ASIAN DISASTER REDUCTION CENTER

Visiting Researcher Program FY2023

RESEARCH REPORT

FLOOD DISASTER RISK MANAGEMENT

HABIL HUSEYNOV

ADRC Visiting Researcher FY2023

The Academy of the Ministry of Emergency Situations of the Republic of Azerbaijan

Teacher, Academy of MES

Doctoral (PhD) student,

Azerbaijan State Oil and Industry University

THE ACTUALITY OF THE RESEARCH TOPIC

Floods, which are among the most advanced natural disasters that occur in Azerbaijan and the world in terms of percentage, cause great damage to the country's economy, as well as human casualties and material losses. The inundation that occurred in the country was mainly manifested as a result of the overflow of the river in Azerbaijan.

Japan has a big experience in disaster reduction for almost all types of disasters, such as earthquakes, floods, typhoons, etc. So, this research will identify Japan’s experience in flood risk management (countermeasures that japan takes, technologies they use in flood management, simulation models of inundated areas, etc.).

For this reason, the topic of the research is actual and appropriate for both countries.

THE PURPOSE OF THE RESEARCH

The purpose of the research work is to learn about Japan’s experience in flood risk disaster management and to make an appropriate proposal and recommendations for the purpose of reducing and partially preventing the damage that floods can cause to the life activities of the population living there. Moreover, to identify the new technologies that are being used for flood management in Japan. Additionally, to learn simulation models for making hazard maps of the inundation areas.

The research paper consists of an introduction, 4 chapters, a conclusion, acknowledgement and a list of references. It consists of 63 pages with computer writing, 79 pictures (map, table, diagram, equations), and a reference with 50 names.

STRUCTURE OF THE RESEARCH

I. PHYSICAL-GEOGRAPHICAL, ECONOMIC, SOCIO-DEMOGRAPHIC CONDITIONS, DISASTER RELATED REGULATIONS AND LAWS, THE CHARACTERISTICS OF DISASTERS, THE CONSEQUENCES OF FLOODS IN AZERBAIJAN AND JAPAN

II. THE EXISTENCE OF EARLY WARNING AND MONITORING SYSTEMS AND THE LATEST TECHNOLOGIES IN FLOOD MANAGEMENT IN AZERBAIJAN AND JAPAN

III. SHELTER MANAGEMENT, DISASTER RISK REDUCTION AWARENESS AMONGST PUBLIC, BUILDING BACK BETTER SYSTEM IN JAPAN

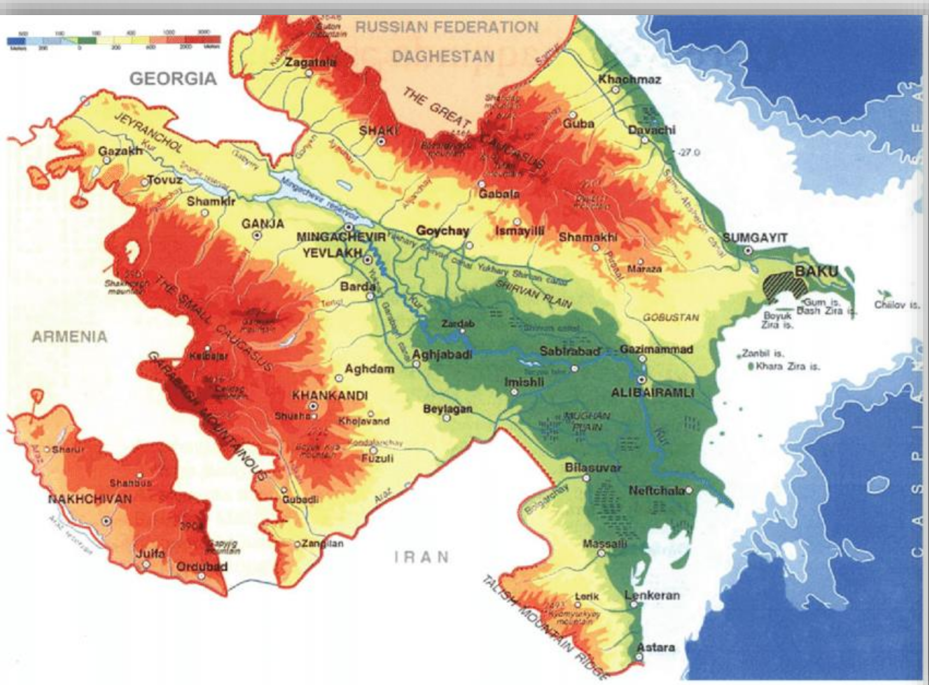
IV. PREDICTION OF THE CONSEQUENCES OF FLOODS BY USING LOCATION-SPECIFIC FLOOD SCENARIOS AND SIMULATION EXERCISES IN JAPAN

I Chapter

PHYSICAL-GEOGRAPHICAL, ECONOMIC, SOCIO-DEMOGRAPHIC CONDITIONS OF AZERBAIJAN

Azerbaijan is a country located at the crossroads of Eastern Europe and Western Asia, bordered by the Caspian sea to the east.

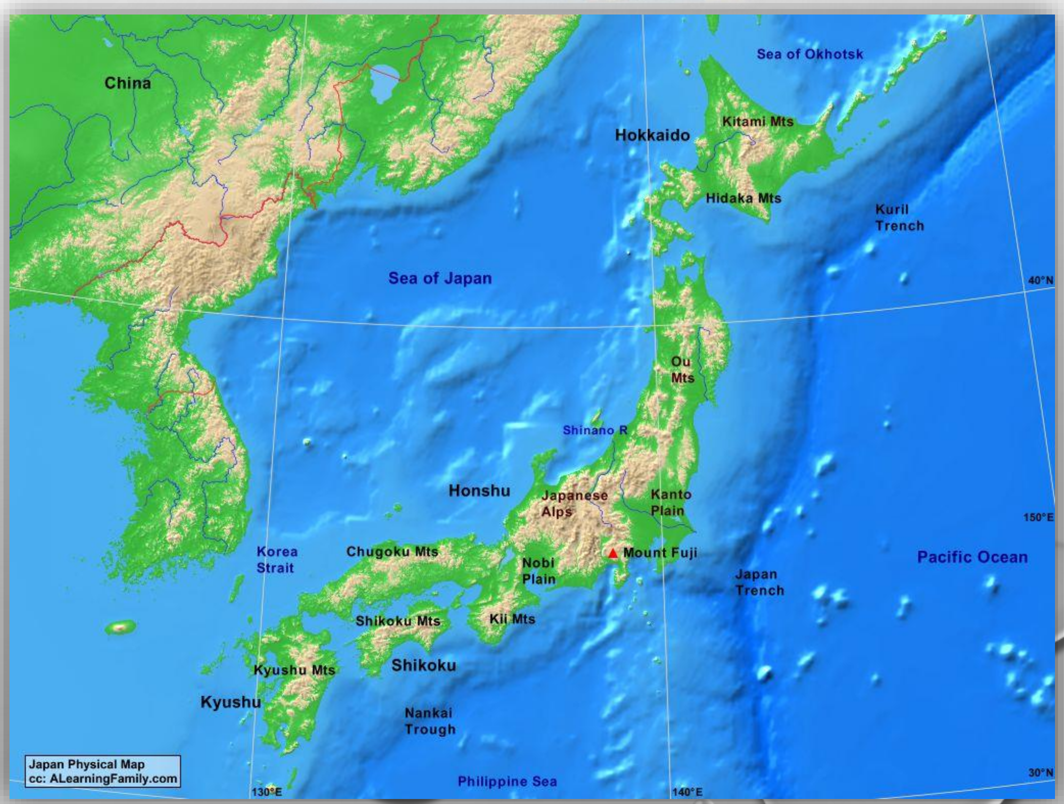
Economic conditions: Azerbaijan has experienced significant economic growth due to its oil reserves, making it a key player in the global energy market. Additionally, Azerbaijan has been focusing on diversifying its economy into non-oil sectors, such as tourism and technology. With its strategic location and significant natural resources, Azerbaijan has become an important hub for regional economic activities.



PHYSICAL-GEOGRAPHICAL, ECONOMIC, SOCIO-DEMOGRAPHIC CONDITIONS OF JAPAN

Japan's physical-geographical conditions are diverse and unique. The country is an archipelago consisting of over 6,800 islands, with four main islands: Honshu, Hokkaido, Kyushu, and Shikoku.

Japan possesses a robust and advanced economy, being the third-largest in the world by nominal GDP. The country is renowned for innovation, technological advancement, and a strong industrial base. Moreover, Japan has a highly skilled workforce, efficient infrastructure, and a formidable export-oriented manufacturing sector. The economy is globally influential, with a focus on industries such as automotive, electronics, robotics, and high-tech machinery.



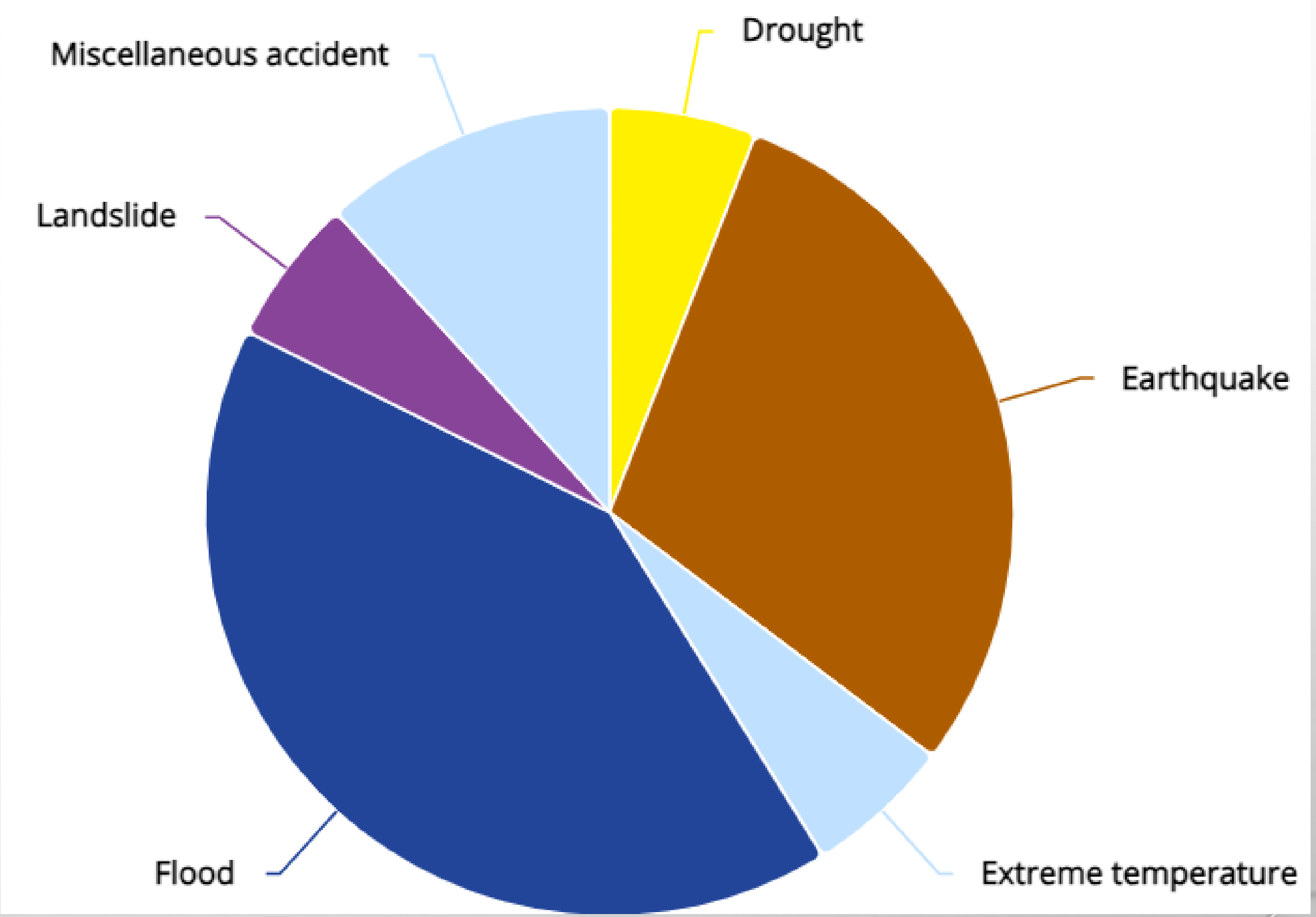
DISASTER MANAGEMENT REGULATIONS, LAWS AND ACTS IN AZERBAIJAN AND JAPAN

Law on Civil Defense provides a legal framework for disaster management and outlines the responsibilities of relevant authorities and organizations in Azerbaijan. Furthermore, there are many regulations related to evacuation management, the management of disasters, etc.

