THE 25TH EAST ASIA
ROUND TABLE MEETING
& SYMPOSIUM

Prevention and Mitigation of Disasters as Climate Change Adaption

November 10, 2022

SYMPOSIUM 09:30-15:05 GMT+9
ROUND TABLE MEETING 15:30-17:00 GMT+9

公益社団法人 日本工学アカデミー THE ENGINEERING ACADEMY OF JAPAN

NAEK 한국공학한림원 The National Academy of Engineering of Korea

中国工程院 CHINESE ACADEMY OF ENGINEERING

About the EA-RTM

- Creation

East Asia Round Table Meeting of Academies of Engineering "EA-RTM" is a non-profit and non-governmental association with science, engineering and technology interests. It is founded by the Chinese Academy of Engineering (CAE), the Engineering Academy of Japan (EAJ) and the National Academy of Engineering of Korea (NAEK). EA-RTM shall be expanded and consisted of academies of engineering and technological sciences of East Asian Countries.

- Objectives

The objectives of EA-RTM are to discuss the issues of common concern among members related to engineering and technological sciences and to find out best solutions and provide impartial and balanced advice on technological issues for the short, medium and long-term future of East Asia.
In order to carry out these objectives, EA-RTM will:
(a) Provide an independent non-political and non-governmental international forum of engineering and technological sciences academies in East Asia, prepared to advise governments and international organizations on technical and policy issues related to its areas of expertise;
(b) Contribute to the strengthening of engineering and technological activities in order to promote sustainable economic growth and social welfare throughout East Asian countries;
(c) Foster a balanced understanding of the applications of engineering and technology by the public;
(d) Provide an international forum for discussion and communication of engineering and technological issues of common concern;
(e) Foster cooperative international efforts for development of programs of bilateral and multilateral interests;
(f) Support establishment of additional engineering academies in countries where none exist.

（East Asia Round Table Meeting of Academies of Engineering (EA-RTM) Bylaws 2004）

The 25th East Asia Round Table Meeting and Symposium (EA-RTM)

Symposium on Prevention and Mitigation of Disasters as Climate Change Adaptation

9:30 Opening Remarks
Yuko Harayama, EAJ Distinguished Fellow
Oh-Kyong Kwon, NAEK President
Wang Chen, CAE Vice President

9:45- Keynote Speech: "The Climatic Risk Boundaries and Adaptation"
Prof. Taikan Oki, University of Tokyo

10:00- Session 1: Frontiers of flooding prediction and flood control in the river basin

1. "Development of Today's Earth: A global to regional simulator of terrestrial hydrological cycles"
   Professor Kei Yoshimura, Institute of Industrial Science, the University of Tokyo (EAJ)

2. "Flood Assessment and Mitigation to Support Flood Control in the Soemjin River Basin, Korea"
   Dr. Joonwoo Noh, K-water Research Institute, Korea Water Resources Corporation (NAEK)

3. "Historical and future changes in droughts, floods and abrupt drought-flood shifts in a warming climate"
   Professor Yang Dawen, Tsinghua University (CAE)

Q&A, Discussion(10min)

11:15- Session 2: Frontiers of landslide disaster prediction and damage reduction measures

1. "Climate Change-induced landslide and debris flow Prediction and Countermeasures in Korea"
   Professor Sangseom Jeong, School of Civil and Environmental Engineering, Yonsei University (NAEK)

2. "Challenges and Strategies of Risk Mitigation on Catastrophic Landslides in China"
   Dr. Yin Yueping, Chief Geologist, China Institute of Geo-Environment Monitoring, China Geological Survey (CAE)

3. “Influences of long-term changes related to forest vegetation and heavy rainfall characteristics on sediment-related disasters in Japan”
   Professor Yasuhiro Shuin, Kyushu University (EAJ)

Q&A, Discussion(10min)

12:20- Lunch/Break Time

14:00- Session 3: Other advanced measures for prediction and mitigation of water hazards

