Geographical Study of the Disaster in Japan and the activities of "Commission of Disaster Responses" of the Association of Japanese Geographers

Japan is subject to suffer disasters due to its natural condition. Until the 1970s, the relationship between flood and the geomorphological condition was studied and the results were applied to hazard mapping. After the 1980s, landslide and debris flow, earthquake, and volcanic activity became the main problem of the disaster prevention. After the Great Hanshin Awaji Earthquake Disaster of 1995, the geographical studies on earthquake disaster increased. The Association of Japanese Geographers (AJG) established the Commission of Disaster Responses in 2001, and it holds symposium on disasters from the geographical viewpoint every year in the general meeting of the AJG. The mapping of the tsunami stricken area of the Great East Japan Earthquake Disaster of 2011 was carried out by a special team of the Association of Japanese Geographers. The study on disaster is conducted now in the field of physical geography and the human geography. The role of the Japanese geographers becomes very important in a world disaster study.

Geographical Characteristics and Natural Disaster of Japan

Since the Japanese Islands (Fig. 1) are situated along the convergent boundaries of four plates (Pacific, North American, Eurasian, and Philippine Sea plates), they are tectonically very active. Earthquakes occur frequently (Fig. 2), and there are many active volcanoes. Uplift rate of mountain area is very high. Therefore, the mountain slope is steep and is geologically open to collapse, and the river gradient is steep in general.

Japan is located in the Asian monsoon zone and has high annual precipitation (1500mm on average, up to over 4000mm). Tropical cyclones (typhoons) and/or *baiu* (early summer rain) sometimes lead to torrential rainfall.

While area of alluvial plains underlain by thick unconsolidated sediment account for only 25% of whole Japan, they contain approximately 80% of population. Owing to such geographical characteristics, various natural disasters have occurred in Japan.

Outline of the History of Disaster Studies by the Japanese Geographers

After World War II, the damage of the typhoon was heavy until the 1950s. The Typhoon *Kathleen* of 1947 (more than 1,900 dead or missing) brought the flooding of rivers widely and inundated a part of Tokyo. The relationship between the micro-landform distribution of plains and the flooding situation was investigated (Ogasawara 1947). This was the first geomorphological disaster study by using air photos in Japan. In 1958, studies on the floods and debris flow disasters of Kanogawa Typhoon (Typhoon *Ida*), by which more than 1,200 people were killed or missing, were done from both physical and human geographical viewpoints. The resulting papers were published in a special issue of the *Geographical Review of Japan* (AJG 1960)(Fig. 3).

Isewan Typhoon (Typhoon *Vera*) of 1959 brought the biggest damage caused by flood in Japanese modern history (Fig. 4). More than 5,000 people were killed or missing by it. The main damaging phenomenon was the high tide invading into Nagoya city and its surroundings, southern part of Nobi Plain. Three years before the disaster, geographer OYA Masahiko made a 1:50,000 geomorphological map on Nobi Plain (Oya 1956)(Fig. 5). The damage area was in accordance with the map which was based on geomorphic features. After this, it became well-known that the geomorphological mapping is effective for understanding the flood risks, and the Geographical Survey Institute (present name: the Geospatial Information Authority of Japan; GSI) of the government started a project to prepare the "1:25,000 Land Condition Maps," which show geomorphic feature and facilities for disaster measures of the plain area in 1960 (Fig. 6).

After the 1960s the occurrence of broad flood decreased as the river improvement facilities of big rivers advanced. In 1982, extraordinary heavy rain hit Nagasaki city. It caused a lot of landslides, debris flows, and flooding of small rivers resulting approximately 300 deaths of residential people. It indicated that small-scale flooding and debris flow in populated area became the big problem (Koike 2001). 1980s is also the period when studies of the debris flow mechanism based on the observation was advanced (Suwa 1988, Fujita et al. 1989., etc.).

It is notable that the National Research Institute for Earth Science and Disaster Prevention (NIED) has been preparing 1:50,000 "Landslide Distribution Maps" using air photos since the beginning of the 1980s[1].

Since the 1980s, the risks of potential earthquake and volcanic activity have been also recognized broadly. Both plate boundary and intraplate active fault are the major origin of great earthquakes in Japan. Typical examples are the 1923 Kanto Earthquake (the Great Kanto Earthquake Disaster; more than 100,000 people were killed) and the 1995 Southern Hyogo Prefecture Earthquake (Hanshin Awaji Great Earthquake Disaster; more than 6,400 people were killed), respectively. Geographical studies on the damage by ground motion and its secondary phenomena (soil liquefaction, landslide, deformation and flow of fill-ground, etc.) have been performed through the experience of repeated earthquakes. It became clear that the soil liquefaction as well as the strong motion is affected by geomorphic condition through 1964 Niigata Earthquake and the 1983 Central Part of Japan Sea Earthquake, both of which occurred along the eastern Japan Sea. Oya et al. (1982) made a 1:50,000 geomorphological map indicating the risk of liquefaction, and the real liquefaction distribution of the 1983 Central Part of Japan Sea Earthquake was in accordance with the map. Since then, geomorphological earthquake hazard map came to be made by local governments.

