



Disaster Mitigation Research Center

Further promoting collaboration as a base for disaster mitigation studies

02

Greetings

Director

Takeshi SAGIYA

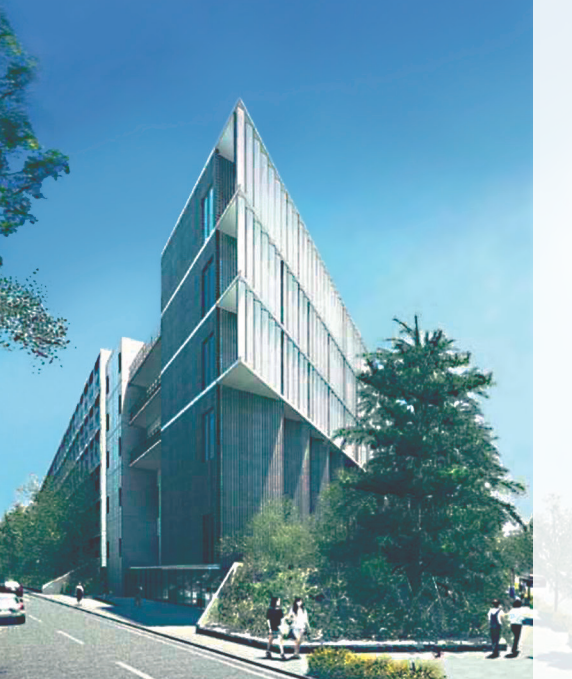


Located in the mid-latitude of far-east Asia along the circum-Pacific "ring-of-fire", Japan is subject to various natural hazards such as large earthquakes, volcanic eruptions, tsunamis, heavy rains, and landslides. Under such a situation, our lives here are always beset by disasters. In recent years, climate change due to artificial causes has made metrological hazards more severe and frequent, bringing a new fear for human beings. Living a stable life while preparing for various natural disasters has been an old and new challenge.

Over the past several decades, the population has been increasingly concentrated in large cities, while rural areas have experienced depopulation and rapid aging. As a result, vulnerability against natural disasters has worsened in both. Reckless urban development and people's dependence on transportation and logistics make large cities highly vulnerable to disasters. On the other hand, in rural areas, there is not enough manpower for rescue or recovery. These potential problems reflect the existing various social issues in our society. Natural disasters can present different features depending on their timing and locations. To maintain society sustainably, it is of essential importance to grasp future disasters and to minimize the damage through various mitigation countermeasures.

The Nagoya area suffered from the 1891 Nobi and the 1945 Mikawa earthquakes and was heavily damaged by the 1959 Ise Bay typhoon. Our main concern for now is the Nankai Trough megathrust earthquakes that have repeated in history. This area holds the largest industry in the country and is an important hub of various transportation connecting the East and the West. A severe natural disaster has grave effects on the Japanese socio-economic situation. The Disaster Mitigation Research Center was established in January 2012 to develop state-of-the-art research on natural disasters and disaster mitigation measures through close collaboration among various stakeholders including industry, government, academia, and citizens. Our final goal is to strengthen local disaster preparedness. The Disaster Mitigation Building (Gensai-kan) was built in 2014 and has been utilized to proceed with disaster mitigation research activities and to promote the dissemination of research outcomes. In 2017, together with Aichi Prefecture, Nagoya City, and local industries, the Aichi-Nagoya Resilience Co-creation Center was established to promote various collaborations for disaster mitigation.

We contribute to society through practical applications of frontier research through integrating multidisciplinary approaches. Let's work together for the future!



The Disaster Mitigation Research Building —a Base for Research, Response, and Preparedness

Completed in March 2014, the Disaster Mitigation Research Building is the first building to feature a base isolation structure system on the Higashiyama campus of Nagoya University. The building provides a base for researchers involved in the Disaster Mitigation Research Center to carry out leading research on disaster mitigation, while functioning as a base for social collaboration toward disaster mitigation.