It is a national priority to protect national land as well as citizens' lives, livelihoods, and property from natural disasters. The turning point for strengthening the disaster management system came into effect in response to the immense damage caused by the Typhoon Ise-wan in 1959, and led to the enactment of the Disaster Countermeasures Basic Act in 1961, which formulates a comprehensive and strategic disaster management system.

THE CAUSES AND CHARACTERISTICS OF DISASTERS IN AZERBAIJAN

Azerbaijan's population is vulnerable to earthquakes, drought and flooding. The GFDRR Disaster Risk Profile for the country estimated that an earthquake with a 250-year return period would affect $40 billion (71%) of Azerbaijan's GDP and 3 million (34%) of its population (GFDRR, 2016). Droughts are of frequent occurrence, and can lead to forest fires such as those experienced in 2014, when 59 hectares of forest were damaged by 12 fires. Flooding is a regular issue in the country, denuding the land and damaging soil. It is estimated to cause the Azerbaijan economy a total damage of $18-25 million each year.



Average Annual Natural Hazard Occurrence for 1980-2020

THE CAUSES AND CHARACTERISTICS OF DISASTERS IN JAPAN

Japan experiences numerous natural disasters which pose significant risks to its population and infrastructure.

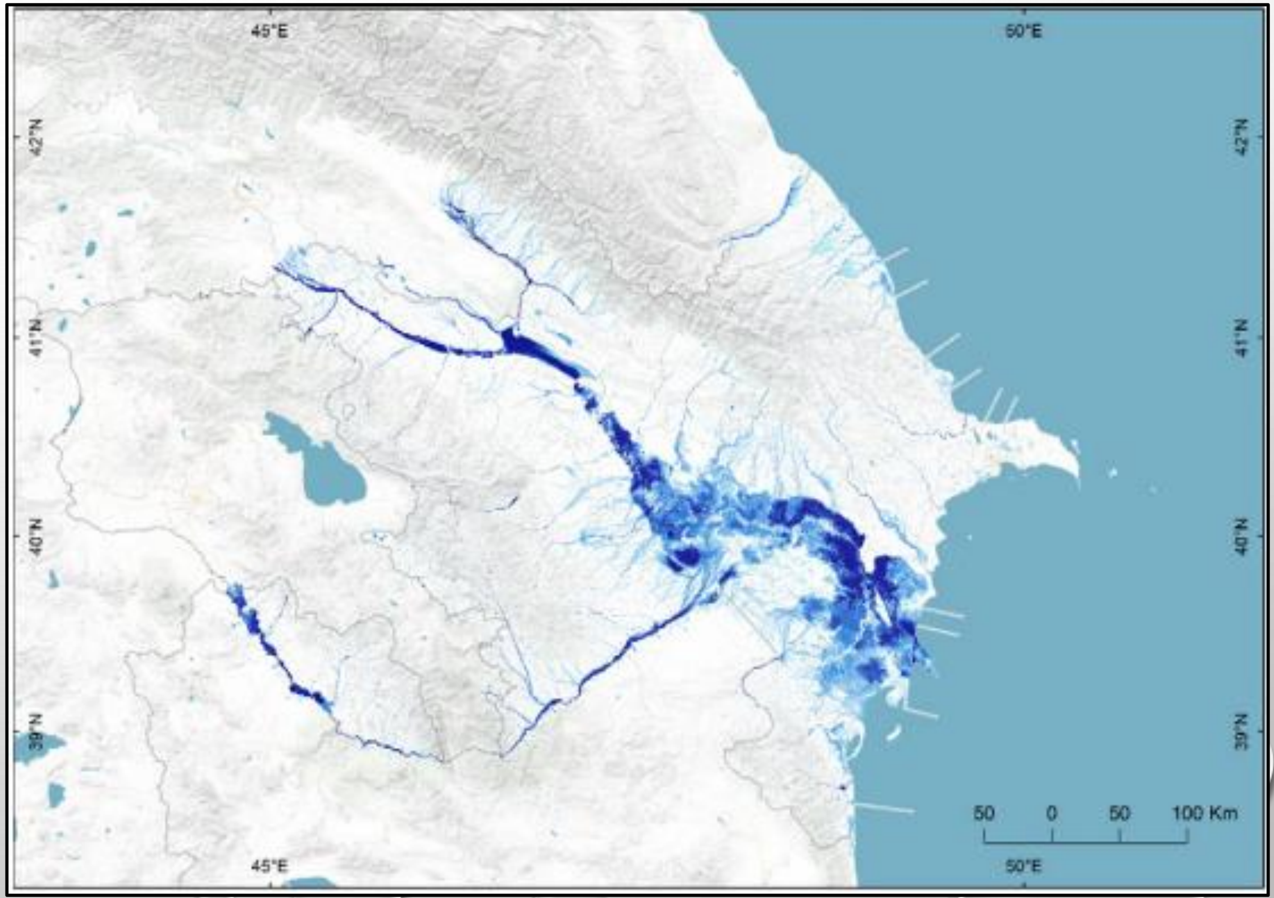
- Earthquakes;
- Tsunamis;
- Typhoons;
- Volcanic eruptions;
- Floods, etc.

Earthquakes are a common occurrence in Japan due to its location along the Pacific Ring of Fire. The country has a history of devastating earthquakes caused by the movement of tectonic plates beneath the earth's surface. Tsunamis, triggered by undersea earthquakes and volcanic eruptions, are a significant hazard for Japan’s coastal regions. These massive waves have caused tremendous destruction in the past. Japan is regularly affected by typhoons, particularly during the summer and autumn months. These tropical cyclones bring strong winds, heavy rainfall, and often lead to widespread flooding and landslides. Due to the presence of several active volcanoes, Japan faces the constant threat of volcanic eruptions. These eruptions have the potential to cause significant damage to nearby communities and infrastructure.

STATISTICS OF FLOOD DISASTERS, ECONOMIC, SOCIAL, ECOLOGICAL CONSEQUENCES OF CATASTROPHIC FLOODS IN AZERBAIJAN

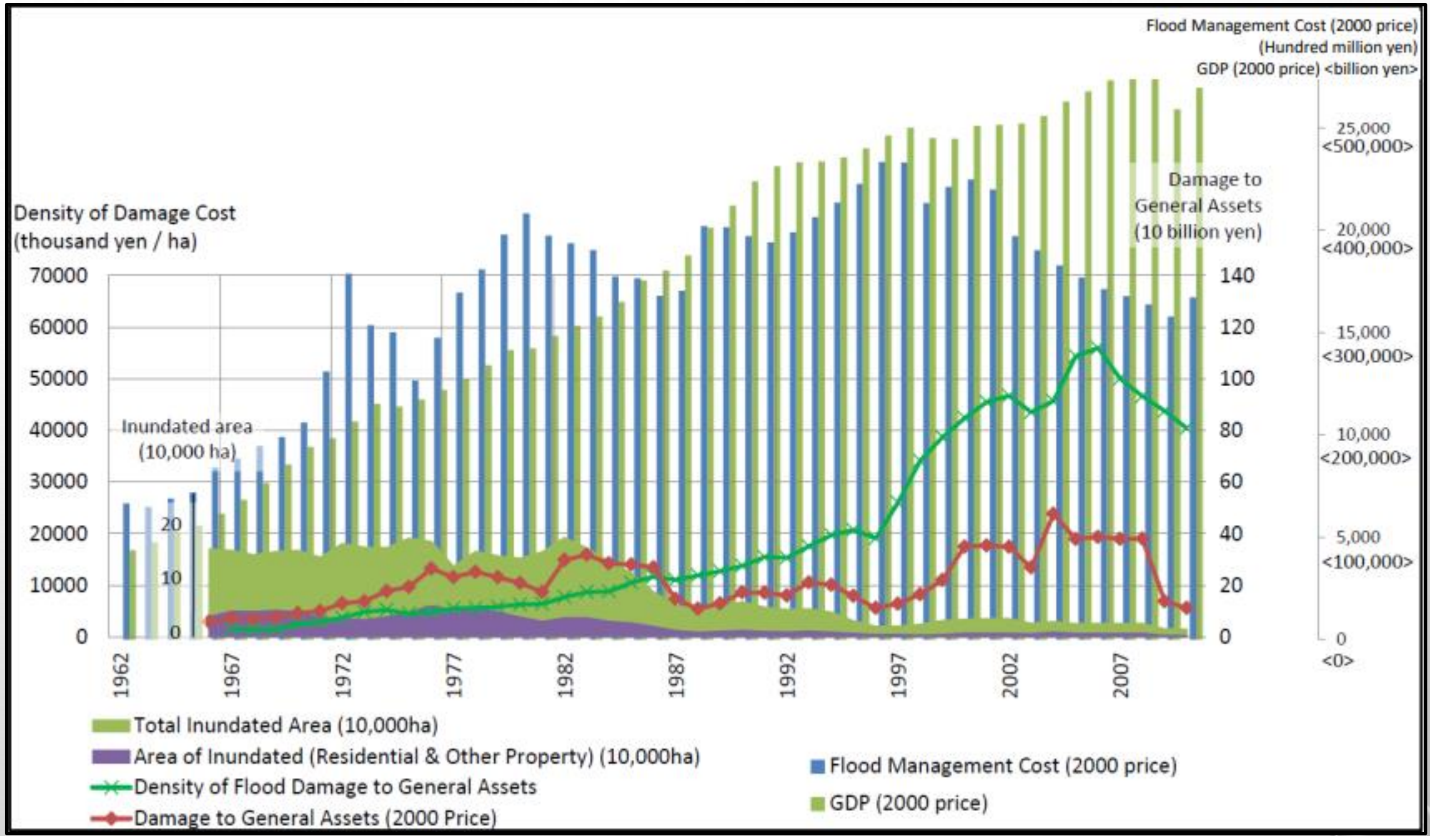
Based on historical facts, we can say that the territory of our country is often exposed to the threat of floods. In Azerbaijan, especially in the Yevlakh-Neftchala zone along the Kura River coast, this emergency is more evident. In general, the Yevlakh-Neftchala zone along the Kura River coast is known as the area most affected by floods and overflows. The population of this area is more than 1.8 million people. There is a constant threat of overflow and flood in these areas with more than 700 settlements.

Map of river (fluvial) flooding (areas in blue) at the 200-year return period level



STATISTICS OF FLOOD DISASTERS, ECONOMIC, SOCIAL, ECOLOGICAL CONSEQUENCES OF CATASTROPHIC FLOODS IN JAPAN

The Infrastructure Development Institute of Japan and Japan River Association estimates about 49% of the population and 75% real estate in Japan are located in alluvial plains exposed to flooding risk. The annual damage amount caused by water-related disasters in Japan from 1966 to 2010 is shown



ECONOMIC, SOCIAL, ECOLOGICAL CONSEQUENCES OF CATASTROPHIC FLOODS IN JAPAN

Past heavy rainfall events causing major damage. Isewan Typhoon, 1959

The 15th typhoon (commonly known as Isewan Typhoon) made landfall at Shionomisaki shortly after 6 pm on September 26, 1959, with a pressure of 929 hPa. A maximum instantaneous wind speed of 45.7 m/s and a maximum tide level of 5.31 m (Nagoya port) were recorded in Nagoya city. The typhoon caused major storm surge damage from Nagoya city to the coast of Mie prefecture. The daily rainfall from September 26 to 27 was approximately 160 mm in Tsu city, Mie prefecture, equivalent to once in 80 years. Of the 5,098 people reported dead or missing, over 90% were in the three prefectures of Aichi, Mie, and Gifu around the Ise Bay, and 70% of these casualties were due to the storm surge. Over 5,000 people were reported dead or missing, approximately 149,000 homes were destroyed, 158,000 homes flooded, and 5760 levees breached, making it Japan’s largest flood disaster of the 20th century.