1. “From Resolute Flood Defense to Active Flood Diversion: Practices and Challenges of Flood Risk Management”
   Dr. Cheng Xiaotao, former deputy chief engineer, Chinese Academy of Water Sciences (CAE)

2. “Future changes and adaptation to coastal hazards due to climate change”
   Professor Nobuhito Mori, Disaster Prevention Research Institute, Kyoto University (EAJ)

3. “Other Advanced Measures for Prediction and Mitigation of Natural Disasters”
   Professor Hungsoo Kim, Department of Civil Engineering, Inha University (NAEK)

Q&A, Discussion (10min)

15:05 Closing

The Climatic Risk Boundaries and Adaptation

Taikan OKI
Professor, Special Advisor to the President
The University of Tokyo

Anthropogenic climate change is influencing the frequencies of extreme weather events. Considering the adaptability to extreme climatic risks in the future, we focused on determining whether humans have been exposed to the risks before. We define the rim of two-dimensional histograms of population under 20-year extreme temperature and precipitation as a climatic risk boundary. More than 30% (16.3%) of world population in South Asia, sub-Saharan Africa, and other regions will transgress the climatic risk boundary by the end of this century under RCP8.5 (RCP2.6) scenario. While many areas with large cities will remain within the global climatic risk boundary, they will transgress their regional climatic risk boundaries. This study shows that it is also necessary to consider the limits to adaptation for each appropriate area, considering the cultural, technological, and social transferability of adaptation.

These figures allow us to examine human beings in which region will be exposed to unfamiliar extreme climatic risks in the future. When climate conditions change, humanity must transform its socioeconomic systems to adapt. If the risks are within the climatic risk boundaries, we can identify which regions are currently under the similar climatic risk and learn and implement appropriate adaptation measures. More reasonable assessments of the risks will also be enabled by considering the transferability of knowledge and technologies in relation to social and economic disparities, however, this study will make a significant contribution to future research on climate change in that the methodology presented here can be used to perform similar analyses no matter what model or scenario is chosen. These findings highlight the importance of smooth exchanges of knowledge and technologies through global partnerships based on multilateralism for implementing applicable adaptation measures to climate change.

Climate change is a serious risk that affects human society and ecosystems, and the realization of a carbon-neutral society as a countermeasure for climate change requires rapid social change and has significant impacts on society. Thus, not only human activities affect climate change, but climate change and climate change countermeasures also bring significant changes in human society.

The University of Tokyo established the UTokyo Center for Climate Solutions (UTCCS) in July 2022 to organize diverse researchers involved in a wide range of climate and social issues. The UTCCS is creating a new academic discipline that will elucidate the interaction between climate and society, and contribute to the development of a sustainable society, as well as to the promotion of green transformation within the University of Tokyo.

Reference:

Sano, T., and T. Oki, 2022: Future population transgress climatic risk boundaries of extreme temperature and precipitation, *Environ. Res. Commun.*, **4**, 081001. https://doi.org/10.1088/2515-7620/ac85a1

Development of Today’s Earth: A global to regional simulator of terrestrial hydrological cycles

Kei Yoshimura
Professor
Institute of Industrial Science, The University of Tokyo

In an effort to mitigate the increasing number of water-related disasters caused by extreme precipitation and to elucidate the phenomenon, a joint research group from the Institute of Industrial Science (IIS) at the University of Tokyo and the Earth Observation Research Center (EORC) of the Japan Aerospace Exploration Agency (JAXA) developed Today's Earth, a simulation system that provides integrated estimates of physical quantities related to the terrestrial hydrological cycles (e.g., soil moisture content, river flows, evapotranspiration, and many others).

Today's Earth utilizes the land surface simulation technology of the University of Tokyo and the satellite data analysis technology of JAXA/EORC, respectively, and enables us to continuously monitor global land conditions through the internet. In the Japanese region in particular, we have established a system to distribute real-time situations and data with a resolution of 1/60th degree of a latitude and longitude grid (about 1 km grid) to the public, and detailed river discharge and floodplain estimation results are available to everyone.

