



Global Center of Excellence for  
Education, Research and Development  
of Strategy on Disaster Mitigation  
of Cultural Heritage and Historic Cities  
***Newsletter No.18***

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## Disaster Mitigation for Historic Cities and Visiting Tourists

Most historic cities with a wealth of cultural assets also happen to be centers of tourism that attract large numbers of tourists. In the event a large-scale disaster was to strike such a city at the height of its tourist season, many tourists would be among the casualties or evacuees unable to return to their homes. Hence, as that scenario suggests, when devoting study to plans for disaster-prevention and response, attention should be given to the needs not only of local citizens but also of tourists.

In that context, what are the defining attributes of tourists that should be taken into account? The following come to mind.

- Tourists contribute to major changes in local population by season, day of the week, and daily time frame.
- Although tourists may be knowledgeable of the sightseeing spots on their itineraries, they generally have little or no knowledge of the neighborhoods surrounding those spots.
- They also typically have no awareness of the risk of fire or other disasters in the areas surrounding tourist spots or of the evacuation centers or safe areas that would be utilized in the event of a disaster.

Consequently, taking the disaster-related needs of tourists into account demands that we have an accurate understanding of the times during which tourist volume is high, the spots where tourists tend to congregate, and the scale of tourist turnout at those locations. Additionally, it demands that we set up evacuation centers or safe zones as well as escape routes that ensure tourists with limited familiarity with the locale will still be able to readily find their way, evacuate the area, and remove themselves from danger.

Charts 1 to 3 plot the findings of a tourist questionnaire survey (931 respondents) that the authors conducted with the cooperation of tourists visiting the Higashiyama district of Kyoto in 2008. Chart 1 illustrates the number of visitors to major sightseeing spots in the Higashiyama district; Chart 2 plots samples of the hourly flow of tourists entering and leaving the Higashiyama district; and Chart 3 plots samples of the hourly change in the local Higashiyama tourist population based on the data in the first two charts. Analyzing patterns of tourist flow in this detail allows us to better understand when, where, and how many tourists are visiting. Additionally, it facilitates study and preparation for the location of evacuation centers and the design of escape routes based on these patterns of movement or behavior that will ensure tourists are better able to escape to safe areas without losing their way.

Cultural assets and historical urban zones are major resources for tourism and serve as a vital base of economic activity in a historical city. Sustaining historical city demands that steps be taken to ensure the security and peace of mind of its tourists as well as create an urban fabric that supports the economic viability of its tourism industry. The Global COE Program for Education, Research and Development of Strategy on Disaster Mitigation of Cultural Heritage and Historic Cities comprises research that involves analyses of the above-described patterns of tourist behavior as well as disaster-mitigation planning. For further information, please browse the papers and reports in the "Disaster Mitigation of Cultural Heritage and Historic Cities" proceedings. (<http://r-cube.ritsumei.ac.jp/browse-journaltitle>)