ECONOMIC, SOCIAL, ECOLOGICAL CONSEQUENCES OF CATASTROPHIC FLOODS IN JAPAN

Nagasaki Flood, July 1982

On July 23, 1982, torrential rainfall exceeding 100 mm/h fell for approximately three hours in Nagasaki, causing flooding, landslides, and avalanches of rocks and earth. The daily rainfall in Nagasaki city was 448 mm, equivalent to once in 200 years. Nagasaki is a hilly city, and approximately 90% of the 299 casualties died in landslides due to the collapse of slopes. The damage to agriculture and forestry land in Nagasaki prefecture included approximately 2700 ha of agricultural land flooded, buried, or covered in debris; and approximately 20,000 agricultural and forestry facilities damaged. The cost of damage to agricultural facilities, produce, and livestock was approximately 8.4 billion yen.

ECONOMIC, SOCIAL, ECOLOGICAL CONSEQUENCES OF CATASTROPHIC FLOODS IN JAPAN

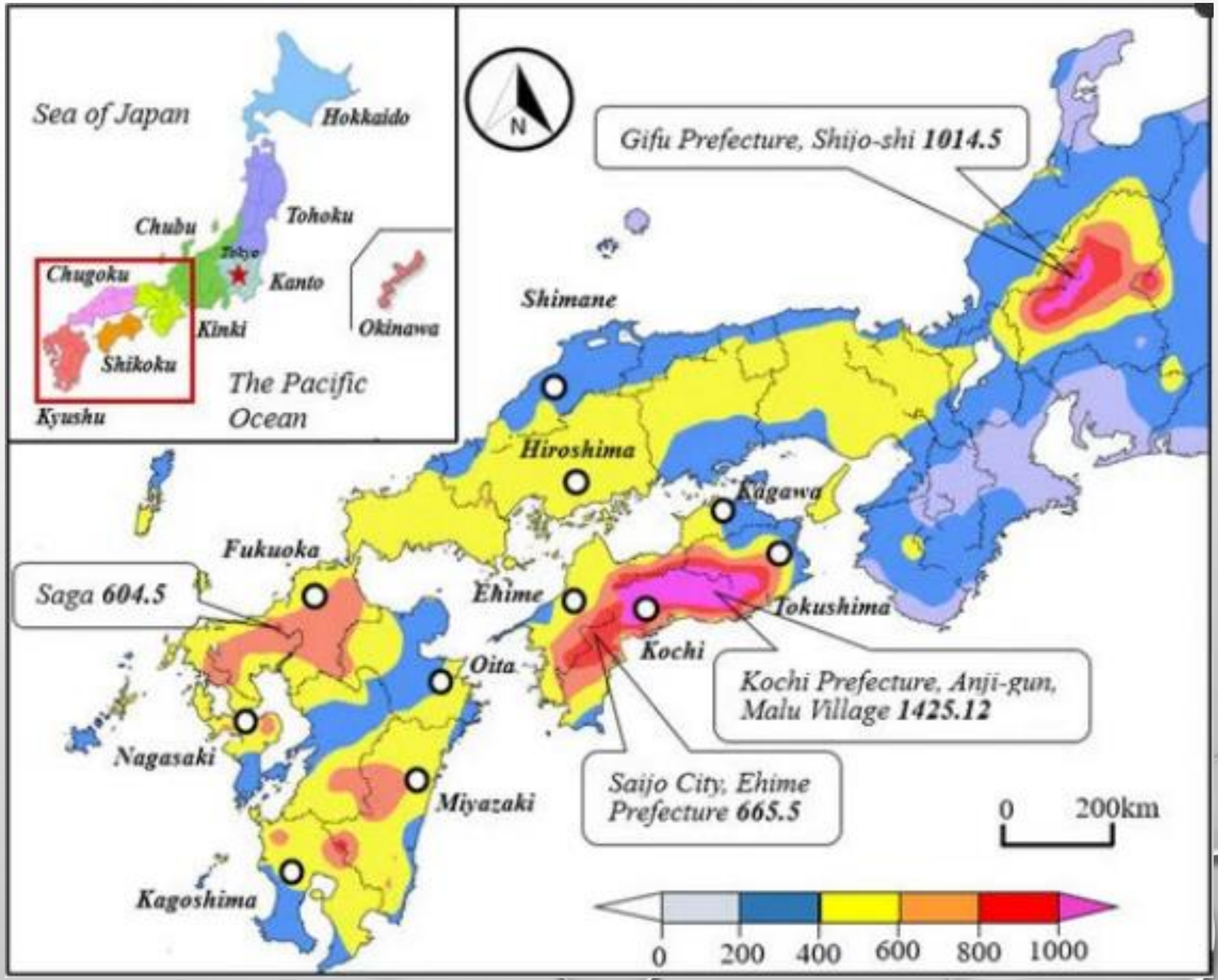
Kagoshima Flood, 1993

In the afternoon of August 6, 1993, heavy rainfall of up to 99.5 mm/h fell for several hours in the area around Kagoshima city. The banks of three rivers flowing through Kagoshima city burst, flooding approximately 11,000 buildings. The daily rainfall in Kagoshima city was 259 mm, equivalent to once in 200 years. Cliffs alongside the national highway collapsed at 22 points along a 4 km stretch. The death toll was 71, and about 2,500 people who were in cars, buses and trains were saved by fishing boats and ferries which carried them to Kagoshima through the Kagoshima Bay.

ECONOMIC, SOCIAL, ECOLOGICAL CONSEQUENCES OF CATASTROPHIC FLOODS IN JAPAN

Flooding in Western Japan in 2018

The western regions of Japan experienced catastrophic flooding from 5 to 9 July 2018. Of the 1300 rainfall observation stations across Japan, precipitation at 119 stations reached its highest level within 72 h and 123 stations received the highest amount of rainfall within 48 h compared to all historical recordings. The water depth in some areas was up to 3 m, and numerous residual houses were immersed in the flood. Figure 1.15 presents the flooded areas in western Japan. Kochi, Gifu, Ehime and Saga were the most seriously flooded areas in this catastrophic flood. The cumulative rainfall of these four prefectures was over 600 mm.



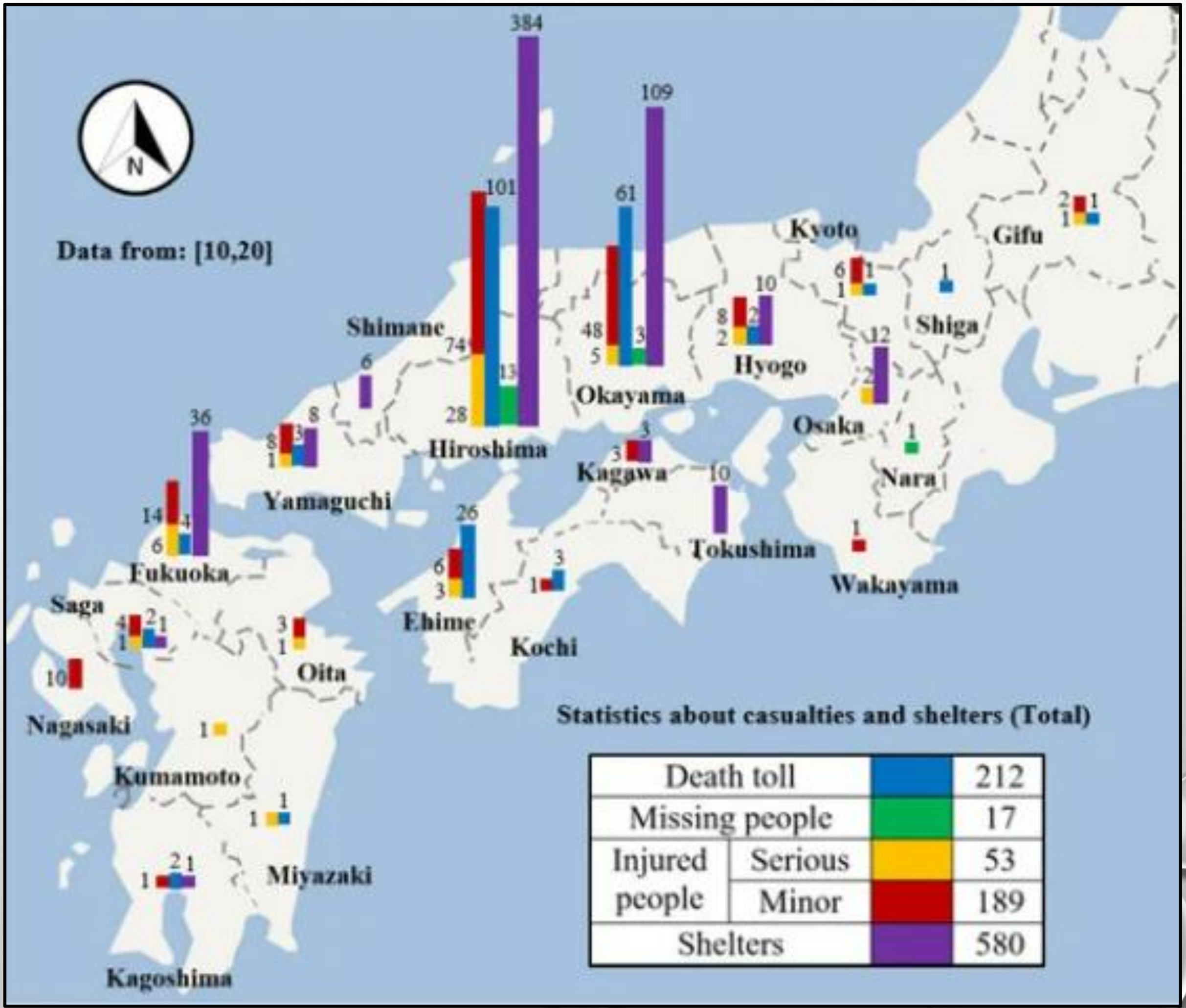
ECONOMIC, SOCIAL, ECOLOGICAL CONSEQUENCES OF CATASTROPHIC FLOODS IN JAPAN

Flooding in Western Japan in 2018

Serious disasters were caused by heavy rainfall during 5–9 July 2018, leading to numerous casualties and a huge economic loss. According to the work presented in, the rainfall disasters resulted in 212 deaths in total, and nearly 50% of the deaths were from Hiroshima Prefecture.

The death toll in Hiroshima was the highest, at 101 within five days, followed by Okayama, where the death toll was 61. The majority of deaths were suffered by elderly people (70% of the total deaths), who were not capable of rescuing themselves.

The economic loss to agriculture related to flooding was 16.1 billion JPY, and Hiroshima Prefecture accounted for the biggest loss of 2.5 billion JPY.



ECONOMIC, SOCIAL, ECOLOGICAL CONSEQUENCES OF CATASTROPHIC FLOODS IN JAPAN

2020 Kyushu Floods

At the beginning of July, continuous rainfall hit several parts of southern Japan, particularly in Kyushu, causing flooding and extreme damage.

As a result of flooding and landslides, 77 people were confirmed dead (includes 1 death due to cardiopulmonary arrest) and approximately seven are missing. Fourteen of the victims were residents of an old age home in Kuma, Kumamoto that was flooded. Approximately 15,335 buildings were destroyed, damaged or flooded.