In the case of Typhoon Hagibis, which caused extensive damages at more than 70 river systems and killed more than 100 people in the eastern part of Japan during 12th to 13th October 2019, we used the Today's Earth system to conduct forecasting simulations and confirmed that we were able to predict the flood hazard information, including the Chikuma River, where catastrophic damage was reported. In more detail, at 130 of the 142 sites where breaches were reported, the system predicted a once-in-200 years flood event (defined as an alert) for an average of 32.3 hours prior to the event. The actual breaches occurred 8.5 hours later than the predicted alerts. The false alarm rate was around 70% to 80 % throughout the period. This predictive information is being considered for use in a variety of fields, such as the distribution of disaster prevention information in the domestic media and public municipal offices.

Flood Assessment and Mitigation to Support Flood Control in the Soemjin River Basin, Korea

Joonwoo Noh
Head Researcher
K-water Research Institute

Heavy rainfall occurred from August 7th to 8th in 2020, resulted in severe flood damage especially in the Soemjin River basin located in south west of Korean peninsula. While its downstream end is subject to the tidal variation of the Korea Strait, the Soemjin River is regulated mainly with two multipurpose dams, one is at the very upstream of the main river and the other one is at the upstream of one tributary that confluences with the midstream of the main river. Most of flood damages occurred at the junction points where unregulated tributary confluences with the mainstream because the water level exceeds the elevation of the levee due to increased rainfalls. For example, at the junction of the biggest tributaries, Yochun, levee breaching due to piping and bank erosion occurred.

To evaluate the flood inundation to estimate flood damages, quantitative analysis has been done based on a modeling application using flood simulation software packages including distributed rainfall-runoff model, 2 dimensional flood propagation model, and flood level hydraulic simulation model. The application of flood simulation packages are useful to reproduce flood inundation areas and to evaluate causes of the flood damages. For efficient reservoir operation for the purpose of flood control, K-water has proposed artificial reservoir operation based on the software applications. From the experience of the flood damages in 2020, K-water has incorporated Digital Twin concept as a decision support tool to minimize flood damages in downstream. Initiated from the Soemjin River basin the reservoir operation system of the 4 other river basin will be improved in the same manner.

Historical and future changes in droughts, floods and abrupt drought-flood shifts in a warming climate

Dawen Yang
Professor
Tsinghua University

Droughts and floods, two water-related hazards of great concern, occurred frequently throughout the world in the past decade. As the climate warms, more unprecedented floods and droughts are expected around the world. Droughts and floods barely occur at the same place and at the same time, but a rapid succession of these two hazards can aggravate adverse impacts caused by individual hazards alone, leading to drought-flood weather whiplash. Such an abrupt shift between drought and flood poses an emerging threat to ecosystems, agricultural systems, and human development.

In this talk, we first examine the occurrence and changes of abrupt drought-flood shifts (ADFS) across the globe for the past 60 years using observation and reanalysis-based meteorological datasets and for the coming century based on the ensemble of climate model projections. The frequency, duration and intensity of ADFS events are found to show consistent increasing trends over time. Attribution analysis indicates that such changes in ADFS events are primarily caused by greenhouse gas-induced climate warming, which are, however, partly offset by aerosol-induced climate cooling.

We also take a closer look at the upper Yangtze River Basin (UYRB), which was just hit by a record breaking heatwave and drought that led to unprecedented water and power shortage in August, 2022. Based on the simulation results, the annual runoff volume in the future UYRB is expected to decline compared with the historical period. The agricultural drought severity will increase more severely than the meteorological droughts, and the most extreme events in the historical period would become the new normal. There will also be more frequent drought-pluvial seesaws at major hydrological stations. These findings highlight the importance of adaptive water resources management to tackle the elevated risk of water shortage and more frequent and severe hydroclimatic extremes in a warming climate.