In a world-first, the underground seismic isolation devices and rooftop laboratory of the Disaster Mitigation Research Building can be used to carry out oscillation experiments that are conducted by using the entire building. In addition, an elastic base isolation structure was used for the base isolation structure devices and sufficient design margins were ensured—making this building the safest in the region against mega-earthquakes.

During ordinary times, this building serves as a base for research into disaster mitigation as well as for education and human resource development. The first floor offers various attractions: an experimental laboratory in which long-period ground motions can be simulated, an exhibition that combines detailed geographic miniatures

and hazard maps, and panel exhibitions for learning about disaster prevention and mitigation, as well as aerial photographs providing a bird's-eye view of Nagoya and its surrounding areas, miniatures for learning about earthquake resistance structures, and a handcraft area for kids. In addition, the building serves as a venue for the “Disaster Prevention Academy” and the “Gen-Sci Café”. On the second floor is a library where visitors can browse a range of materials and information systems.

Once disasters occur, the building will become a base for the university and related institutions to respond to disasters and to release information. In preparation for such disasters, the building has one week's supply of water and food, large-scale private power generation devices, terminals for connection to power supply vehicles, propane-powered air-conditioning equipment, and solar power generation devices. In addition, with the aim of sharing real-time disaster information, local authority satellite communications were established with Aichi Prefecture, while a long-distance wireless LAN was established with the Chubu Regional Development Bureau.



Disaster Mitigation Research Building

The first base isolation building on the Higashiyama campus with its distinctive triangular figure the building is a facility that is designed to serve as a Base for Research, Response, and Preparedness.



Disaster Mitigation Gallery

By seeing and touching a variety of educational materials, visitors can understand the necessity of disaster mitigation, which encourages them actively take measures. In this way, the building contributes to disaster mitigation in the region. The building regularly functions as a venue for the “Disaster Prevention Academy” and the “Gen-Sci Café”.



Disaster Mitigation Research Library

This library houses approximately 4,000 materials and are open to the public. Books relevant to disaster reduction, municipal histories, historical earthquake materials, hazard maps, etc. are available, and the collection can be retrieved. In addition, the library is equipped with various systems that allow users to view old maps and videos of past disaster reduction academy lectures.



Isolation Structure Gallery

The gallery displays the base isolation structure devices. This offers visitors the opportunity to learn about the technologies behind isolation structure systems and vibration control systems by seeing the actual devices. They can also learn about various seismometers and recording devices.



Environment to enable oscillation experiments using the entire building

By moving the building with a hydraulic jack, it is possible to generate free oscillation in order to conduct experiments using the entire building. In the rooftop laboratory, a range of simulation experiments can be conducted in which long-period ground motion and virtual images are synchronized.



Disaster response base

In addition to its elastic base isolation structure, which provides a high degree of safety, the building has an emergency power supply, a store of various necessities, and facilities for communication with the central and local governments.

Outline and Organization of Disaster Mitigation Research Center

Creating models to realize disaster mitigation by deepening many types of cooperation in the whole region based on advanced disaster mitigation research

Build disaster mitigation models through interdisciplinary cooperation.
Realize a safe and secure society through regional collaboration.

Creation of "Intelligence" for Disaster Mitigation

Realize interdisciplinary cooperative research and regionally integrated disaster mitigation research capitalizing on collective regional powers.
Take on roles of strengthened cooperation between researchers inside/outside the University, liaisons between local communities, information transmission, and the planning, coordination and promotion of disaster mitigation research projects and regionally cooperative activities.

Expert Development

Realize human resource development projects strategically for disaster prevention that support "new communities."
→Systematized disaster prevention education and human resource development through regional cooperation.

Regional Cooperation

Promote framework building that helps implement regional cooperation.
Interface research results through "visible" regional networks.

International Cooperation

Transfer the best practice of regional disaster mitigation strategy models to overseas countries, so that such disaster mitigation strategies will develop in Asia.