Keiichi Ogawa

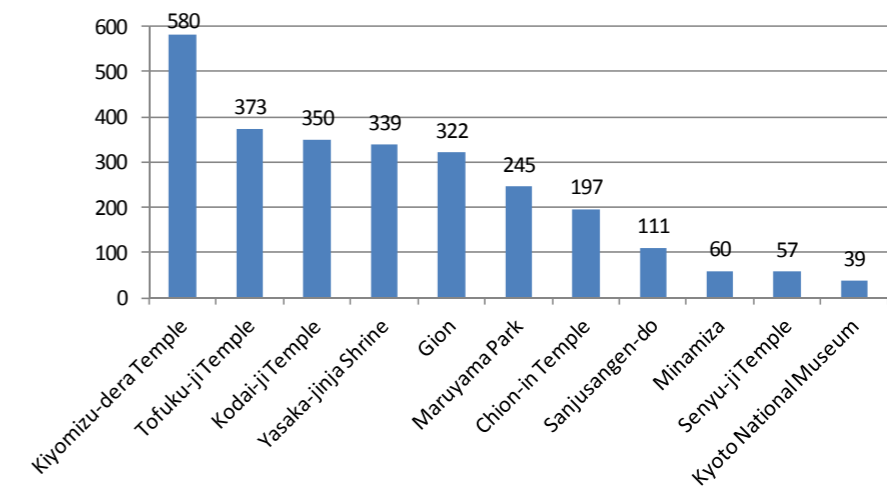


Chart 1 Number of Visitors to Major Sightseeing Spots in the Higashiyama District

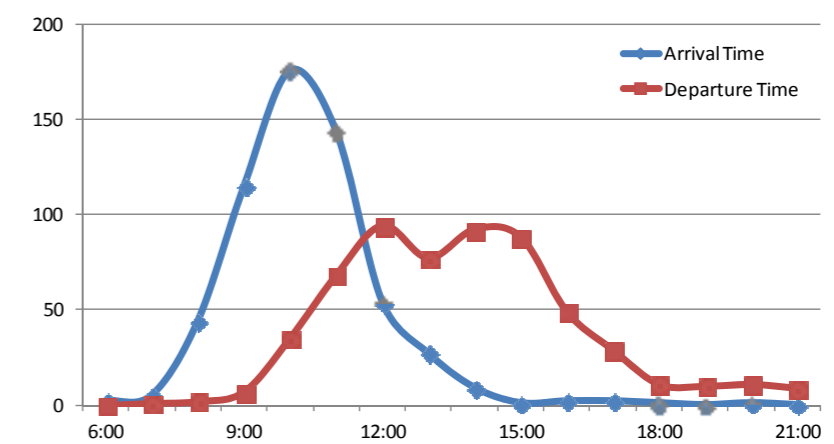


Chart 2 Hourly Tourist Flow (Arrivals and Departures) in the Higashiyama District

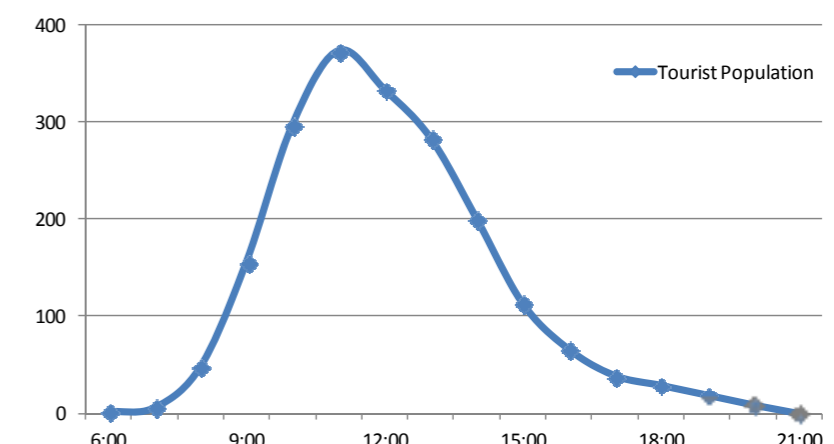


Chart 3 Hourly Change in Local Higashiyama Tourist Population

## Survey of Damage Caused to Timber Buildings by May 6, 2012 Tornado

This report documents damage caused to wooden buildings by a tornado that struck an area of the Kanto district on May 6, 2012. The survey team consisted of three members involved with the Ritsumeikan Global COE Program: Yoshiyuki Suzuki, Kyosuke Mukaibo, and Yuu Ooka. The team toured scenes of tornado-inflicted damage on May 12 in Mooka City, Tochigi Prefecture as well as the two towns of Mashiko and Motegi in the same prefecture's Haga district, and on the following day in Tsukuba City, Ibaraki Prefecture. Note that this was not a comprehensive survey as it only involved tours to locations with reported damage.