II Chapter

ESTABLISHMENT OF EARLY WARNING AND MONITORING SYSTEMS IN AZERBAIJAN

High altitude hydrometeorological station

Kura Basin Hydrological Monitoring Stations

ESTABLISHMENT OF EARLY WARNING AND MONITORING SYSTEMS IN AZERBAIJAN

Kura Basin Hydrological Monitoring Stations

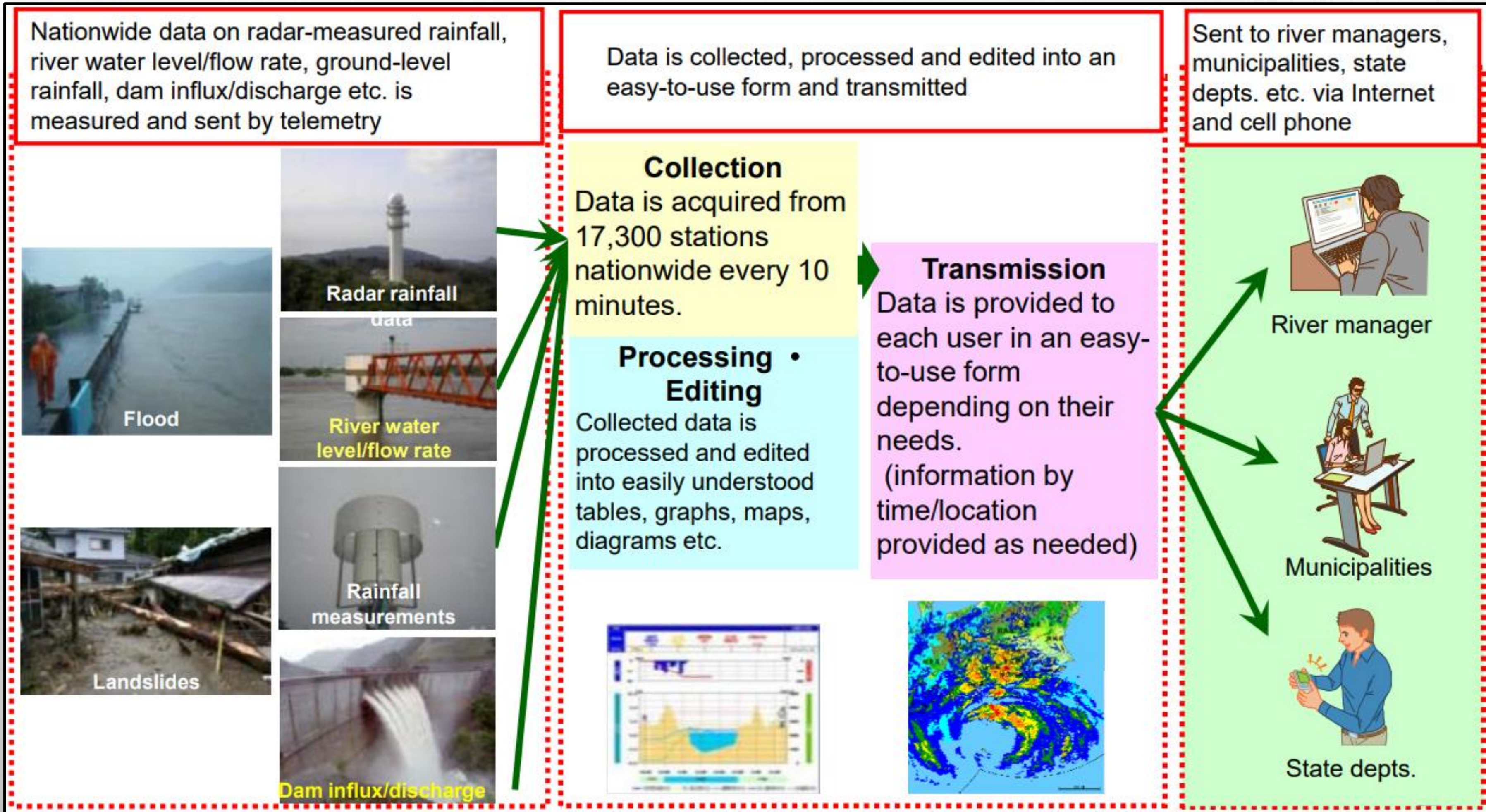
Emergency Sirens for Flood and Landslide Disasters and Early Warning System

First Responder Emergency Equipment

ESTABLISHMENT OF EARLY WARNING AND MONITORING SYSTEMS IN JAPAN

The Ministry of Land, Infrastructure, Transport and Tourism provides river information in real time, 24 hours a day, 365 days a year throughout Japan to help protect lives and property from rainfall-induced river and land-based hazards

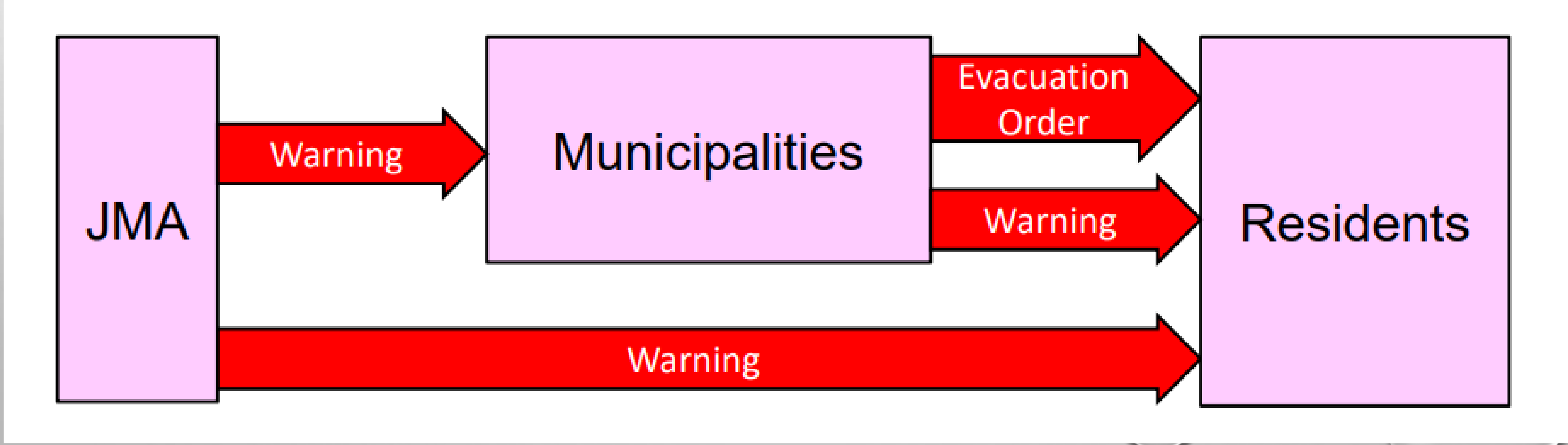
Routinely measured river information is provided in real-time (24hours a day, 365 days a year) to river managers, municipal supervisors, and other state departments.
*Includes various data from radar, rainfall measurement stations, river water level meter stations, dams



ESTABLISHMENT OF EARLY WARNING AND MONITORING SYSTEMS IN JAPAN

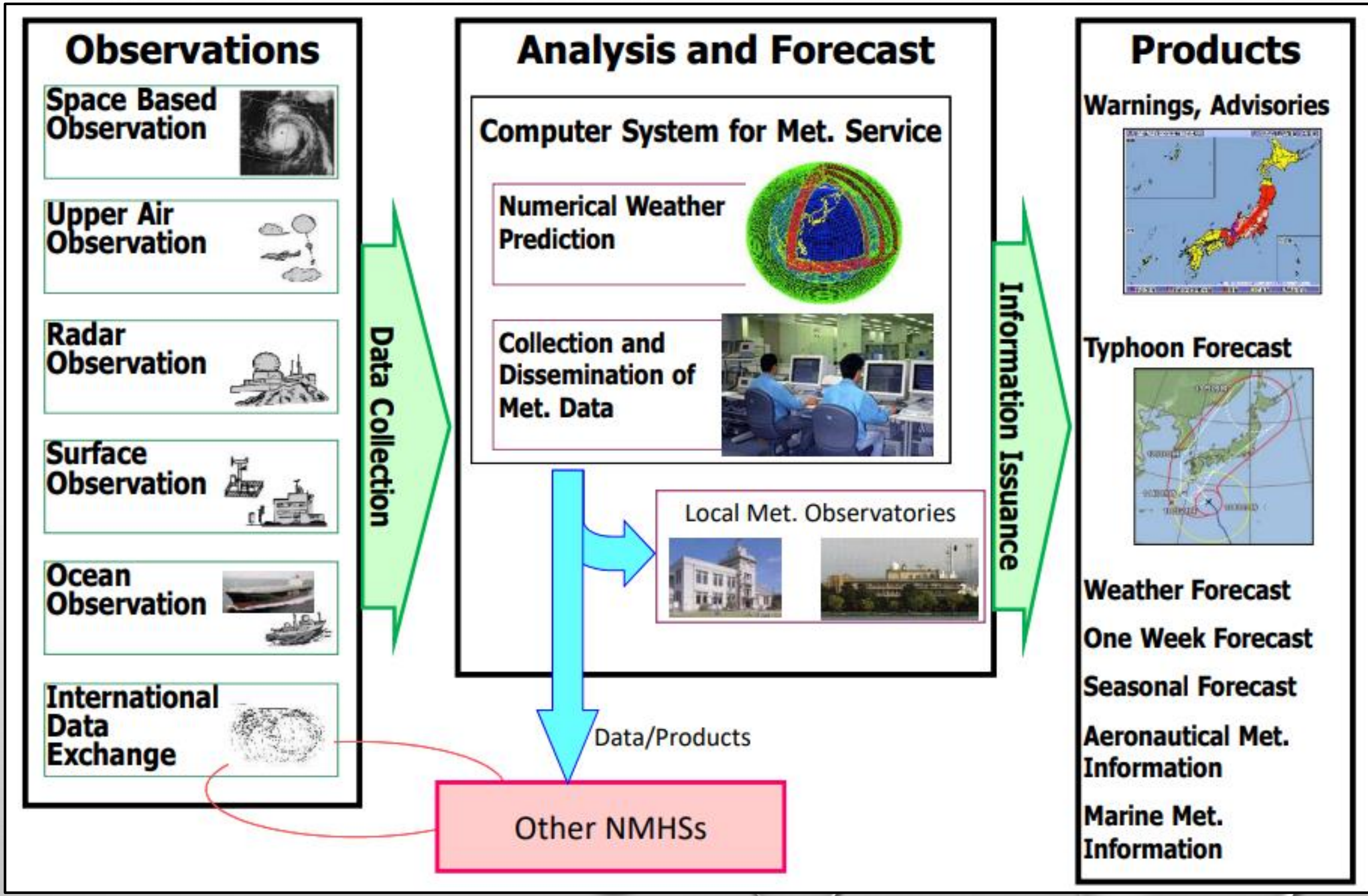
If hazardous weather conditions are expected, the Japan Meteorological Agency (JMA) issues a variety of messages including Emergency Warnings, Warnings, Advisories and Bulletins so that appropriate measures can be taken to mitigate possible disasters.

These messages are issued by Local Meteorological Offices (LMOs) to their respective prefectures.



ESTABLISHMENT OF EARLY WARNING AND MONITORING SYSTEMS IN JAPAN

Weather alerts from different organizations have been combined to give people a clearer understanding of the situation.



ESTABLISHMENT OF EARLY WARNING AND MONITORING SYSTEMS IN JAPAN

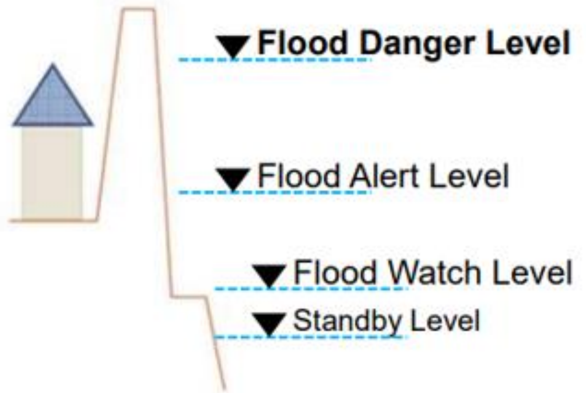
In order that JMA's warnings help mayors' decision:
1. Warnings should be issued to city / town / village respectively.
2. Warning criteria should be consistent with the criteria for evacuation advisory and order.

