make people rely on them, except for natural systems that have been standing for 3 billion years. For the nuclear field, the effective track record is only 60 years."

Taleb summarizes his points of discussions as:

1. Small probabilities tend to be incomputable; the smaller the probability, the less computable.
2. Model error causes the underestimation of small probabilities & their contribution.
3. If you compute the likelihood of an event that threatens your survival, you will inevitably

underestimate its probability.

4. The probabilities are underestimated but the consequences are much, much more underestimated.
5. Because of globalization, the costs of natural catastrophes are increasing in a nonlinear way.

He then concludes that there is no such thing as "measurable risk" in the tails, no matter what model we use.

4. RETROSPECTIVE PREDICTABILITY

The third condition of the Black Swan event is "retrospective" predictability. The event is rationalized by hindsight, as if it could have been expected. This attribute is what we have been observing among almost all experts/professionals that specialize in earthquakes.

Prior to March 11 earthquake and tsunami, except for the very small circle of seismologist, people did not know that there were historical records of a great tsunami in 869 most probably caused by an M8.6 earthquake that caused considerable damage to the area which was devastated by March 11, 2011, earthquake and tsunami. According to the media, although a few scientists did assert the importance of the 869 event, such an opinion was never officially accepted. Most earthquake engineers (not seismologists) were not aware of the possibility of the recurrence of the 869 tsunami.

It should be noted that probabilistic estimates had been made for each of the eight zones from the Sanriku to the Kanto coastal areas. In one of them, an M7.5 earthquake had been estimated to occur with 99% probability in 30 years. However, March 11 event was associated with a simultaneous crustal slide of at least five of the eight zones. In the hindsight, many of the great earthquakes in the circum-Pacific belt were associated with crustal slides with from 500 km to 1,000 km long. In spite of this scientific fact, Japanese seismologists conceived that earthquakes occurring along the coastal line of Japan would have the rupture length of the order of 100 km and Japanese engineers blindly believed what scientists said. March 11 earthquake is reported to have occurred due to the crustal rupture of 500 km x 200 km. All of us were unable to see the wood for the trees. This was nothing but the professional hubris.

5. BLACK SWAN ROBUST SOCIETY

The main idea in Taleb's book is to not attempt to predict Black Swan events, but to build robustness against negative ones that occur and be able to exploit positive ones. He advocates what he calls a "black swan robust" society, meaning a society that can withstand difficult-to-predict events. In the revised edition of "The Black Swan (2010)," Taleb provides "Ten Principles for a Black-Swan-Robust Society," a society robust against expert errors, forecasting errors and hubris, one that can be resistant to the incompetence of experts and professionals. His discussions mostly focus on the field of business and finance, but these principles seem to be extremely meaningful to scientific problems such as natural disasters.

Let us first summarize the Taleb's ten principles for building Black Swan robust society.

1. Let what's fragile break early, while it is small. The most fragile often becomes the biggest.
2. Do not socialize losses and privatize gains. Whatever needs to be bailed out should be nationalized; whatever does not need a bailout should be free, small and risk-bearing.
3. People who were driving a school bus blind-folded (and crashed it) should never be given a new bus.
4. Do not let someone making an "incentive" bonus manage a nuclear plant – or your financial risks. Odds are he would cut every corner on safety to show "profits" while claiming to be "conservative." Capitalism is about rewards and punishments, not just rewards.
5. Counter-balance complexity with simplicity. Complexity from globalization and highly networked economic life needs to be countered by simplicity in financial products which is already complex enough.
6. Do not give children sticks of dynamite, even if they come with a warning. Complex derivatives need to be banned because nobody understands them and few are rational enough to know it.
7. Governments should never need to "restore confidence." Cascading rumors are a product of complex systems. Governments cannot stop the rumors.
8. Don't give addicts more drugs if they are in withdrawal. Using leverage to cure excess leverage is pure denial.
9. Citizens should not use financial assets as a repository of value and should not rely on fallible expert advice for their retirement.

10. Make an omelet with the broken eggs.

6. WHAT MESSAGES WE HAVE TO LEARN FROM THE 10 PRINCIPLES?

Since Taleb's book was strongly aimed at problems in financial fields, several of 10 principles are difficult to simply apply to the natural catastrophes. However, there are many messages to listen to from his proposition of a Black-Swan-Robust Society, although most of my comments will be what Taleb calls rationalization by the hindsight.