Climate Change-induced landslide and debris flow Prediction and Countermeasures in Korea

Sangseom Jeong
Professor
School of Civil and Environmental Engineering, Yonsei University, Korea

Global climate change is affecting regional weather patterns, rainfall trends, and their variability. This report presents an overview of the present prediction methods for rainfall-induced landslides and subsequently debris flows under climate change and present possible adaptive measures against disasters in Korea.

Examples of disasters include torrential rainfall-induced shallow and deep slope failure, flooding and destruction of the roads and buildings triggered by several typhoons and intensifying inundation. Special attention is given to the calculation of the propagation of debris flows by considering rainfall infiltration into soil slopes and soil entrainments by debris flows.

Based on Digital Elevation Model(DEM), rainfall characteristics, hydrological parameter and geotechnical and mechanical soil properties of the study area in Korea, the assessment of landslides susceptibility was conducted by using a GIS-based physically-based model and the necessity of adaptive measures is highlighted for overcoming climate change-associated compound geo-disasters.

Challenges and Strategies of Risk Mitigation on Catastrophic Landslides in China

Yin Yueping
Chief Geologist
China Institute of Geo-environment Monitoring

China is the country with the most complicated and serious geological disasters in the world. Through more than 20 years of efforts, a nation-wide reduction system including in the geological disaster investigation and evaluation, the monitoring and early warning, the emergency response and the comprehensive treatment system has been established. The number of deaths caused by geological disasters has significantly decreased, from 1500 deaths per year in the 1990s to about 100 deaths per year in recent years. This presentation first introduces about the national monitoring and early warning systems consisted of about 50,000 of landslides covering the whole country, including the hilly and mountainous areas in South China, the Loess Area in Northwest China, the Wenchuan Ms8.0 earthquake mountainous area and the high mountains and valleys of the Qinghai Tibet Plateau. The risk criteria of warning is discussed on base of multi parameters combined with GNSS, displacement, tilt, acceleration and others. Secondly, taking the Three Gorges Project area as an example, the presentation introduces the geological disasters and risk control techniques of the reservoir-induced landslide since the water storage and operation in 2008. The mitigation on landslide-induced surge disaster is introduced. Finally, the presentation introduces long-runout catastrophic geological disasters at high altitude that have occurred in the Western Alpine and canyon areas in China in recent years, and points out that because of their extreme destructive power on highway, railway and hydraulic power plants, they are the frontier key scientific and technological issues in the global geological disaster prevention and mitigation research. The disaster risk assessment and mitigation method of more than 10km long runout catastrophic mixed ice and rock avalanche initiated at top of mountain with a height of over 5000m and the secondary disaster chain is proposed.

Influences of long-term changes related to forest vegetation and heavy rainfall characteristics on sediment-related disasters in Japan

Yasuhiro Shuin
Professor
Kyushu University

Fundamentally, sediment-related disasters (SRDs) are determined by two groups of factors: “predisposing factors” such as topography, geology, and vegetation and “triggering factors” such as heavy rainfall characteristics, earthquakes, and volcanic activity. Of these, forest vegetation changes are significantly influenced by socioeconomic activities, while rainfall characteristics are affected by climate change. This presentation briefly describes the effects of long-term changes in forest vegetation and rainfall characteristics on SRDs using two cases. CASE 1 is on a national scale across Japan, and CASE 2 is on regional scale across the southwestern slope of Mt. Mihara on Izu Oshima Island.

