Disaster-vulnerable society—What is a truly strong society like?

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1. Introduction

Being born and raised in Osaka, I had many opportunities to visit Kyoto and Nara, typically as destinations of school excursions. After I entered university and started to study geoscience, I developed an eye for looking at the two cities from a geoscientific standpoint.

History usually considers that human society develops autonomously. It is thought that terrestrial changes and disasters are little more than disturbing factors, and historical and aesthetic consciousness develops with little influence from them. Few academic paperbacks about Japanese history mention such factors.

"Is this correct?" That was a question that occurred to me after I started to specialize in geoscience a half century ago. After retiring from Kyoto University, I worked as a specially appointed professor for three years at the Research Center for Disaster Mitigation of Urban Cultural Heritage (Institute of Disaster Mitigation for Urban Cultural Heritage today), which is a MEXT Global Centers of Excellence program at Ritsumeikan University in Kyoto. I was involved in the program "Hazards over a time scale of one thousand years," which provided an opportunity to address the original question I had as a student.

The 2011 earthquake off the Pacific coast of Tohoku occurred while I was engaged in this program. I watched disaster-stricken people digging out cultural assets from the rubble, reviving local festivals, and rebuilding historical architectures. I became deeply aware that the historical culture and cultural assets constitute prayers for reposing resting people's souls, as well as the origin of the identity of the Japanese or the local residents. I thus realized that this was part of the old question that had occurred to me as a student. Through this paper, I would like to add a small, geoscientific viewpoint to the issue: "Where have we come from and where are we headed."

2. Terrace surfaces formed during the glacial ages

The level ground surfaces on which large segments of the Japanese population dwell were created mostly during the glacial and interglacial periods over the past 400,000 years.

Figure 1 is the ratios of oxygen isotopes of Antarctic glacial cores containing material formed from 400,000 years ago. The ratios of oxygen isotopes are closely related to atmospheric temperature. Based on this relationship, the ratios of oxygen isotopes are appropriately converted to sea surface height, which is represented by the rightmost scale of the diagram. In this diagram, the peaks represent interglacial periods, during which the sea surface was as high as the present sea level. This diagram indicates that there have been five interglacial periods: the present day, 120,000 years ago, 200,000 years ago, 300-plus thousand years ago, and 400,000 years ago.

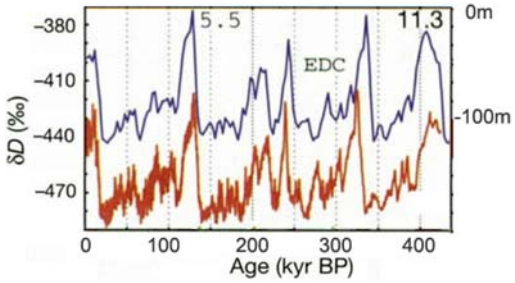


Figure 1 The ratios of oxygen isotopes over the past 400,000 years, obtained from the sea-bottom depositions sampled by the EPICA (European Project for Ice Coring in the Antarctica Dome) (upper line) and by the Vostok Station (lower line). The rightmost scale represents the approximate sea surface height, converted from the ratios of oxygen isotopes by the author. Courtesy EPICA community members (2004).

In coastal areas, there is a lower terrace surface, which developed between the glacial period 20,000 years ago and the Holocene glacial retreat 7,000 years ago; a middle terrace surface that developed between 120,000 and 130,000 years ago; and a higher terrace surface that developed over 300 thousand years ago.

What occurred during the glacial age in inland areas, such as the Nara Basin, Nara Prefecture, was different from the coastal areas. In inland areas, gravel production due to freezing and thawing predominated, developing a depositional surface. Thus, a lower terrace surface developed about 20,000 years ago when the glacial age was at its peak. A middle terrace surface developed between 60,000 and 100,000 years ago. A higher terrace surface developed during the previous glacial age about 150,000 years ago. These three terrace surfaces distributed widely in the Nara basin.

Between the latest glacial age and the present, alluvial fans and alluvial plains developed. While alluvial fans and alluvial plains were formed typically due to repeated river inundations, floods and debris flows, the lower, middle, and higher terrace surfaces retained their respective topographical characteristics. This means that the terrace surfaces have been seldom hit by inundations, floods and debris flows.

3. Hashihaka Tumulus and Makimuku Ruins

I would like to introduce some cases in which development of ancient societies can be recognized in light of the terrace surfaces.

Figure 2 shows a photograph of the Hashihaka Tumulus (Sakurai City, Nara Prefecture), which lies south of Makimuku Station on the Japan Railways Sakurai Line, reachable in five minutes on foot. The archaeological era of this tumulus (middle of the 3rd century) corresponds to the time of the ancient Queen of Wa (Japan), Himiko, who lived in the first half of the 3rd century according to the Chinese history book *Wei Chin*.

Figure 2 The Hashihaka Tumulus in Sakurai City, Nara Prefecture, built in the middle of the 3rd century. The Tumulus is presumed to be the resting place of Himiko, queen of Wa (Japan). Photograph by the author.

The Makimuku Ruins are located immediately north of Makimuku Station. This vicinity has many tumuli and ruins from the same era, which are collectively called the Makimuku Ruins. At the eastern end of the Makimuku Ruins, the Nara Basin Eastern Edge Fault runs in a south–north direction.

The Andonyama Tumulus is located 2 km north along the fault. The Tumulus is attributed to Emperor Sujin the 10th, the first real Emperor of the Yamato administration in the first half of the 3rd century, according to archaeological evidences. He is presumed to have co-governed Wa (Japan) with Himiko. Unification of Wa (Japan) initiated the Tumulus era and a peaceful time arrived.