### 1) Nishidai district of Mooka City

On the premises of one Shinto Shrine site, a small wood-frame structure (possibly a chouzuya, for ritual hand-cleansing) had collapsed (Photo 1). However, the front and main shrines remained virtually untouched (Photo 2). Some trees in the vicinity had been entirely uprooted (Photo 3). Additionally, buildings nearby exhibited extensive roofing tile loss or shifting as well as some damage to their roof sheathing and trusses also suffered damage (Photos 4-6). The extent of damage was generally limited to the path of the tornado, which was estimated to be a few dozen meters wide.

### 2) Osawa district of Mashiko

A golf-course clubhouse located on high ground received extensive damage to its exterior from high winds and blowing debris (Photo 7). A traditional timber building located about 100 m distant from that clubhouse displayed damage to its tile roofing (Photo 8). Another, conventional-style wood-frame building had roofing tiles blown off and sections of mortar exterior that had fallen away (Photo 9).

### 3) The Motegi and Kita-takaoka districts of Motegi

Tornado-inflicted damage in the Motegi area was limited chiefly to roofing damage on a few structures here and there (Photo 10). Although it was reported that the main gate (sanmon) of a Buddhist temple in the Kita-takaoka district had been destroyed, the rubble had already been removed when we toured that location (Photo 11). The Great Buddha Hall (daibutsuden) of that temple had been built in 1679 A.D. and was so old it had been reinforced with diagonal beams to prevent collapse (Photo 12). Fortunately, it was somewhat off the tornado's path and thus escaped harm. Still, some trees in the small mixed-growth woodland located immediately behind this structure did suffer damage.

### 4) Hojo and Osuna districts of Tsukuba

The tornado inflicted damage over a fairly wide swath of the Hojo district (Photo 13). That included scattered roofing tiles, damage to roofing trusses, and damage to building exteriors and wooden framework (Photo 14). Horizontal tornado-force winds tilted or laterally shifted entire structures (Photo 15). Partly due to the high concentrations of buildings in the Hojo district, the path of damage spanned an estimated about 100 m in its width. Although damage in the Osuna district was apparently not as extensive, structures with damage to their roofing tiles and roof trusses were observed nevertheless (Photos 16-18). Further, while some houses and storage sheds apparently had been entirely destroyed in the Hojo and Osuna districts, this could not be confirmed because much of the debris had already been cleaned up and removed by the time the survey was performed. The status of damage immediately after the tornado disaster has been reported by the Building Department of the National Institute of Land and Infrastructure Management (NILIM). (<http://www.nilim.go.jp/lab/bbg/saigai/index.html>)

Yoshiyuki Suzuki, Kyosuke Mukaibo, Yuu Ooka



Photo 1 Scene of small wood-frame structure that collapsed



Photo 2 Front and main shrines of Shinto shrine complex, virtually untouched



Photo 3 Damage to trees nearby



Photo 4 Damage to conventional wood-frame building (1)



Photo 5 Damage to conventional wood-frame building (2)



Photo 6 Damage to traditional wood-frame building



Photo 7 Damage to golf-course clubhouse



Photo 8 Damage to traditional wood-frame building



Photo 9 Damage to conventional wood-frame structure



Photo 10 Damage to tile roof



Photo 11 Vestige of main gate



Photo 12 Great Buddha hall of Buddhist temple



Photo 13 Scene of damage in Hojo district



Photo 14 Heavily damaged wood-frame building



Photo 15 A standing structure tilted and horizontally shifted from its foundation



Photo 16 Damage to tile roofing



Photo 17 Damage to tile roofing and exterior walls



Photo 18 Damage to wooden roof truss section

# Survey of Flood Damage to Ayutthaya Historical Park

Located about 76 km north of Bangkok, the Ayutthaya Historical Park envelopes the ruins of the ancient city of Ayutthaya that were declared a UNESCO World Heritage Site in 1991. This city was built by King Uthong in 1350 A.D. on a small delta surrounded by the Chao Phraya, Lopburi, and Pa Sak Rivers. Until its destruction by the Burmese Army in 1767, it served 417 years as the capital of the Ayutthaya Dynasty and as a center of Thai politics and commerce. During this long period of dynastic rule, many Buddhist temples and statues were built. The ruins include temples that even today are reminiscent of the prosperity that once reigned in Ayutthaya's heyday (Fig. 1).