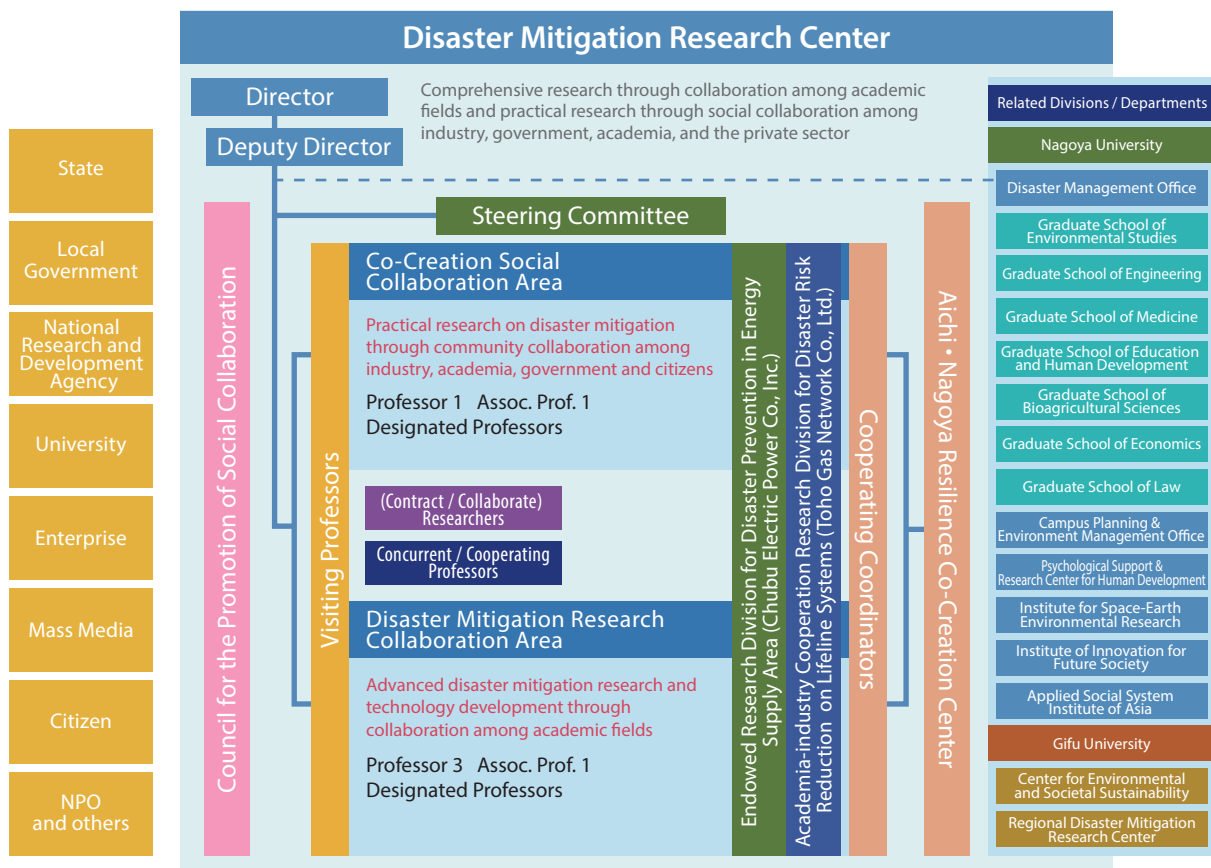
Organization

Comprehensive research through collaboration among academic fields and practical research through social collaboration among industry, government, academia, and the private sector

Reorganized into two new areas of research: the Co-Creation Social Collaboration Area and the Disaster Mitigation Research Collaboration Area, with the aim of deepening and integrating the two areas

The Nagoya University Disaster Mitigation Research Center is engaged in research, dissemination, and awareness-raising for disaster mitigation while promoting social collaboration among industry, government, academia, and the private sector through a two-field structure: the Co-Creation Social Collaboration Area and the Disaster Mitigation Research Collaboration Area.

In the Co-Creation Social Collaboration Area, based on the clarification of social hierarchy and chain system, we promote practical disaster mitigation research that contributes to the improvement of regional disaster mitigation capabilities through social collaboration among industry, academia, government, and the private sector, in order to develop industrial disaster prevention and civil disaster prevention.



