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Review:

Protection of Cultural Heritage from Post-Earthquake Fire

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The cultural property protection field is wide and varied, with the problem of natural disaster alone often being overlooked, especially in seismic hazard measures. Cultural property preservation field experts recognize that fire-prevention measures, for example, having focused on accidental fires and arson within shrine and temple precincts that have been ineffective in preventing fires from spreading to historical buildings during simultaneous fire outbreaks in surroundings of concern during earthquakes. In 2003, the Japanese government recognized the importance of cultural heritage disaster mitigation, and a National Committee was organized whose first report was released in 2004, leading, in turn, to the first national project for protecting cultural assets against natural disasters. The project focused on two 1,500-ton underground water storage tanks near Kiyomizudera and Sanneizaka. With a pressurized water sprinkler system and other fire control facilities, the facility is expected to be used to fight fires during earthquakes and to provide easy-to-use fire hydrants for other fires.

Keywords: cultural heritage, natural disaster, anti-seismic fire extinguish system

1. Deep Gaps in Cultural Heritage Disaster Mitigation

The 1950 Cultural Assets Preservation Act was implemented one year after the Horyuji Kondo's famed murals were destroyed by fire. Since then, ongoing efforts by central and local governments and the cultural heritage community have enabled Japan to achieve significant results in preserving cultural heritage sites. Results include the prevention and mitigation of age-induced changes, the excavation and examination of buried cultural assets, and the protection of cultural heritage sites from fire.

All this has not, however, been sufficient in preparing against natural disasters. Treasures lost due to natural disasters include, for example, damage to the Itsukushima Shinto Shrine stage during Typhoon No.18 in September 2004 and damage to the five-story Muroji pagoda by a fallen tree due to strong wind in September 1998.

This lack of attention is particularly prevalent in measures against seismic hazard, as shown by leading cultural properties protection expert Kakichi Suzuki, former director of the Nara National Research Institute for Cultural Properties, who says, "Measures for coping with big fires caused by earthquakes have been completely lacking in policy for cultural assets preservation." Tamae Ohnishi, then manager of the Traditional Culture Division of the Agency for Cultural Affairs and in charge of protecting government cultural properties, acknowledges that cultural property fire-prevention measures thus far having focused on accidental fires and arson within shrine and temple precincts, ineffective in preventing fires from spreading to historical buildings during simultaneous fire outbreaks in surrounding areas of concern during earthquakes. In other words, cultural property preservation field experts recognize the need for focusing on this problem now. Although nearly 2,000 researchers nationwide are involved in preventing and mitigating natural disasters, they lack organization in tackling the problems inherent in protecting cultural properties. Individual research encouraged by an interest in scholarship has been conducted on a small scale, for example, for historical buildings. What must be recognized before their destruction is that cultural properties and assets are irreplaceable and should be viewed from a perspective different from than other of society's assets – an aspect not conducted from an all-encompassing perspective.

As shown in **Fig. 1**, safeguards against natural disaster have been neglected among cultural property preservationists, with those in charge of natural disaster prevention and mitigation neglecting to treat cultural properties as the very special cases that they actually are. Problems involved in such protection have been overlooked, although rethinking of problems has followed the 1995 magnitude 7.2 Great Hanshin-Awaji Earthquake, commonly called the Kobe Earthquake, has gradually been assimilated over a wide spectrum. This neglected issue has come to the attention of an increasing number of people, including those of the cultural assets community, those in natural disaster prevention and mitigation, and even those not directly involved in either area.

2. What is the Problem?

During the Kobe Earthquake, Japan's ancient capital of Kyoto, the site of numerous cultural heritage sites, was shaken by a seismic intensity of 5 and damage was rel-

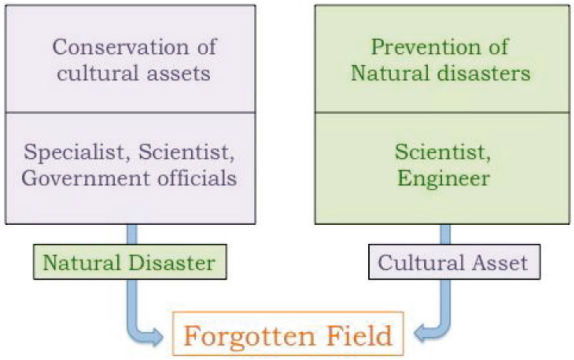

Fig. 1. Protection of cultural heritage from natural disaster.