Due to its low elevation in a wetland zone, Ayutthaya in recent years has suffered from frequent flooding. In fact, the ruins were inundated by floodwaters on a large scale in 1995 and 2006. In 2011, they were submerged from October 4 through October 14 after enduring relentless torrential rains for as long as one month. To investigate the damage from this disaster, in 2012 we toured the area from March 10 to March 15 and conducted interviews and questionnaire surveys with the cooperation of spokespersons from various institutions concerned (Fig. 2).

Exhaustive steps had been taken to protect the Ayutthaya ruins from flooding. Local residents had built sandbag embankments while Ayutthaya city employees had formed a full-time 24-hour monitoring framework. However, around 10 p.m. on the evening of October 7, an embankment or sluice gate on the northeastern bank of the city's delta zone (near the confluence point of the Pa Sak and Lopburi Rivers) was undercut by water erosion, allowing a massive influx of floodwaters into the delta (Fig 2, Location A). These floodwaters reached from 0.5 to 2.0 meters in depth and continued to inundate the city delta for over a month. Additionally, a zone of public parklands along the southwestern perimeter -- one of the lowest areas within this entire district -- remained flooded the longest (Fig. 2, Location III).



'Plan de la Ville de Siam' drawn by a French engineer, Jacques Nicolas Bellin, shows Ayutthaya in 1750. (Courtesy the Dawn Rooney Collection)

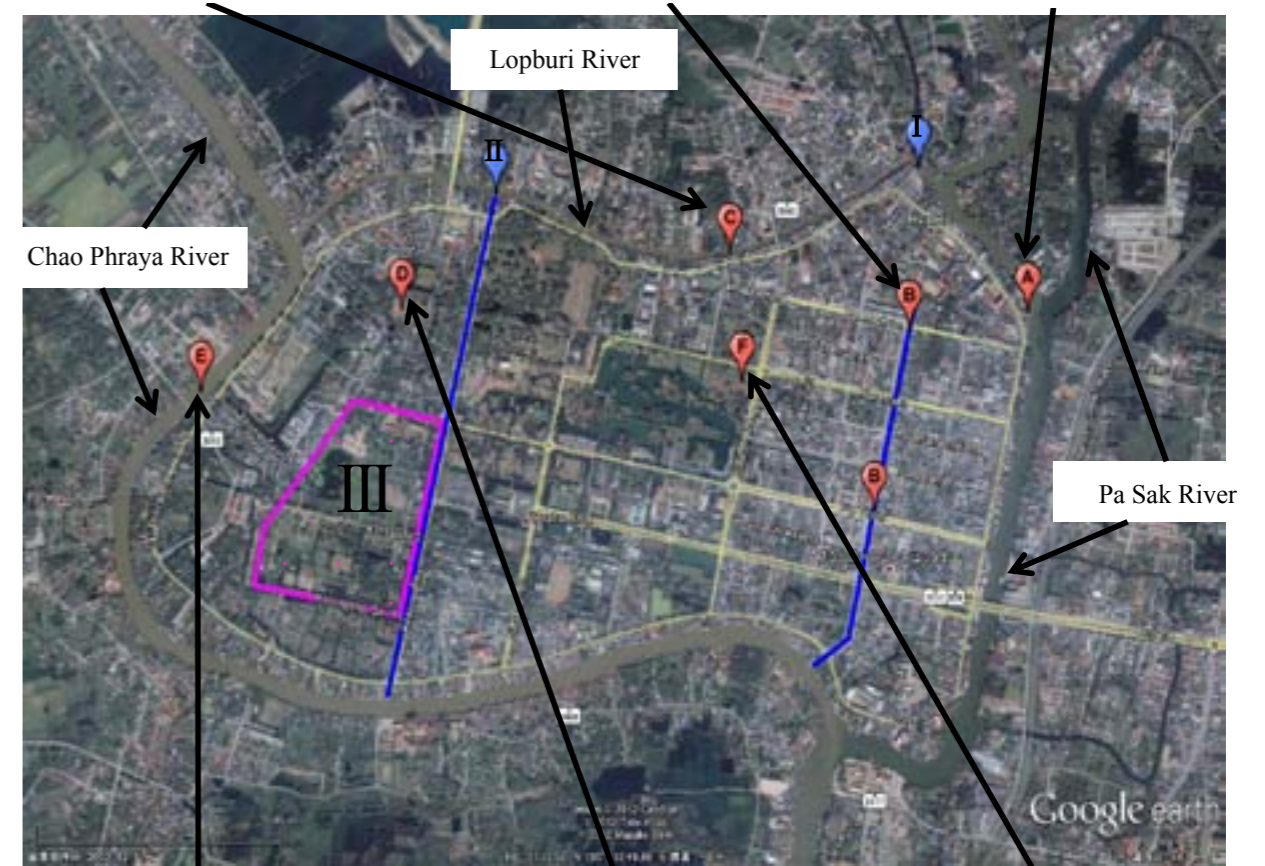
Fig. 1 The Ayutthaya ruins around 1750 A.D.