Aichi · Nagoya Resilience Co-Creation Center

In 2017, Aichi Prefecture, Nagoya City, and Nagoya University, in cooperation with the industrial sector, established Aichi-Nagoya Resilience Co-creation Center to strategically promote research and human resource development to ensure the continuation of socio-economic activities in the Chubu region, with Aichi and Nagoya at its core, in the event of a large-scale disaster.

As a research center, we will conduct research activities on disaster prevention and mitigation measures that match the needs of the Chubu regions, provide one-stop coordination for disaster prevention, support industry sectors, prefectural residents, and local governments, and coordinate disaster prevention/mitigation training courses.

Disaster Management Office, Nagoya University

The Disaster Management Office of Nagoya University is an organization that is working to improve the disaster prevention and disaster response capabilities of Nagoya University which is a large organization of more than 25,000. Since 2011, we have been working closely with the Disaster Mitigation Research Center. In June 2017, the eight universities around Tokai region concluded an agreement on “cooperation during both disasters and peace-time” in anticipation of large-scale disasters such as the Nankai Trough earthquake. In April 2020, Tokai National Higher Education and Research System was established together with Gifu University. In response to these circumstances, we believe that in addition to disaster management of Nagoya University, it is necessary to proceed with concrete studies on the role of us as this organization or as a member of the eight universities around Tokai area.

Research Projects

Disaster Prevention in the Energy Supply Area Endowed Research Division (Chubu Electric Power Company)

● Research aims

In order to improve the ability to respond to disasters in terms of energy supply and enhance measures for rapid recovery in the case of earthquakes and other natural disasters, it is essential to conduct hazard assessments by examining historical earthquake damage, assess the earthquake resistance of energy supply facilities, and accurately understand the supply-demand balance in the case of disaster.

Accordingly, this endowed research division will conduct research on the following themes with the aim of helping to enhance the region's disaster prevention ability through the maintenance of a safe and assured energy supply.

- 1 More accurate estimates of the scale of seismic ground motions and tsunami caused by Nankai Trough mega-earthquake
- 2 More accurate estimates of damage at energy supply facilities in the event of Nankai Trough mega-earthquake
- 3 Examination of preparatory measures for maintaining the function of facilities when disaster strikes, and measures for rapid recovery

Disaster Risk Reduction on Lifeline Systems Academia-industry Cooperation Research Division (Toho Gas Network Co., Ltd.)

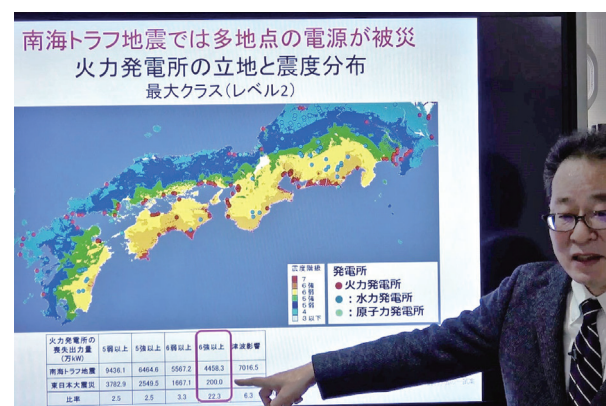
● Research aims

Lifelines such as water, electricity, and gas are critical social infrastructure, and it is extremely important to minimize damage, maintain their functionality, and restore them quickly even in times of emergency.

In order to contribute to the enhancement of resilience and sustainability of future society, we will promote the following research themes on disaster prevention and mitigation of lifeline,

based on a comprehensive analysis of the latest academic findings of recent natural disaster damage cases, which will play a role in mitigating large-scale disasters such as the impending Nankai Trough Earthquake and Ise Bay Typhoon.

