Water-related disaster risk reduction considering climate change
-transition to River Basin Disaster Resilience and Sustainability by All-

Council Report

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1.Preamble

The largest mission in Japan had been to utilize a limited country, raise the productivity and the profitability and achieve material economical abundance. After serious damages by typhoons and the torrential rainfalls which occurred frequently in the devastated nation after the WWII, central government, prefectures and municipal governments improved the nation's security significantly through various measures such as dams, embankment, erosion and sediment control, sewage system as well as high-level embankment (embankment with widened cross section) and comprehensive flood controls. There had been few large-scale typhoons which occurred frequently after the WWII in a high economic growth period. As such, flooded areas and the number of victims have successfully decreased. 2019 Typhoon Hagibis showed the improvement of nation's security through the measures when its damages were small in some areas compared with those by the similar-scaled typhoons. The improvement of nation's security facilitated the land development for additional urbanization in urban areas, for industry in marginal areas, and for farmland consolidation for rural areas. This accumulated the land use in the whole country and increased land productivity with the development of transportation networks.

However, the threat of water-related disasters remains as imminent all over the country. IPCC has issued the climate gas emission scenario and prediction periodically since 1990s, including increased accuracy on climate variability caused by human activities. The density of the greenhouse gas is increased steadily every year indeed, and the increased tendency of the torrential rainfall also becomes clear. 2018 July Heavy Rainfall brought more than 200 victims, the largest number following the 1982 Nagasaki Flood. The general amount of rainfall of this torrential rainfall increased about 6.5% because of climate variability, which showed the influence of climate variability already became clear. In 2018, climate change adaptive law was enacted for both mitigation and adaptation.

Paris agreement was concluded for the purpose of suppressing a rise of the average temperature of the world in 2 degree compared with present and before the Industrial Revolution, and facilitating restrictive measures of a greenhouse gas emission worldwide. Even if it's suppressed by 2 degree, the influence is enormous. The climate variability has already influenced recent heavy rainfalls, and followed the further increase of torrential rainfalls in the next 20-30 years.

While a flood control measure of river works and dam construction has

improved the nation’s security and reduced the flood damages, the influence of climate variability may overcome the improvement. Recent climate variability has made torrential rainfalls more frequent and severe, which increased the human loss and financial damage. The increase of the amount of payment of the insurance delays the economic recovery, so devastates social fear.

Further, the proportion of elderly people grows and the population decreases in recent years. The population decrease and the rapid rise of aging rate except for a large urban area have raised vulnerability of communities during the disasters. Vacant houses and land uses have increased both in urban areas and rural areas, which require another land use planning. Sustainable urban planning under the concept of "compact plus network" has rebuilt to maintain the regional activities more sustainable after post-WWII high economic growth followed by a low growth era upon termination of bubbling economy.

Regarding science and technology, technological innovation is remarkable especially in information technology. Observation and information accumulation technology by 5G and other ITs, and IoT, development of big data and utilization of AI technology by enhanced computer capacity, these enables the guess and grasp of the phenomenon difficult so far, which supports evacuation assistance and various disaster prevention activities.

Under such background, more robustness toward water-related disasters is necessary through various tools including reorganizing land use and log-term perspective toward sustainable development. For this, whole society has to confront this crisis in an inclusive way and out of traditional thinking, recognizing a threat of water-related disasters under climate variability.

Traditional disaster countermeasures are based on past experience. However, as unexpected events occur and society and science and technology rapidly change, future water-related disaster risk reduction should be based on the future risk prediction under climate variability.

The River Committee of the National Land Development Council issued its Report on “water-related disasters conscious society” which made it conscious that “a facility’s ability is limited, so the facility cannot prevent severe flooding” after the Torrential Rainfall in 2015 with a lot of isolated evacuees. cannot be prevented puts it in the Panel on Infrastructure Development river subcommittee meeting up to now, and receives that a lot

of isolation person; and Report on effective combination of structural and non-structural measures after complex multi-hazards of riverine flood, urban flood, landslide and mudflows in 2018 July Heavy Rainfall. Technical consideration has been also advanced about influence of climate variability by the Technical Working Group on flood management planning and so on since April 2018.

This Council Report has recognized the enormous damages by recent water-related disasters, advanced reconstructive actions based on the former “water-related DRR conscious society”, and advocated the water-related DRR with the concept of the “River Basin Disaster Resilience and Sustainability by All”, which calls for all stakeholders to consider DRR as natural, mainstream DRR, and take collaborative actions in each river basin including watershed and flood plain area.

2.Recent disasters

2.1 Frequent and severe disasters

- Serious floods (riverine, urban, storm surge) and landslides (floods and landslides are called "water-related disasters" in the following.) recently occur by the unexperienced torrential rainfall at a various part of Japan almost every year.
- The 2015 Torrential Rainfall occurred from beyond 600mm in Kanto district and beyond 500mm in Tohoku district, more than twice of monthly precipitation in normal September [1)]. The humid air flew into the low air pressure which changed from 2015 Typhoon Etau and created many linear precipitation zones. The amount of rainfall renewed 1st place of record for 24 hours at many spots in Miyagi-ken, Ibaraki-ken and Tochigi-ken in particular [1)]. The floodings from embankment bursts in Kinugawa river etc. collapsed houses and inundated wide areas for long duration. Delay of evacuation created a lot of isolation people.
- Hokkaido and Tohoku-districts were seized with typhoons successively in 2016. Three typhoons landed Hokkaido in a year. A typhoon landed from the Pacific Ocean. These phenomena were first in the meteorological statistics. The embankment bursts in small and medium sized rivers occurred. The pitiful damage by which a tenant fails to escape occurred facilities in mountainous area.
- The 2017 July Torrential Rainfalls occurred when warm and humid air flew into the seasonal rain front and formed linear precipitation zones with heavy rain beyond 600 mm per 12 hours in Fukuoka and Oita, especially at a tributary basin in the right side of the Chikugo river [2)]. Large amount of mudflows and driftwoods went down in the tributary and blocked the channel [3)]. Large scale landslide also occurred in some channels. Three embankment bursts [4)] damaged 40 people dead, 2 persons missing, 1,476 houses broken and 1,667 houses flooded in Fukuoka and Oita prefectures [5)].

2.2 2018 July Heavy Rain, 2018 Typhoon Jebi

- 2018 July Heavy Rain, there was the amount of rainfall in the wide area around western Japan by a torrential rainfall: over 1800 mm at Shikoku district, over 1,200mm at Tokai district, around 2-4 times of monthly in July. It was the record heavy rain at 125 spots for 48 hours, and at 123 spots for 72 hours out of about 1300 spots of Japan Meteorological Agency (JMA) observation [6)]. Riverine, urban floods and landslides widely occurred in simultaneous multiple way with 224 victims, 8 persons missing, 21,460

houses of complete or partial destruction, 30,439 houses of flooding [6] and at most 263,593 houses of no water supply [7].
- The general amount of rainfall of the land was calculated by variation in climate as a test with about 6.5 % more by 2018 July Heavy Rain. The JMA noted about 2018 July Heavy Rain, "There was contribution of global warming." first referred to influence by climate variability about an individual event [8].
- 2018 Typhoon Jebi recorded the highest tide level at Osaka Bay, exceeding 1961 Typhoon Nancy, which landed Japan in lowest pressure under uniform record after 1951 and affected more than 200 people dead or missing. A runway and a terminal building at Kansai International Airport were flooded. The connection bridge to the airport was collided by an oil tanker, about 3,000 tourists isolated. Flood damage occurred in houses in Ashiya-shi, Hyogo.

2.3 2019 Typhoon Hagibis
- 2019 Typhoon Hagibis was born near Minamitorishima Island on 6 October 2019, moved to the Mariana Islands towards west, became larger, changed its course to the north, landed Izu Peninsula at 19:00 on 12 October with its strong power, passed Kanto district and changed to an extratropical storm in the east of Japan at 12:00 on 13 October [9]. The course and strength were predicted with smaller error [10].
- JMA announced the first alert on 9 October, and then "It will be record heavy rain equivalanet1958 Super Typhoon Ida" on 11 October [11].
- JMA declared the special warning to 13 prefectures (Shizuoka, Kanagawa, Tokyo, Saitama, Gunma, Yamanashi, Nagano, Ibaraki, Tochigi, Niigata, Fukushima, Miyagi and Iwate) in sequence from 15:30 on 12 October. All warning was released by 8:40 on 13 October [12].
-Evacuation instructions were announced 7.97 million people at maximum.
- The general amount of rainfall of 4 days reached 1,000mm at Hakone, Kanagawa, recording the first at 120 spots for 12 hours, and at 103 spots for 24 hours rainfalls. 142 points of embankment were burst with 35,000 ha area flooded. Damaged people and flooding were not captured enough in the medium and small rivers where inundation maps were not created.

(The outline of a riverine flood)
- Average rainfall at the upstream watersheds in major rivers exceeded or nearly exceeded the target rainfall of each river's basic management

policy (*). In Abukuma River, peak flow exceeded the target flow of its river basin plan.

* According to the River Law In Japan, river administrators establish basic river management policies, then formulate river implementation plans to provide the target and the measures to be implemented within a few decades.

- In 40 rivers (managed by central government), the flow levels exceeded the designated inundation alert levels.
- The embankment burst was observed at 14 spots in 7 rivers under 6 river basins (managed by central government), and at 128 spots in 67 rivers under 20 river basins (managed by prefectures) [13)].
- The burst of embankment flooded about 35,000 ha area in total.
- In Chikuma River under Shinano River Basin, the burst of embankment flooded in train stock yard of Shinkansen with 10 Shinkansen vehicles (total 120 cars). The train operation was affected for extended period.
- The operation of 146 dams (managed by MLIT) including Watarase Retarding Basin, Arakawa Retarding Basin and Yamba Dam, reduced the flood risks effectively. At 6 dams, the inflow exceeded the dam's capacity for flood control, so stopped flood controls when the outflow became equivalent to the inflow.

(The outline of urban flood)

- The damage by urban floods occurred in 15 prefectures, 135 municipals around eastern part of Japan.
- By flooding train stations, automatic ticket gates were submerged. Lifeline (water, electricity) was suspended more than a week in some tower apartments located in flood areas.

(The outline of storm surge and high wave)

-Storm surges and high waves were observed in Suruga Coast etc., which damaged shore protection facilities.

(The outline of landslide)

-Landslides occurred at 950 cases in 20 prefectures. More than 40 cases counted in 8 prefectures.

(The feature of the human damage)

-The number of victims because of floods was higher among 1999-2018 records.
-The ratio of victims more than 60 years old was higher.
-The ratio of victims outside buildings was higher.
- 84 people were dead as of 12 December 12 except for accident related death: about 65% were those more than 65 years old; about 74% were by flooding [14)].
- About 79% of 34 people who died inside houses were those more than 65 years old. More than half people who died outside buildings were dead during driving.
-Most of the flood victim at indoor occurred in urban areas.

(The feature of economic damage)
-101,673 house damages comprised of 3,308 total damaged, 30,024 half damaged, 37,320 minor damaged, 8,129 flooded over floor and 22,892 flooded below floor. Medical facilities, senior citizen welfare facilities, facilities for person with disabilities and child care facilities, etc. were also damaged.
-Blackout occurred in about 520 thousand houses. Water supply was stopped in about 170 thousand houses. It took about a month to recover water supplies because water sources, water intakes and water pipes were destroyed in some areas in Fukushima, Yamanashi and Nagano. 17 sewage treatment plants were flooded with function stopped.

(Announcement)
-In Kuji-gawa, the flood occurrence was confirmed and announced after heavy rain special warning was released at 2:20am on 13 October. Likewise, flood occurrence was announced after the release of heavy rain special warning in 7 rivers: Yoshida, Abukuma, Ishida, Sabi, Toki, Oppe and Chikuma Rivers. In Agano River, heavy rain special warning was released when preliminary flood alert had been announced. Flood occurrence was announced after 4 hours.
- The access concentration occurred in the MLIT website and made it difficult to get information. (Access beyond 1.6 times of the former biggest number of accesses)
-The access concentration also occurred in some local governments and made it difficult to get important information [15)].
- Flood damages occurred in the medium and small rivers where inundation

maps were not created [15].