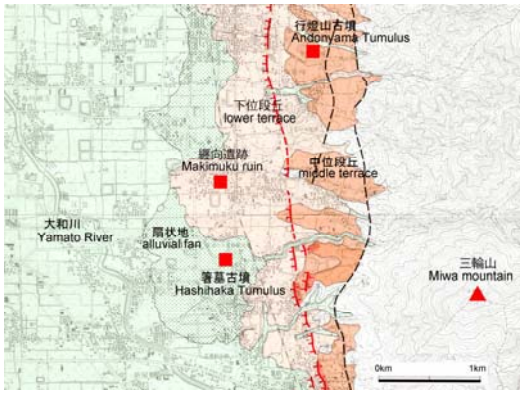


Figure 3 Part of the *25,000:1 Active Fault Map in Urban Area: Sakurai* (Sohma *et al.*, 1997). The light pink part in the center is the lower terrace surface, while the dark pink part on the right is the middle terrace surface. F denotes the Nara Basin Eastern Edge Fault

In 2009, the remains of a group of three large high-floored buildings were found in the Makimuku ruin, which are considered to have been built between the end of the 2nd and the beginning of the 3rd century.

Many researchers believe that the buildings were part of the Palace of Himiko and the first Emperor of Yamato administration (e.g., Tsude, 2011). I suspect that prayers were offered in these buildings to those who had died in the many battles between local countries during the Yayoi Era.

Figure 3 is the part of the *25,000:1 Active Fault Map in Urban Area: Sakurai* (Sohma *et al.*, 1997) from the Geospatial Information Authority of Japan. The Makimuku Ruins are located in the center of the map. They are located on the lower terrace surface (light pink part), which developed about 20,000 years ago. The dark pink part is the middle terrace surface, which formed 60,000 to 100,000 years ago.

Based on Figure 3, people in the beginning years of the Yamato Administration, who built a large settlement in Makimuku, are presumed to have been aware of the need to avoid inundation risks. Those ancient people must have been sensitive to them. The Makimuku Ruins vicinity should have been a place for assurance and prayers for them.

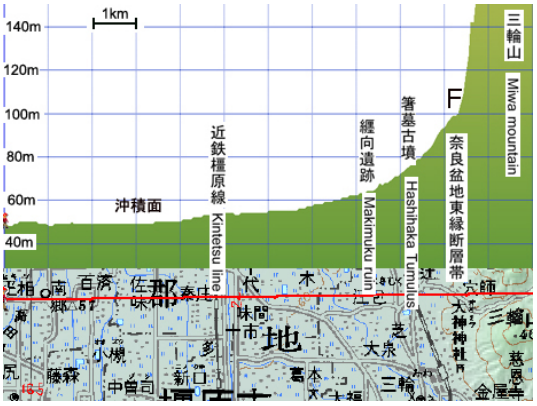


Figure 4 Ground elevation cross-section along the east–west line that runs through the Makimuku Ruins and the Hashihaka Tumulus. It is expanded 50 times in the vertical direction compared with the horizontal direction. The diagram is produced using the software Kashmir.

Figure 4 shows the ground elevation cross-section along an east–west line that runs through the Makimuku Ruins and the Hashihaka Tumulus. It clearly shows the lower terrace surface of 60 to 70 meters in altitude, on which the Hashihaka Tumulus and the Makimuku Ruins are situated. From the Tumulus and the ruins site,

the Yamato River, which flows through the center of the Nara Basin, can be distantly viewed.

The Emperors' tumuli were built on the upper block of the fault while settlements and religious buildings were built on the lower block. This topographic setting of upper and lower blocks along the Nara Basin Eastern Edge Fault was formed over a period of a few hundred thousand years. Repeating earthquakes enlarged the height difference by about 2 meters each time.

Fault excavation and boring researches indicate that the Nara Basin Eastern Edge Fault ruptured at least once during the period between about 10,000 years ago and the Nara Era (the 8th century). No further information is available. When an earthquake occurred, the Makimuku vicinity is presumed to have been subject to strong seismic motions of seismic intensity level 7.

If the technical phrase *terrace surface is* used as a mere replacement for the term *altitude*, the phrase does not carry special meaning. However, as described above, terrace surfaces carry information associated deeply with human society, which is not visible when the word altitude is used.

4. Palaces of the 5th and 6th centuries

Table 1 lists the emperors and palaces between the 3rd and 6th centuries. The categories of locations in the rightmost column, which are alluvial fan, lower terrace surface, middle terrace surface, or mountain that is not classified as either, were taken from the *Active Fault Map in Urban Area*. The palaces before Emperor Keitai (reign for 507-534) were all on terrace surfaces or on mountains, except the Palaces of Emperors Ingyo, Kenzo and Ninken, whose locations are unknown. Later in the 6th century, many imperial palaces were built on lower alluvial plains. In 593, the palace was relocated to Asuka on a small-scale high-altitude alluvial plain.

List of ancient emperors in Japan

	Name	Accession		Current place name		Category
10	Sujin			Sakurai,	Nara Pref.	lower terrace
11	Suinin			Sakurai,	Nara Pref.	lower terrace
12	Keiko			Sakurai,	Nara Pref.	middle terrace
13	Seimu			Ohtsu,	Shiga Pref.	alluvial fan
14	Chuai			unknown		unknown
15	Ohjin			Kashihara,	Nara Pref.	mountain
16	Nintoku			Osaka,	Osaka Pref.	middle terrace
17	Richu	400	6	Sakurai,	Nara Pref.	mountain
18	Hanzei	406	6	Matsubara,	Osaka Pref.	lower terrace
19	Ingyo	412	42	unknown		mountain
20	Anko	454	3	Tenri,	Nara Pref.	alluvial fan
21	Yuryaku	457	23	Sakurai,	Nara Pref.	mountain
22	Seinei	480	5	Kashihara,	Nara Pref.	mountain
23	Kenzo	485	3	unknown		
24	Ninken	488	11	unknown		
25	Buretsu	499	8	Sakurai,	Nara Pref.	mountain
26	Keitai	507	27	Hirakata,	Osaka Pref.	lower terrace
			→	Sakurai,	Nara Pref.	mountain
27	Ankan	534	2	Kashihara,	Nara Pref.	alluvial plain
28	Senka	536	3	Asuka,	Nara Pref.	mountain
29	Kinmei	539	33	Sakurai,	Nara Pref.	alluvial plain
30	Bidatsu	572	13	unknown		
			→	Sakurai,	Nara Pref.	alluvial plain
31	Yomei	586	2	unknown		
32	Sushun	588	5	Sakurai,	Nara Pref.	mountain
33	Suiko	593	36	Asuka,	Nara Pref.	alluvial plain