CASE1 (national scale): [Forest vegetation] From 1958 to 2017, the forest area remained nearly constant at approximately 25 million ha. However, the growing stock of forest per hectare (GSF) increased 2.5-fold from approximately 81 to 221 m^3/ha. [Characteristics of heavy rainfall] From 1976 to 2018, the annual number of rainfalls with intensities exceeding 50 mm/h, and the proportion of the maximum daily precipitation for each year relative to the average from 1981 to 2010, were investigated. The annual number of occurrences increased to 28 per decade, and the annual maximum daily rainfall increased 3.4% per decade. [SRD area] There were no clear correlations between the SRD area and heavy rainfall characteristics. However, the SRD area tended to decrease with increasing GSF until the 1990s and remained constant thereafter. The GSF in 1995 was approximately 146 m^3/ha.
CASE2 (regional scale): This area suffered from two severe SRDs caused by Typhoons Ida in 1958 and Wipha in 2013. As a result, 2 people died or went missing in 1958 and 34 in 2013. The estimated GSF was 108 m^3/ha in 1958 and 183 m^3/ha in 2013, and the differences in the heavy rainfall characteristics inducing SRDs between 1958 and 2013 were evaluated using the return period (RP) derived from the early warning system (EWS) used widely in Japan. In 1958, the RP at the initial occurrence of the SRD was 30 years, and the maximum RP was 112 years. In 2013, the respective values were 183 and 2497 years.

These results suggest that GSF is an appropriate indicator of the SRD mitigation function of forest vegetation. However, there are limitations to the mitigation function of forest vegetation. The limit across Japan was approximately 146 m^3/ha. On a regional scale, the RP derived from the EWS is effective for evaluating heavy rainfall characteristics. Investigating the relationship between the RP and GSF may lead to climate change adaptation related to disaster countermeasures that consider changes in both triggering and predisposing factors, including forest management.

From Resolute Flood Defense to Active Flood Diversion: Practices and Challenges of Flood Risk Management

Xiaotao CHENG
Professor
China Institute of Water Resources and Hydropower Research

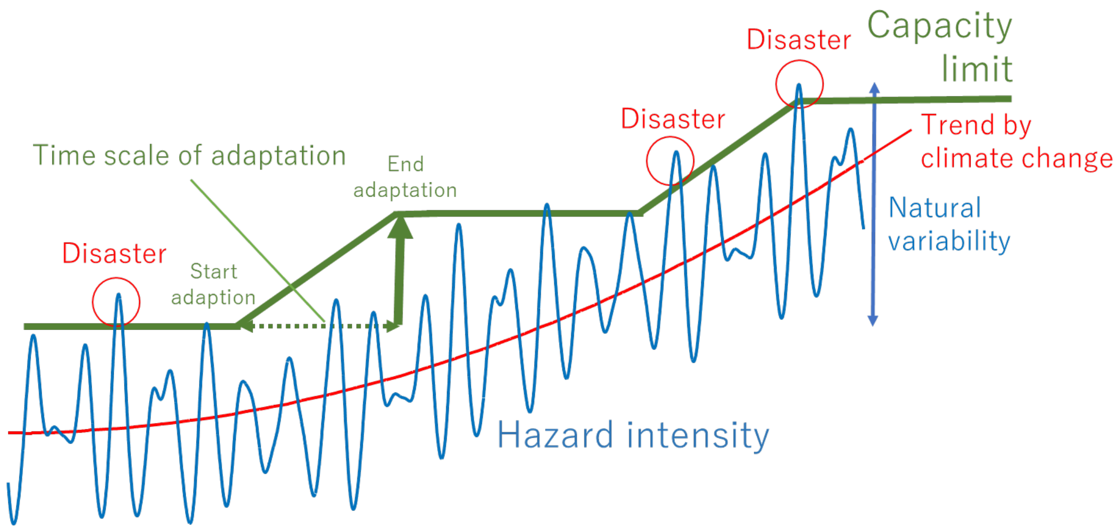
With global warming and rapid urbanization process, the possibility and uncertainty of floods beyond the defensive capacity are on the rise, and the threated objects, disaster mode, damage-caused mechanism, loss composition, and risk characteristics of extreme floods are undergoing significant changes. According to the statistical report of the United Nations, in the first 20 years of the 21 Century, eight of the top 10 countries by occurrence of disasters sub-groups were in Asia, and people affected by flooding in China over the two decades accounted for approximately 55% of that worldwide. In fact, after the great flood in 1998, the Chinese government continued to double the investment in flood control system, and promoted the idea of harmony between people and water, balancing development and security. The relative loss of flood decreased from 2.25% in 1990s to 0.58% in 2000s, and further to 0.38% in 2010s, and both the affected people and the death toll showed a significant trend of decline. In 2020, the Yangtze River Basin suffered the most serious flood since 1998. In addition to the joint operation of reservoir cluster with the Three Gorges as the core in the Yangtze River Basin, 185 polders in Poyang Lake region and 183 polders in Chaohu Lake region took the initiative to divert floods, which alleviated the damage of severe floods on the whole, but it also faced some issues and challenges in the new situation of social and economic development. The severe rainstorm and flood disaster in Henan Province in July 2021 and the extreme drought in the Yangtze River Basin in the flood season of 2022 further demonstrate the severity of the challenges. The presentation analyzes the characteristics and mechanisms of disaster risk evolution, and highlights the necessity and feasible ways to improve resilience.