Fig. 2. Wooden residential buildings close to an temple containing cultural heritages.

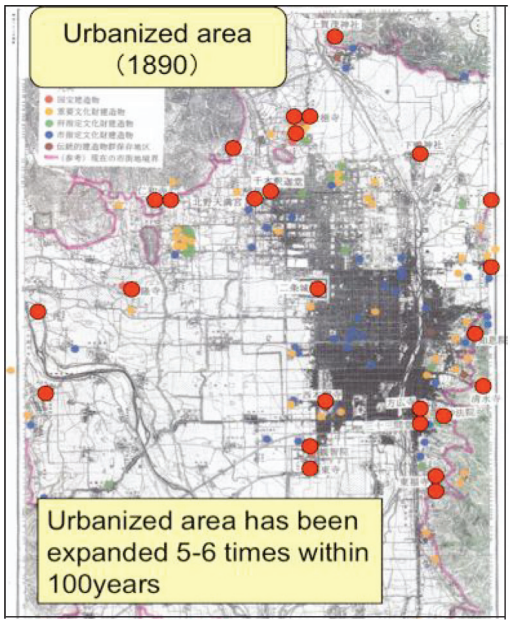

Fig. 3. Densely populated area in 1890 and location of National Treasure buildings.

atively slight, although 30 people were injured and over 1,000 homes were slightly damaged. Over 80 shrines and temples were at least slightly damaged, however, including cases of partial damage to earthen walls and other structures. In some instances, such as at Ninnaji and Daigoji, firefighting equipment was disrupted, preventing efforts to extinguish flames.

With Kyoto only 50 or 60 km from Kobe, an earthquake striking closer to Kyoto would surely damage many more culturally valuable temples, shrines, and other structures. Firefighting and fire-prevention equipment, including underground and mountain-based water tanks and fire cannons, are connected by underground pipes, but most pipes have low earthquake resistance. Historically important temples and shrines have had such facilities for decades, but until the 1980s, seismic effects on underground pipelines were not considered in seismic design, leaving these historic sites essentially unprotected from earthquakes.

In addition to this lack of equipment and facilities for combating earthquake-induced fires, another important lack must be pointed out.

What is lacking in the existing facilities? Most firefighting facilities at temples and shrines are for extinguishing flames from accidental fires and arson within temple and shrine precincts, meaning they have only enough water for short-term flame fighting, e.g., until fire engines arrive or during the fire's early stages.

In the multicity fires to be anticipated following strong urban earthquakes, however, the possibility of enough fire engines being sent to temple or shrine is ridiculously low and, even if they were sent, they would probably not get through to their destinations due to Kyoto's narrow streets being blocked by fallen buildings and flames.

In short, it is reasonable to assume that fire engines would not be arriving during or after an earthquake. This is further aggravated by the fact that water reserves are set aside assuming that fire trucks would show up. Without sufficient water reserves, fires in surrounding areas would inevitably spread to temple and shrine precincts (**Fig. 2**).

Exacerbating these inadequacies is the lack of quake-resistant water cannon pumps and power generators at temples and shrines, together with an overall incapacity to combat fires. We are left with the facts that the quake resistance of firefighting and fire-prevention facilities is rarely checked, facilities and equipment from protecting cultural assets have not been adequately inspected for quake resistance or sufficient seismic strength, and – worst of all – measures for containing the spread of fires are not even a topic of consideration.