(Emergency measure)
- Prepared suspension put it in railroad operations around Tokyo and Nagoya districts from afternoon on 12 October to morning on 13 October [16]. The prepared suspension worked for damage and confusion reduction by 83 enterprisers at 254 routes of railroads and at most 15 sections of 13 routes of highways [17]. However, Nagano railroad stock yard of Hokuriku Shinkansen flooded, and some railroad or road bridges dropped severely damaged railroad and road networks into pieces so it took periods to recover traffic function.
- The part of local governments closed evacuation places to avoid flooding the places, and carried refugees to the other evacuation places [18) 19)]. About 3,200 people evacuated, and 2,200 people among them re-evacuated to the other safer evacuation places where not for usual evacuation.
-There were some cases that overflown people had to evacuate to the places with flooding risks because of the capacity of evacuation facilities in some local areas, Tokyo [20].

(Support and response)
-MLIT dispatched TEC-FORCE (Technical Emergency Control FORCE: urgent disaster countermeasures dispatch experts formed by MLIT experts) from regional development bureaus all over the country and supported affected areas in 303 municipals, 34 prefectures. The number of dispatched experts reached maximum 748 per day on 23 October, and total 30,513 by 27 December, the biggest number since TEC-FORCE established.
-TEC-FORCE conducted the damage surveys and emergency restorations collaborated with local contractors in Tohoku, Kanto and Hokuriku districts.
- For damage surveys, ICT like drones facilitated the prompt surveys on public facilities for quick decision making on financial support by central government. (Official endorsement by the Cabinet on 29 October)
-To response to flood damages, about 200 drainage pump cars were dispatched. The 24-hour drainage operation finished flooding by the end of October.
-Collaborated with local contractors, road surface sanitation trucks were dispatched and the removal of sand and gravel accumulated in cities and roads, etc.
-Watering activity in the no water areas, grasping needs and other living

support in disaster areas were performed.
-Central government conducted emergency response at 41 spots at 14 rivers under 3 river basins on behalf of local governments, where urgent response requires for the next flooding in minor rivers managed by local governments.

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3 Climate variability
3.1 The situation of the climate variability
(The increase of rainfall)
-"There is no doubt in global warming of a climate system" about the climate variability in the past 100 years according to the IPCC AR5 published in 2013-2014 [1)].
-0.78 degree rose on the world average ground temperature compares 2003-2012 from 1850-1900 [2)]. Also in Japan, JMA observed 1.21 degree rise in 100 year from 1898 to 2018 [3)].
-It is mostly certain that the water temperature rose on marine surface layer (water depth 0-700m) from 1971 to 2010 [2)]. The increase rate, 1.12 degree per 100 years, of the sea surface temperature around Japan is higher that one, 0.54 degree per 100 years, of the average sea surface temperature in the whole world [4)].
-The world average sea level rose 0.19 meter from 1901 to 2010 [1)].
-JMA observation shows the increase of frequency is about 1.4 times for hourly precipitation above 50mm, and about 1.7 times for hourly precipitation above 80mm, compared with about 30 years before [5)]. About 30 percent of all observation points in Japan showed the first record for hourly precipitation after 2013.

(Water-related risk)
-Serious water-related disasters including embankment breaks and landslides, occurred almost every year in Japan recently: Series of typhoons in 2016, 2017 North Kyushu Flood, 2018 July Heavy Rain, 2019 Kyusyu Flood in August, 2019 Typhoon Hagibis in October.
-Meteorological Research Institute calculated about 6.5% increase of land precipitation at 2018 July Heavy Rain by climate variability using the JMA 55-year re-analysis (JRA55) model. JMA first noted global warming on a specific event "Observed long-term increase trend on temperature and water vapor in the atmosphere because of global warming, (omit), and impact of global warming at the torrential rainfall in July 2018." [6)]
-The number of rivers which exceeded the flood dangerous water level by recent torrential rainfalls downpour is in the increase trend. There is a possibility that the climate change influence, including the increased rainfall, has exceeded the progress of river works [7)].
-The mudflow and landslide disasters have occurred more frequently and severely recently and provided damages to people's lives and assets through water, debris and woods such as 2011 Kii Major Flood, 2013 Izu Disaster,

2014 Hiroshima Disaster, 2016 Typhoons, 2017 Kyushu Heavy Rain, 2018 July Heavy Rain and 2019 Typhoon Hagibis.
-Along with the increase of torrential rainfalls, the number of mudflow and landslide events has increased. 2,581 events, 2.5 times of annual average, occurred at 2018 July Heavy Rain, 952 events occurred at 2019 Typhoon Hagibis [8)].
-When special rainfall alert announces, there has been number of landslide events occurred even where sediment disaster designation does not cover nor where geographical information is not clear [8)].
-The mudflow and landslide disasters have occurred more frequently and severely recently because of climate change.
- During the 2018 Typhoon Jebi, highest tidal levels occurred and provided serious damages along Osaka Bay. When the sea level rises, wide seashore areas have to be exposed by tidal disasters.

3.2 Climate Change prediction
-According to the IPCC, when keeping discharging a greenhouse gas as it is, the amount of emission is increased at more than about 2 times in the end of 21st century compared with the Industrial Revolution before in 21 end of a century, and the average ground temperature of the world is predicted that 2.6-4.8 degree or 0.3-1.7 degree under RCP8.5 (Global warming was suppressed most.) or RCP2.9 (Global warming was suppressed least.) scenario [9)] respectively compared with 1986-an average in 2005 [1)].
-The ocean snow ice area special report, approved by the IPCC general meeting in September 2019, showed that the prediction rise reach 0.61-1.10 meter or 0.29-0.59m in RCP8.5 or RCP2.6 scenario respectively in 2100 compared to the average sea level in 1986-2005 [10)].
-There is a possibility that about 80 percent loss in RCP8.5, about 60 loss in for the beach around Japan [11)].
-The occurrence total number of the tropical storms in world decreases about 30 percent in 21 end of a century in RCP8.5, but the thing with a high possibility that the occurring frequency of the furious tropical storms is increased around the Japanese southern sea, Hawaii and the Mexican western sea [12)]. Simulated result was reported that strong typhoon would land more to Japan [13)].
-MLIT established the Expert Group meeting for flood control plan under climate change to estimate the rainfall increase in the future, which provides the assumed information on facility design based on flood control plan [14)].

-The result estimated about 1.3 times increase on the target rainfall, about 1.4 times increase on the flood flow, and about 4 times on the average frequency of flood, for flood control plan in the major rivers from the end of 20th century to 21st century in the case of 4 degree rise of world average temperature compare to before the Industrial Revolution. Even in the case of 2 degree rise (target scenario for the Paris Agreement), the result estimated about 1.1 times increase on the target rainfall, about 1.2 times increase on the flood flow, and about 2 times on the average frequency of flood, for flood control plan in the major rivers from the end of 20th century to 2040 in the major rivers.
-This study could not identify how climate change has influenced to the change in the weather factor and space-time distribution of rainfall, which affects disasters. Therefore consideration is needed continuously about the method to reflect a change in space-time distribution of such rainfall in flood control plan in the whole country.
- MLIT established the Expert Group meeting for urban flood control under climate change to estimate the rainfall and adaptation, which provides the assumed information on sewage design in case of frequent heavy rain and increased risk for urban flooding.
-When the average ground temperature of the world rose 4 degree compared with before Industrial Revolution, about 1.3 increase of rainfall for sewage planning from the end of 20th century to 21st century. For the scenario of 2 degree rise showed about 1.1 increase of rainfall from the end of 20th century to 2040 [15)].
rainfall before about setting of the external force which becomes the premise of
- MLIT established the Expert Group meeting for erosion and sediment control under climate change to estimate the change of the rainfall and the impact on erosion and sediment disaster.
-Sediment disasters, floods and slope failures more frequently and likely occur because of the rainfall change under climate change, even where there is no designation or target for sediment disaster hazard area. There is urgent need that these risked areas should be identified and appropriate alert, evacuation and facilities should be equipped [16)].
- In particular, when the rainfall has increased, the simultaneous landslides and mudflows are likely to occur, and the duration of rainfall becomes longer, both sediment disasters and increase of river flow happen. These risked areas should be checked again.

- MLIT and Ministry of Food and Agriculture and Fishery established the Expert Group meeting for coastal preservation under climate change to estimate the change of the hazards and the impact of climate change which raises the average sea level, tidal deviation and mightier waves.
-Based on both observed and predicted influence on coastal area, further consideration for new measures and controls should be facilitated as well as quantification of climate change.

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4. The trend of the society

4.1 Change of local communities under decreasing population, declining birthrate and growing proportion of elderly people

-A starting point of estimation calculation of the "future's Japanese estimation population" of the National Institute of Population and Social Security Research (IPSS, It was estimated in 2017.) was 2015, and the Japanese total population of this year was 127,090,000 according to the census.

-Medium estimation showed the population decrease process in the long term, so total population were predicted about 88,080 thousand in 2065.

- The productive population (15-64 years old) reached its peak 87,260 thousand in 1995, and decreased to 75,450 thousand in 2018. This will decrease to about 45,290 thousand in 2065 according to IPSS future estimation.

-The aging rate kept rising after 1990s, and reached its peak about 27.7 % in 2017. While the total population decreases, the aging rate above 65 years old keeps rising. The estimate showed that one out of about 2.6 people would become more than 65-year-old person in 2065.

-A senior citizen generally more likely to become sacrifice during disasters because of failing to escape, so serious aging leads to victim's rise.

-245 people was dead or missing persons in 2018 July Heavy Rain, the largest number since 1990. Half of victims during the sediment disaster in Hiroshima and about 90 % during the flood in Mabi town, Kurashiki city, Okayama were more than 65 years old.

- A local community plays a very important role on disaster risk reduction. For instance, about 80 % people was rescued by community from broken houses during 1995 Great Hanshin Earthquake. Quick and effective rescues of elderly people by community were reported during 2007 Noto Peninsula Earthquake and Niigata Chuetsu Earthquake.

-Thus it's expected that the role mutual assistance in an area will become bigger while the decline tendency of mutual disaster prevention power has become serious.

-For example, community firemen, who play as rescuers during disasters collaborated with fire department, were more than 2 million in 1954, but its number has decreased to less than a million in 1990 and 890 thousand in 2007. The age composition of the fireman changed: the percentage more than 50-year-old member was about 7% in 1985, and increased about 14.4 % in 2007. A fire brigade consists of resident's voluntary participation. Its area close adherence, mobilization power of personnel and quick

response play the important role. The decrease and aging trend shows the decline of community disaster risk reduction. The similar situation is also seen about the flood fighter party charged with the role for stopping expansion of damage on the occasion of floods.
-It's pointed out as the background where such flood fighter party decreased came from the decrease of younger population, the population decrease in rural areas, and increase of the employee, who mainly supported the activity of flood fighter party. While the big role is desired by mutual assistance, moreover to secure safe relief in an area such as various utilization of a new technology and cooperation with the person concerned, how to secure the local safety should be considered comprehensively.

4.2 Future national planning
-After the WWII, the population tended to increase consistently to 128,060,000 in 2010 from 84,110,000 in 1950. River works for the flood control security in floodplains where the population and the development pressure of land use increased, had supported Japanese high economic growth and its productivity improvement. However, such development pressure becomes weaker under the population decrease. The way of thinking for flood control measure should be transformed and moved to a new concept for further momentum and productivity.
-While the population has decreased and the birthrate declined, unused lands have increased both in urban and rural areas after the change of industrial structure. National planning based on the “compact plus network” which maintains community’s momentum, has become important.
-City revival special measures law revised in May 2014 established location rationalization plan system for compact city planning.
-City revival special measures law revised in April 2018 institutionalized the low under developed land right setting and location lead promotion agreement of facilities to promote the use of vacant lots and vacant houses crowd creation in the urban areas.
-City revival special measures law revised in June 2020 facilitated "restraint of new location in hazard area", "promotion of move from hazard area" and "safety ensuring in a resident area" to promote disaster-prone community and response to the frequent and severe natural disasters.
-A new style of how to work spreads over society telework duties for prevention of the new coronavirus infection has become more popular. Various progress of digitalization, change of business activity and lifestyle,

and structure of the city and rural areas by IT have influenced to the land structure and community development.

4.3 Sustainable Development Goals (SDGs)

- 2030 Agenda for Sustainable Development was adopted at UN General Assembly in 2015. Sustainable Development Goals (SDGs) require the action for sustainable, diversified and inclusive society in interdisciplinary way.

-SDGs include robust and adaptive capacity building toward climate-related natural disasters. Our action for water-related disaster risk reduction can contribute to the international society.

-The actions for SDGs in Japan showed 8 priorities including:

(Sustainable robust country and quality infrastructure)

Vital society and disaster risk reduction

Compact plus network

Investment for quality infrastructure

(Efficient and renewable energy, climate change, recycling)

Efficient and renewable energy in global stage

Climate change

Recycling

-Climate change variability in whole society needs water-related disaster risk reduction in a whole basin with all stakeholders.