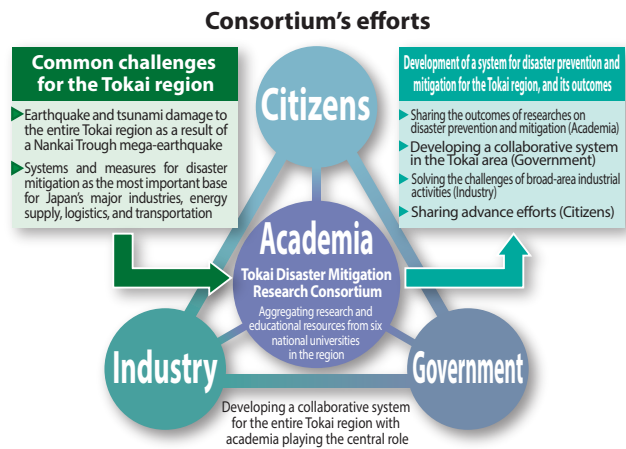
- 1 Vulnerability assessment of lifeline systems to large-scale disasters
- 2 Design of effective BCP measures for lifeline systems in preparation for large-scale disasters
- 3 Investigation and evaluation of damage prediction and countermeasures for various disasters in lowland areas



Social Contributions

Tokai Disaster Mitigation Research Consortium

Located at the center of Japan and as the nation's largest industrial base, the Tokai region faces the risk of a Nankai Trough mega-earthquake as well as other disasters. Therefore, developing effective strategies for disaster prevention and mitigation is a nationally important and urgent challenge. This Consortium was established with the aim of aggressively implementing research into reducing the impact of natural disasters in order to realize safe and assured regional societies. It is a collaborative effort involving six universities in the Tokai region—namely Gifu University, Shizuoka University, Nagoya University, the Nagoya Institute of Technology, Toyohashi University of Technology, and Mie University.



Research Project for Disaster Prevention on the great Earthquakes along the Nankai trough(2020.7~2025.3)

In this research project, we will structure the elements required for the continuity of industrial activities in the region, particularly manufacturing, at the time of the Nankai Trough Earthquake Extra Information announcement, and develop an industrial timeline modeling with proactive disaster prevention measures and post-event response. In addition, we will conduct a risk assessment of urban infrastructure and supply chain resilience.

Our research group will develop a method for real-time monitoring of the social situations with comprehensive and overview perspectives in case of the announcement of Nankai Trough Earthquake Extra Information.

We will develop a simulation methodology to assess the situation, examine the avoidance of social contraction, and encourage pre-disaster preventive investment through regional cooperation.

"Focus Survey and Observation on Byobuyama–Enasan Fault Zone and Sanageyama Fault Zone (Enasan–Sanageyamakita Fault Zone)" supported by MEXT(2020.4~2023.3)

This fault zone is located in a total length of 100 km from the Ena Mountains to the Chita Peninsula, and is close to cities such as Nagoya City and Toyota City; therefore, it is important for earthquake disaster prevention. This project carries out a survey to improve the long-term evaluation of earthquake occurrence and strong motion prediction in the northern part of the fault zone (mainly the Enayama-Sanageyama north fault zone), under the financial support of MEXT (Ministry of Education, Culture, Sports, Science and Technology).

This study conducts 1) tectonic landform survey, 2) paleo-seismicity survey, and 3) geological structure survey, and reexamine the source fault scenario. In addition, 4) it improves the prediction of strong motions, and 5) collaborates with the local community on the appropriate handling of prediction information with uncertainty. Based on the above, we aim to propose active fault evaluation methods and strong motion prediction in areas where fault distribution is complicated. Furthermore, we discuss how to utilize active fault information with uncertainty for earthquake disaster prevention in this region.

JICA Partnership Program “DISASTER AWARENESS ENLIGHTENMENT PROJECT FOR LARGE-SCALE NATURAL DISASTER CAUSED BY GLOBAL ENVIRONMENTAL CHANGE IN MONGOLIA” (2017-2023)

Nagoya University aimed to demonstrate the importance of bottom-up disaster risk reduction (DRR) activity led by local governments and citizens, and to spread good examples of Japanese regional strategy to Mongolia. We aimed to 1) build a collaborative system between the local government, NEMA(National Emergency Agency), schools, 2) develop DRR educational materials for the region, and 3) promote DRR activities for the residents with local leaders.