3. Kyoto as a Precarious Place

Although Kyoto's low rate of fire outbreak – one of the lowest in urban Japan is probably due to an inbred awareness of potential danger among its citizenry due to the city's many old wooden buildings, which, together with Kyoto itself, were spared from World War II bombing. A low fire outbreak rate is nowhere near the same thing as high fire resistance, however. With so many old buildings, any considerable fire would probably be very difficult to

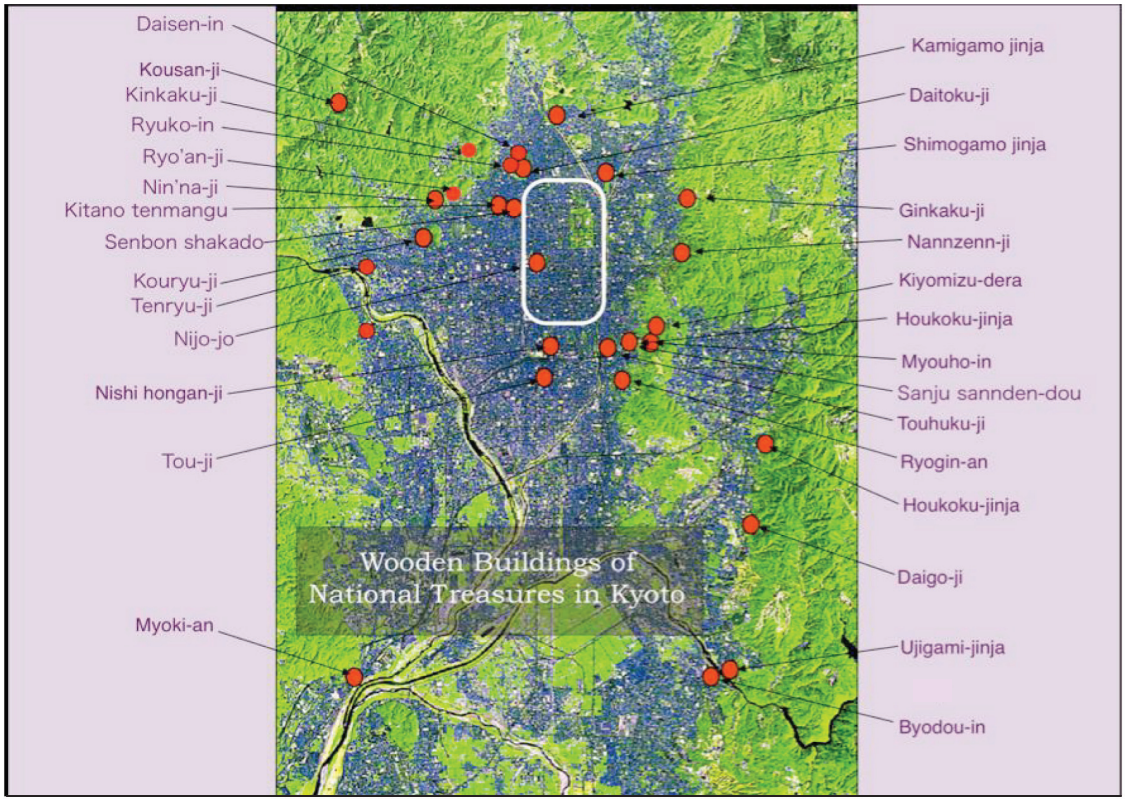

Fig. 4. Existing cultural assets and area burned out by the Tenmei Great Fire (inside of the white line is the area burned out by the Tenmei Great Fire).

extinguish.

Areas of population density in Kyoto 120 years ago, in 1887 (**Fig. 3**), was about the same as at the time of the great Tenmey era fire in 1788, which destroyed 80% of the city (**Fig. 4**). According to an Ordnance Survey map, just 100 years ago, Kyoto's downtown population was enclosed in the comparatively narrow district between Higashiyamadori and Senbon-dori and Kitaoji-dori and Kyoto Station – with the rest of the city simple farmland. Today Kyoto Basin is crammed to every corner with residential buildings and a populated area that has expanded five-fold in just a century.

Today, not even one wooden building designated a national treasure (Nijojo) stands in the area burned during the Tenmei Fire. National treasures in the area not burned survived only because houses were sparse in and around these areas. The many national treasures located today's densely populated Kyoto Basin would inevitably be lost forever if the multiple fires breaking out simultaneously as in the Kobe Earthquake of 1995.