Table 1 From left to right columns, ancient Emperors, year of accession and years of reign, location of palace (as per *Tumuli and the Yamato Administration* [Shiraishi, 1990] and others), current place name, and topographical classification (alluvial plain, alluvial fan, terraces, and mountain).

In the 5th century, hard unglazed ceramic ware *sueki* reached the country from the Korean peninsula. The Suemura area, a hilly terrain ranging from the southern part of Sakai City to Osaka-sayama City, Osaka Prefecture, became a production base for the unglazed ceramics. The firewood used there at first came from broadleaf trees such as oak, which are typical trees in evergreen broadleaf forest zone on the Earth. However, from the latter half of the 6th century, needle-leaved trees such as Japanese red pine became increasingly used, and by the Asuka era, was the most common source of firewood. This indicates that people in the Tumulus era used up the broadleaf trees in the evergreen broadleaf forests, and that needle-leaved trees such as Japanese red pine replaced them, changing the flora of the Osaka plain (Tadaki, 2010).

The fact that palaces came to be built in an alluvial plain in the Nara Basin and that flora in the Osaka plain changed drastically in the latter half of the 6th century suggests that the population increased and people entered the lower alluvial plain in search of a larger place for new palace. According to *Japanese history based on population* (Kito, 2000), the population increased from 0.6 million at most at the end of the Yayoi Era (2nd century) to 4-5 million in the Nara Era (8th century). In 500 years, the population had drastically increased by 7 to 8 times.

5 From Asuka to Fujiwara capitals

The Asuka Era lasted approximately 100 years, starting from the year 593, when Emperor Suiko relocated the capital to Asuka, and ended in 694, when Emperor Jito relocated the capital to Fujiwara capital (Fujiwara-kyo).

Figure 5 is a map of the distribution of landslide tracks around Asuka. Asuka is a small alluvial plain about 110 meters in altitude. For those who had built palaces on the alluvial plain (40–50 meters in

altitude) in the Nara Basin and had been frequently disturbed by inundations, Asuka might seem an ideal location at first. However, in order to build many large-dimension buildings, forests upstream along the Asuka River were supposed to have been plundered, resulting in frequent inundations.

In 694, a new Fujiwara capital was built about three kilometers northwest of Asuka (upper left in Figure 5). It was the first full-scale capital in Japan. People must have been aware of the inundation hazards and taken preparatory measures, but to build the Fujiwara capital architectures, they felled a great number of trees, thus plundering the forests, allowing greater inundations to hit Fujiwara capital. Figure 6 shows a ground elevation cross-section along the line that runs through Asuka and the Fujiwara capital from N30W to S30E. The distance between Asuka and Fujiwara capital is only three kilometers, but the difference in the altitude is 30 to 40 meters. Inundations caused by heavy rains that hit Asuka should have reached Fujiwara capital immediately.

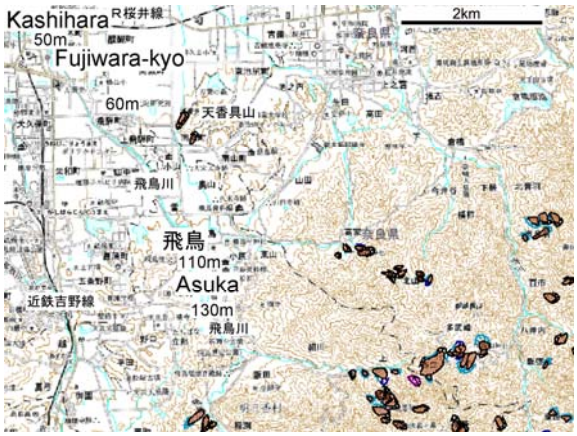


Figure 5 Distribution of slope failure topography in the Asuka and its vicinity, from the National Research Institute for Earth Science and Disaster Prevention's website

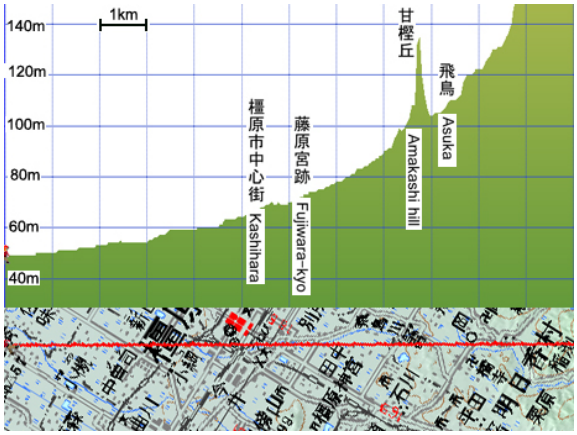


Figure 6 Ground elevation cross-section along the NNW-SSE line that runs through Asuka and the Fujiwara capitals. Pertinent data are the same as in Fig.4.

Around the time when construction of the Fujiwara capital started, there were no large-diameter trees in the Nara Basin vicinity. Large-diameter timbers were collected from Tanakami, Ohmi (Shiga Prefecture today). Accordingly, the beautiful ancient cedar woods in Tanakami were destroyed, and great amounts of earth and sand started to flow from the Ujigawa River to the Yodogawa River, filling the bay around Naniwatsu port (Osaka today), damaging its function as a port. This is a very early case of large-scale environmental destruction caused by human activity (Ohta, 2012). In Japan, forests in mountainous areas near plains were plundered for more than one thousand years. Totman (1989) called this the Ancient Predation.