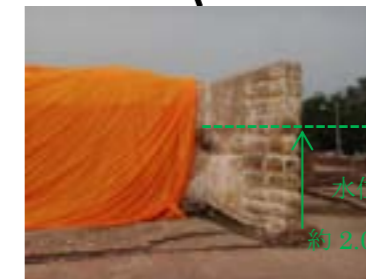
Location C Variations in elevation along left and right banks (Blue line delimits delta side, orange line delimits outer, non-delta side.)

Location B Water canals

Location A Embankment that collapsed during flooding



Location E A sluice gate



Location D Watermarks on Sleeping Buddha



Location F Deterioration of brick materials and settling of structural foundations

Fig. 2 Scenes of flood damage to the Ayutthaya Historical Park

The ancient city's Wat Lokaya Sutharam temple (Fig.2, Location D) houses a large statue of the sleeping Buddha, on which traces of the water line from the most recent flooding clearly remain. Like the Wat Mahathat temple (Fig.2 Location F), it contains numerous structures built from brick. This brick material is referred to as "field brick" and is produced through firing at relatively low temperatures. The surface features of field brick that has been exposed to extensive weathering can be literally rubbed out with one's fingertips. Some of the brick used in structures at the ruins showed signs of whitening but these were actually marks indicating the depth of the water line from the most recent flood and are thought to be discoloration caused at that time by the leaching of dye or pigment from the brick material.

The deterioration and erosion of the brick material as a result of long-term inundation during the most recent flood presents a serious problem. Another extremely serious problem is that like the Leaning Tower of Pisa, structures at many locations throughout the ruins have begun leaning due to the irregular settlement of soil sediments under their foundations. Several centuries have intervened since the buildings of the ancient city of Ayutthaya were constructed. In view of the likelihood that the soil settlement process is still under way, it is entirely plausible that some of these structures could eventually collapse if left unattended. This is an issue demanding an urgent response.

Following is a summary of some of the findings of a tourist questionnaire survey. The effective survey samples included 57 tourists from abroad, 22 Thai tourists, and 46 Thai tourists that had visited the Ayutthaya ruins two times or more. Fig. 3 graphs the findings of the questionnaire survey, which asked tourists about their most recent visit to Ayutthaya. Although most of the interviewed tourists had visited the ruins without any changes to their planned itineraries despite knowledge of the flooding, just under 20 percent of the foreign tourists were unaware of the most recent flood. Additionally, 20-30 percent of the interviewed Thai tourists had come specifically to view the extent of local flooding.