4.4 Technical innovation for Society5.0

- AI, data-driven society by big data, 5G IT, observation technology and computer calculation have developed rapidly recently. Our country takes these high technologies in our society and creates new value from innovation for human-based Society 5.0 prior to the world.

-Traditional society focused too much on economy and institutional system and created a gap on goods and services depending on each ability. In Society 5.0, IoT connects all people and goods and create new value through various knowledge and information. AI and robots using big data substitute works and arrangement traditionally done by people, and make all people from such complex and hard chores, so all people can live with high vigorous quality and comfortably.

-This can be human-centered society, which contribute not only to our country but also to all the other countries for SDGs.

-To adapt a non-contact and remote working style under new coronavirus infection and improve productivity and safety, infrastructure development needs the conversion to the BIM/CIM utilization for which three-dimensional data and promote DX (Digital Transformation) which utilized key technology for 5G.
-More effective river information by numerous points of a water level and river monitoring camera, drone or satellite monitoring, community information, SNS, AI utilized information, user-based smart phone information, and two-way communication will work for disaster risk reduction and early recovery in water-related disaster risk reduction.
- Disaster risk reduction Society 5.0 should be sought through various new technology and application in water-related disasters, and further innovation and interdisciplinary integration of technology under collaboration with stakeholders.

4.5 Conversion to the new lifestyle under new coronavirus infection
- Emergency declaration based on the special measures law for infectious diseases was issued on 7 April 2020 to 7 prefectures (Saitama-ken, Chiba-ken, Tokyo-to, Kanagawa-ken, Osaka-fu, Hyogo-ken and Fukuoka-ken) for the new coronavirus infection.
- On 16 April, 7 prefectures plus 6 prefectures (Hokkaido, Ibaraki-ken, Ishikawa-ken, Gifu-ken, Aichi-ken and Kyoto-fu9, total 13 prefectures were designated as specific cautious urban and rural prefectures. Including these prefectures, all over the country became under emergency declaration.
- Until the release of emergency declaration on 25 May, the avoidance of "three dense", the reduction of a contact chance of a person to person to 80%, at least 70% through commutation restraint by promotion of consecutive holidays and remote-working and staying at home. Even after the release, the avoidance of "three, dense" was recommended.
- Re-expansion of infection happened after the release of behavior restriction in some countries. This infection is expected to stay longer.
- Therefore the government experts’ group showed a new lifestyle to prevent infection expansion including remote-working, rotation duties, flex commutation and offices with enough space for each worker.
- Further infection measures in evacuation shelters are necessary when a disaster happens under the expansion of infection. Therefore the improve of ventilation in evacuation shelters, more evacuation shelters including hotels, and the reduction of evacuee concentration through lift-up of

resident area and more evacuation spaces, were sought all over the country.
-This experience and a suggestion of new lifestyle won't stop at remote-working, and further bring to the change of supply chain, land use planning and countermeasures for water-related disasters.

5 Future water-related disaster risk reduction
5.1 Policy trend
(Change in flood control)
-Old River Law was established in 1896, with systematic legal system about river management, as the first modern public property management system in Japan. Multi-purpose Dam Law in 1957 and New River Law in 1964 were established for comprehensive river basin management and water use. The River Law introduced the national administration so national government took responsibility of river works and water use arrangement in major river basins as a river administrator. The river administrator decides the master plan of river works for flood management.
-The flow volume was based on the maximum record rainfall, but to be updated in the 1950s. The maximum rainfall had to be revised frequently after major rainfalls which occur randomly without normal probability. The universal unified linear measure was considered. The Yodo River Master Plan in 1954 first included the annual over probability "1/100" based on the accumulated hydrological data [1)]. Ministry of Construction river erosion and sediment control technical standard in 1958 introduced the concept "Annual over probability was considered according to the importance in a plan target area." [2)]
- In the same period, basic method of statistical survey for flood damage and project survey for economical validity was established. The statistical survey for flood damage comprised of a flood damage actual condition survey and flood damage resource research, based on the guideline for statistical survey for flood damage in 1961, the unified guideline for estimation of assets in flood district in 1962, and some updates in 1970. The method of project survey for economical validity was based on the economic survey principle and guideline, which applied in major rivers all over the country.
- These planning methods and economic estimation methods facilitated the flood management projects efficiently and effectively for pre investment for disasters all around the country.
- Concentration of the population and fortune and a rise of volume of run-off to a river at the time of a flood, etc. were brought by development in and around urban area. A rise of flood damage risk has put the comprehensive flood control program which cooperates improvement and maintenance of collection facilities in a basin since 1979.
- Embankment has been upgraded (high standard embankment) with wider width than before since 1987 to avoid embankment burst and serious damage to the dense population and fortune along the major river by the

flood in which the scale of the plan is exceeded.
- The River Law revised in 1997 added the maintenance of river environment into its purpose, and introduced new planning system for river development, which divided the former construction implementation master plan to the river development basic management policy and implementation plan. River development set the target which should be achieved in the future, and was performed based on this. As the river development takes the great budget and time, middle-term development target should be set for the implementation plan while the implementation could be arranged among river basins all over the country.
-The measure and process to get comments from experts and opinions from the related resident, and hear from the head of local government, were set in decision process of the implementation plan for consensus building in the river basin.

(Change in flood fighting)
- "Flood fighting" has its historical tradition in Japan, based on community autonomy of villages, for flood control work. The Flood Fighting Law in 1949 designated the flood control work as community autonomy work and "flood fighting group", flood fighting administration association or flood prevention association, which takes primary responsibility on flood fighting works such as team building of flood fighting and flood inspection.
- The Flood Fighting Law revised in 1955 established flood forecast system (flood forecast river) and the revision in 2005 established notice system of water level (water level monitoring river), which introduced river information for evacuation actions. The revision in 2001 established the announcement of inundation area and depth (point information) to make resident people understand water-related risks. These river information for evacuation actions and point information have been maintained for securement of evacuation.
- More revision for the Flood Fighting Law established further institutional actions for water-related disaster risk reduction, through preparatory evacuation for floods well before the hazard, river information update for resident safe evacuation, various preparatory planning for stakeholders. These includes broader definition of flood fighting in addition to the traditional on-site flood fighting (*).
* The precaution activity for embankment monitoring during flooding and the sandbag accumulation for flood response to protect embankment from

burst as much as possible.
- The 2011 Great East Japan Earthquake, the 2011 Typhoon Talas etc. showed the frequent water-related disasters exceeding the record. The 2015 revision obliged flood assumption mapping (flood, storm surge, and rainwater overflow) with record-high external hazards in addition to flood assumption mapping for river implementation plan to protect human lives and assets from flooding by non-structural measures.
- The revision in 2017 shifted the mindset on flood fundamentally from protecting floods by facility to exceeding facilities capacity by flood. It integrated structural and non-structural measures for flood risk reduction with wider participation of stakeholders. It also reorganized the "water protection against disasters conscious society" which prepares for floods by the whole society, by foundation of large-scale flood risk reduction steering committee.
- Torrential rainfall flooding occurs frequently all over the country in recent years, while there is fear of the decline of community power toward flooding. The 2005 revision reinforced flood control system, established the flood control cooperation team by public foundations collaborated with firefighting sectors and flood fighter teams, and established a retirement bonus provision regulation. The 2017 revision introduced private sectors which receive a part of authority for flood fighting, and facilitated the private involvement in flood fighting. Reinforcement of the flood fighting power by community will be desired more.

(Comprehensive flood control)
- "Comprehensive flood control programme specific river project" started in 1979 and guided land use change from hazard, secured more detention function, conducted the river works more efficiently, and considered the change of basin with harmonizing land use. By March 2020, 17 rivers in Hokkaido, Chubu and Kanto districts, have been designated as the specific rivers.
- Comprehensive flood control programme specific river project has contributed to a certain degree, but showed its limitation because of the weak voluntary consensus in the basins.
- The Specific Urban River Flood Preservation Law started in May 2004 for new scheme. 8 rivers have been designated for the specific rivers.
- The characteristics of the law provided legal binding such as retarding ponds and rainwater infiltration obstruction for developers, compared to the

original comprehensive flood control measures.
- The river administrator, sewage administrator, local government and local residents, etc. cooperate for flood damage measure at the Tsurumi River basin first designated as a specific municipal river in 2005.
- Local heavy rain occurs frequently in the short duration at small location. For such floods, municipal government, river administrator and sewage administrator collaborated for flood risk reduction by registration plan, called "100mm/h Relieved plan". This plan includes flood management projects for river basin improvement, such as river works by river administrator, sewage works by sewage administrator, distributed typed rainwater storage penetration facilities by local resident groups and private companies, information network for flood hazard. These projects seek flood risk reduction at 24 locations by March 2020.
- Hyogo-ken carries out "comprehensive flood control measures regulation" in 2012 as a precedent measure for comprehensive flood control. Under this regulation, the prefecture, municipal governments and resident people collaboratively work for flood control by local comprehensive flood control plan. The regulation clarifies the responsibility of each stakeholders, asks for local comprehensive plan, and obligates the developers to set important retarding pond for the development activity beyond the fixation scale volume of run-off of rainwater increases.
- Shiga-ken carried out "regulation about promotion of Shiga-ken basin flood control" in 2014 for land use control and building license system in the flood areas. The prefecture also announced the flood risk information on inundation under various scaled rainfalls, called “local security map”, which worked for land use, housing and evacuation behaviors.
- Nara-ken carries out "regulation about promotion of comprehensive flood control measures in Yamato River basin" in 2018 with three pillars of "the measure let run", "saved measure" and "the measure cut down". The regulation included the reinforcement of the target area of the protection against disasters regulation pond (application of a penalty), the restriction of urban area to flood hazards, and the promotion of MoU among municipal governments.

(Reinforcement of local government support)
- Local heavy rain by seasonal rain front as well as landing of 10 typhoons which become record most provided severe flood damage in 2004. This showed the delay of evacuation alert by local government. Since 2005, MLIT

local office can directly provide the information and forecast about rivers for early evacuation alert by local government. This also applied to the sediment disasters and small rivers administered by prefecture. After the 2015 Kanto Tohoku September Heavy Rain, workshops for mayors were organized for appropriate evacuation alert.

- MLIT founded TEC-FORCE in April 2008 in order to support local governments quickly in the case of large-scale natural disasters, for prevention of expansion, grasp of disaster damage area, and technical guidance for early response to the damaged area. Since the foundation of TEC - FORCE, personnel and equipment have been secured and properly trained for quick and effective correspondence.
- The number of dispatched staffs were about 115 thousand at 106 disasters since its foundation. At East Japan Earthquake in 2011, the first dispatched staffs arrived at the disaster area, and more than 18 thousand staffs were dispatched for early response through damage observation and pumping. At the 2018 July Heavy Rain, more than 10 thousand staffs were dispatched at the 2019 Typhoon Hagibis, about 30 thousand staffs were dispatched, the largest number.
- The smooth receiver capacity has been built at the local government through joint training in case of disaster and cooperation for the dispatch of TEC – FORCE.
- The lack of personnel and technical knowledge in local government may create the difficulties on dam renovation projects, emergency embankment recovery. The River Law revision in 2017 establish a right vicarious execution system by MLIT. The system worked at the 2017 North Kyushu Torrential Rainfall and 2019 Typhoon Hagibis.
-There were similar system for vicarious execution of disaster recovery business based on "law about rehabilitation from a large-scale accident", but this is limited to the extraordinary disasters, such as 2011 Great East Japan Earthquake and 2016 Kumamoto Earthquake. The law revision made it possible that national government put construction which requires high technical power or mechanical effort into effect for disaster rehabilitation works.

5.2 Climate change and recent water-related disasters

- MLIT installs the flood control measure consideration subcommittee under climate change in August 2007 and has made the policies to protect the people’s lives from external forces exceeding the ability of the facilities,

based on the Council Report "Climate change adaptation in the field of water-related disasters" in August 2015 [3]. The 2015 Flood Fighting Law revision facilitated the designation of flooding assumption district (flood, storm surge and rainwater overflow) for record-high external force and evacuation planning.