Large scale erosion which caused large volumes of sediments in the rivers enlarged alluvial plains. That is to say, human activity prepared the ground of modern cities as the large alluvial plains.

6. Kofuku-ji Central Golden (Main) Hall

The capital was relocated to Heijo (Nara city today) in 710 and at the same time, Kofuku-ji was built in the eastern end of Heijo capital (Heijo-kyo) inside what is today Nara Park. About 714, the greater part of the golden hall of the temple was completed. Later, the Eastern Golden Hall and the Western Golden Hall were built, and the first golden hall was called the Central Golden Hall thereafter. Daigokuden Hall, imperial audience hall in Heijo Palace, was moved from the Fujiwara Palace, which was completed around 714 as well. Daigokuden Hall was the most important building in the palace for political ceremonies. In the Heijo capital, Daigokuden Hall at the center was matched by the Kofuku-ji Cenral Golden Hall at the eastern end. The capital was a twin-tower city for some time.

Figure 7 Kofuku-ji Central Golden Hall reconstruction site. The columns, 80 cm in diameter, in rows are from African Apa trees. Photograph by the author.

There was a large fire in 1046 (Eisho 1 in the Japanese calendar), and original buildings of Kofuku-ji were totally destroyed, including the Central Golden Hall. This hall was repeatedly rebuilt and lost by fire. In 1182 (Jisho 4), it was destroyed by the Siege of Nara, and rebuilt in 1194. After it burnt down again in 1717 (Kyoho 2), the hall was left unrestored. However in 1819 (Bunsei 2), a temporary golden hall was built, using pine tree timbers which are inappropriate for such a large-dimension building. To commemorate the 1,300th anniversary of Kofuku-ji temple, a decision was made to rebuild the Central Golden Hall in the original design. The construction started in 2010, and is scheduled to be completed in 2018.

The dimension of the rebuilt Central Golden Hall will be 37 meters in the east–west direction. It will be smaller than the restored Daigokuden Hall, which was completed in 2010 in its original design (44 meters in the east–west direction) in the original Heijo Palace site.

As I entered the Central Golden Hall under construction (Figure 7), I saw columns about 80 cm in diameter situated in rows. They are made of Cameroon Apa trees (often dubbed African zelkova). This wood is extremely hard and heavy, and does not expand or shrink under moisture. The framework above the columns are made from American white cedar (a cedar variety) imported from Canada. The fact that foreign timber is necessary to rebuild a building that is a symbol of Japanese cultural heritage demonstrates the plundering of native forests throughout the history of Japan since the Tumulus era.

As is seen in Figure 8, stainless steel latticework is built in the walls of the hall to ensure safety in the case of an earthquake. It may be an inevitable seismic measure against possible ground shaking caused by the Nara Basin Eastern Edge Fault, which runs only one kilometer to the east of the hall in a NNW-SSE direction. Such latticework is invisible to visitors and the appearance will be authentic. However, many people may feel unsure of such latticework in a sense of authenticity.

Figure 9 is a photograph of the five-story pagoda taken from the footwork at the construction site. Kasuga Mountain lies far in the distance. As I was observing this beautiful landscape, an idea came to me. The religious sense of Kasuga Mountain as a divine area and prohibiting tree-cutting there may have come from the past of plundering forests, which resulted in frequent inundations and thus posed difficulties for people. Based on this idea, I decided to put together this presentation, as I mentioned in Section §1.

Figure 10 is a part of the *25,000:1 Active Fault Map in Urban Area: Nara* (Yagi *et al*, 1997), on which I plot sites of Daigokuden Hall and Nara Park. This map shows that Daigokuden Hall and Nara Park are located on the middle terrace surface, where the risk of inundation and debris flows is low. Those who built Daigokuden Hall and Kofuku-ji must have been conscious of the risks.

Figure 11 is an east–west cross section of the ground elevation where Nara Park is located. The Nara Basin Eastern Edge Fault runs along the boundary

Figure 8 Anti-seismic stainless latticework in a wall of the Kofuku-ji Central Golden Hall. Photograph by the author.

Figure 9 The five-storied pagoda around 50 m high, reconstructed in 1426, as seen from the footwork of the Kofuku-ji Central Golden Hall reconstruction site. Kasuga Mountain is far in the distance. Photograph by the author.

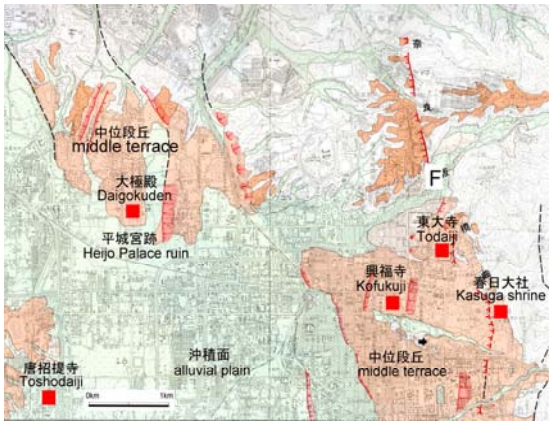


Figure 10 Part of the *25,000:1 Active Fault Map in Urban Area: Nara* (Yagi *et al*, 1997). Daigokuden Hall and Nara Park are located on the middle terrace surface (dark pink color part). Pertinent data are the same as in Fig.4

between Nara Park and Kasuga Mountain. The figure shows how the Nara Park area on the middle terrace surface is located topographically.

The topographic environment, where mountains lie on the upper block and religious buildings and housings are located on the plain on the lower block, was formed by the Nara Basin Eastern Edge Fault. If another earthquake occurs here, this area will be subject to strong ground shaking of seismic intensity level 7.