It is commonly assumed that anything that burns down can be rebuilt, since the many historical and cultural properties once privately owned by political leaders or the nobility destroyed by fire were rebuilt or restored through donations from political and religious leaders. The reason so many of Kyoto's rebuilt or restored historical buildings date back to the turn of the 17th century is because the leaders of the government of the time held firm political power.

How changed today's situation – with no such political power, few private individuals are either able or apt to donate funds for restoring or rebuilding historical buildings, and the national government is legally prohibited from providing "support" to specific religious institutions. Another point is few buildings currently or likely to be designated national treasures exist in the area destroyed by the Tenmei Fire.

4. Kinki's Active Seismicity

During the 6 decades following World War II (WWII), Japan has caught up to and even surpassed Western societies in its drive for economic advancement and since the 1948 Fukui Earthquake and 1959 Typhoon Isewan (Vera), the country has not been hit by any natural disaster killing thousands of people. Only two earthquakes of magnitude 6 or more occurred during the 40 years between the Fukui and Great Hanshin-Awaji earthquakes in the Kinki region where Kyoto is located. The half-century between 1900 and the 1949 Nankai Earthquake marked over 13 earthquakes of magnitude 6 or more in the Kansai region alone (**Fig. 5**) – during the short eighteen-year period between 1925 and 1943.

It would be a mistake to think that there few earthquakes occur in the Kansai region, as indicated during the 50 years since WWII ended. A fact giving pause in the area today is that the entire seismic environment

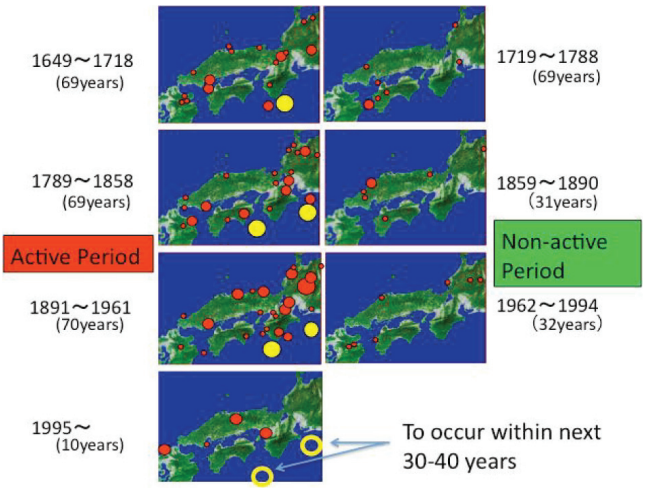

Fig. 5. Many earthquakes occurred inland in the Kinki Region before the Tonankai and Nankai earthquakes.

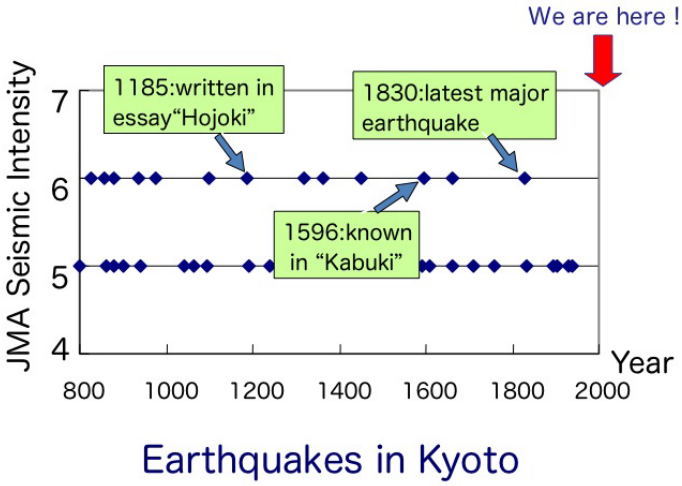

Fig. 6. Earthquakes causing damage in Kyoto.

from Kansai to Tokai is a product of Tokai, Tonankai, and Nankai Earthquakes along the Nankai Trough, where earthquakes recur in 100- to 120-year cycles (**Fig. 6**). These earthquakes must be viewed in 100-year, not 50-year terms.