- The 2015 September Kanto and Tohoku Torrential Rainfall indicated that the ability of the facilities was limited, and there would be certain that the facilities could not finish cataclysm. MLIT decided to promote "water disaster prevention conscious society" which combined structural and non-structural measures comprehensively for disaster risk reduction.
- The 2016 August Hokkaido and Tohoku Torrential Rainfall showed the damages to social welfare facilities, school and a medical facility, etc. in prefecture management rivers in Tohoku-district by the evacuation delay. MLIT revised the Flood Fighting Law and River Law to enforce the measures in the medium and small sized rivers managed by prefecture governments.
- The 2018 July Heavy Rain showed the enormous financial damage as well as human damage. MLIT put into effect in urgent measures to accelerate the reorganization of "water protection against disasters conscious society" [4].
- The 2018 July Heavy Rain, Typhoon Jebi, and Hokkaido East Iburi Earthquake and recent disasters showed the serious damages by losing the function of essential infrastructure necessary to the nation's social and economic activities. The Cabinet meeting on urgent check of essential infrastructure issued the 3-year emergency countermeasures for robust nation with disaster risk reduction especially on urgent structural and non-structural measures on 14 December 2018, by intense investment in three years by 2020.
- The 3-year emergency countermeasures facilitated the comprehensive and intensive measures in three years, both structural measures of embankment reinforcement in the part where danger to human life is high when bank break has formed by soil excavation and the back water phenomenon, etc., and non-structural measures of risk information announcement including hazard mapping etc.
- The additional measures included the comprehensive disaster risk reduction by society as a whole in multiple ways by utilizing large-scale flood risk reduction committees joined by public entities in designated river basins, and enforcing preparatory measures and collaboration by many stakeholders.

5.3 New water-related disaster risk reduction

- The future forecast by climate change assumed the intense rain in short duration, more frequent and intensified rainfall, more total rainfall, rise of the average sea level, more sea level deviation from normal. There is fear of occurrence of severe and frequent water-related disasters and another mega disaster combined landslide, flood, storm surge and inundation.
- The river improvement works and urban works take long duration of time, so these planning should consider the climate change despite of the uncertainty on the forecast. Without the consideration, frequent change and additional works may happen so it should take longer period to complete necessary works.
- Only structural measures traditionally by river administrator in river area cannot catch up the increase of external force by severe and frequent water-related disasters from climate change as it takes more time to deliver the flood security.
- Therefore it's necessary to accelerate traditional preparatory disaster risk reduction by administrators, consider the river basin as one comprehensive system from its catchment to river area including the floodplain, and involve all stakeholders there even who did not join before for the disaster risk reduction.
- Population decrease, the declining birthrate and growing proportion of elderly people, and rise of vacant land use and abandoning cultivation farmlands appear in river basins. The land use in the basins needs to be changed dramatically to "compact plus network". Such changes require the water-related disaster risk sharing in the basins by reconsidering land use planning and water-related disaster risk reduction by new land use. The risk sharing needs the knowledge sharing among stakeholders, and combination of water-related disaster risk reduction and land use/urban planning. It's also necessary to use effectively the existence stock in the basin such as retarding securement of new place and utilization of the multilateral function for overflow.
- Remarkable development has been observed in information: acquisition of information by new tools such as the IT utilization like 5G, IoT, artificial satellite and drone, processing of information by AI technology and these big data. The digitalization in society like contactless and remote-typed measures has developed under the new coronavirus infection. The platform where all stakeholders in the basin can work for water-related disaster risk reduction, should be built to utilize these technology, share information and

knowledge on water-related disasters, accumulate them sustainably and use the information effectively. Interdisciplinary innovation for water-related disaster may happen in the fields of the assessment of current conditions and the forecast of water-related hazard risk, the information sharing, and risk reduction methods. Such technologies should be introduced early and advanced for application in fields.

- These change of climate change and society, and the technological innovation will provide the various impacts in wide fields. The protection of people's lives and assets from water-related disasters needs inclusive risk communication on knowledge and information on water-related disasters, land use planning, community vitalization and more productivity for population decrease and ageing society, resilience , and sustainability under positive participation of all stakeholders.

Resilience: Tough and flexible society with minimizing the loss of human lives and the economic damages even under the worst situation under maximum water-related disasters, responding and recovering early and avoiding falling malfunction on economic activity.

Sustainability: Even if a catastrophe occurs, community can be restored promptly, moreover improve the international competitiveness and also contribute to national growth strategy.

Inclusiveness: All stakeholders in the basin interdisciplinary from various fields always pay attention to water-related disaster risk reduction collaboratively, and advance countermeasures on water-related disaster risk reduction on a viewpoint jointly from various technological innovation.

(1) Water-related disaster risk reduction from phenomena in the past to climate change forecast

- The method to estimate accurately about a phenomenon with various uncertainty has been developed in the field of flood management. For fair and effective flood management in the country, the method changed from the accumulated observation maximum in the past to the extreme probability value in 1958. However, climate change will make this method difficult in efficient management as the phenomenon do not follow the estimation from trend probability data. The correspondent change often needs reconsideration of the flood management plan and further reinforcement in facilities. Therefore the flood management should be based on the forecast simulated by climate change, not based on the phenomenon occurred in the past.

(2) Conversion to "River Basin Disaster Resilience and Sustainability by All"
- The recent severe water-related hazards have led the assumption that the floods exceeding the ability of facilities may occur. The assumption needs the reorganization of "water protection against disasters conscious society" which prepares for floods by the whole society has been advanced. "River Basin Disaster Resilience and Sustainability by All" calls for all stakeholders, including the national government, local municipalities, private sectors and residents. All the stakeholders are encouraged to work together to take all possible actions towards water-related disaster risk reduction, in each river basin from the upstream to downstream areas of the main streams and tributaries. - "River Basin Disaster Resilience and Sustainability by All" is defined as follows.
"In addition to the actions that public administrators for rivers, sewages, erosion and sediment controls and coastal areas etc. have taken mainly, all the stakeholders are encouraged to work together in each river basin from the upstream to downstream areas of the main streams and tributaries, including floodplain, (i) to prevent and reduce the inundation as much as possible, (ii) to minimize the exposure, and (iii) to take all possible actions from risk reduction early response and recovery."
An area: The catchment area where rainfall pours, the river area managed by public administrators, and floodplain where flooding is assumed.
Concept: The comprehensive management for water-related disasters, controlling the hazards such as rainwater, running flow, inundated flows, sediment and high tide, land use control, planning and flood proofing, evacuation during flooding, reduction of economic damages, response and recovery from floods, enhancement of resilience.
-Further the report in which Japan Society of Civil Engineers was released after the 2019 East Japan Typhoons, and proposed the "River Basin Disaster Resilience and Sustainability by All". [5)]

(Comprehensive and multilayered concept based on the feature of river basins)
- All the stakeholders are encouraged to work together for the "River Basin Disaster Resilience and Sustainability by All" including the following three measures comprehensively and multi-layeredly around a river basin.
(i) hazard control : to improve flood control facilities and reduce the inundation as much as possible, (ii) exposure reduction: to improve urban

planning and way of living for damage avoidance by assuming possible flooding, and (iii) vulnerability decrease: to conduct proper evacuation and carry out early response and recovery during flooding.

(Acceleration of preliminary disaster risk reduction)
- The preliminary disaster risk reduction should be emphasized to prevent the loss of people's lives and economic assets, rather than the ex post measures which restore for response and recovery after suffering.
- Severe water-related disasters occur almost every year, which clearly noted as the influence of climate change. The improvement of flood control facilities suffered from such disasters is still on the way, but it can be noted that the damages by the disasters should be much smaller if these facilities had been completed when the disasters occurred. There are growing concern that the effects of climate change will further exacerbate the risk of water-related disasters through more frequent and severe torrential rainfalls and higher tides. The improvement of flood control facilities cannot secure the expected safety if the improvement follows the traditional estimation.
- Therefore the ongoing improvement should be facilitated. Further effective preliminary disaster prevention measures are also necessary by sharing present targets among national government, local governments, private sectors and local residents, etc., and combining structural and non-structural measures effectively based on the concept of "River Basin Disaster Resilience and Sustainability by All".
- The flood management planning should facilitate and accelerate the improvement works by converting the mindset from the data "based on results in the past" into those "considering the increase of rainfall and the rise of tide level under climate change".

Reference (in Japanese)
1) https://www.kkr.mlit.go.jp/river/kasen/yodogawa.html
2) https://www.mlit.go.jp/river/shishin_guideline/gijutsu/gijutsukijunn/index2.html
3) https://www.mlit.go.jp/report/press/mizukokudo03_hh_000892.html
4) https://www.mlit.go.jp/river/shinngikai_blog/shaseishin/kasenbunkakai/s

houiinkai/daikibokouikigouu/pdf/daikibokouikigouu_toushin_honbun.pdf
5) http://www.jsce.or.jp/strategy/files/hagibis_20200123.pdf

6. Water-related disaster risk reduction to be conducted promptly

6.1. Reconsideration of the plans and the standards

- The flood control facilities for rivers, sewage and coasts have been planned, designed and arranged based on precipitation and tide level records in the past or their statistical analysis.
- The river management basic management policy, the long-term goals for the river improvement, sets a target flood which shows the basis of a flood protection plan, the annual probability of exceedance 1/100-1/200 in case of major rivers administrated by national government. The river improvement plan set the lists of the improvement works in 20-30 years based on the basic management policy. In most of the major rivers administrated by national government, the improvement works try to prevent from the biggest torrential rainfall in the past (after the WWII in most cases). The coast protection facilities have been targeted to the highest tide level occurred in the 1959 Typhoon Vera, which affected the worst flood damage, more than 5,000 people dead or missing after WWII. However, there is a possibility that the security made these targets can't be secured any more as the increase of rainfall etc. considering the climate change.
- River management facilities and coast protection facilities, etc. are designed so that safety by which the facilities or their parts, etc. are required in their whole service duration may be secured. If the external force exceeds the initial condition before the renewal, the safety levels and required functions cannot be secured.
- Climate change may exacerbate the water-related disaster risks, so the target of flood control plan, sewage plan, coast protection plan and erosion and sediment control plan (hereafter, flood control plans) and the design level of the facilities should apply the external force by which floods, urban floods, sediment induced disasters, storm surges and high waves forecasted during their target duration.

(Climate change scenario for water-related disaster risk reduction)

- The climate change scenario for water-related disaster risk reduction should be based on the ongoing mitigation efforts to reduce greenhouse gas set by the Paris Agreement on climate change in November 2016, "an average temperature rise of the world is suppressed in less than 2 degrees compared with the Industrial Revolution before, 1.5 degrees by the effort". The current security level is less than the final target in most of the rivers. It will take a considerable period before reaching the target.

- The scenario, which make the standard of the external force for current flood control plan, should be based on the average external force calculated under 2 degrees rise [1)]. There should be the variation and change on this external force under the 2 degrees scenario, and further more rise on temperature. As such, the scenario under 4 degrees rise should be also considered for the reference, as well as the possible further climate change in temperature and extreme hazard.
-It is suitable to utilize the 4 degrees scenario for the check and reference on full improvement works and their redundancy, and fail-safe on the facilities. The 4 degrees scenario can also apply to the long-term and overall aspects such as national land use and land use controls.
- Only the precipitation change magnification has been estimated quantitatively are nationwide as the change of external force so far. Various estimation could be applied for flood control planning and individual structure designing.

6.1.1 Application of climate change into flood control planning for target security in each area

-Flood control plan should be reconsidered in order to secure the target safety in the final year of the flood control plan. It is necessary to reflect the increase of the external force such as the amount of rainfall directly in the present plan when considering the target safety.

(Reconsideration of maximum probable flood in river management basic management policy)

- The peak flow at the reference point in the case of maximum probable flood should be set appropriately based on the rainfall forecast advancely calculated for future climate change under global warming.
- The river improvement is still on the way, so the target of the river implementation plan is much lower than that of the river basic management policy in the most of major rivers. The priority should be focused on the work under the present river basic management policy.
- There is uncertainty in climate change forecast, and there is also a possibility that future forecast will be reconsidered in the future. However, it's certain to increase in the amount of rainfall, and it takes certain period for the improvement of flood control facilities. It is desirable to revise river basic management policy and establish a target based on climate change. Specifically, maximum probable flood under climate change should be

applied at first, in the rivers where large-scale flood occurred and exceeded maximum probable, and where the distribution flow rate should be changed between the channels and dams.
- For "River Basin Disaster Resilience and Sustainability by All", the flow rate reduction effect in the target flood should be calculated and put in the plan after stakeholders' arrangement and necessary implementation such as in operational regulations are taken place regarding various outflow restraint measures and preliminary discharges by water supply reservoirs.

(Reconsideration of the target flow in river improvement plan)
- All scenarios for climate change forecast, the temperature will rise two degrees in 2040-2050 compared with before the Industrial Revolution. This rise of two degrees likely occurs before the target year of the river improvement plan for river works in 20-30 year. The target flow based on the increase of the rainfall under climate change, and the prioritized works on the facilities for early effects or existing facilities should be applied to secure the target flood safety.
- It's necessary to aim the immediate achievement of the present river improvement plan based on the flood record in the past, and further to shift the target of river improvement plan considering the increase of rainfall under climate change.