Criteria recommended in the Guideline

Mayor's Decision	Criteria
Evacuation Order	✓ Water level of the river has reached "**Flood Danger Level**." ✓ Embankment is broken.
Evacuation Advisory	✓ Water level of the river is expected to reach "**Flood Danger Level**" in certain hours*. *: Necessary time for people to evacuate
Evacuation Preparation Information	✓ Water level of the river is expected to reach "**Flood Danger Level**" in certain hours*. *: Necessary time for people who require assistance to evacuate

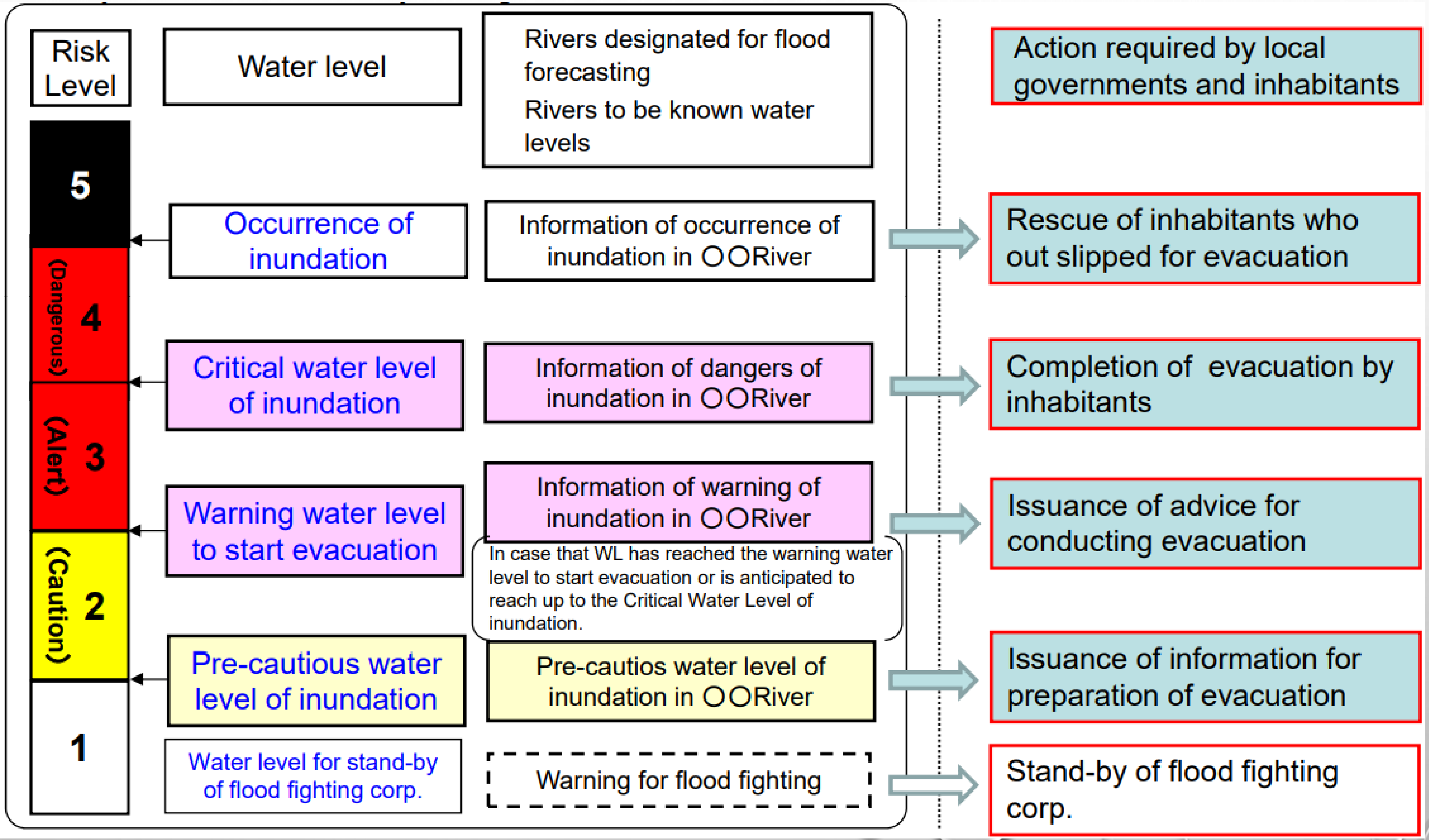
Flood Forecast with Level

Water Level Setting



Flood Forecast Title	Water Level
Lv5: Flood Occurrence Info.	(Flood occur)
Lv4: Flood Danger Info.	**Flood Danger Level**
Lv3: Flood Alerting Info.	Flood Alert Level
Lv2: Flood Advisory Info.	Flood Watch Level
-	Standby Level

ESTABLISHMENT OF EARLY WARNING AND MONITORING SYSTEMS IN JAPAN



ESTABLISHMENT OF EARLY WARNING AND MONITORING SYSTEMS IN JAPAN

Japan Bosai Platform (JBP) is an association of private companies with leading bosai solutions. Their goal is to make society disaster resilient and sustainable by sharing Japanese bosai solutions with the world.

Quartz Type Water Level Gauge
QS Series

Quartz Type Water Level Gauge(RS485)
QSM Series

Quartz Type Water Level Gauge
Optical Fiber Transmission type
OPQS Series

BEST PRACTICES AND THE LATEST TECHNOLOGY IN FLOOD MANAGEMENT, PREVENTION AND RESPONSE

TOWN WATCHING FOR DISASTER PREVENTION

"Town watching for disaster prevention" is the program that people who are living or going to school in the area such as residents and students etc., Walk around, see, and understand facilities, activities for the safety and dangerous places in the local area, and after that, those people think and make solutions against danger. "Town watching for disaster prevention" consists of 4 parts below.

Field survey → Develop a map of observation → Discussion to solve the problem → Presentation

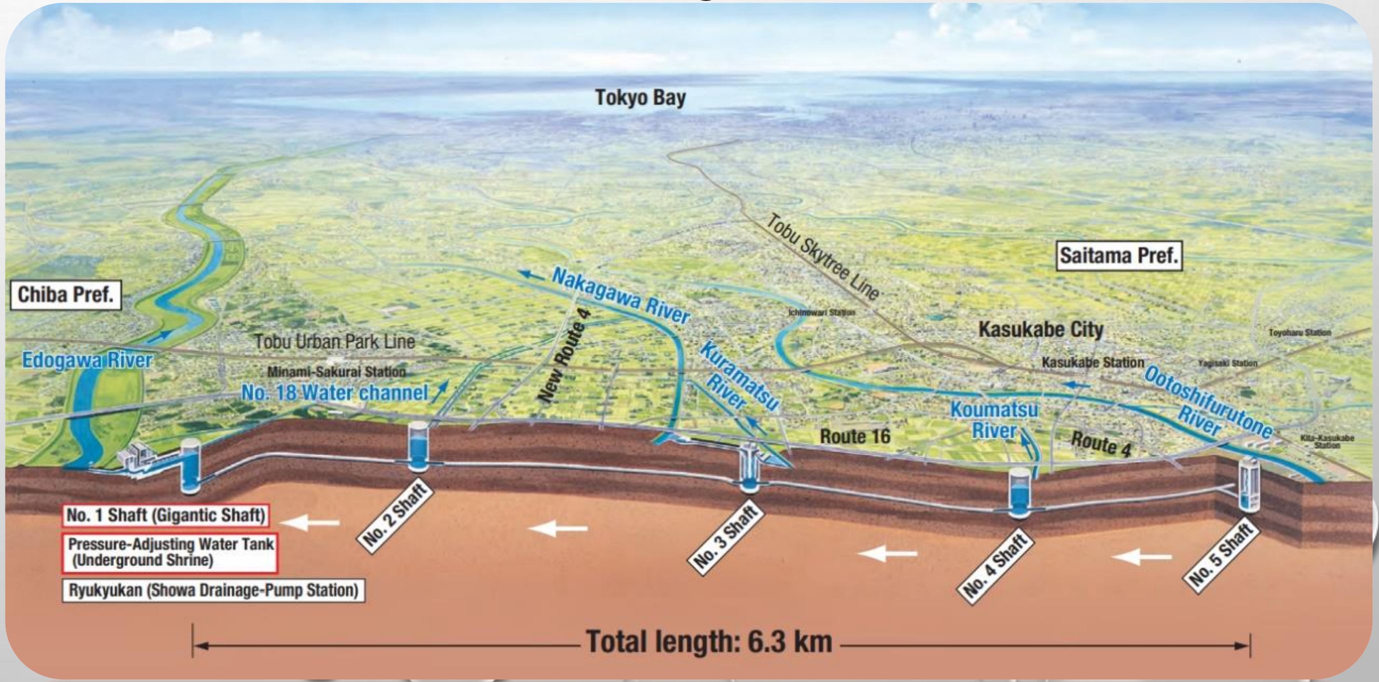
BEST PRACTICES AND THE LATEST TECHNOLOGY IN FLOOD MANAGEMENT, PREVENTION AND RESPONSE

THE METROPOLITAN OUTER AREA UNDERGROUND DISCHARGE CHANNEL

The Metropolitan Outer Area Underground Discharge Channel provides safety and security for the Tokyo metropolitan area.

Location of the Metropolitan Outer Area Underground Discharge Channel

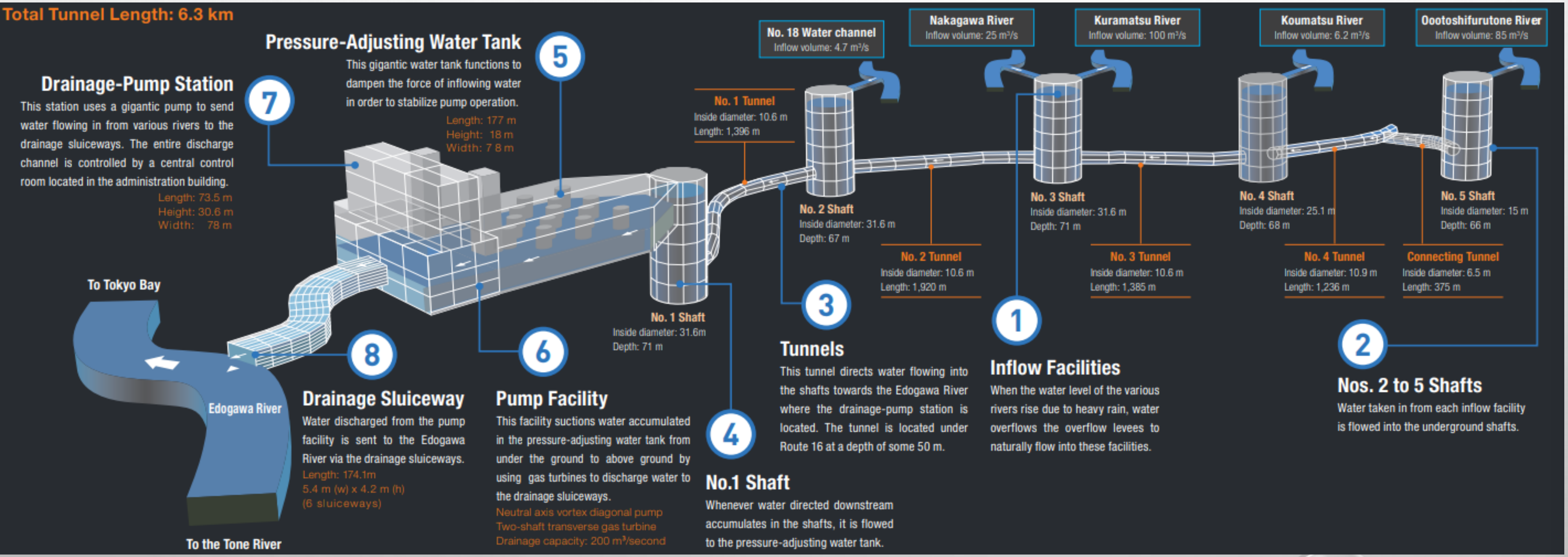
Structure of the Metropolitan Outer Area Underground Discharge Channel