With a seismically active period similar to that beginning in 1925 starting with the 1995 Kobe Earthquake, it appears that the 2000 Western Tottori Earthquake and the 2001 Geiyo Earthquake are part of a series of inland quakes, one of which is sure to occur in the not-too-distant future.

Despite hopes to the contrary, most people hold the sentiment expressed by a victim of the October 2004 Mid-Niigata Prefecture Earthquake in a televised interview – "I never thought an earthquake would strike where I live!" Despite the 6,000-plus deaths in the Kobe Earthquake, few probably thought on the evening of Monday, January 16, "Tomorrow morning, I may die in an earthquake." With experts saying that Kansai is now in an active seismic period, now is no time for wishful thinking.

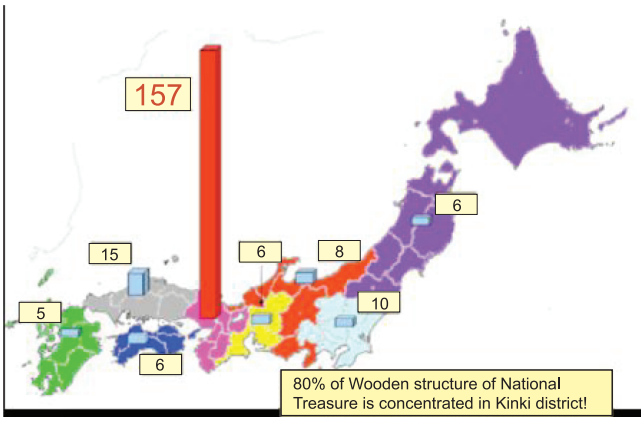

Fig. 7. Location of National Treasures (buildings) by individual regions.

5. Earthquake Measures as Kyoto's "Life Insurance"

Some 47 million tourists flock annually to Kyoto to see its historic buildings and cultural properties at temples and shrines (**Fig. 7**), so the loss of these cultural assets would probably spell the end to Kyoto's famous tourist attractions. Kyoto's cultural properties and historical heritage are, in short, its economic lifeline.

If cultural assets determine Kyoto's fate, is it in need of some sort of insurance policy? Such insurance lies in disaster prevention. Given the number of days it took fire-fighting equipment to fight its way into Kobe, with its relatively roomy road networks, Kyoto's cultural assets appear to be poorly insured. Two of Kyoto's famous temples, as mentioned early, could not even fight the fires following the Kobe quake 50 km away. The results following an earthquake in Kyoto are almost too devastating to consider.

Even without an earthquake, Kyoto does not have enough water to protect buildings until fire trucks arrive. Kyoto also has over twice as many pre-WWII wooden buildings as pre-earthquake Kobe had.

Considering the potential danger, it would be seen that no one can dispute the need for measures against natural disasters, especially earthquake-induced fires, in a city such as Kyoto. We surmise that the reason people do not become seriously involved in countermeasures against disaster must be their concern about the non-collectable nature of such "insurance." Certainly no one wants to collect on life insurance. Even putting disaster measures in place does guarantee either that Kyoto will have many of its cultural assets destroyed in an earthquake. If people do not worry about the fact that they can never collect on their life insurance policies, there should be no problem if all types of insurance of Kyoto were made to be noncollectable.

Cultural properties represent a cultural heritage, the thinking of generations long gone. Cultural properties teach about that thinking, and without cultural properties,

Inspection Committee to Protect Cultural Heritage and Local Regions from Natural Disaster

Central Disaster Prevention Council
(Cabinet Office, organized in January 27, 2003)

Academic experts on the committee
15 experts and Chairperson

Committee members representing the government and public sectors
Disaster-prevention specialists from the Cabinet Office
Fire and Disaster Management Agency
Agency for Cultural Affairs, Ministry of Education, Culture, Sports, Science and Technology
Ministry of Land Infrastructure, Transport and Tourism
Local public agencies (Tokyo Metropolitan Government,, Kyoto City)

Fig. 8. Committee organization chart.