One survey question asked visitors to the Ayutthaya Historical Park -- now a designated World Heritage Site -- how much they would be willing to pay in an admission fee surcharge to help protect the site from natural disasters. Respondents were asked to select their answer from a list of amounts denominated in Thai bahts. As Table 1 illustrates, though a significant difference was noted in the percentage of the domestic tourist group willing to pay a fee for this purpose, no significant difference was observed in the size of the fee deemed acceptable. However, significant differences regarding the reasons for the fee distinguished the foreign and domestic tourist groups from each other. Respondents that were willing to pay this fee were allowed to choose up to three reasons as justification.

The three reasons cited by the largest percentage of foreign tourists were that the Ayutthaya Historical Park is a World Heritage Site, has cultural value, and deserves to be preserved for future generations of humankind. By contrast, the three reasons cited by the largest share of domestic tourists were that the ruins possess architectural importance, historical value, and should be preserved for future generations. These were among the differences highlighted by the survey findings on questions regarding the value of the Ayutthaya ruins in the eyes of foreign and domestic tourists.

Hitoshi Taniguchi

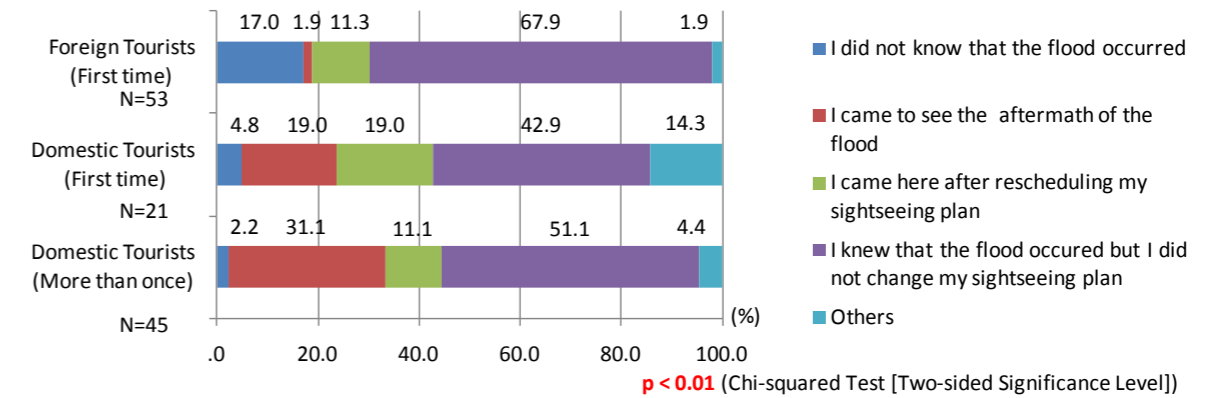


Fig. 3 Sightseeing Plans by Type of Tourist

Table 1 Percentage of Tourists Willing to Pay Admission Fee Surcharge and Average Surcharge Amount Deemed Acceptable, by Type of Tourist

	Foreign Tourists (first time)	Domestic Tourists (first time)	Domestic Tourists (more than once)	One-way Analysis of Variance	Willingness to Pay (Choice)
Percentage of Tourists Willing to Pay	70.0	95.0	79.0	p < 0.10	5 baht or less    100 baht
N	56	20	43		10 baht    150 baht
Average Surcharge Amount Deemed Acceptable (unit: TH baht)	90.1	56.3	66.2	p > 0.10	20 baht    200 baht
N	38	19	34		30 baht    500 baht
					50 baht    1000 baht or more
					70 baht    (____) baht

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