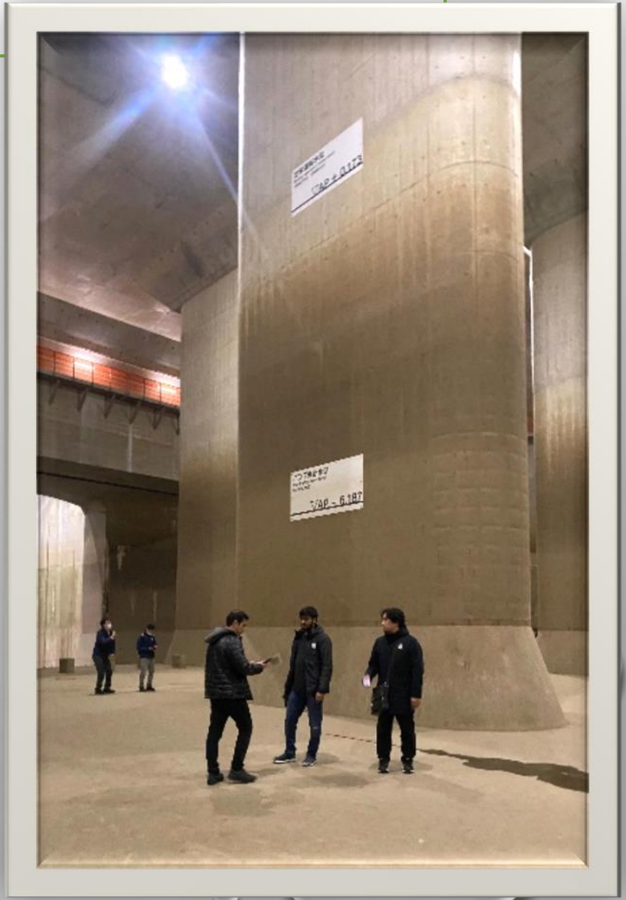
BEST PRACTICES AND THE LATEST TECHNOLOGY IN FLOOD MANAGEMENT, PREVENTION AND RESPONSE

THE METROPOLITAN OUTER AREA UNDERGROUND DISCHARGE CHANNEL

The Metropolitan Outer Area Underground Discharge Channel is making a significant contribution to reducing damage due to flooding of the Nakagawa/Ayase river basin.



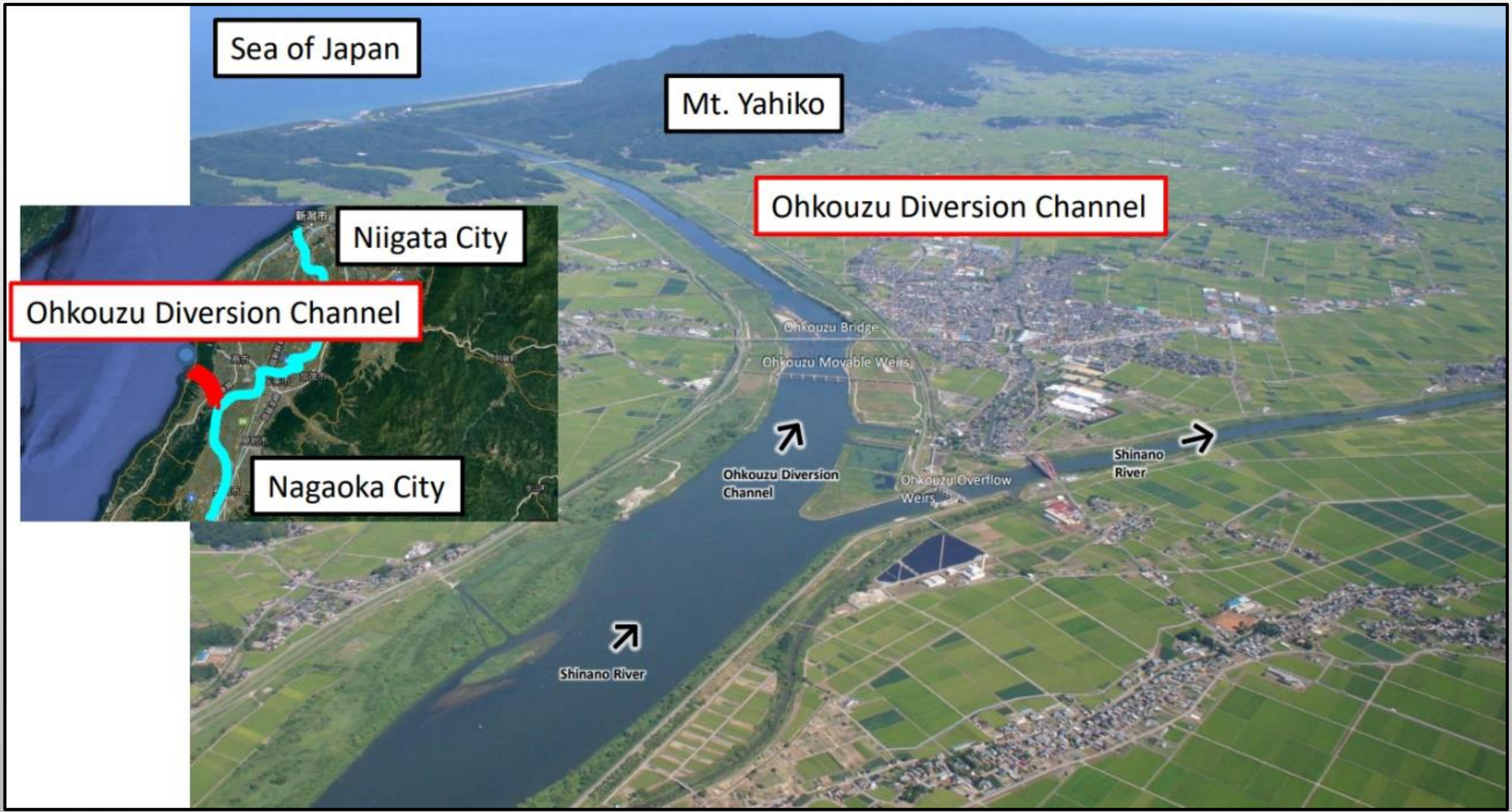
Mechanisms of the Metropolitan Outer Area Underground Discharge Channel



BEST PRACTICES AND THE LATEST TECHNOLOGY IN FLOOD MANAGEMENT, PREVENTION AND RESPONSE

OHKOUZU DIVERSION CHANNEL

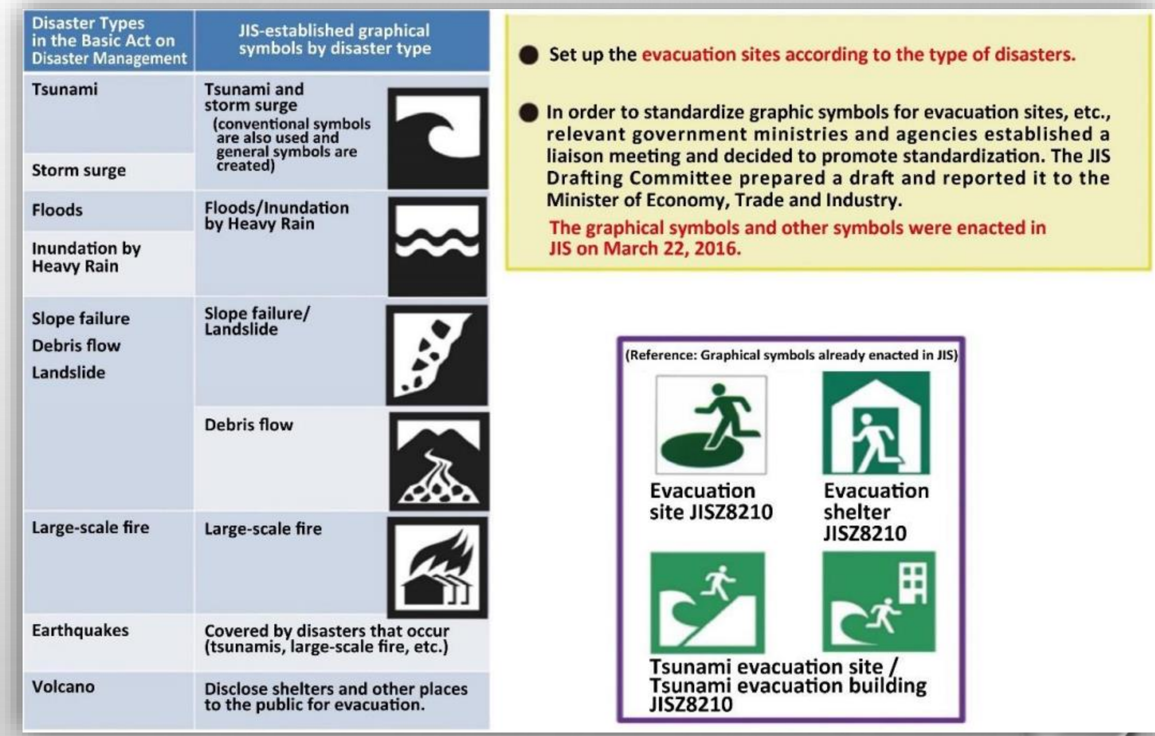
The Ohkouzu Diversion Channel is a 10-km man-made river constructed to allow floodwaters of the Shinano river to escape to the sea of japan before entering the Echigo plain.



SHELTER MANAGEMENT AND THE LOCATIONS OF EVACUATION CENTERS IN CASE OF DISASTERS IN JAPAN

The Cabinet Office, together with the Fire and Disaster Management Agency, is urging local governments to designate their designated emergency evacuation sites.

Example Map Showing Indications of Designated Emergency Evacuation Sites



Example of Information Board Using Hazard Specific Evacuation Guidance Sign System

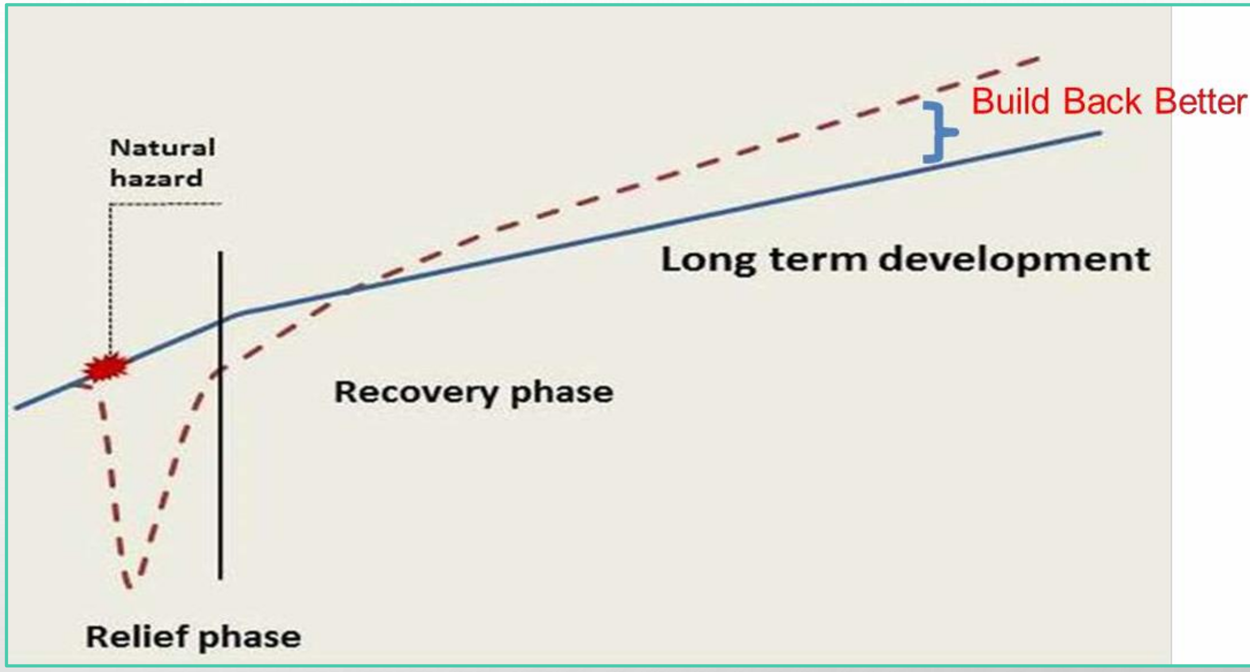
BUILDING BACK BETTER AS AN ASPECT OF SUSTAINABLE DEVELOPMENT GOALS

'Build back better' – a phrase first popularized in the united nations Sendai Framework for disaster risk reduction in 2015, and now ubiquitous.