Measures Needed to Protect Cultural Heritage and Local Regions from Seismic Hazard

Chapter 1: Background of Plan
Chapter 2: Basic Views in Protecting Cultural Heritage and Local Regions from Seismic Hazard
Chapter 3: Basic Views in Protecting Cultural Heritage and Local Region from Seismic Hazard
Chapter 4: Specific Measures
Chapter 5: Tasks in Realizing These Measures

Relevant government agencies will pursue the following toward protecting cultural heritage and local regions from seismic hazard:

1. Raise the level of importance placed on cultural heritage disaster mitigation measures, as part of a disaster-mitigation project
2. Support local regions in realizing these objectives

Fig. 9. Contents of report.

no glimpse remains of the hearts and minds of ages past. The wealth of information contained in cultural properties help us learn about our history, particularly thinking – for which very reason we alive today must work to preserve our cultural heritage for future generations.

Where once, e.g., following WWII, people were concerned simply with surviving, then with attaining the everyday comforts of modern civilization, when with economic prosperity and material comfort. Now isn't it about time that we start thinking about future generations?

6. Importance of Cultural Heritage Disaster Mitigation Recognized

The importance of cultural heritage disaster mitigation is recognized by the national government and some local governments. As indicated in **Fig. 8**, for example, in June 2003, the Cabinet Office established an Inspection Committee to Protect Cultural Assets and Local Regions from Natural Disaster, and in July 2004 it issued a report on "Measures Needed to Protect Cultural Assets and Local Regions from Seismic Hazard" (**Fig. 9**). This committee consists of academic experts, government agencies acting as secretariat for the committee. The report cites the importance of protecting both cultural assets and local interests, collaboration among local citizens, custodianship of cultural assets and government, and types of measures required in the future.

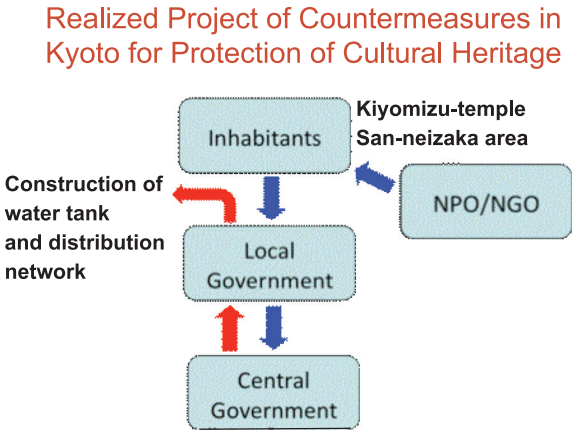

Fig. 10. Cycles of collaboration.

It also presents case studies on areas around Kiyomizudera and Sanneizaka in Kyoto, and on Tokyo's Shibamata Taishakuten area. A separate page appended to the report, which begins with the words "relevant government agencies," which could be interpreted as a kind of national to protect cultural assets from disaster. This page also states that government agencies will collaborate to raise the importance placed on cultural assets in preventing local disaster and helping implement projects in the near future.

Government agencies thus must at least recognize the importance of cultural heritage disaster prevention measures. Kyoto, with its wealth of cultural properties, has expressed concern on these issues for the last several years. Determined to maintain its historical ambience, the city has set up a committee to find ways to create water supplies for use in disaster prevention efforts. The Society for Protecting Cultural Assets from Disaster (SPCAD), an NPO, has worked nearly 15 years, in different forms, to conduct case studies for the above committee. At the national government's request, the society, Kiyomizudera and local citizens have collaborated to formulate specific disaster prevention measures for Kiyomizudera, Sanneizaka, and their surroundings. The local Kyoto government is also involved. After the plan was completed in March 2005, it was established officially as a Kyoto City plan and submitted to the national government. Implementing cultural heritage disaster mitigation measures requires the cooperation of cultural properties custodians and specific plans acceptable to local citizens (**Fig. 10**).