Principle 1: "Nothing should ever be too big to fail" seems to be highly suggestive to the Fukushima accident and the following turmoil in energy policy of Japan. Around 2010, nuclear power plants provide about 6% of the world's energy and 13–14% of the world's electricity, with about 20% in the U.S., 28% in Europe, and 23% in Japan. Do these numbers indicate that nuclear energy has become too big to fail? Once a certain kind of energy source becomes too dominant, it may be useless and too late to examine the best mix.

Principle 3: "It is irresponsible to put our trust in the ability of the professionals and organizations that lost their legitimacy." Most professionals and experts in the fields of seismology, nuclear and earthquake engineering were driving a school bus blind-folded, that requires the highest safety, and they crashed it. It is irresponsible and foolish to put our trust in their (i.e. our own) ability. Although a few senior professionals may still be needed because of their (maybe wise) experiences, it is high time to find the smart people whose hands are clean. Too many specialists who were unable to presume (or even imagine) such a huge size of tsunamis to occur are still playing the leading role in the aftermath of the catastrophe. I agree with Taleb a new bus should not be given to many of irresponsible professionals.

Principle 4: "Do not let someone making an "incentive" bonus manage a nuclear plant. After the Fukushima meltdowns, it just surprised me that Taleb identified "nuclear" as an explicit example. To put it perhaps a little too strongly, people in the "nuclear village" in Japan were definitely getting incentive bonus in the near past according to the national policy to introduce more nuclear energy into the electric power in Japan.

7. PRINCIPLES 7 AND 10

Taleb's Principle 7 basically says that govern-

ments cannot stop the rumors (and governments often exaggerate them). Relating to this principle, I would like to refer to an article by Professor Geller on Japan's earthquake prediction. Robert J. Geller is Professor in the Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo. He is known as a strong antagonist to the Japan's earthquake prediction policy. His article⁶⁾ which appeared in *Nature* on April 13, 2011, about a month after March 11 catastrophe, discusses the involvement of Japanese Government in the earthquake prediction policy. Geller writes in an article "Shake-up time for Japanese seismology" as follows:

In the mid-1970s, several researchers in Japan proposed that the plate boundary off the Tokai district, about from 150km to 200km to the west of Tokyo, was a seismic gap where a magnitude-8 earthquake could be expected. This hypothetical earthquake became the first named-earthquake prior its occurrence. Over the past 30 years or so, government spokesmen and university scientists have used the term "Tokai" earthquake so often that the public and news media have come to view it as a real earthquake. In recent days, the neighboring Tonankai and Nankai districts are also labeled as being seismic gaps.

Public discussion of the supposedly imminent Tokai earthquake reached quasi-panic levels. Geller says this was exploited by the Japan Meteorological Agency (JMA) and university scientists, who persuaded the Japanese parliament to enact the Large-Scale Earthquake Countermeasures Act (LECA) in 1978. This law in effect requires the JMA to operate a continuous monitoring system to detect precursors indicating that the Tokai earthquake will occur within up to three days. If and when signals thought to be precursors are ever observed, a panel of five geophysicists will review the data, the JMA director will inform the prime minister, and the cabinet will then declare a state of emergency, which will stop almost all activity in a wide area around the Tokai district.

Geller then asks why the Tokai prediction system has been in place for more than 30 years, without a strong doubt being cast from most mainstream Japanese seismologists. The reasons for this silence are complex. First, many researchers have been co-opted in various ways (such as with funding and committee memberships). Second, government decisions are nominally reviewed, but review panels are chosen by bureaucrats of the agency being reviewed. Third, cogent criticisms do get reported by print media, but are usually ignored by broadcasters, so critics don't get much traction. Fourth, through

the press-club system, the government pipes its views directly into the media, often through reporters lacking in scientific knowledge. Finally, as long as the LECA stays on the books, the government can claim that it is obligated by law to try to predict the Tokai.

Geller criticizes the belief in assumption of "characteristic" earthquakes for various zones with fault parameters as the input to their model to then bring out probabilistic hazard maps when the modelers produce national seismic hazard map used by the Japanese government. Although such maps may seem authoritative, a model is just a model. All of Japan is at risk from earthquakes, and Geller says the present state of seismological science does not allow us to reliably differentiate the risk level in particular geographic areas. We, specialists, should instead tell the public and the government to prepare for the unexpected and do our best to communicate both what we know and what we do not. And future basic research in seismology must be soundly based on physics, impartially reviewed, and be led by Japan's top scientists rather than by faceless bureaucrats.