As for the safety of the area of Daigokuden Hall and Nara Park, there is a hidden hazard. Figure 12 shows the distribution of tracks of large-scale slope failures in the past. Since the start of documented history, there has been no document of slope failures in this area. However, in the event of a very heavy rain that occurs with a frequency of once every thousand years, large-scale slope-failure will occur, such as the 1953 Minami-yamashiro flood damage or the 2011 Kii Peninsula flood damage. This will trigger debris flows that can directly hit Kofuku-ji and Todai-ji temples, and spreading even to the city housing area. Ancient people and we modern Japanese are alike in that neither of us is aware of the risk of such disasters that happen over long time scales.

This example is instructive in many respects. Unless we consider low-frequency disasters that have little or no records in historical documents, we cannot protect our society, culture and people in a real sense. The 2011 earthquake off the Pacific coast of Tohoku was one of such disasters.

If this is the case, I wonder "how far in the past should we consider?" Some 7,300 years ago, the Kikai Caldera in the southern Kyushu caused a huge eruption, covering the whole of Japan with volcano ash, and destroying the Jomon culture in the Kyushu Island. We may need to reconstruct a whole structure of sciences based on geoscience.

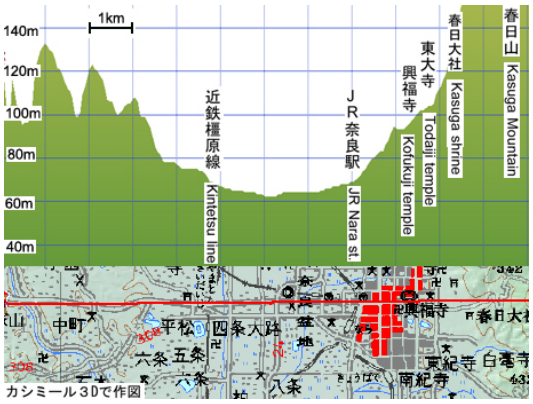


Figure 11 Ground elevation cross-section along the east–west line that runs through Nara Park. Expanded 50 times in the vertical direction. Pertinent data are as the same as Fig.4.

Figure 12 Distribution of slope failure topography near the Nara Park. Courtesy the National Research Institute for Earth Science and Disaster Prevention website.

7 Objection to studies of history

Natural disasters have been ignored in historical studies. For example, three academic paperbacks relate reasons why the capital was relocated to Heijo capital as follows:

"Fujiwara no Fuhito prepared a site of magnificent scenery for his grandson, Obito no miko (Prince Obito) to became Emperor Shomu in 724." (M. Senda, *Capital Relocation to Heijo-kyo*, 2008.)

"The Taiho (Era) Japanese missions to Tang China held an imperial briefing session on the land zoning of Changan, capital of Tang dynasty, after their return."

(Y. Sakaue, *The Era of the Heijo-kyo Capital*, 2011.)

"The Asuka River inundated frequently." (T. Ohta, *Forest Saturation*, NHK Books, 2012.)

All of the above might represent part of the facts. However, what I find hard to accept is that, as the books *Capital Relocation to Heijo-kyo* and *The Era of the Heijo-kyo Capital* typically indicate, the studies of history totally ignore natural phenomena.

The six-volume Japan Ancient History Series of Iwanami Shinsho paperbacks were published in 2010-2012. They did not mention natural phenomena at all, except volume 6, *Capital Relocation to Heian-kyo*, which was published immediately after the 2011 earthquake off the Pacific coast of Tohoku.

Natural disasters must have damaged lifelines, destroyed production infrastructures and spread starvation, which greatly debilitated the population. Therefore, the fact that studies of history ignore natural disasters implies that they ignore the debilitation of the people. In this sense, we can say that modern studies of history share the same standpoint as *Nihon Shoki* (The Chronicles of Japan written in the first of 8th century).

In the book *Chi no giho* (Kobayashi and Funabiki, *ed.*, University of Tokyo Press), two of co-authors had the following statement:

"'Intelligence' is the spiritual function of removing blocks and illuminating areas that have conventionally been in darkness."

H. Matsuura (Studies of culture and representation)

"There are three stages for intelligence: description, exploration, and prediction."

K. Yamanaka (Information linguistics)

I wonder how studies of history will illuminate disasters that remain in darkness in the future. What futures could studies of history predict without the description and exploration of natural disasters that will enervate people, in a coming era of starvation and global warming?

My intention is not to criticize existing studies. I expect that mutual interdisciplinary interaction will take place in the future to address this issue.

8 Aesthetic sense of the Japanese

While contemplating these ideas, I have thought I have reached one of the reasons for the characteristics of the Japanese aesthetic sense. I would like to discuss this with reference to Kyoto, the subsequent Japanese ancient capital from 794 to 1868.

The Kyoto Basin is situated between the Hanaore Fault on its eastern edge and the Nishiyama Fault on its western edge. They repeatedly brought about earthquakes during the period from hundreds of thousands of years in the past. As a result, the mountains and plain are abruptly disconnected, and the basin includes a great groundwater vein. The boundary zones between the mountains and basin have many historical and cultural properties, which render Kyoto a culturally distinguished city.

Figure 13 The Yokuryuchi pond overlooked from the Rin-untei tea pavilion above the cliff in the Shugakuin Imperial Villa, built in the 17th century. Photograph by the author.

Many of the historical cultural properties that are intact today were built during a period of a few decades in the beginning of 17th century, following the end of the provincial war age in the 16th century. During this period, peace was realized by the Tokugawa Shogunate. For example, the Nanzen-ji temple's Sanmon gate, the Chion-in's Mieido main hall, the Enryaku-ji's Konpon Chu-do main hall, the To-ji's five-storied pagoda, the Ninna-ji's five-storied pagoda, and the Myoshin-ji's Hatto (Dharma hall) were built during this period. The Shugakuin Imperial Villa and the Katsura Imperial Villa, both of which pursued the ultimate beauty of simplicity, may be differentiated from the above mentioned buildings.