(Reconsideration of the plan rainwater in the sewage plan)
- Considering the increase of rainfall under climate change and recent urban floods, it is necessary to reconsider increase of the rainwater under climate change and deliberately advance preliminary disaster prevention.
- To advance the preliminary disaster prevention which contemplated influence of variation in climate, risk analysis on urban floods based on the updated plan rainfall should apply to the decision and publication of the stormwater management comprehensive plan which shows a med- or long-term urban inundation plan by sewage (improvement level for each area, step-by-step improvement etc.), reconsider the plan based on the impact of climate change, accelerate and prioritize the sewage work under the concept of choice and concentration, optimize the existing facilities, and facilitate urban flood management under the multiple collaboration.

(Reconsideration of the produced earth and sand volume in erosion and sediment control planning)

- Reconsideration of structural and non-structural measures for frequent and extreme sediment disasters should be advanced practically. The change in produced earth and sand volume should be estimated properly by the analysis on local presumes and triggers characteristics under the increase of rainfall. The hazard areas for landslides and sediment floods should be estimated from the analysis on sediment phenomenon. The external force for the design in erosion and sediment control related facilities should be updated.

(The reconsideration of target tide levels for coastal protection)
- Necessary height of coastal dyke is normally set by necessary amount to the design wave and allowance height to the planned tide level. The external force are likely to increase under climate change through the rise amount of average sea level and the increment of tide deviation for design storm surge, and the mightier waves for design wave. Therefore it is necessary to reconsider these external force for coastal protection considered by the tide level based on the prediction in the future rather than by historical tide level of the past.
- It is now difficult to estimate the change in wave and the section topography by off-shore sediment movement caused by extreme phenomenon considering climate change accurately. The monitoring should be enriched and adaptive measures and management should be applied.
- The adjustment and consideration to secure the protection function successively at river and coastal area are necessary for setting of the water level for river planning by which river embankment and coastal dyke are rubbing around the river mouth.

(Comprehensive sediment management)
The rainfall increase by climate change may create the flood increase, the change in sediment production and transportation in quantity and quality, and the change in environment. The change in river channel, coast, and dam sedimentation should be monitored. The comprehensive sediment management should be facilitated through current sediment supply from dams, sediment removal of river channel and improvement of coastal areas.

6.1.2 No rework measure by reflection to design standards
-It is necessary to consider so that needed safety has been secured during the service life of facilities or parts, etc. when river management facilities

and shore protection facilities and sewage facilities are designed. Therefore when the climate change influence applies to the design in facilities, it's necessary to reconsider external force by utilizing the increased amount of rainfall and tide level etc. as of their service life.
- The forecasted change in future external force includes the uncertainty. To avoid no rework measure because of the further increase of external force, such as for the 4 degrees rise scenario, it is better to include the design policy beforehand, whether easy reconstruction design to be set in case of the increase of external force, or necessary reconstruction work to be added after the increase of external force cleared.

(Reconsideration of facility design)
-It is necessary to consider a rise of external force by climate change in case of establishment in facilities. For long-service facilities like barrages and large-scaled floodgate, the Additional design measures for further climate change can be included in advance, so the reconstruction work becomes easy and cheap even in case of the actual increase of external force. It is desirable to consider influence of climate change into the design of facilities like pumps, which expire their duration of the services before the temperature rises 2 degrees.

6.1.3 Others

(Reconsideration of the methods of the biggest external force assumption for flood assumption district mapping)
- The biggest rainfall for flood assumption district map is basically estimated district by district in Japan, based on 15 districts where rainfall characteristics is observed similarly (the district’s biggest rainfall). However, when being much lower more than the annual 1/1000 probability rainfall, the annual 1/1000 probability rainfall applies on behalf of the biggest rainfall. [2)]
- The biggest high tide, as well as rivers, is basically estimated under the condition where a typhoon with the lowest core atmospheric pressure at the 1934 Muroto Typhoon which landed Japan in lowest pressure before uniform record in 1951 and affected more than 3,000 people dead or missing and the largest radius and velocity at the 1959 Typhoon Vera attacks during the high tide by the worst course. The biggest high tide is estimated by the atmospheric pressure and tide level based on the observed data.
- On the other hand, the flood assumption district map by the maximum

assumption scale applies to the structural measures, such as the flood preparation and response activities for public building. [3)]
- It is not clear so far how climate change gives an impact to the low frequent phenomenon. Further research on extreme rainfall and climate change forecast should be conducted cooperated with research institutes etc. for the method improvement of setting the assumption biggest external force.

6.2. Conversion to "River Basin Disaster Resilience and Sustainability by All "

6.2.1. Comprehensive and multi-layered measures reducing hazard, exposure and vulnerability around a whole basin

6.2.1.1. Flood Prevention to control hazard

- The improvement of area safety, the measure in which rainwater and running water, etc. are stored up at the whole basin, the measure which makes flooding goes down and the measure which controls inundation are necessary respectively as well as the effective combination of them.
- It is first necessary to further accelerate embankment improvement, channel dredge, levee displacement, dam and retarding basin construction by river administrators, the improvement of rainwater line and underground storage by sewage administrators etc.
- The economic loss is influential if flooding occurs in a large river. Low security is only secured in small or medium rivers. Such district distribution of water-related disaster risks should be considered, and the basin safety should be secured in a whole basin from upper to lower area, either main river channel or tributary.
- It is important to ask for the cooperation to the stakeholders who have not consult with. The platform where such stakeholders can cooperate for the basin should be set depending on the characteristics of the basin, such as for the implementation of preliminary discharge by water users ’ dams, rainwater storage penetration facilities around rapid populated rivers by local governments or private sectors, and land preservation for water holding and overflow function, to improve flood safety and water-related risk reduction in the basin.
- Further, the technological research and development about embankment reinforcement should be advanced for "persevering embankment" difficult to be burst even if flooding occurs. This can reduce the flood amount during flooding, at higher risks in particular.

(1) Expansion of the storage function of the flow

(Reinforcement of the flood control function of existing dams including water users' reservoirs)

-The "preliminary discharge" for which stored water is discharged beforehand for flood control at multi-purpose dams and water users' reservoirs, should expand radically through facilitating the cooperation by water users.

- For the cooperation, a flood control agreement including implementation policies of preliminary discharge every basin system has been signed among MLIT, all dam administrators, and stakeholders in major rivers, for preliminary discharge during the rainy season from 2020. This should be applied to the minor rivers in Japan.

-After placing the operating method of the preliminary discharge in operational regulations, the effect of the preliminary discharge to the target of flood control plan should be estimated and reflected to the update of the flood control plan.

- Flood control functional enhancement of existing dam should be advanced through the collaboration between river administrator and dam administrators based on water users where the certain effect is expected.

- For more effective preliminary discharge, the technology and system should be developed for rainfall forecast, dam inflow forecast, dam operation forecast, and flow forecast of downstream by long-term forecast improvement using AI and other new knowledge and methods.

(Improvement of the overflow function united with land use)

- To avoid destroying damage in a basin, the land use in the area with the overflow functions along the river should be restricted appropriately by the preservation and maintenance of the kasumitei, discontinued levee (*), as well as secondary levees.

- While river improvement works and the flood control safety improves, the kasumitei might be replaced by continuous levee or urbanization might occur behind existing kasumitei. Since possessing the function which weakens momentum of flood water by making them flow backward from its discontinued part as well as the function which returns the flooded water from the upper reach to the river, the kasumitei can contribute to the destroying damage reduction in the lower reach depending on the topography, by overflow and flow reduction in the lower reach.

- More frequent floods may exceed the facility capacity under climate

change. The function of the kasumitei should be evaluated, and the preservation and maintenance of the kasumitei should be promoted with the collaboration with local people, while development restriction and relocation should be promoted within the basin in cooperation with district designation (hazard danger zones) by related local governments.
- If necessary, secondary levees should be constructed and existing banks should be preserved for the levees, collaborated with various organizations for damage control of houses from expanded flooding.
*A kasumitei means discontinued levee mostly located in torrent river. There are some functions such as returning inundated water to the river from the burst of the levee in upper reach, and storing the part of the flood tentatively.

(2) The capture of earth, sand and driftwood etc. flown in quantities during flooding
(Intensive maintenance of and the erosion and sediment control related facilities to prevent sediment disasters and floods)
- Frequent torrential rainfall occurs recently all over the country. Slope failure and landslide might occur more frequently under climate change. The increase of river flow may raise the risk of sediment disasters and floods. Hazardous rivers for sediment disasters and floods should be identified by the risk validation methods. The prepared disaster risk reduction should be conducted intensified in such rivers by effective measures such as erosion and sediment control dams and sediment capture facilities.
-Effective maintenance of facilities should also be promoted to the occurrence of driftwood flows in quantities at the time of sediment disasters and floods.

(Maintenance of the erosion and sediment control facilities for more frequent movement of earth and sand)
- The change in rainfall under climate change may make the movement of earthy and sand more frequent. There is a possibility that consideration and reconsideration happen to the timing and the implementation frequency of maintenance of the erosion and sediment control dams, as well as the steady progress of the preliminary disaster prevention of the erosion and sediment control dams etc. Careful consideration is necessary.

(3) Improvement of the rainwater storage penetration function of the basin

(Reinforcement of the urban flood control measure)
- The cooperation of river and sewage improvements, and the improvement of large-scale rainwater storage reservation facilities in the underground should be advanced for the river-side urban area. The rainwater outflow restraint including the rainwater storage penetration facilities by local governments, individual and private partners should also be advanced.

(Substantial outflow restraint measure all around the country)
- Comprehensive flood prevention measures in a basin including the designation of preservation regulation pond and the permission of the rainwater infiltration obstruction to developers, etc. along with river and sewage improvements for the rapid urbanized river basin have been working for the flood safety toward the increase of river flow, based on the specific municipal river flood damage control act.
- At 2019 Typhoon Hagibis, the disaster prevention pond etc. developed by local government and private developers worked very well at Tsurumi River, one of the designated river basins under the specific municipal river flood damage control act. It is expected that these outflow restraint measures show the effective effect especially for flood prevention and damage reduction at small river basins.
- Local government measures should be facilitated for the measure which produces outflow inhibiting effect at the existing resident area and the measure more than outflow increase by development is suppressed, as well as the outflow restraint measure to make the rainwater storage penetration function convalescent and prevent the rainwater increase by new housing development or ground pavement. The measures for private sectors should be also facilitate for their cooperation.
- As the new development for housing and large-scale agriculture farms may increase river flow, in addition to the measure to make the rainwater storage penetration function convalescent, the outflow restraint measure for water-related disaster risk reduction should be facilitated including the utilization of existing ponds, rice paddies and the abandoning cultivation places expected, depending on the characteristics of the basin. The cooperation by various stakeholders should be facilitated for disaster risk reduction all over the country.

(4) Sustainable maintenance and increase of flow capacity and strategic operation and maintenance

(Promotion of strategic operation and maintenance)
-There is the fear of many aging river facilities which constructed after the high economic growth period in Japan. There are a number of facilities which require urgent cares with visible damages appeared lack of maintenance. The future climate change will devastate the disasters more severe and frequent. Preventing maintenance cycle and well prepared operation and maintenance will become essential for appropriate functioning facilities event during the disasters in order to secure people's lives and their social and economic activities.
- Strategic operation and maintenance will become more necessary, such as the application of efficient operation and maintenance structures at their upgrade timing or new river works.
- Renewable power generation using cultivated trees in river channel by private sectors, as biomass fuels, should be facilitated for reduction of operation and maintenance costs and climate change mitigation.

(Status monitoring and advance of operation and maintenance)
-The change in river channel shape caused by changes in disposition characteristic of the river flow and the change in progress of vegetation may bring a change to production in earth and sand and the movement environment in the long run though it is not clear so far.
-Therefore the advance of the monitoring technique in river channel should be promoted with efficient operation and maintenance continually. For example, the three-dimensional altitude point group data by the laser measurement should be utilized for capture of yearly quantitative change in vegetation, sediment accumulation and loss. The big data like three-dimensional point group data and image data should be utilized for check and grasp of channel and embankment by the AI technology-based automatic distinction. Such works should advance the operation and maintenance.

(Improvement of the flood prevention function with channel and embankment)
-Channel excavation and the work which improves the flowability by setting back of embankment have been put into effect to make the flow running safely up to now. There are also rivers where the flowability declines by sediment re-accumulation and re-vegetation, and the channel differentiates into two heights *.