Future changes and adaptation to coastal hazards due to climate change

Nobuhito Mori
Professor, Vice-Director
Disaster Prevetion Research Insitute, Kyoto University

Tropical cyclones (TC) cause severe coastal hazards in the middle latitude. Hurricane Katrina in 2004, which made landfall in Louisiana, caused more than 1000 people dead or missing and caused USD 108 billion in economic damage. Typhoon Haiyan hit the Philippines in 2014, leaving 8123 people dead or missing. The main cause of these events was the storm surge caused by the typhoon. TC intensity will be expected to increase due to climate change by global warming. TC intensity and the other TC characteristics are linked to future changes in extreme storm surges and wave climates in middle latitudes. Therefore, it is important to know future long-term changes in extreme water levels, the contribution of increased storm surges, and wave height for coastal hazard mitigation. In addition, finding a hot spot of large changes and adaptation strategies are important for designing a safer coastal region.

The historical and future long-term changes in extreme water levels, the contribution of increased storm surges, and wave height by the monitoring data and climate projections will be presented based on the Japanese research group. In addition, several examples of impact assessment and adaptation of storm surges and extreme wave changes in Japan will be presented.



Schematic view of hazard and acceptance level including adaptation (blue: hazard intensity (e.g., water level), green: limit of capacity (e.g., dike height), red: climate change trend)

Other Advanced Measures for Prediction and Mitigation of Natural Disasters

Hung Soo Kim
Professor
Inha University

A large number of actions are needed to mitigate the effects of natural disasters, especially by water-related hazards, may it be heavy rain, flood, drought, heavy snowfall, typhoon, strong winds or worse, compound natural disasters. Each category of disaster produces huge impacts not just to the economy but to the society as a whole. Thus, advanced measures are deemed important and necessary. In this study, several methods have been explored to be able to lessen the large-scale damages of each aforementioned natural disaster. Today, machine learning algorithms are widely used to predict stream water levels and risk indices for heavy rains and floods. Different prediction functions were also found to be helpful in addition to damage economic analysis for heavy snowfall, typhoon and wind damage which are potentially helpful for decision-makers and stakeholders to mitigate the effects of these disasters. However, further research and exploration of methods are needed for drought and compound disasters since data are insufficient. Indeed, technical- or in-depth calculation-based methods and models used by scientists have caught the attention of many including urban planners and hydrologists. Additionally, hydrologists, engineers, and urban developers have considered including nature-based solutions as part of community planning and management strategies to the natural disasters. Wetland restorations, reviving old channels in addition to machine learning-based models are only few of the complementary measures to mitigate the effects of natural disasters, certainly with aim to enhance the existing environmental and societal benefits.