Figure 14 Huge San mon gate of the Nanzen-ji temple, built in 17th century. There are Buddhist statues on the upper floor. Photograph by the author.

Figure 13 is a photograph of the Shugakuin Imperial Villa. The Yokuryuchi pond is viewed from the Rin-untei tea pavilion above the cliff. Although it is invisible in this photograph, the Kitayama hill area lies far off in the background. Between the place where I took this photograph and the Yokuryuchi pond, there is the Hanaore Fault running in an N-S direction, which is the biggest risk factor for the Kyoto Basin. The fault brought about many earthquakes, and the geological formation seen in this photograph was created over hundreds of thousands of years.

This landscape is very beautiful, and has been used as a subject of Japanese paintings. Well known are the paintings included in *Four Seasons in Kyoto* of Higashiyama (1969). Figure 13 is taken from the almost the same angle that was depicted in one of the paintings *Lush Green*.

Yosa Buson's painting *Yashoku-rodai-zu* ("Snow Scene at Night") and Kaii Higashiyama's *Toshikuru* ("Yearend") in *Four Seasons in Kyoto* both express the scenery of the Higashiyama hill area seen from the

city center. Many of Japanese love these paintings.

Figure 14 shows the Sanmon (main) gate of Nanzen-ji. The temple ground extends behind the gate, and the Higashiyama hill area extends further into the background. The Sanmon gate was built on the initiative of Takatora Todo in the first part of the 17th century. He was a daimyo, feudal lord, of Ise（Mie Pref. today）. When I see the Buddhist statues on the upper floor of the huge San mon gate, I deeply sense the intention of Takatora Todo. I feel his laments over the dead. During the period of the provincial wars, many relatives, subordinates and associates of his must have had undesired deaths.

Why do we Japanese find such a landscape beautiful? It may be because, since the era of the Makimuku Ruins, or probably even before, a span of thousands of years is condensed into such a landscape, which has been a place of assurance and prayers. Of course, the Makimuku Ruins palace, the Shugakuin Imperial Villa, and the Nanzen-ji temple were intended to represent the power of the dominating people at their respective times. However, it would not be fair to criticize this fact from the standpoint of modern times, when society has become more mature and humanism has become better established. Rather, I would like to emphasize that these places carry laments over the dead.

From the geoscientific point of view, those places were formed by a seismological environment in which inland active faults repeatedly caused earthquakes. Japan is a unique country that has a tectonic plate subduction zone in an evergreen broadleaf forest zone on the Earth. I am confident that this uniqueness is one of sources of the distinguished Japanese historical consciousness and aesthetics.

The Japanese people take such landscapes for granted, but foreigners discovered their uniqueness.

In the book *Nippon* (in Japanese translation), Bruno Taut wrote:

“Mountains stand out extremely abruptly from the plains and seas. Compared with mountains in other countries, their altitude above sea-level is not very high, but flirting with the clouds, their loftiness is surprisingly impressive.”

“At all temples and shrines, the impression of beauty comes from the unity between the architectures and nature, rather than from the buildings themselves.”

Although he uses different words, Bruno Taut correctly pointed out one of sources of the Japanese aesthetic sense.

9 Unequal society

Figure 15 presents a newspaper article that estimates human losses from a presumed Nankai megathrust earthquake of magnitude 9. They are afraid that the earthquake may kill 320,000 people: 230,000 due to tsunamis, 82,000 due to housing collapses, and 10,000 due to earthquake-caused fires. Those who may be killed in housing collapses and earthquake-caused fires will include the economically disadvantaged people such as the elderly and temporary employees with an annual income less than two million yen. These people live in old densely inhabited wooden housing districts of modern cities in the western Japan, and are unlikely to retrofit their houses to make them earthquake-resistant.

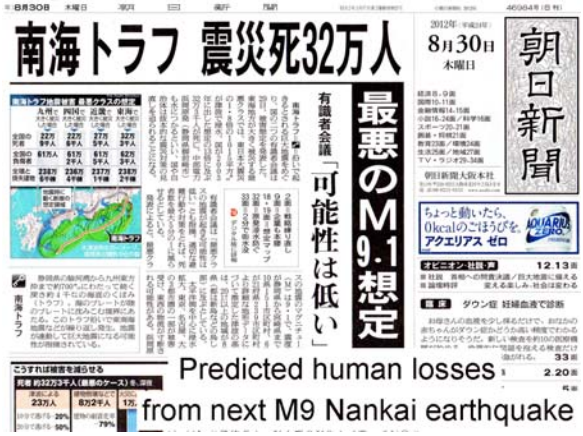


Figure 15 Asahi Shimbun article estimating human losses from the level 2 Nankai megathrust earthquake, based on a release from the Central Disaster Management Council on August 29, 2012.

In about 10 years, a Tokyo metropolitan inland earthquake is expected to occur. In this earthquake, most of those killed will be the same, the economically disadvantaged people living in such densely inhabited wooden housing districts in Tokyo.

Figure 16 shows the predicted earthquake-caused fires in the case of a Tokyo metropolitan inland earthquake. In Tokyo, densely inhabited wooden housing districts are located in lowland districts developed before the Second World War between the Arakawa and Sumidagawa Rivers (right half of Figure 16), where there are many old tenements. The areas close to Ring Roads 6 and 8 in the middle of the Figure are also the housing districts, in which many wooden rental housings were built as a result of rapid urbanization during the high economic growth years in the 1960’s and 1970’s. A major part of the area between the Arakawa and Sumidagawa Rivers has multistory buildings and fewer fires are expected to occur there today, although the damage due to seismic shaking will be tremendous.