*The decline of the channel bed and accumulation of sediment ground with vegetation differentiate into lower channel bed and higher ground. The ground where vegetation becomes widely lush, sometimes declines flowability, forms water opposition parts, and scours partly. These phenomena are not good for flood management and environmental preservation by declining water ponds.
- Channel improvement for more flow and embankment reinforcement put into effect deliberately based on each idea respectively, but they give influence each other. The level of flooding and control of flow by an embankment have an influence on the topography change in the channel. The topography changes in the ground part of channel have an influence on the permeation to the foundation ground in an embankment and the flow velocity change close to the embankment. The channel and embankment should function in an integrated manner. During large flooding, these interaction shows conspicuously, so channel and embankment should be treated appropriately overall.
-In particular, for the flooding beyond the target of improvement, the evaluation technique of the reductional effect of flood risk in a basin should be considered for the integration of channel and embankment, in addition to land use in the back and inundation control.
-It is investigated about the most suitable channel section to preserve and create the propagation environment and various landscape which a river possesses primarily, as well as the difficulty in sediment re-accumulation. The knowledge should try to reflect in channel planning.
-A great deal of sediment movement and accumulation occur during large-scale disasters, and the channel topography and the propagation environment change. Therefore the efforts should be toward monitoring for the grasp of dynamic river system by the basin scale including the environment, and it should reflect to the plan as needed.

(5) Restraint of the inundation amount
(Embankment reinforcement aiming at "persevering embankment")
- Out of 142 embankment burst points during the 2019 Typhoon Hagibis, more than 80 percent happened because of overtopping. The maximum record storm surge and high wave occurred during the 2018 Typhoon Jebi.
-The measure which lowers the water level is a fundamental principle of flood control. However even in the case that the external force exceeds and overtopping occurs beyond the ability of the facilities, the embankment with

"the persevering structure" should be considered as difficult to be burst and a little lengthily before the burst.
- For urgent short-term embankment reinforcement, the construction method which keeps performance in existing levees should apply for the proof to the overtopping water, the workability, the cost, the site, operation and maintenance, and the durability, etc. in the narrow part, the upper part of bridges, merging section and a bilge where immediate measures are difficult and the situation of the embankment back place are captured.
-There is a problem of non-explication by the present technology about the embankment with "the persevering structure". It is important to understand well that there is uncertainty in the proof strength to the overtopping before the application.
-When embankment reinforcement is introduced into a site, the consideration to a view suitable for the respective rivers and areas and public use, etc. is indispensable because the view shows the geography, geometry, climate, vegetation, natural environment and human activities and their relationships in time and space aspects and retrospective works comprehensively.
-Technological research and development for further reinforcement in an embankment with "the persevering structure", should be advanced, considering the operation and maintenance, landscape, the environment, the cost and the durability, etc. in mind. The research and technology development system about the structure of the embankment with government, academy and industry participation should be built for embankment structure difficult for burst even when exceeding its capacity, as well as the anti-permeation measures and earthquake-proof measures, etc. This requires the various material development and the method of construction as well as planning, evaluation methods and the influence to the environment by the change in burst.
-Technological research and development about the embankment which endure to the certain external force toward overtopping (for example, the overtopping depth and duration, etc.) should also be advanced.

(Reinforcement of local flood fighting system)
-The 2019 Typhoon Hagibis showed the problem about information sharing for flood fighting and insufficient capacity for a leak of the embankment and flood occurrence (bank burst) etc.
- Under aging and decrease of flood fighting capacity, the information

sharing structure should be built through maintaining the flood fighting function cooperated with private sectors, collaborating between flood fighting and river administration, and sharing the river observation data and deformation data.

(Sewage facilities waterproof.)
- During the 2019 Typhoon Hagibis, flood damages occurred at 17 sewage treatment plants. It took a certain duration for their recovery for a part of facilities.
- Flood proofing technology standards should be set and implemented deliberately toward more severe recent disasters, to secure the certain sewage function event during flooding and to minimize the social impact by the damage of sewage facilities.

6.2.1.2. The measure to reduce a damage target – exposure reduction
-The principle is to prevent flood hazard as much as possible, but it is also desirable to take the measure for damage minimization as well in case that flood may occur. Specifically, "regulation" for land use and way of living in water-related high risk areas, "leading" resident and urban function to the lower risk areas, "limiting the flooded area", the augmentation in land for housing in an area with flooding risk, and the device of building structure, these measures for flood damage reduction are effective.
-Land use and the building structure have been regulated by designating the high risk area as a hazard area, but these were performed with river works. There is still new development even in the area with high water-related hazard risk, and flood damage occurs there. Therefore it is important to collaborate with urban planning sectors, connecting water-related disaster risk reduction with "compact plus network", lead to the low risk zones and give devices of how to live. For local revitalization, the community should take the leading measures for urban planning resilient to water-related disasters according to each characteristic.
-It is necessary that all kinds' information about water-related hazard risk is being estimated appropriately and is being reflected in actual measures. Risk information about water-related disasters has been published mainly for smooth evacuation by residents to protect their lives, but these should be improved for urban planning. Water-related hazard risk evaluation should apply to the risk reduction around a whole basin.

- "Limiting flood hazard zones ” and controlling inundation, such as secondary levees and ring levees, have been put into effect in some areas. Flood control measures toward frequent and severed flood which exceeds the plan under climate change are important when considering the function of limiting hazard zones and controlling inundation.

(1) Land use and device of how to live in water-related hazard area
(Land use and device of how to live in water-related hazard area)
- It is important to considers disaster prevention in building community, lead the residents to the lower water-related hazard risk area, facilitate the measures for flood risk reduction by the measures of building structure in the water-related hazard area, and apply various risk information to actual urban planning, as well as prohibiting and making stricter on housing permission at flood assumption districts in urbanization control areas, especially with higher risk areas to people’s lives.
-Therefore, the information of water-related hazard risk should be upgraded for more cooperation between flood disaster management and urban planning sectors and urban planning based on community water-related hazard risk assessment. For higher risk areas, land use control and building structure control should be considered. The pilot studies and guidelines are necessary.
- Upon community’s consensus, the system and incentive policy should be announced for sustainable urban planning through transferring to safer areas by disaster group moving promotion and augmenting housing zones etc.
-For reduction in financial damage and prompt response, the cooperation with insurance and financial sectors should be strengthened.

(Hill community building in the low-lying areas below sea level (hill and building))
- Sustainable urban planning with prosperity, communication and more attraction, is necessary at low-lying zones below sea level in large cities formed densely and exposed to huge damages for extreme flooding. It is necessary to make an effort on structure improvement in the cities, and secure the evacuation living standards without long interruption of social and economic activities even in case of major flooding.
- Therefore the related sectors should collaboratively work for good urban atmosphere and resiliency toward water-related disasters to avoid

destroying damages through:
* Hill construction by land readjustment, park space and high standard embankments, etc.
* Construction and securement of the building with evacuation space
* Construction of routes between buildings enabling to move from buildings outside flooding, and from riverside buildings to embankment etc.
* Construction of piloti structured buildings and hills with cooperation of private sectors

(Construction of flood control facilities cooperated with consolidation of area base)
- The multiple water-related risk reduction should be cooperated with urban planning sectors through considering disaster risk reduction at compact city policy, guiding resident and urban function to lower risk area, and networking between the resident and urban function and center or pivots of areas, for flood prevention measures.
- The effective flood damage reduction should be implemented at the dense sewage building districts in the comprehensive rainwater management plans through promoting the utilization of individual aid programs, and accelerating new construction of facilities and appropriate function securement of old facilities as well as improving the operability of sluice gates etc.
- More rainwater outflow restraint should be facilitated along riverside urban areas through cooperating between river and sewage works, constructing major rainwater storages etc. in the underground spaces, and rainwater storages by local government, individuals and private sectors.

(2) Substantiality of area's water-related risk information for utilization to urban planning
(Substantiality of area's water-related risk information necessary for urban planning and improved way of living)
- Water-related risk information is useful not only for people's evacuation but also for urban planning and flood proofing of facilities. Multi-step flood hazard information should be developed and announced, such as inundation forecasting for medium high frequency external force (for example, 1/10* or 1/30 or 1/50 or 1/100) as well as maximum rainfall or target rainfall for flood planning, and future change in inundation hazard after the river improvement work.

* 1/10 means yearly probable exceeding probability. “1/10” shows that the probability that big rainfall beyond the subject of flooding assumption occurs is 10% every year.
- Water-related risk information should be devised for urban planning sectors. Risk communication among stakeholders should be advanced for their actual measures.

(Reduction of water-related risk information blank area)
-When not publishing the information though there is water-related risk potentially, this may cause misunderstanding that local resident thinks themselves safe. The human loss occurred at such information blank areas during the 2019 Typhoon Hagibis, so the information blank areas should be reduced.
-Therefore early designation of maximum assumption flood, storm surge and urban flood zones should be advanced. The hazard information like assumed areas and depth for predicted maximum scale floods should be announced in the areas outside designation of maximum assumption flood along medium and small scale rivers, coasts and sewage.
- Early designation of the landslide disaster hazards should be advanced for the awareness of the risk on landslide disaster. The hazard areas should be clearly shown in the site. New topographic data with higher resolution should be applied in the future basic survey (abstraction of a district) for the improvement of precise abstraction.

(2) Limitation of flooding area and flood control
(Improvement of secondary levee and natural levees for damage area downsizing for houses)
- The banking structure with the function of secondary levees by local government should be promoted under the cooperation with road construction and urban building with community and resident understanding to limit flooding area as much as possible even during flooding.
- Existing natural levees etc. achieving its function should be preserved by utilization of flood damage reduction district system based on flood fighting law to prevent further expansion of flooding in a flood area.
- The secondary levees may sometimes generate disadvantage in part of area. It is necessary to consider the mechanism to build community consensus smoothly.

6.2.1.3. Damage reduction, early response and recovery –vulnerability decrease -

- The damage to people’s live and social economic assets should be minimized even when floods and sediment disasters become inevitable. Public sectors should provide the information on water-related hazard risks appropriately. It is important that every stakeholder in the basin have information and attitude on water-related disasters, prepare beforehand, and take appropriate actions during the disasters.
- Various measures for more effective evacuation have been taken place, such as designating flood forecast and flood alert rivers for flood suffered rivers, mapping flood hazard areas with flow observation, and providing those information to the resident.
- Flood prevention mapping and evacuation practice in underground with high flood risk, and evacuation securement planning at welfare facilities for people who need special assistance should be mandated and facilitated through assistance to users based on the flood fighting law, cooperated among national, prefecture and municipal governments.
-The evacuation drill and disaster risk reduction education have been implemented all over the country for awareness raising and effective raising of evacuation. My timeline has been developed as an individual action plan for emergency.
- The 2019 Typhoon Hagibis shows the damage to people’s lives in the water-related risk information blanket areas as well as in the designated flood assumption areas because of escape delay. Further evacuation system should be advanced by reinforcing existing activities and widening evacuation.
- Flood prevention plan, flood prevention drill and self-defense organization establishment have been advanced for economic damage reduction according to the Flood Fighting Law in voluntary basis. Companies’ practices and experiences for flood control and prevention have been accumulated and announced.
- The 2019 Typhoon Hagibis showed extreme water-related disaster occurred and huge financial damages by damaged infrastructure including public transportation and facilities. Because of these damages, it is necessary to lead urban function to lower water-related disaster risk areas, to reinforce social infrastructure, and to accelerate the works on economic damage reduction.

- The flood assumption district maps apply to the community building (location lead), flood prevention in facilities, notice on land and building trade, and more usages. “Water-related disaster risk information” should be further upgraded depending to the purposes.
-National support including TEC-FORCE has worked for assistance to affected areas as measures of early response and recovery. Such support mechanism by national government should be reinforced and strengthened by the cooperation among all stakeholders in a whole river basin.

(1) Substantiality of water-related disaster risk information of land
(Reduction of water-related disaster risk information blank area)
- Flood assumption district for maximum flood, storm surge and urban flood should be designated early. The hazard information such as expected maximum flood for small or medium rivers, coast, and sewage, should also be at present so reduce the risk blank area.
- Early designation of sediment disaster hazard district and clear sign in the site should be advance for higher awareness of the risk about sediment disasters. Higher resolution topography date should newly apply for future basic survey (abstraction of the district) so the abstract precision should be improved.

(Substantiality of the water-related disaster risk information which leads to water-related disaster measures by various stakeholders)
- Flooding hazard information should be announced in multiple steps from maximum expected sized, medium-high frequent external force sized 81/10, 1/30, 1/50, 1/100 for example), after the completion of river improvement in the future.
- All stakeholders should share risk information for resilience for water-related disasters and sustainable society foundation. The information providing methods should be enriched so private sectors can use flood hazard information for BCP.
- These water-related hazard risk information leads to measures by various stakeholders. These should be enriched and updated depending on their needs. The research on evaluation method for the effects of information should be promoted by clear relationships between the costs and effects.