In order to prevent residents from experiencing unexpected disasters, DRR education contents were developed, including (1) explanatory videos by experts, (2) a flood hazard map for Khovd city, and (3) DRR cards (“Bosai Carta”) co-created with

children. In addition, (4) citizen workshops were held on the role and necessity of citizen activity, and a DRR volunteer organization was officially established in Khovd city. These efforts were highly evaluated by NEMA, the Ministry of Education, and JICA. Due to the increasing need for nationwide expansion, a proposal for the second phase of the JICA Partnership Program was accepted in March 2024.



Grants-in-Aid for Scientific Research - KAKENHI - Fund for the Promotion of Joint International Research (International Collaborative Research) "Improving the seismic performance of buildings by foundation sliding structures and seismic countermeasures for nonstructural components" (2022-2026)

Damage to buildings during major earthquakes causes significant functional and economic losses in society. While securing the strength and deformability capacities of structural systems has been effective for improving the seismic resistance of buildings in the past key phases, improving the seismic performance of interior and exterior nonstructural components and a variety of equipment still remains a major challenge. Here, the research and development policies apply a probabilistic methodology to the accurate performance evaluation of the entire building systems including the secondary members, as well as the rational evaluation of seismic enhancement through the countermeasures. A systematic international collaboration team (Taiwan, Korea, USA, China, Turkey, Switzerland, New Zealand, etc.) is active to develop next-generation performance

evaluations and designs that scientifically represent real phenomena while ensuring practice application feasibilities. The relevant numerical simulations reflect experimental data and damage fragilities for various consisting members. Seismic response evaluations, when force interactions between the foundation and the surrounding soil enter a significant nonlinearity, will be developed, consistently reflecting this effect into the seismic performance assessment.



“Development of Risk Assessment Method for Storm Surge and Wave Inundation in Ports” (2023-2025) supported by the Cross-ministerial Strategic Innovation Promotion Program (SIP)

This research is a task in a sub-theme of “Promotion of Disaster Mitigation Actions Based on Risk Information” under a theme of “Development of a Resilience Smart Network System against Natural Disasters” in the SIP Third period, which is a 5-year project from September 2023 and funded by the Cabinet Office of Japan. Storm surges and waves pose significant hazards to ports, which are critical infrastructure. Their intensity may increase due to global climate change. Risk assessment of inundation induced by these phenomena, which involves uncertainty,

is crucial for promoting and accelerating action and investment in disaster risk reduction for port-related sectors. Collaborative disaster risk reduction, involving multiple actors working together to reduce the risk of disasters in port areas, is also crucial for enhancing regional resilience. This study aims to develop a method for visualizing disaster risk, particularly focusing on inundation caused by storm surges and waves, enabling port management organizations and private sectors to manage actionable and effective disaster risk reduction.

Disaster Mitigation Renaissance through improved regional capabilities

Every year, a single municipality is chosen and designated as a model area from among municipalities in Aichi Prefecture that have populations of 100,000 or fewer (a total of five municipalities chosen in five years). All of the designated municipalities differ from one another in terms of geography, geology, past experience of natural disasters, natural disaster risk level, industrial structure, and historical background. In the model areas, documents are collected concerning regional history and geography, the population's ability to respond to disasters, and information on disaster prevention and mitigation based on the latest scientific and technological research concerning seismic disaster prevention. Using these documents, workshops are held by municipal office staff, regional companies, and residents to pave the way toward implementation of appropriate disaster prevention and mitigation countermeasures. After the completion of this project, we will aim to apply and widely extend this study's results to other municipalities that have geographical

characteristics that are similar to those of the five model municipalities. (Business subcontracted by the Ministry of Education, Culture, Sports, Science and Technology "Project for the study on support of local disaster-damage prevention measure")