Since ancient times, the population has had steeply increased, forests have been plundered, earth and sand sediments have increased in rivers, and alluvial plains have expanded. Modern cities had been built on

these alluvial plains, and in view of this history of two thousand years and an expected earthquake disaster, I feel that the anticipated huge losses of lives of economically disadvantaged people should be attributable to none other than man-made causes.

The governmental administration is aware of the danger and is planning safety measures, but the budget is very limited.

To drastically reduce the huge losses in densely inhabited wooden housing districts, seismic diagnosis and seismic retrofitting must be conducted. The effects of seismic retrofitting are evident, but why is little progress made in seismic retrofitting? While I was wondering this, I came across the newspaper article in 2007 (Figure 17), and felt as if a fog had been lifted. If my income is two million yen or less, I would not feel like spending nearly one million yen on seismic retrofitting. The landlords of low-rental housings in which economically disadvantaged people live will not spend a lot of money on seismic retrofitting either. Even to me, a researcher of natural science, it became apparent that inequality has made Japan deeply vulnerable to disasters.

Figure 18 shows that the ratio of unmarried people drastically increases in population layers whose annual income is three million yen or less. It is clear that inequality is one of the factors of population decrease.

Society is being separated into two groups and polarized, and is becoming highly vulnerable to disasters. The number of children is decreasing, which may cause Japan to be pressed down by the loads of social security services in the future. Nevertheless, measures for controlling temporary employment have been put on the shelf.

If the inequality is temporary, the problems may be not serious. However, once people become temporary employees, it is difficult to find a permanent position, drastically differentiating lifelong aggregate income. Many people may be unable to pay contributions to the national pension plan. In June 2011, a newspaper (in Figure 19) reported that the number of welfare recipients exceeded two million. As an unequal society in which more than ten million temporary workers earn an annual income of two million yen or less continues, an increasing number of people will be unable to make their payments into the national pension plan, and this number will never decrease. The situation will become a permanent condition. This will make the future society extremely weak, when the next Nankai earthquake will hit. It will not hit today's society, which is more or less healthy.

In today's society, companies employ more temporary workers to reduce costs, thus earning more profits. I am a non-professional to economics. However, it seems even to me that the social welfare cost, which will be necessary for today's temporary

Figure 16 Predicted earthquake fire locations in the case of a Tokyo metropolitan earthquake. The yellow-colored areas are supposed to be strongly hit by fires and designated as areas prioritized for countermeasure implementation. Courtesy Metropolitan Tokyo government website.


年収200万円以下、1000万人超
民間給与、格差拡大

Figure 17 *Asahi Shimbun* article of September 28, 2007. Number of people of income less than 2 million yen exceeded 10 million.


結婚 年収300万円の壁
20～30代男性 既婚率1割未満
厚労白書案

Figure 18 *Yomiuri Shimbun* article of August 26, 2013. Number of unmarried people drastically increased in population layers whose annual income is three million yen or less.

workers in the future, is being transferred to corporate profit.

Individual seismological achievements or disaster prevention measures cannot fundamentally reduce the great death toll associated with housing collapses and fires in an extremely weak society. Only politics and economics can drastically reduce the huge losses of economically disadvantaged people who cannot carry out seismic retrofitting. This possible solution may be applicable to populated seashore districts, which could be hit by great tsunamis, to a certain extent.

I am not saying seismology or studies of disaster prevention technology are unnecessary, of course. The more they are advanced, the fewer future victims there will be. The problem is that even if the results of these studies are accumulated, they cannot deal with the tremendous scale of human losses. We should probably question how society is built and how the academics should function


夕刊 讀賣新聞 2011年(平成23年) 6月14日 火曜日

生活保護200万人突破

不況で59年ぶり

被災で申請 福島、最多335世帯

Figure 19 *Yomiuri Shimbun* article on June 14, 2011. The number of welfare recipients exceeded two million.

10. Trans-Pacific Partnership (TPP)

I would like to move to discuss the issues of the Trans-Pacific Partnership (TPP). TPP is said to enable people, merchandise, services and money to move completely freely across national borders. The issue is whether it could make people in Japan and the world happier.

Figure 20 shows a diagram of how Japanese timber production, imports and self-sufficiency rates have changed in the past half century. The red bars indicate domestic production; blue bars, imports; and the broken line, the self-sufficiency rate. The horizontal axis represents the year. Since about 1970, the timber self-sufficiency rate has fallen drastically. At first, it was mainly because of an increase in housing demand due to high economic growth: the timber supply was insufficient and the shortage was accommodated by imports. However, gradually, imported timber occupied a larger share of the domestic market due to its lower costs, which caused the Japanese forestry industry to deteriorate.