(Abstraction of high probability sites of visible sediment movement phenomena)

- Sediment moving phenomenon and loss of people's live occurred in the sites where sediment disaster hazard zones are not designated or designation standards do not apply based on sediment disaster prevention law when heavy rain special warning was issued.
-Thus sediment disaster occurred frequently where topography does not show the clear risk of sediment disasters, flooding, and visible landslides, or valley topography is not clear. Such high probability site with disaster risks should be specified though the hazards are not clear. The method on specifying such hazard should be promoted.

(Evaluation of frequent and visible sediment disasters clarifies every area)
- Surface failure induced by heavy rain in the west-south Japan inner geographic zones with widely distributed granite rocks, or simultaneous multiple landslides occurs with severe damages. Such major sediment disasters are different because of the feature of sediment moving phenomenon depending on the basic factors and triggers in each area.
- The rainfall characteristics change under climate change. It should be appropriately evaluated where and how sediment moving phenomena become more frequent. The evaluation method should be newly developed. The result of the evaluation should be shared by the whole society.

(2) Offer of water-related hazard risks using every opportunity
(Offer of water-related hazard risks in case of purchasing land)
- It becomes important to recognize water-related hazard risks in the site when purchasing land and building, and starting newly living there.
- Therefore the consideration which mandatory requires land and house dealers to explain flood damage risk on each property by placing one of the important issues to be explained according to the land and building transaction business law is advanced, so further cooperation should be taken place among related agencies.
- The explanation of flood risk information should be continued at the training opportunities for flood management sectors, disaster management sectors and real estate groups so land and house dealers can explain flood damage risk more precisely.
- The information providing tools for information users should be advanced through identifying water-related disaster risk at each house and identifying flood depth in the detailed map.

(3) Reinforcement of the evacuation system

(The information for evacuation and damage reducing actions by each stakeholder)

-The information on water-related disaster risk for each hazard area under disasters, and the information of river water and inundation levels for appropriate actions should be upgraded and arranged.

- Evacuation in large area with cooperation by many stakeholders may be necessary in case of large-scale and huge water-related disasters occurs. The longer lead-time forecast, comprehensive basin-wide forecast of flooding in main river channel, tributary, and urban area for torrential complex rainfall, storm surge forecast in coastal areas, should be upgraded with more accuracy by technology and science development.

-It is necessary to promote simplification and simplification of the disaster prevention information by automation of system for certain and prompt flood forecast and announcement as well as by use of arranged disaster information and cautious levels.

-Landslide disaster cautious information should work for municipality evacuation alert. The accuracy of the information should be promoted.

- Monitoring system should be enhanced through river monitoring camera installment and river gauge. Technical development with private sectors for gauge, AI camera and SNS information applying to levee overtopping and burst, real-time inundation mapping by satellite should be promoted.

(The information sharing and providing for evacuation and damage reduction actions)

-Mechanism to share real-time information on hazard by river administrators, flood fighting administrators and private sectors quickly among stakeholders in a basin should be built in order to put appropriate flood control activity and evacuation support into effect in the area.

-The administrative agencies which send information and the private enterprises such as the mass media and net media which distribute the information, etc. should cooperate and make the mechanism to deliver the imminent information to the resident for their actions timely as well as to improve terminology and how to tell for each evacuation actions and damage reduction actions.

- The delivery method on supplemented cautious information for sediment disaster should be devised as well as understandable way of announcement on hazard degree and change to the resident.

- The relationships between the information sent from the public and actual situation, and between the situation and people’s appropriate actions should be announced to the public in normal time.

(Securement of evacuation place)
- Based on the clear the allocation of responsibility with administrators in private facilities, utilization for the evacuation space should be promoted when it is sometimes difficult to reserve enough evacuation space only by designation in public facilities. The securement of hills or pedestrian deck are considered for emergency evacuation space to be reserved under the community voluntary idea just in case that the resident fails to escape.
-Though polity cooperates with people, it'll be an important point of view to advance securement of evacuation by cooperation between private and public sectors, including building evacuation facilities by the private and constructing hills by the public.
- Various stakeholders should collaborate for "three dense measures" at evacuation places and "dispersion evacuation" under COVID-19 pandemic. The three dense measures include "improvement of the preservation of health sanitary society of the shelter" such as other infection, food poisoning and heat exhaustion measure. The dispersion evacuation includes evacuation at home, acquaintance home evacuation, vehicle evacuation and other "various means of evacuation (place)". These evacuation should be generalized as future standard evacuation.
- Even after the COVID-19 Pandemic is over, it is important for various stakeholders to cooperate, share the experience of this pandemic and make an effort toward the improvement of evacuation place.

(Evacuation in large area)
- It is necessary to consider the implementation of evacuation in large area in case that flooding occurs at large river in large area, sometimes a whole municipal area. Evacuation in large area takes longer time and more arrangement among many stakeholders. It is necessary to arrange the timeline in advance which disaster response actions and each responsibility are decided in case of disaster, to coordinate it by the large-scale flood prevention conference, and share the information among stakeholders.
-Concretely, it is necessary to consider the analysis on the target of evacuation in large area, secure the evacuation place, and plan the means and route of evacuation etc. in advance. For larger disaster response

operation, long-term forecast of river flow under development should be utilized. The cooperation mechanism among national government, local governments and private sectors, as well as smooth coordination scheme should be considered.
- The planned suspension of the public transport has widely applied recently. This gives an impact on community activity and evacuation system. The information should be shared among stakeholders by using the large-scale flood prevention conference in order to keep smooth evacuation alert system under the planned suspension of the public transport.

(Preparatory efforts to facilitate the resident's independent evacuation behavior)
- Preparatory efforts for understanding water-related hazard risks have been put into effect up to now, such as evacuation drills and workshops with using a hazard map, education for disaster risk reduction, and inundation mapping in field.
- For each resident’s individual appropriate action during the disasters not only by public assistance by the government, but also by mutual assistance and self-help, the education for disaster risk reduction should be promoted to provide disaster risk reduction knowledge to children, households and community. Such efforts should be expanded to all over the country through good practices at large flood disaster prevention conferences and website.

(Evacuation planning by individuals and community for the residents individual independent actions)
- It is important for each resident to choose timely evacuation action among the evacuation place, vertical evacuation within the house, and evacuation to the relatives or acquaintance house, as well as district disaster prevention plan, for practical preparatory evacuation reinforcement. Therefore, preparing my timeline which describes each evacuation action in advance for the appropriate evacuation depending on each situation and water-related disaster risk information, my disaster risk reduction map which describes the route to evacuation place and hazard areas in the map, and disaster risk reduction applications should be very effective. The support to the actions by municipals should be promoted for district communication for these activities.

(4) Reduction of economic damage

(Promotion of community flood prevention and BCP development)
- It is necessary for private sectors to understand the water-related hazard risk and prepare for it based on the facilities' priority, for economic damage minimization. It is also important to consider the damage by an operation stop as well as material loss by flooding, etc. and prepare for them appropriately in particular.
-Related public institutes should support owners of factories and private buildings for their effective and efficient flood prevention measures such as establishing water sealing plates, constructing flood prevention walls, augmenting lands, equipping flood-proof electricity facilities and preventing floods by flood control goods and materials.
-The disfunction of public facilities like city halls, hospitals requiring electricity for life-keeping patients and social infrastructure like water supply and sewage created severe impacts because of water-related hazards. Preparatory actions and response actions such as flood proof wall equipment and temporally relocation to upstairs should be arranged and implemented step by step, by scoping the maximum scale flooding and continuing operation and responding early under flooding.
-Thus all stakeholders should simulate the flooding and prepare, and conduct drills depending on their activities. Flood BCP should be promoted for smooth actions under the disasters and early response and recovery.
-Therefore, effective flood prevention measures using water-related hazard information should be accelerated by sharing information in community and using the framework of large flood prevention conference.

(Securement of transportation network by cooperation among railroad, river and road administrators)
-Washing away in railroad bridges and in roads by frequent and severe torrential rainfalls, and cutting into pieces of railroad and road network by sediment disasters occur frequently.
-Therefore railroad bridge prevention by railroad enterprises, road protection by road administrators should be implemented effectively by providing information by river administrator, cooperating among stakeholders, and collaborating measures among railroad companies, road administrators, river administrators and erosion and sediment control sectors etc.

(Dissemination of information on flood damage risk to finance and insurance

industry, various measures for flood avoidance and for damage reduction)
-There are financial and insurance tools by which the housing loan interest rates and the insurance fees are discounted when individuals and enterprises take preventive measures appropriately for water-related hazard risk reduction. It is expected that affected people can achieve early response and recovery by using such tools.
-These tools can show the effect on facilitating individuals and companies for their flood prevention measures, which brings the merit to users as well as financial and insurance institutes. Water-related hazard risk information and preventive activities should be informed properly for financial tools development all over the country.

(5) Reinforcement for early response and recovery cooperated with stakeholders
(Wide area damage information capture)
-The technical development for prompt wide area damage capture should be promoted for effective drainage activities for early response by using artificial satellite, sensor and AI, etc.

(The measure for early drainage of flood water)
- Well advanced drainage planning for damage reduction and early response and recovery in case of flooding, drainage facility equipment for early drainage of flooding water, and flood proofing on important drainage facilities for their continued operation should be promoted. Securement in an access way and securement of alternative power supply and storage fuel, etc. for fuel filling should be also promoted.
- As well as drainage by drainage pump car, flood fighting, river and sewage administrators should collaborate for flooding drainage by using existing drainage facilities and facilitate early flood drainage in a whole basin.

(Further reinforcement of TEC - FORCE activity)
- Under large scale disaster, personnel and materials have been dispatched from MLIT reginal development bureau etc. to affected local government as the TEC-FORCE activity. The further reinforcement of TEC-FORCE activity is indispensable. The reinforcement of MLIT reginal development bureau, capacity building and training, equipment of ICT and the others and storage and installment of materials and goods should be promoted.
- New mechanism for TEC-FORCE activity on behalf of affected local

government should be established.
- Further support and preparation for local government should be prepared in advance for large and severe water-related disasters.

(TEC-FORCE promotion cooperation between the public and the private)
-Immediate response for securement of necessary personnel and materials in each area is also indispensable for the support to affected local government in case of severe water-related disaster occurs in wide area. The partnerships with local construction companies and local partners, as a "partner" of TEC-FORCE should be arranged through the MoU for disaster response.

(Expansion of support to affected local government by national government for disaster response)
-It is important to utilize the country's high technology and mechanical effort, grasp the damage promptly and support response in case of large and simultaneous water-related disaster, considering the decline of capacity and technology of local government. The country's institutional substantiality is only limited to country administrative rivers and prefecture administrative rivers. The collaborative disaster response cannot apply with the neighboring municipal administrative rivers, so early response might become difficult.
- The country's institutional substantiality should be applied widely for local rivers so the support for river damage survey and river dredging should be further promoted.

6.2.2. Acceleration of preparation for disasters
- The disasters take people's lives, the assets individuals, enterprises and local community have built up, fortune and the outcome of development right away, as well as the opportunity of local sustainable development if it takes a lot of time for response and recovery, which becomes impoverished big.
- It is the recent situation that large water-related disaster occurs almost every year. The disaster prevention measures to avoid another disaster should take place in the affected area. Preparing for disasters in advance (" preparation for disasters` hereafter), not responding to disasters tentatively, is indispensable to protect people's lives and assets under more severe meteorological situation by climate change and more difficult

disaster administrative situation by aging society in the local area.
- For example, the improvement work is still on the way even in the major rivers, such as Tone and Ara rivers in Tokyo metropolitan area. Fundamental disaster prevention facilities, such as Arakawa regulation pond and Yamba dam, showed the big effects at the 2019 Typhoon Hagibis, but it was a critical situation. Almost all rivers in the country cannot correspond to record-high flood after the WWII, and it takes more time for the measures.
- Hypothetically if the ongoing measures (the measures in river improvement plans) all completed in the rivers damaged by the 2019 Typhoon Hagibis, the social and economic damages should have reduced significantly in the most part of rivers.
- Based on this experience, it is necessary that the preparation for disasters should be further accelerated with enough budgets in the country.
- The comprehensive measures combining structural and nonstructural should be promoted by building back better beyond simple recovery, building resilient society and updating the land use at affected areas even if the preparation for disasters has not taken place and a disaster occurs.
- There is fear of increasing water-related disaster risks through more severe and frequent torrential rainfall and higher tide by future climate change. The planned safety level cannot be secured only by constructing the flood prevention facilities based on the current plan. The improvement should be updated by planning and considering climate change impacts, and further accelerated.