In F.Y 2017, we have newly developed a unique multi stakeholder workshop methodology, combining a huge floor map with portable projection mapping system covering Aichi prefecture and its vicinity. Emergency routes, pivotal disaster response facilities, hazards generated by earthquakes are overlaid, so that numerous experts can share the geographical recognition and identify the bottlenecks for emergency operations and recovery. On 26 Dec. 2018, disaster response & waterworks experts from 10 municipalities of Nishi-Mikawa region together with Chubu Regional Bureau of MLIT, Aichi Pref., utility companies and major companies conducted a workshop with this mapping system to discuss ways to cope with possible Nankai-trough earthquake emergency.

Research and development of advanced educational materials for disaster management

We are developing educational materials that allow people to experience realistic sensations of an earthquake, along with materials for learning about the results of seismic engineering research. The "Koso Bururu" (High-rise Building Shaking Earthquake Simulator) is a 4-layer construction with liner guide rails. It is a large-scale educational tool that allows users to easily experience the difference in shaking according to height of the building they are in, by locking and unlocking the joints between the layers. "Bururu Glasses" combine a head mounted display and 3-D virtual room images to create a virtual reality that realistically simulates the damage caused by a massive earthquake. We also developed equipment to overlay various spatial information onto the high-definition aerial photographs of Nagoya city, using projection mapping from the ceiling. This allows visitors to visually understand the features of the terrain around their home and workplace, and how they are connected to disaster risks.

The Disaster Mitigation Research Building's BIM, makes use of BIM (Building Information Modeling) construction technology, in a system that allows visitors to visualize the building as a 3-D model, from its structure right through to the interior and exhibits. It gives visitors a virtual view of things that are normally out of sight, such as the Disaster Mitigation Research Building's seismic laboratory equipment.

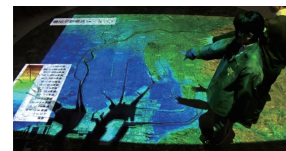
Development of the "Bururu" series of experiential educational tools for learning about disaster mitigation is ongoing. We have developed the BiCURI (Bi-directional shaker and Computed Ultra-Response Integration environment). The BiCURI system can simulate the "shaking of a skyscraper" using a vibrating table that reproduces the floor responses that result from an earthquake (long period ground motions,) together with videos of damaged rooms synchronized with its movements. The rooftop laboratory is able to shake the

entire room at any given waveform, using an actuator. The vibration of the laboratory is synchronized with video and audio so that visitors can experience the shaking of a building caused by an earthquake through all of their senses. For detailed terrain models, 3-D visualization equipment which projects hazard maps, etc. with image enhancement based on altitude data, enables visitors to gain awareness of disaster risks based on 3-dimensional information.

In addition, we are also progressing with development of effective materials that raise awareness about disaster risks, in convenient formats. We are also developing educational materials aimed at raising awareness. These include, cards, called "MAGIC Bururu" that change design according to viewing angle (lenticular printing), making it easy to see overlays of ground conditions and hazard maps. There are also the booklets, The Story of The Sujikai Family, and The Story of The Takai Family, which combine scenarios of what might happen to regular families in the event of a disaster with information on disaster management. There is an accompanying web application based on the same content called "escape" which allows users to experience disaster scenarios.



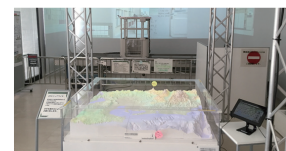
"Koso Bururu"



Projection mapping (elevation) onto an aerial photograph of Nagoya city



3-D image of the Disaster Mitigation Research Building BIM



2-dimensional long stroke shaking table, "BiCURI" and a 3-D visualization

Human Resource Development Programs for Disaster Reduction

Disaster Reduction Academy Lectures

Disaster Mitigation Research Center organizes monthly lectures for citizens with keen interests in disaster reduction and who are the supporters of disaster reduction activities at localities. Participants can acquire latest knowledge on wide range of research topics. This is offered in hybrid style and approx. 200 participate every time.