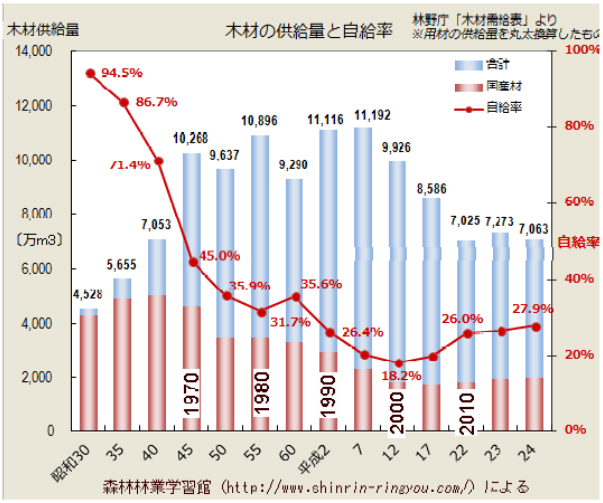


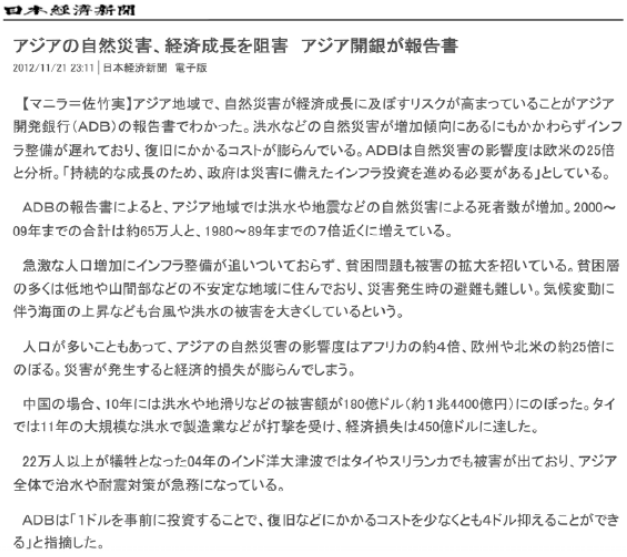
Figure 20 Transition of the timber self-sufficiency rate of the past half century from the Forest and Timber Industry School website. The red bars indicate domestic supply; blue bars show imports; red broken line shows the self-sufficiency rate; the horizontal axis is the year. The left vertical axis is the amount of timber supply, and the right vertical axis is the self-sufficiency rate. The original information comes from the Japanese Forestry Agency's table regarding timber supply and demand.

As a result, ironically, Japanese forests are today saturated, and compared with when I was a child, mountains are covered with green as far as we can see from alluvial plains, and inundations, slope failures, and debris flows have become surprisingly rare (Ohta, 2012). At this moment, artificial forests that are not tended are a big issue, but I will refrain from discussing this matter in detail here.

Figure 21 is a *Nihon Keizai Shimbun* electronic article stating that the Asian Development Bank warned that natural disasters are interfering with Asian economic growth. I understand that the logic of this report is preposterous. It should state, rather, that economic activities crossing national borders have actually increased disasters.

Isn't this a transfer of disasters? Of course, the international trading of timber is not the only problem. The development of plains and forests for international companies who entered developing countries in pursuit of timber product trading and low-cost labor has had a considerable indirect impact. In either case, as a result of activities crossing national borders based on economic rationality, Japan has, incredibly, transferred the disasters to developing countries in Asia.

In a coming age of global starvation and global warming, if the countries that plan to participate in TPP—namely Malaysia, Indonesia, Vietnam, Chile, and Peru—proceed with trading and economic development based on economic rationality, the risk of disasters may unintendedly be transferred. What Japan has experienced in the past 2,000 years, which includes forest devastation, outflow of great volumes of earth and sand, loss of port functions, and frequent inundations and droughts, will occur in these countries at a higher rate.



日本経済新聞

アジアの自然災害、経済成長を阻害　アジア開銀が報告書

2012/11/21 23:11 | 日本経済新聞　電子版

【マニラ＝佐竹実】アジア地域で、自然災害が経済成長に及ぼすリスクが高まっていることがアジア開発銀行（ADB）の報告書でわかった。洪水などの自然災害が増加傾向にあるにもかかわらずインフラ整備が遅れており、復旧にかかるコストが膨らんでいる。ADBは自然災害の影響度は欧米の25倍と分析。「持続的な成長のため、政府は災害に備えたインフラ投資を進める必要がある」としている。

ADBの報告書によると、アジア地域では洪水や地震などの自然災害による死者数が増加。2000～09年までの合計は約65万人と、1980～89年までの7倍近くに増えている。

急激な人口増加にインフラ整備が追いついておらず、貧困問題も被害の拡大を招いている。貧困層の多くは低地や山間部などの不安定な地域に住んでおり、災害発生時の避難も難しい。気候変動に伴う海面の上昇なども台風や洪水の被害を大きくしているという。

人口が多いこともあって、アジアの自然災害の影響度はアフリカの約4倍、欧州や北米の約25倍にのぼる。災害が発生すると経済的損失が膨らんでしまう。

中国の場合、10年には洪水や地滑りなどの被害額が180億ドル（約1兆4400億円）にのぼった。タイでは11年の大規模な洪水で製造業などが打撃を受け、経済損失は450億ドルに達した。

22万人以上が犠牲となった04年のインド洋大津波ではタイやスリランカでも被害が出ており、アジア全体で治水や耐震対策が急務になっている。

ADBは「1ドルを事前に投資することで、復旧などにかかるコストを少なくとも4ドル抑えることができる」と指摘した。

Figure 21　Article of *Nihon Keizai Shimbun* Electronic version. Asian Development Bank warned that natural disasters are interfering with Asian economic growth.

Economics in Japan seems to discuss TPP in a narrow sense, which is whether participating in TPP will make money or lose money. I wonder "Will TPP make people in developing countries happier?" In a coming age of starvation and frequent disasters, "how can the Japanese economics contribute to helping them become happier?" I would like Japanese economics to discuss such global issues. Those who object to TPP are dismissed as narrow-sighted people through canny rhetoric, and many people seem to hesitate to oppose TPP. However, as I discussed so far, such reasoning is preposterous.

What is economics for? (Inoki, 2012) stated: "It is necessary to learn the logics, roles and limits of economics, and the decency of not discussing the logic of economy alone is required."

11. Concluding remarks

We must realize a future society where workers are equally treated and historical culture is respected. We should not emphasize the interests of Japan alone; we desire to have economics that takes the happiness of developing countries into consideration. However, nature is violent, and even if we realize such a society, it will be difficult to nullify the victims of disasters. Cultural and aesthetic activities will continue as prayers for peaceful resting of the souls of victims.

The author has spent most of his life as a researcher in seismology. The parts discussing fields other than seismology must include many misunderstandings and errors. As I finish this paper, let me apologize for such shortcomings.

This paper is mainly based on chapter 3 of a paper I contributed to *Intelligence for Disaster Prevention and Restoration—Living after March 11, 2011* (in Japanese), scheduled to be released by Kyoto University Press in 2014.

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