Building Back Better (BBB) is an approach to post-disaster recovery that reduces vulnerability to future disasters and builds community resilience to address physical, social, environmental, and economic vulnerabilities and shocks.

What we **DO NOT** want. Actions taken in the aftermath of a disaster to:

- Reconstruct same as before;
- Rebuilding the pre-existing vulnerabilities;
- Community in the same state as before the disaster.



Build Back Better (BBB) Development approach

DISASTER RISK REDUCTION AWARENESS ACTIVITIES IN JAPAN

The government has designated the 1st day of September as the “Disaster Preparedness Day" and the week including this day as the disaster preparedness week and carries out various events to raise awareness and readiness about the disaster. Disaster drills and promoting events are held in various parts of Japan.

In 2011, the act on promotion of tsunami countermeasures was enacted, and November 5th was designated as the "tsunami preparedness day." In the 70th UN general assembly, November 5th was designated to be the "world tsunami awareness day".

Further, in Kobe city, Hyogo prefecture, “Disaster Reduction and Human Renovation Institution" was established in memory of the Great Hanshin-Awaji Earthquake and is engaged in activities to pass the lessons from the earthquake disaster on to the younger generations through reproduction of the big earthquake by audio-visual and model construction

IV Chapter

METHODS TO DEVELOP FLOOD HAZARD MAP

Methods to develop flood hazard map. In japan, flood hazard maps are mainly prepared by the ministry of land, infrastructure, transport and tourism (MLIT) and prefectural governments (local municipalities) using inundation information. The steps being currently used by MLIT to prepare flood hazard maps in japan are given in the following sub-sections.

Flood inundation model: Shallow Water Equations. MLIT uses the following shallow water equations (SWE) for the simulation of flood inundations areas:

$$\gamma \frac{\partial Q_x}{\partial t} + \frac{\partial}{\partial x}\left(\gamma \frac{Q_x^2}{h}\right) + \frac{\partial}{\partial y}\left(\gamma \frac{Q_x Q_y}{h}\right) + g\gamma h \frac{\partial (h + z_b)}{\partial x} + g\gamma n^2 \frac{Q_x\sqrt{Q_x^2 + Q_y^2}}{h^{7/3}} + \frac{1}{2} C_D'(1-\gamma)\frac{Q_x\sqrt{Q_x^2 + Q_y^2}}{h} = 0$$

$$\gamma \frac{\partial Q_y}{\partial t} + \frac{\partial}{\partial x}\left(\gamma \frac{Q_x Q_y}{h}\right) + \frac{\partial}{\partial y}\left(\gamma \frac{Q_y^2}{h}\right) + g\gamma h \frac{\partial (h + z_b)}{\partial y} + g\gamma n^2 \frac{Q_y\sqrt{Q_x^2 + Q_y^2}}{h^{7/3}} + \frac{1}{2} C_D'(1-\gamma)\frac{Q_y\sqrt{Q_x^2 + Q_y^2}}{h} = 0$$

$$\frac{\partial h}{\partial t} + \frac{\partial (\gamma Q_x)}{\partial x} + \frac{\partial (\gamma Q_y)}{\partial y} = q$$

where, Q_x, Q_y are the discharges per unit width in x and y directions, h the water depth, z_b the bed elevation, γ the porosity, q the rainfall, inundation from the sewerage, etc., n the roughness coefficient according to the land use, C_D the drag coefficient. The spatial resolution (grid size) for the model simulation of the Yodogawa River Basin is 25 m x 25 m.

METHODS TO DEVELOP FLOOD HAZARD MAP

Levee breach conditions. The amount of the flow overtopped from the river is estimated using modified Honma's overflow formula (as used in Manual for Economic Evaluation for Flood Control Investment, 2005, MLIT).

a. Honma's front-overflow formula:

For complete overflow (for $h_2/h_1 < 2/3$),

$$Q_0 = 0.35\, h_1\sqrt{2gh_1}B$$

For submerged overflow (for $h_2/h_1 \geq 2/3$),

$$Q_0 = 0.91 h_2\sqrt{2g(h_1 - h_2)}B$$

where Q is overflow discharge through structure and h_1, and h_2 are the water depth measured from the bed height of a breached levee.

METHODS TO DEVELOP FLOOD HAZARD MAP

b. Honma's side-overflow formula:

Inundation discharge (Q) following a levee breach is given by:

For I>1/1580,

$$\frac{Q}{Q_0} = \left(0.14 + 0.19 \times log_{10}\left(\frac{1}{I}\right)\right) \times cos\left(48 - 15 \times log_{10}\left(\frac{1}{I}\right)\right)$$

For 1/1580≥I>1/33600,

$$\frac{Q}{Q_0} = \left(0.14 + 0.19 \times log_{10}\left(\frac{1}{I}\right)\right)$$

For 1/33600≥I,

$$\frac{Q}{Q_0} = 1$$

where Q is inundation flow, Q_0 is flow volume calculated by Honma's formula, I - is bed slope of a river, and B is the width of the crest. The unit of "cos" in the parenthesis is "degree.".

FLOOD SCENARIOS OF YODOGAWA RIVER BASIN

Scenarios of external force to develop flood hazard map. According to the Flood Fighting Act (FFA) amended in 2014 the river administrators, MLIT and prefectural governments should design the area that might be inundated during the flooding events. The act specifies that two rainfall scenarios should be considered as inputs to simulate flood hazard (inundation area) maps. The first scenario is to use the design-rainfall used for the river works as input to simulate flood inundation. In case of the Yodogawa River, the design rainfall is assumed equivalent to 200-year return period (261 mm in 24 hours) while the upstream tributaries assume comparatively smaller return periods (150-years): for the Uji River (164 mm in 9 hours), the Kizu River (253 mm in 12 hours) and the Katsura River (247 mm in 12 hours).

The second scenario is to use the largest-scale (worst case) rainfall as input to simulate flood inundation. Based on rainfall patterns, the whole Japan is divided into 15 regions, and DepthArea-Duration (DAD) analysis is conducted using recorded maximum rainfall in each region. Figure 4.2 shows the DAD relationship for the Kinki region [39]. The average basin rainfall can be estimated from DAD analysis and typically exceed or equivalent to 1000-year return period. If the historical maximum rainfall observed is less than the rainfall corresponding to the exceedance probability of 1/1,000 (360 mm/24 hr.), then the rainfall corresponding to that exceedance probability is used for the simulation as maximum rainfall in the worst-case scenario. The historical maximum rainfall observed in the Hirakata station (Yodogawa River Basin) is 314 mm in 24 hrs. which is less than 360 mm in 24 hrs. Hence the rainfall by DAD analysis for the Yodogawa River Basin is assumed to be 360 mm in 24 hours for the simulation, whereas for its major tributaries: for the Uji River is 356 mm in 9 hours; for the Kizu River is 358 mm in 12 hours; and for the Katsura River is 341 mm in 12 hours.

FLOOD SCENARIOS OF YODOGAWA RIVER BASIN

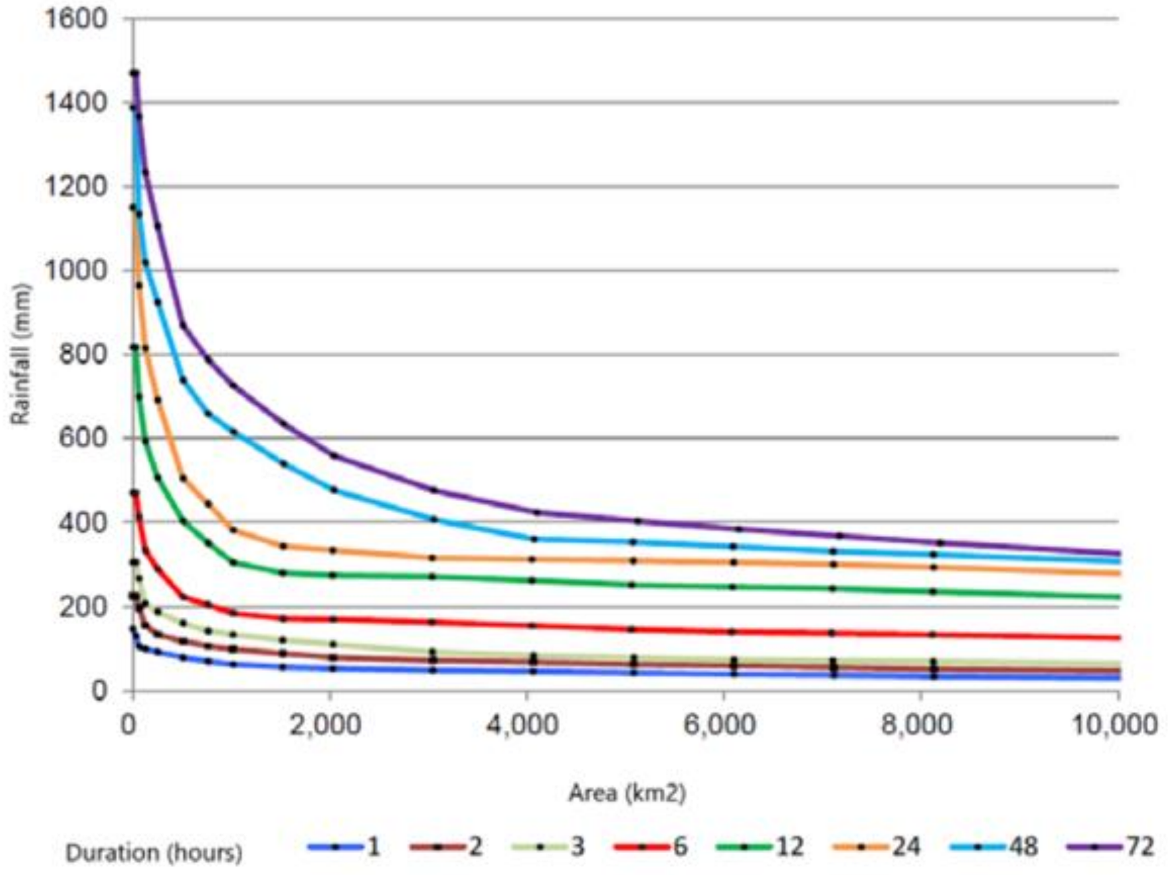


Figure 4.2. DAD analysis for the largest-scale scenario (e.g., Kinki Region)

The inundation simulation maps are prepared by MLIT using the second scenario in combination with steps in subsection "Flood Hazard Mapping in Japan" above. The prefectural government may use the flood inundation map (25 m x 25 m) prepared by MLIT to plan mitigation activities during flood events for decision making, planning, and implementation of flood management strategies. However, the prefectural governments can also develop their own inundation models using different tools. For example, the Shiga Prefectural government uses own model for flood inundation simulation (50 m x 50 m).