"Gen-Sci Café" (Science Café for Disaster Mitigation)



"Gen-Sci Café" is an event where lecturers with various areas of expertise respond to questions from citizens about disasters in an interactive, easy-to-understand way through a facilitator. The monthly cafés focus on themes related to disaster prevention and mitigation. The short distance between the facilitator, guest speaker and the audience always encourage vigorous discussions.

Developing and Conducting Training Programs to Nurture Disaster Reduction Experts

Disaster Mitigation Research Center through dialogue with local governments in this region has proposed and initiated a wide variety of training programs to nurture disaster reduction experts. The faculty members of Disaster Mitigation Research Center serve as lecturers for various training programs organized by prefectures and municipalities in this region, such as the Nagoya Volunteer Coordinator Course, Disaster Resilient Town Creation Advisor Course, Seismic Retrofitting Advisor Course, Young Anti-Seismic Town Creation Trainer Course, etc.

"Tsunagi-ya" (Exchange seminars for local disaster reduction practitioners)

This series of seminars aims to provide opportunities for alumni of disaster mitigation programs provided by various prefectures and municipalities, who are the local disaster reduction practice leaders, so that they can forge human networks across localities. Exchange programs with the affected areas of the 2011 Great East Japan Earthquake are included. Through such interaction, the participants will take home learnings from other localities and lead to developing new activities in their home ground communities.

Disaster Reduction Seminars for High School Students

These seminars hosted by Aichi Prefecture target high school students with the aim of nurturing future disaster reduction leaders who will contribute to enhancing the disaster preparedness capabilities of schools and communities. A total of about 150 students from 30 high schools in Aichi prefecture—several students and teachers from each school—have attended the seminars over two years. Participants initially attend four days of lectures during the summer holiday, acquiring knowledge on natural disasters and practical responses to disasters. Based on this learning, they implement their own activities for disaster reduction at their respective schools. Afterwards, during the winter holiday, they will present their findings and outcomes.

Workshop Series for the Mass Media

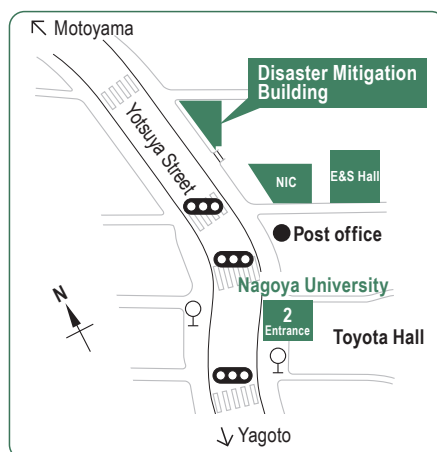
In the Tokai area, to be better prepared against large-scale disasters caused by big earthquakes and other natural hazards, members from the mass media, researchers, administrative offices, NPOs, and utility companies (operating mainly in this area) started NSL (Network for Saving Lives) in 2001 for the purpose of exchanging their opinions and information. Monthly meetings are held, inviting various professionals as guest speakers. The faculty members of the Disaster Mitigation Research Center proactively participate in the NSL workshops.

"ESPER" (Extended Seminar for Professional Engineers and Researchers)

The aim of this seminar is to help young engineers from a range of fields to enhance their skills in leadership in the prevention of earthquake-related disasters so that they can support future disaster prevention measures in the Chubu region. In addition, it aims to enhance the effectiveness of the region's capabilities in terms of disaster prevention and mitigation through the promotion of face-to-face collaboration among young engineers.

Lectures for students

Faculty members of Disaster Mitigation Research Center offer classes of "Be Ready for Imminent Natural Disasters" for liberal arts students, and "Comprehensive Disaster Reduction Theory I-IV" for postgraduates. In cooperation with Japan Bousaisi Organization, Disaster Mitigation Research Center provides a framework in which students who took classes of "Comprehensive Disaster Reduction Theory I-II" are granted qualifications of candidacy for Bousaisi expert. Also, an English lecture titled "Preparedness for Imminent Natural Disasters" are offered to students from abroad.



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