
Tradition and revolution of urban fire management research

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1. Disaster investigation

On December 22, 2016, a fire that started in a shopping arcade in front of a station in Itoigawa City, Niigata, spread in a strong wind and resulted in a massive fire that burned down about 4 ha of the urban area and 147 buildings (3 ha) in nearly half a day. The scale of this urban fire was the largest since the major fire in Sakata in 1976, except for fires caused by earthquakes or tsunamis. It resulted in the public recognition that urban areas crowded with houses and stores were associated with the risk of massive fires when conditions were met.

Upon the request for an investigation from the Housing Bureau of the Ministry of Land, Infrastructure and Transport, the NILIM immediately dispatched a team of researchers jointly with the Building Research Institute and released the first report in January 2017. The team consisted of five members, including midlevel and young researchers in the fields of urban fire management, fire management standards, fire management research, and housing and urban research in both organizations.

The team then conducted hearing investigations, analyses of recorded fire images, reproduction experiments, and simulations and analyses and released the report to the press in July. The report discussed the following: the process of the spread of the fire as flying sparks in strong winds, the phenomena in which sparks entering from the gaps of old roof tiles constructed in the early Showa period (1920s to 1930s) spread to the roof underneath, and the effect of fire management measures on roofs and the outer walls of individual buildings on the fire safety of urban areas. The report supported the effectiveness of fire management measures that the national government had implemented thus far. It also gave hints to fire management measures for the era of keeping stock of the currently available buildings and became one of the factors that resulted in the revision of the Building Standards Act.

Disaster investigations like this are one of the main activities of the NILIM (and Building Research Institute of the Ministry of Construction, the predecessor of the NILIM). The NILIM has investigated various disasters without being limited to urban fires, explored the causes and preventive measures, and reflected the findings in measures, research, and development. Among them, this paper focuses on the investigations and research that the Building Research Institute of the Ministry of Construction conducted on the major fire in Sakata to compare the findings with the major fire in Itoigawa.

2. *Quick Investigation Report on the Major Fire in Sakata (1976)*

The major fire in Sakata started from a busy section of Sakata City, Yamagata, in the late afternoon of October 29, 1976. The fire kept burning until the next morning and destroyed 22.5 ha of the urban section, 1774 buildings, and damaged 15.2 of the area. The total financial loss from the fire was 40.5 billion yen. The government designated the fire as a serious disaster. It is also known for the surprisingly quick restoration; the preparation of a restoration plan started immediately after the fire, and the restoration plan was established in 51 days, followed by complete restoration in two years and six months. The lessons from this fire are kept in many records and investigation and research reports, which were used as the reference for fire management urban constructions in many areas and restoration after the Great Hanshin-Awaji Earthquake.

Urban fires back then were a more severe problem than today, and prevention measures were in high demand since it was an urban problem that threatened the lives of citizens. The Building Research Institute of the Ministry of Construction dispatched six officials as the first team for an on-site investigation from October 31 to November 3. It conducted four additional follow-up research projects, and 13 officials in total investigated the site of the fire. Researchers from various research divisions were involved in this investigation, such as urban fire management, urban planning, urban development, fire management, smoke management, organic materials, inorganic materials, isotopes, and planning. The City Bureau of the Ministry of Construction also dispatched officials to support the establishment of restoration plans, and the National Research Institute of Fire and Disaster of the Fire and Disaster Management Agency dispatched officials to investigate aspects related to the fire, firefighting, and evacuation.

The outcomes of the investigations were compiled as the *Quick Investigation Report on the Major Fire in Sakata (1976)* (December 1976, Building Research Institute, Ministry of Construction). The preface at the beginning of the report said that the investigation of massive urban fires would provide various topics to the research of urbanization and construction, which was because the outline of the disaster must be promptly provided to relevant officials to make use of them for future actions. The overall structure of the report

included: (1) an outline of the fire, (2) overall condition of the urban area, (3) damage to fireproof buildings, (4) overall condition of damage to the trees, (5) condition of evacuation, and (6) a summary and problems. It summarized the causes of the fire and preventive measures in a short period.

The research has progressed since then. A lecture session in 1977 presented the results of estimating the spread of the fire and the outcome of a survey on evacuation behavior and the lecture session in 1979 discussing the result of the experiment on trees in regard to fire management effects.

In addition, *Araka*, the first compilation of the result of architectural research published in 1979 introduced research titled "Simulation analysis of a major urban fire" about the analysis of the progress of the spread of the fire in Sakata using a computer simulation. This was about when the development of computers and the accumulation of knowledge was finally enabling computer simulations of massive urban fires. The simulation analysis of the spread of the fire exposed new research topics, which were taken over in the Development of Methods to Prevent and Control Urban Fires, the General Technology Development Projects of the Ministry of Construction that started in 1977.

3. Traditions of an organization and the creativity of individuals

The comparison of the investigation and research of the two urban fires clarifies many similarities. ◇ Prompt on-site investigation and the release of findings immediately after the fire, ◇ a flexible system to examine the situations in cooperation among different fields and organizations, ◇ emphasis on identifying actual on-site conditions, ◇ multilateral analyses using various methods including experiments and simulation, ◇ feedback on policies, ◇ continuous development of researches and discovery of new research themes, ◇ reflection of advanced research outcomes in the future disaster management and policies, and ◇ the cycle of the above.

Various demands and needs raised both directly and indirectly from society, such as through the experience of disasters, became the source of energy to engage in research at the NILIM. As we continue and advance research activities in response to such demands and needs, new research themes and technologies emerge, and their advancement will start responding to new needs in the future. The repetition of this process will deepen and systematize the research. Such a process of research projects and investigations are now the tradition of the NILIM.

On the other hand, in terms of the differences observed from the perspective of investigations and research besides the fact that needs have changed along with changes in the times and socioeconomic environment, differences include the ◇ available technologies differ

due to technological advancement, and the ◇ people involved with the research have been replaced.

In the fire in Itoigawa, the research team conducted experiments that reproduced strong winds in a fire tunnel experiment facility in Tsukuba (completed in March 1998) that was not available before. Still, an ideal condition that researchers desire seems to be experimental facilities with higher performance. In addition, the drastic advancement of computer technologies and applied theories also resulted in rapid progress in simulation analysis. Someday, an innovative forecasting method based on AI may be available.

The replacement of human resources is associated with both advantages and disadvantages. Still, the NILIM would like to positively accept it as a research facility that emphasizes creativity because the creativities of individual researchers will bring a revolution in research. Having said that, the accumulation of human resources with abundant experience is the precondition to this, and a long-term perspective is the key. The analysis focusing on flying sparks in the fire in Itoigawa was realized as a result of the combination of the ideas and steady progress of each of the young researchers and the instructions and guidance given by experienced midlevel researchers. It is the outcome of the overall ability of the teamwork of the midlevel and young researchers, or the power of individuals and the organization.

In the end, the greatest difference is the difference in the socioeconomic environment, which is the background to the other aspects. The needs that society will expect from the NILIM are also changing. Needs are the source of the power to engage in research. Thus, the constant goal of the NILIM is to be ready to respond to needs. The tradition of the organization is therefore important, and the creativity of individuals supported by technologies are also needed. We have especially high expectations from challenges that young researchers go through.

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