FLOOD SCENARIOS OF YODOGAWA RIVER BASIN

The Yodogawa River Basin located in the central part of Japan is shown in Figure 4.3. The length of the Yodogawa River is 75 km. It is the seventh largest river basin in Japan with a catchment area of 8,240 km^2 [40]. Flowing south out of Lake Biwa, the largest lake in Japan, first as the Seta River and then the Uji River, it merges the Kizu River and the Katsura River near the border between Kyoto and Osaka Prefectures. The Yodogawa River runs through the heartland of the Kinki region and flows into the Osaka Bay. The Yodogawa River basin consists of six subcatchments, which are the Lake Biwa basin (3,802 km^2), the Uji River basin (506 km^2), the Kizu River basin (1,647 km^2), the Katsura River basin (1,152 km^2), the lower Yodogawa River basin (521 km^2) and the Kanzaki River basin (612 km^2). It extends over six prefectures namely Shiga, Kyoto, Osaka, Hyogo, Nara, and Mie.

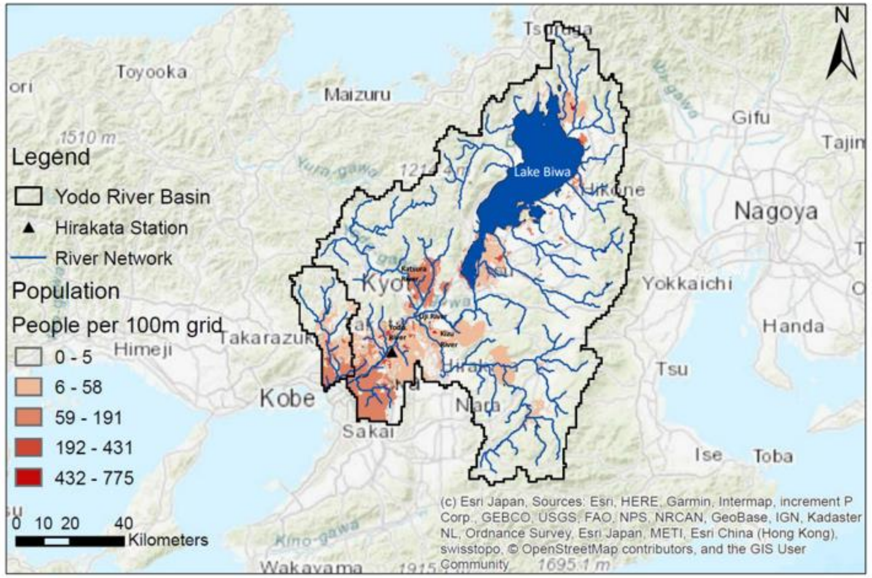


Figure 4.3. Location of Yodogawa River basin in Japan (The figure is prepared in ArcMap 10.6.1 using data from the Geospatial Information Authority of Japan (GSI), HydroSHEDS, WorldPop and ArcGIS online)

FLOOD SCENARIOS OF YODOGAWA RIVER BASIN

City areas spread throughout the basin as shown in Figure 4.4. Metropolitan areas such as Osaka, Kyoto, and Otsu are located along the rivers. The population in the basin is about 9.30 million in 2015 [42,43,44]. In the lower Yodogawa River basin, most of the highly populated urban developments are in areas lower than the river water level. In Osaka City, it is estimated that 94.9% of the total metropolitan area is in the flood-prone area.

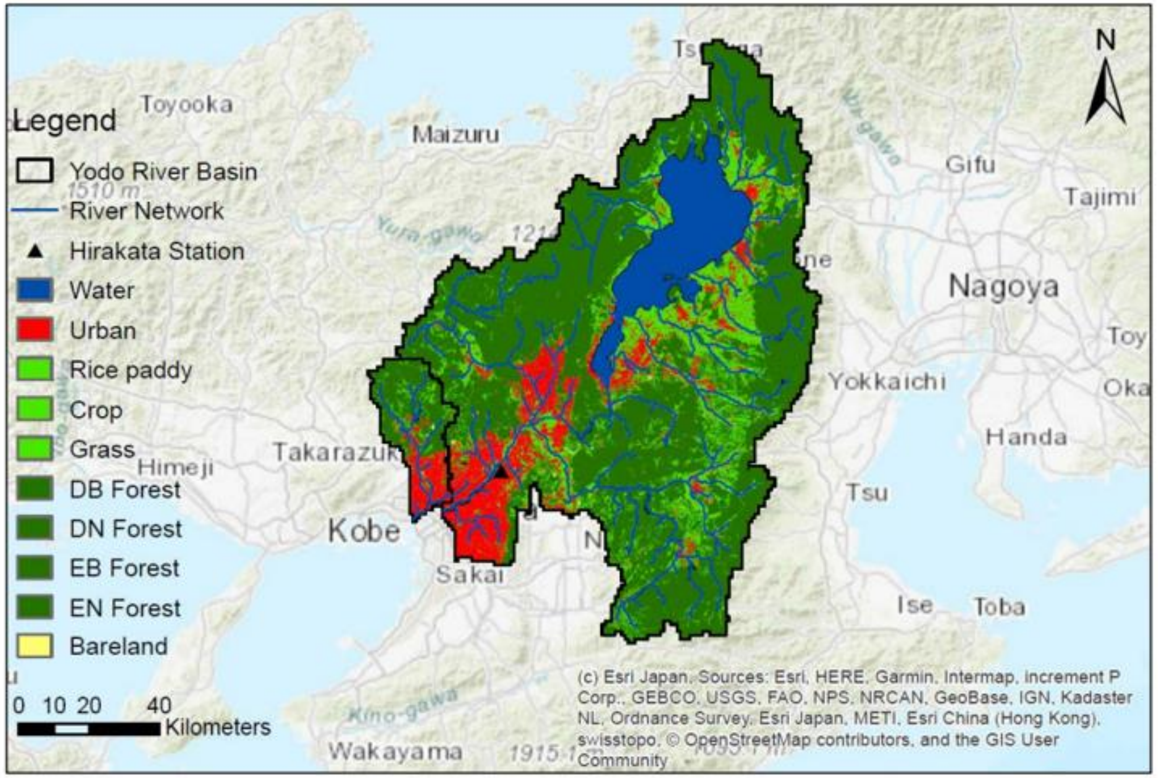


Figure 4.4. Land use map of the Yodogawa River Basin (The figure is prepared in ArcMap 10.6.1 using data from JAXA EORC and Geospatial Information Authority of Japan (GSI), HydroSHEDS, and ArcGIS online)

FLOOD SCENARIOS OF YODOGAWA RIVER BASIN

The simulated flood hazard map of Yodogawa River Basin with 25 m x 25 m resolution is shown in Figure 4.5. The second scenario of the external force, i.e., the amount of rainfall 360 mm in 24 hours is used to simulate flood inundation depth. The estimated inundation areas cover approximately 144 km^2 in Osaka prefecture and 121 km^2 in Kyoto prefecture where Osaka City and Kyoto City are major urban areas, respectively. The maximum inundation area is anticipated in Osaka City is about 62 km^2 with an average inundation depth 2.4 m ranging from 2.6 to 7.2 m. The maximum inundation depth of 8 m is anticipated in Takatsuki City in the Osaka prefecture. The model simulated about 40.9 km^2 inundated area in Kyoto City around Katsura River (and its major tributary Kamo River) and Uji River. The average inundation depth of 2.7 m is anticipated in Kyoto City ranging from 1.9 to 7.4 m

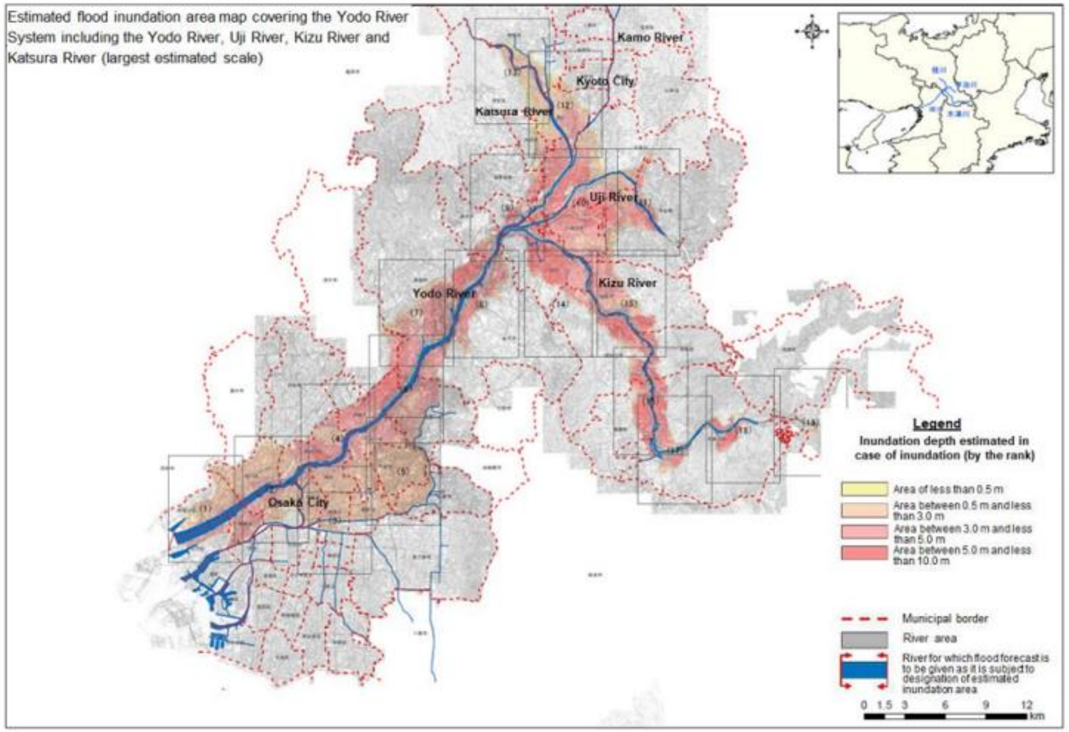


Figure 4.5. Estimated flood inundation area map of the largest estimated scale of the Yodogawa River Basin

CONCLUSION

ACHIEVED RESULTS:

- GOT INFORMATION ABOUT THE DISASTER MANAGEMENT SYSTEM IN JAPAN;
- LEARNED COUNTERMEASURES CAN BE TAKEN TO REDUCE CASUALTIES BEFORE FLOODS HAPPEN IN JAPAN;
- LEARNED ABOUT NEW TECHNOLOGIES (EARLY WARNING TECHNOLOGIES) THAT CAN BE USED FOR FLOOD PREDICTION IN JAPAN;
- BUILDING BACK BETTER APPROACH WAS STUDIED TO IMPROVE RESILIENCE TO DISASTERS;
- LEARNED A SIMULATION MODEL TO MAKE A FLOOD HAZARD MAP FOR THE INUNDATION AREAS IN JAPAN.

ACKNOWLEDGEMENT

Finally, I would like to emphasize that it was a big opportunity for me to participate in the Asian Disaster Reduction Center Visiting Researcher Program FY2023 (ADRC Program FY2023) in Japan. I sincerely thank the Academy and the Ministry of Emergency Situations of the Republic of Azerbaijan and of course, the Asian Disaster Reduction Center for accepting my application to join the Visiting Researcher Program. Thanks for allowing me to do research in Japan.

During my stay in Japan, I had a chance to see how Japan deals with disasters. By taking the program activities, I updated my knowledge, and skills and learned the best practices in disaster risk management. When I return to Azerbaijan, I am excited to share my new experiences with my colleagues, and as a teacher, I will teach students (cadets) for sure what I experienced during the program. Apart from that I also was enjoying while I was learning about Japan's national customs, cultures, and cuisine.

I would like to express my sincere gratitude to Sasahara-san - executive director of ADRC, Kodama-san, Nakamura-san, Gerald-san, Shiomi-san and all staff of ADRC for their kindness, helping and supporting all visiting researchers in all cases during our stay.

Special thanks to my mentor - Ikeda-san for his great kindness and attitude, for giving advice, helping me in all cases, and guiding me in my research. And Fujimoto-san through our stay in Japan, we all got a lot of help from her. And Fujinaka-san for giving us Japanese sweets all the time. I was really happy during my stay in Japan. Thank you all. I am grateful to know all of you and I wish good luck to you and visiting researchers from other countries who studied together at the ADRC VR Program FY2023.

THANK YOU FOR YOUR ATTENTION!
ARIGATOU GOSAI MASU!