Current activities concerning Kiyomizudera include a pilot project, and similar methods and procedures will likely be required to realize disaster mitigation measures in a specific area focusing on cultural assets. Since formulating such plans requires specialized knowledge, including technical expertise, it is a huge task for this NPO, which consists of volunteers and experts from various

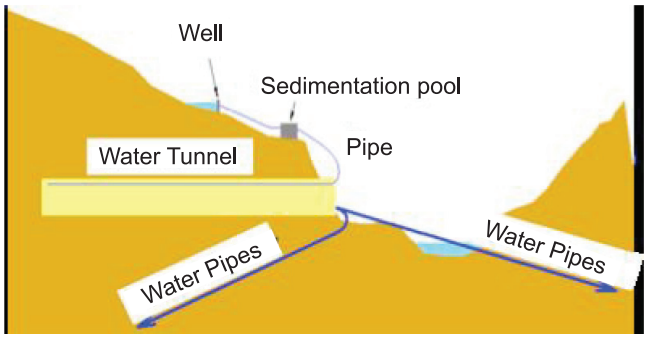

Fig. 11. Water storage tunnel in Higashiyama.

Fig. 12. Mist defense system in action.

fields. It is essential to form a rational, effective plan acceptable to temples and shrines housing cultural assets and to local citizens. Efforts are being urgently taken to find optimum ways for realizing these plans. Not much times remains, however, before the next earthquake is expected to strike.

7. Work has Begun

While duly considering historical ambience, SPCAD has explored water supply details for use in disaster mitigation. To find and implement a viable system, SPCAD has been consulting with Kiyomizudera staff and local citizens thanks to its realization of the need for knowing both the area's geographical features and for forming a fruitful relationship between the temple and local citizens.

To do so, SPCAD has formed a study group for maintaining a disaster mitigation water supply and crafted related plans in cooperation with Kiyomizudera, Kodaiji, local government representatives, and the Kyoto City Fire Department. It has also held workshops on supplying water for environmental disaster mitigation involving people from the city government and others. Detailed study indicated that further technical study was needed, so SPCAD obtained limited financial assistance from the national government in collaborative efforts in its administrative role.

Fig. 13. Water storage in the "disaster-prevention-park" near Kodaiji temple.

Fig. 14. Ongoing project at the foot of Higashiyama mountain.

The resulting proposal was to dig a tunnel to avoid compromising the landscape through the Higashiyama mountains for storing water (**Fig. 11**) and to install fire hydrants and a sprinkler system in the area bounded on the east and west by Higashioji and Higashiyama and on the north and south by Maruyama Koen (park) and Otani Honbyo (mausoleum). One proposed water sprinkler system has a "mist defense" function (**Fig. 12**) that envelops endangered buildings and facilities in a protective mist.

After the concrete proposal was presented to Kyoto City and was slightly revised, the mayor asked the national government in June 2005 to prepare a project budget.

Complying with the city's request, the national government approved funding for project phase 1 in its fiscal 2006 budget request. As the first national project for

protecting cultural assets tank against natural disasters, it focuses on a 1,500-ton underground water storage tank beneath a "disaster-prevention park" next to the Kodaiji parking lot. Equipped with a pressurized water sprinkler system and other fire control facilities, the facility be used to fight fires during earthquakes and as provide easy-to-use fire hydrants for other fires.

The underground water tank was completed in January 2007 (**Fig. 13**). Still in phase 1, the project appears very promising as it progresses, and will develop further to include both Kiyomizudera and areas containing historical assets nationwide. The current project for protecting cultural heritages against earthquake-triggered fires (**Fig. 14**) will be completed in March 2011. Two light blue tanks had as of this writing been constructed and an underground polyethylene pipeline trunk built. Water in this system is used for ordinary fires in the area through hydrants via fire engines and area residents use its water for such everyday purposes via ordinary hand pumps as sprinkling nearby streets to cool them in the hot Kyoto summers. This multipurpose system thus serves its users at all times – not only in fires following earthquakes.

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Selected Publications:
• K. Toki, "Cultural Heritage and Seismic Countermeasures, "Introductory Volume" to Cultural Heritage Disaster Mitigation Studies," Ritsumeikan University, 2010.

Academic Societies & Scientific Organizations:
• Japan Association of Earthquake Engineering (JAEE)
• Japan Society of Civil Engineers (JSCE)
• Japan Society for Natural Disaster Science (JSNDS)