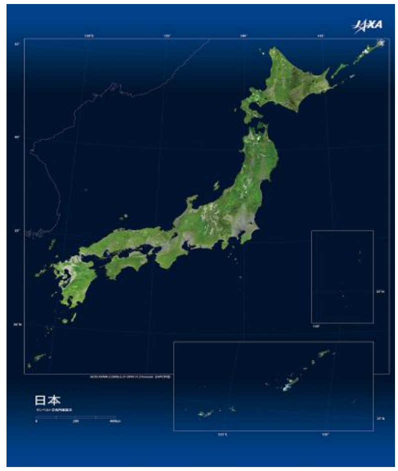

Fig. 1 Satellite image of the Japanese Islands
http://www.sapc.jaxa.jp/gallery/cat01/detail/D-0865_pl.html

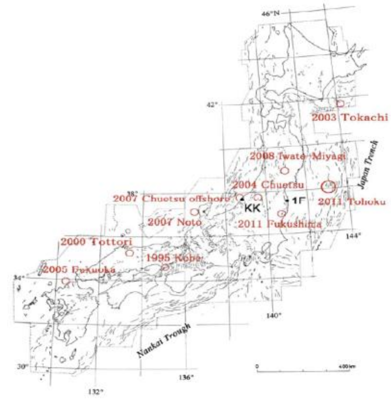

Fig. 2 Main active faults in and around Japan and major earthquakes occurred after 1995 (modified after The Research Group for Active Faults of Japan, 1980). KK: Kashiwazaki-Kariwa nuclear plant. 1F: Fukushima Daiichi nuclear plant. Suzuki (2013).

Fig. 3 Papers in a special issue of the Geographical Review of Japan published in 1960

Fig. 4 Air photo along the coast of Ise Bay after Isewan Typhoon of 1959
The photo was taken by GSI

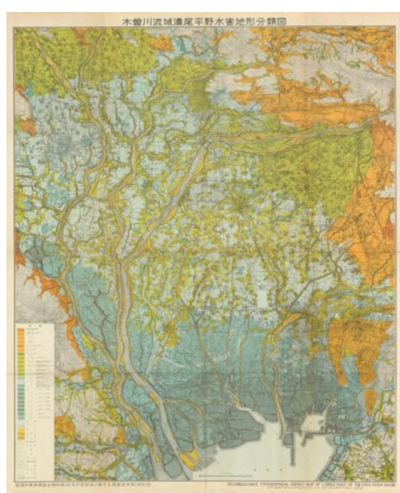

Fig. 5 Geomorphologic landform classification map of the Nobi Plain, central Japan (Oya, 1956)
http://dil.bosai.go.jp/disaster/1959isewan/material/images/fuzu/fuzu_013.jpg

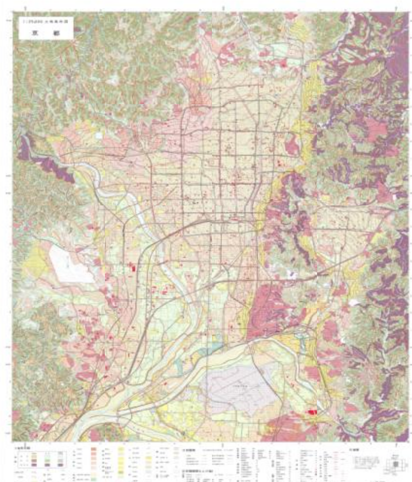

Fig. 6 Land condition map of "Kyoto" published by GSI
http://www.gsi.go.jp/bousaichiri/lc_index.html

Table 1 Major hazard mapping projects promoted by the government

Map name	Scale	Organization	Years of project
Tochi Joken Zu (Land Condition Map)	1:25,000	GSI	1963–
Chisui Chikei Bunrui Zu (Geomorphological Map for Prediction of Flooding)	1:25,000	GSI	1976–78, 2007–
Kozui Hazard Mappu (Flood Hazard Map)	1:10,000–1:15,000	Municipalities	1994–
Jisuberi Chikei Bunpu Zu (Landslide Disaster Map)	1:50,000	NIED	1982–
Kazan Bosai Mappu (Volcano Hazard Map)	indefinite	Municipalities	1992–
Toshiken Katsudanso Zu (Active Fault Map in Urban Area)	1:25,000	GSI	1995–
Yureyasusa Mappu (Earthquake Disaster Hazard Map)	indefinite	Municipalities	2005–