Taleb's Principle 10 may be interpreted as "A real crisis is not a problem to fix with makeshift repairs." Geller's propositions are not makeshift repairs. He says it is time to tell the public frankly that earthquakes cannot be predicted, to scrap the Tokai prediction system and to repeal the LECA. He emphasizes that, although the law presumes that reliable precursors exist based on only one report of a geodetic precursor of an earthquake in Tokai district in Japan in 1944. The 1944 data, taken far from the epicentral region, were interpreted as possibly suggesting uplift of a few centimeters due to slow slip on a deep part of the fault shortly before the main shock. Unfortunately, the data were measured using outmoded surveying techniques, and are subject to considerable uncertainty. He claims that the prediction of Tokai earthquake is scientifically baseless, and therefore, that the LECA must be annulled.

8. CONCLUDING REMARKS

Strictly speaking, I don't think this article reaches the level of presentation at this professional symposium, mostly because I have visited hard-hit sites of the catastrophe only once during the one and a half years time due to the chronicle and yearly worsening backaches. Therefore, what I tried to write here is general and my very personal impressions about March 11 tsunami-earthquake with their emphasis revolving around the Black Swan theory developed by Nassim Nicholas

Taleb. There is nothing new in this approach. As I referred Taleb's blog, he himself received close to 600 requests for interviews about the black swan, the unexpected visitor to the northeastern part of Japan's Main Island.

Although I think some of my impressions may be wrong, I tried to write things as explicitly as possible without uncertain terms which may be summarized as follows;

1. March 11, 2011, tsunami-earthquake was a Black Swan, simply considering the serious impact of Fukushima nuclear issue with no exit in sight even after a whole year since the occurrence.
2. Although it does not seem wise to completely abandon nuclear power generation, by the hindsight, best energy mix discussions should have been made with more seriousness taking into account the Japanese public's (rather resigned) acceptance of nuclear power. It is true that "Nothing should ever be too big to fail."
3. There had been professional hubris among scientists and engineers. It is irresponsible to put our trust in the ability of the professionals and organizations that lost their legitimacy. A new bus should not be given to those who were driving a school bus and crashed it. Find the smart people whose hands are clean.
4. It seems almost certain that people in the "nuclear village" in Japan were getting incentive bonus in the near past according to the national policy to introduce more nuclear energy into the electric power. They cut every corner on safety to show profits while claiming to be conservative.
5. Seismologists must at least review thoroughly whether or not their method and reasoning of earthquake prediction has been proper. As Geller points out, independent and also trustworthy relation among researchers and knowledgeable bureaucrats is essential.
6. Here, I also refer to Geller's article: The public and the government must prepare for the unexpected, and we, professionals, do our best to communicate both what we know and what we do not. And future basic research in seismology must be soundly based on physics, impartially reviewed, and be conducted by the smart people whose hands are clean, and may be partially led by today's top scientists in Japan.

ACKNOWLEDGMENT: "Towards Reducing Earthquakes Risks of India" was held on April 12 2012, in New Delhi. The seminar was hosted by a reputed Think Tank in Delhi by the name of Vivekanand International Forum. My personal host was General Nirmal Chander Vij, a former Chief of Army Staff, one of the key persons who raised National Disaster Management Authority of India which he headed in the status of a Union Cabinet Minister for 5 years till Oct 2010, and presently a member of Vivekanand International Forum. To the invitation, I prepared the original version of this article and sent it to Gen Vij, whose reply was courteous but clear. "Very thoughtful of you to send a copy of your article on Black Swan. It is indeed a most dispassionate assessment of your experience of the recent disaster in Japan. I think personally that your country did marvelously well to cope with this catastrophe. The earthquake really was not your major problem, it is the tsunami and the nuclear facility which became the challenge. In any other country, the earthquake itself would have been most unmanageable.....This Seminar is with a view to learn from your country, as to how have you managed this level of preparedness." So, I had to write a completely new manuscript titled "How Prepared is Well-Prepared – Japan's Experiences," and the Black Swan version has not been presented nor published since then.

My acknowledgment goes to Gen Vij, because this article would not be existent without his dauntless attitude to reject it in the Forum.

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