GSI: Geospatial Information Authority of Japan
NIED: National Research Institute for Earth Science and Disaster Prevention

As for the volcano disaster, Geographers contributed the study of mass movements accompanied the 1977-1982 volcanism of Mt. Usu (e.g., Kadomura et al. 1983). Human response was also studied (Kadomura et al. 1978) (Fig. 7). Eruption of Tokachidake of 1988 accompanying a small lahar was an opportunity to start making the hazard maps of volcanic region by local governments.
In 1993, the "International Congress on Geomorphological Hazards in Asia-Pacific Region" was held in Tokyo organized by the Working Group on Natural Hazards and Environmental Geomorphology, AJG and Working Group on Rapid Geomorphological Hazards (chaired by Oya), IGU, and 27 papers were presented. Eleven papers of 14 Japanese researchers' papers are placed in *GeoJournal* (Kluwer Academic Publishers 1996) (Fig. 8).
The 1995 Southern Hyogo Prefecture Earthquake caused by an intraplate fault activity hit Kobe city and its surroundings, one of the highly-urbanized areas in Japan (Figs 9 and 10). Before the earthquake, geomorphologists and geologists had made an active fault catalog in Japan (Research Group for Active Faults of Japan 1980, 1991) and it paid considerable attention to the occurrence of the earthquake. After the earthquake, the government established the Headquarters for Earthquake Research Promotion (HERP). The "National Seismic Hazard Map," which shows the probability of great earthquake motion, has been open to public by HERP.[2] Many tectonic geomorphologists cooperated with this project (Ota and Okumura 1999, Kumaki 1999).
As to the earthquake, a group led by geographer USUI Teruko of Nara University worked on stricken area support using GIS. The value of GIS became widely recognizable, and it was the big opportunity to develop GIS studies. In addition, geographical studies of the disaster on physical side and social and economic side were conducted, and a special issue of the *Geographical Review of Japan* was published (AJG 1996).
Table 1 shows the major mapping projects that the government promotes. The transition of number of the articles (Table 2) also shows such history. Studies on disaster have been increased since 1995. There were few studies from the field of human geography before 1995[3], but recently studies on disaster by human geographers are not a few. In recent years Japanese geographers (HARUYAMA Shigeko, UMITSU Masatomo, etc.) study the disasters of foreign countries, especially Southeast Asia.

Fig. 7 Oblique view of Mt. Usu (Kadomura et al., 1983). Photo by Kokusai Kogyo, 1981.

Fig. 8 Brief report of the International Congress on Geomorphological Hazards in the Asia-Pacific Region (*GeoJournal*, 38.3)

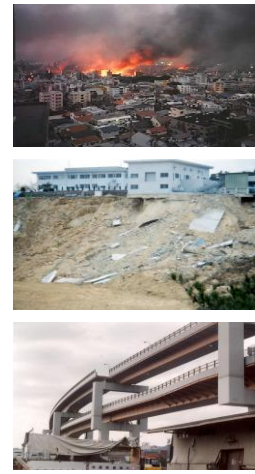

Fig. 10 Disasters caused by the 1995 Southern Hyogo Prefecture Earthquake. (a) Fire in Kobe city (by I. Kobayashi). (b) Slope failure (by T. Kuroki, and (c) Damaged express highway (by T. Kuroki).

Fig. 9 Active fault map of the urban area of Kobe (presented by Geospatial Information Authority of Japan)

Disaster Responses of the Association of Japanese Geographers after 2001

The study of the disaster is the field where geography can contribute to the society directly. It has been thought that the study of the disaster occupied the important position for Japanese geography of the 21st century. Therefore, "Commission of Disaster Responses" was established in the AJG in 2001. The main purposes of the commission are to coordinate geographers' survey and study and to share information when disasters occur, and to contribute society by issuing results of the geography studies. It was chaired by ENDO Kunihiko (2001-2008) and HIRAI Yukihiro (2008-2012). The present chairperson is KUMAKI Yohta.
The commission held an open symposium in every spring meeting and some autumn meetings of the AJG since 2003 (Fig. 11). Through these symposia the commission announced present results of the disaster studies and their importance to Japanese geographers, and submitted a point of issue how geographers contribute to solve the social problem.
On March 11, 2011 the off the Pacific Coast of Tohoku Earthquake occurred (Fig. 12). It caused a huge tsunami and more than 19,000 people were dead or missing. This catastrophic disaster including an accident of the Fukushima Daiichi Nuclear Power Station is called the Great East Japan Earthquake Disaster. The AJG coped with the disaster by the special system. The headquarters for disaster response was set up and YAGASAKI Noritaka, the chairperson of the executive committee of AJG, took office as the general manager. It performed liaison with other academic societies, information dispatch through website[5], etc. until April, 2012.
One of the very notable activities of the headquarters was the 1:25,000 mapping of a tsunami stricken area (Figs. 13 and 14). It started immediately after taking air photos by the GSI and a result map of the first version was uploaded on March 29. This activity was carried out by a great cooperation of geomorphologists who get used to treating air photos and geographers specializing in GIS. The map was updated several times to improve the accuracy. The latest version[4] was uploaded in December 11, 2011. This activity was highly appreciated because the important data opened to public quickly when a field survey was not easy.
Separately from the activity of the headquarters, some geographers investigate the radiation dose distribution[6].

Fig. 11 Poster announcing symposium held by the Commission of Disaster Responses, AJG

Table 2 The number of articles of the disaster study by Japanese geographers of three major geographic journals*

Years	General	Earthquake	Flood	Volcano	Total	(Human Geography)
1980-1984	-	1	1	1	3	(-)
1985-1989	-	1	4	-	5	(-)
1990-1994	1	1	4	1	7	(1)
1995-1999	-	17	3	1	21	(4)
2000-2004	1	2	1	1	5	(9)
2005-2009	-	7	5	-	12	(4)
2010-2012	1	4	7	-	12	(4)

* *Geographical Review of Japan* of the Association of Japanese Geographers
Japanese Journal of Human Geography of the Human Geographical Society of Japan
Journal of Geography (Chigaku Zasshi) of the Tokyo Geographical Society

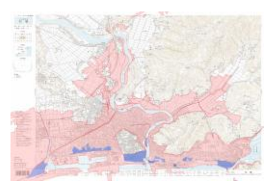

Fig. 13 Map of the area hit by the tsunami of 11 March 2011 mapped by Tsunami Damage Mapping Team, The Headquarters for Disaster Response, AJG.

Fig. 12 Disasters caused by the 2011 off the Pacific Coast of Tohoku Earthquake. (a) Natori city located at the Sendai coastal plain (by K. Hori). (b) Onagawa town located at ria coast (by S. Ishiguro), (c) Vessel beached on the shore (by C. Oguchi) (d) Liquefaction at a park of Tochigi city located far from the epicenter (by Tochigi city employee).

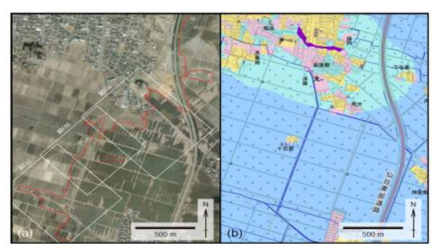

Fig. 14 (a) Tsunami inundation area of the Sendai coastal plain. (b) Land condition map of the area. Sugito et al. (2012).

The Future Prospects

Geography has contributed to disaster prevention measures mainly in a field of the hazard mapping. Geomorphologists have played a large role. However, the disaster study should be based on wide field of geography. As to the Great East Japan Earthquake Disaster of 2011, various studies including social or economic geography have been performed, e.g., radioactive contamination, land use planning for revival of the stricken area, the community maintenance of inhabitants, and influence on circulation of supplies. This should not be ended as a temporary phenomenon. The disaster raised the recognition of the people of the rare and extraordinary big disasters. A natural disaster is a phenomenon that nature has an influence on the human society. Geography is science elucidating area properties by both physical and human sides. The geographical disaster studies, therefore, should be applied to the real society and it is necessary to send its result to the society widely. The development of geographical information science will support it.
Japan has many observation data and historical materials of disasters, and disaster studies in various sciences including geography have achieved much result. Probably the most of the result will be applicable to the world, especially Asia and Pacific regions. The Japanese geographers must promote a study for reduction of the disaster under the cooperation with the foreign scientists.

Notes

1.http://lsweb1.ess.bosai.go.jp/en/index.html (last accessed 12 June 2013)
2.http://www.jishin.go.jp/main/index-e.html; http://www.j-shis.bosai.go.jp/en/ (last accessed 12 June 2013)
3.Nakabayashi Itsuki is one of a few geographers who has been studying the disaster in a field in conjunction with the city planning from the 1970s (Nakabayashi 1990 etc.).
4.http://www.ajg.or.jp/disaster/201103_Tohoku-eq.html (last accessed 12 June 2013)
5http://danso.env.nagoya-u.ac.jp/20110311/map/index_e.html (last accessed 12 June 2013)
6 e.g. http://dbx.cr.chiba-u.jp/act/fukushima/

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