(1) Acceleration of the preparation for disasters by the "River Basin Disaster Resilience and Sustainability by All" projects
- The improvement measures for flood safety have been put into effects, such as embankment, river channel excavation, dam, spillway, and retarding basin. The 2019 Typhoon Hagibis, which exceeded the record rainfall in some areas, showed the effect of such improvement measures for preparation of disasters through reducing and preventing the flood damage.
- For the acceleration of the preparation of disasters combining such effective structural and non-structural measures, it is effective share the immediate targets among national government, local governments, private sectors and the resident and cooperate for the implementation.
- For example, the "River Basin Disaster Resilience and Sustainability by All" measures have been intensively put under the "urgent flood control measure project" in seven major river basin systems (Abukuma River,

Yoshida River in Naruse River basin system, Kuji, Naka, Iruma Rivers in Ara River basin system, Tama River and Shinano River including Chikuma River) affected in the 2019 Typhoon Hagibis, collaborating by various stakeholders as well as national government, prefectures and municipal governments in the basin.

- Specifically, the river improvement includes river channel excavation, retarding basin works, embankment works and reinforcement and other intensive response as well as responding affected embankment in the next 5-10 years. The measures in the basin includes the outflow restraint of rainwater through rainwater storage facilities and flood control utilization in reservoirs, and the land use and way of housing revision through house and housing land augmentation and land use restriction in the flooding zones.
- Similar measures should be advanced in the other basins outside the 7 major river basin system, considering the expected floods, sediment disasters and tsunami and storm surge hazards. Specifically, the clear explanation of the contents and effects of structural and non-structural measures with the appropriate targets, as well as mid- and long-term whole pictures of measures, should be shared among local resident and private sectors for their understanding and conscious improvement, and should be implemented and accelerated deliberately.
- Early stage manifestation of the effect by the drastic utilization in existence facilities and the device of improvement procedure, digitalization and smartization of disaster prevention technology such as ICT technology, the land use and building regulation in the hazard areas by water-related disaster risks, should be considered collaboratively.

(2) Start of the "River Basin Disaster Resilience and Sustainability by All" measures considering the future climate change

- The above measures are not enough when considering the impact of future climate change. The river improvement plan for current measures should be reconsidered on its river improvement targets, considering the rainfall increase, sea level rise and increase of tide departure under climate change. The flood prevention and reduction measures should be implemented deliberately with the cooperation among various stakeholders in the basin under the concept of the "River Basin Disaster Resilience and Sustainability by All".

6.2.3. Social mechanism mainstreaming disaster risk prevention and

reduction - Interdisciplinary approach for "River Basin Disaster Resilience and Sustainability by All " around a whole basin-

(1) Daily life considering disaster prevention and reduction

- National government, local governments, private sectors and individual resident should consider disaster prevention and reduction in their daily lives for the implementation of the " River Basin Disaster Resilience and Sustainability by All" with cooperation by all stakeholders. It is important to include the aspect of disaster prevention and reduction into their daily knowledge and actions.
- Therefore, the whole society's preparation for disasters (disaster prevention and reduction capacity) should be advanced through their daily life considering disaster prevention and reduction, and through reorganization of administrative processes, economic activities and various works considering the aspects of disaster prevention and reduction.
- It is important to make the individual more prepared by more disaster prevention education at schools and more participation in disaster prevention activities, so the resident can collect necessary information advancely and take appropriate preventive actions by themselves.
- A river sometimes causes a large-scale flood and is the existence which threatens human survival and economic activity, but it normally gives rich natural environment, good atmosphere and community relaxation. The community's culture and atmosphere deeply connect with rivers, which mostly form its geography through their flooding. Therefore, it is necessary to effectively cooperate the education between disaster risk reduction and the environment, make more resident understand deeply on diversified aspects of the river, and enhance the people's consciousness on "River Basin Disaster Resilience and Sustainability by All".
- It is also important that all stakeholders in the basin should be informed clearly on the meaning and concept of "River Basin Disaster Resilience and Sustainability by All" for their collaboration works. Specifically, this might include the efforts on clarification of each action at each place, target of climate change action and new growth, and the change of people's mindset.

(2) Visualization of the effect of the various stakeholders' cooperation in the basin

- For the measures by various stakeholders in the basin, it is desirable that each stakeholder has common understanding on the water-related hazard risks and their reduction target as well as each action and its effect.

- In most of the cases, the effect of each measures varies and spreads widely in a multiple way, but its degree is not always elucidated. For example, the effect of water-related disaster prevention and reduction is not only in the reduction on the loss of people's lives and assets, but also in the support of community's function and economy. However, such indirect effects have not been elucidated enough. It is also difficult to estimate the effect of various outflow restraint measures in the basin uniformly as the size and location of such measures vary and their effects change depending on the actual rainfall and basin characteristics. The effect of various non-structural measures has not be estimated numerically one by one.
- It is necessary to advance quantitative qualitative evaluation about the effect of the measure by each stakeholder, so various stakeholders can consider the effective operation and additional measures with enhanced each motivation toward water-related hazards around the whole basin.

(3) Risk management in the basin considering the flood occurrence exceeding the capacity of facilities
- The target of river improvement has been emphasized on how to discharge the certain flooded water safely and secure the local safety. Once the flood occurs exceeding this scale, the damage should occur all over the basin. Even in such a case, it is necessary to consider how the cooperation among stakeholders around the basin can avoid the loss of people's lives, minimize the damages at the center of economic and social activities, and avoid severe water-related disaster damages which require long period for response.
- To consider an effective measure, it is necessary that the rainfall may occur in the pattern different from the plan, the design safety of facilities might not mean their disfunction of such conditions, the smooth evacuation by the resident cannot always be expected, all measures have actual uncertainty on their effects, and the multiplied effects may be expected. Therefore, it is necessary to consider the risk estimation methods which cover the range of effects with enough actual conditions.
- In the near future, the estimation of local risk considering various flooding scales should be promoted for comprehensive management methods and water-related hazard risk sharing in the basin comprehensively by operation of various facilities under exceeding floods, enhanced retarding capacity cooperated with land use, minimization of inundation, zoning of lower water-related hazard risks, limited inundation area by secondary levee

improvement and natural levee preservation, and the reduction of hazard exposure by inundation control.

(4) The promotion of the "River Basin Disaster Resilience and Sustainability by All" by interdisciplinary cooperation among different fields and different sectors

- It is necessary that current situation and risk estimation should be advanced and shared with society for efficient and effective implementation of the "River Basin Disaster Resilience and Sustainability by All" measures. Therefore, it is necessary to build the scheme for interdisciplinary cooperation among different academic societies, business, fields and sectors for new technological development and application.
- It is necessary to support evacuation and flood proofing measures by accumulating water-related disaster data, integrating and consolidating water-related disaster data with social economic activity data, and sharing them among all stakeholders in the basin. It is important that technology and data on water-related disasters should be shared and accumulated in the basin at all disaster management process from preparedness, disaster occurrence, response and recovery, and the scheme for their technological and sustainable development should be constructed.
- Risk evaluation each stakeholder requires is necessary for many stakeholders ' participation to "River Basin Disaster Resilience and Sustainability by All" and appropriate measures for disaster risk reduction and prevention. For these various needs, the scheme for risk communication is necessary upon technological development and various application of technology. It is necessary that public administration should share their data with required accuracy and reliability, and systems for private sector utilization and their capacity building should be promoted.

(Promotion of new technical development)

- There is still un-explicating on the impact of climate change. It is necessary that the monitoring and the research for the estimation on the future forecast of climate change and the risk change of society should be promoted for community's clear understanding.

(New technology application)

-The research and development in the open innovation type (the different field cooperation type) should be implemented for the development and

prompt application in field by using private sectors' innovative and existing technology.

(Urban water-related disaster damage minimization by the smart city promotion)
- The individual field activity at traffic, sightseeing, disaster prevention, health & medical, energy etc. has been accelerated to the smart city activity in trans-disciplinary and optimization of whole city and district, using new technology and public & private data.
- Prompt damage survey and sharing, and efficient operation and maintenance of facilities should be promoted in the field of disaster prevention, using the community information.

(The implementation method on risk communication and public awareness which contemplated a new lifestyle under the post COVID-19)
- The measures for the COVID-19 pandemic have facilitated the on-line business rapidly and the society movement toward the new lifestyle. Under this circumstance, the information sharing among stakeholders by on-line conference, the conventional promotion by community gathering like workshops, and new promotion using VR and AR etc. should be promoted aggressively.

(5) Promotion of "River Basin Disaster Resilience and Sustainability by All" using the regulating methods and the inductive techniques, etc.
- The water-related disaster risk is maldistributed spatially. The land with high risk is evaluated low price in the market, so it can be easily transacted for housing and other development demand. The understanding on the risk information is important at decision on development, housing purchase and residence, but the developer, buyer and resident may accept the risk without enough understanding, and consequently suffer.
- Therefore, it shows the social structural vulnerability that the land with spatially high risk needs higher resident's risk burden. The political methods like land use regulation or leading are necessary considering the spatial characteristics on water-related disasters, the recognized characteristics on disaster risk and the market characteristics on land.
- These political methods include the regulation for preventive measures for people's live protection and control measures for specific stakeholders, and leading for actions reducing economic damages and measures difficult to

control specific stakeholders in wide areas. It is important to combine them according to the situation in the area.
- For the regulation measures to control the increase of outflow to the river by development, it is natural that an actor bears the cost to prevent the risk when the actor can be specified as its action increases the risk. On the other hand, when community safety in wide area improves by an actor ' s cooperation, such as more flood control effect by water utility dams and storage facility construction reducing outflow to the river more than the development action of reconstructed buildings, the public sectors should bear the cost for such development depending on the effect.
- Thus, for water-related disaster risk reduction with the cooperation among all stakeholders in the whole basin, it is necessary to consider how the necessary cost should be allocated in the basin.
- It is indicated below as examples about the considered regulation and leading methods for all stakeholders in a basin to cooperate and promote "River Basin Disaster Resilience and Sustainability by All ".

(Regulation)
-Prohibition of the act which makes the present state be aggravated, and leads to trouble to others
Example: Obligation of establishing the storage penetration facilities to prevent increase of outflow to a river, by new housing land development and pavement in the ground, etc.
-Prohibition of the act with high risk
Example: Restriction of land use and construction in the area where water-related disaster risk is high in particular

(Leading)
-Land-use lead to the area where water-related disaster risk is lower
Example: Urban function and resident lead to the area where water-related disaster risk is lower by the compact city policy

(Economic incentive)
-Support of the cost necessary to cooperation to the preventive measure for flooding
Example: Flood control functional enhancement of water utilization reservoir and support to flood control capacity securement in a pond, etc.
-Support to the device cost of how to live to avoid and reduce water-related

disaster risk
Example: Move, augmentation in the ground for housing and support to the additional cost of the piloti structure etc.
-The tax measure to preserve the function of the existing facilities
Example: The reduction and exemption of the fixed asset tax for flood damage reduction areas, or for the case when putting flood prevention measure into effect
-Flood damage insurance and financial product according to ups and downs of the water-related disaster risk
Example: Setting of the flood damage insurance rate according to ups and downs of the water-related disaster risk in land, the insurance rate and finance charge privilege when putting flood prevention measure into effect, etc.

(Incentive of information)
The visualization of implementation situation and effect for measures in the area
Example: Visualization maps of the measure for the implementation rates of storage facilities
-Commendation system and introduction for the measures with high contribution and innovative contribution
Example: Commendation system for contributors on flood fighting, best example books (introduction of private sectors contributing to disaster prevention and reduction, etc.)

(6) Establishment of the platform where the "River Basin Disaster Resilience and Sustainability by All" measures are arranged among stakeholders in a basin
- For the deliberate implementation on the River Basin Disaster Resilience and Sustainability by All, it is necessary to share the information on the evacuation and flood fighting activities coordinated by stakeholders in the large-scale flood prevention conference etc. as well as river works and dam construction in the river improvement plan, and coordinate the stakeholders' basin activities for water-related disaster reduction and prevention such as land use and rainwater storage penetration facilities.
- Therefore, the platform where sharing water-related disaster risk information among stakeholders in the basin and coordinating the "River Basin Disaster Resilience and Sustainability by All" measures should be

established.
-It is necessary to study appropriate evaluation methods on the applied area and effect for each stakeholder's measures, in order to coordinate various measures for risk reduction in the whole basin. Each stakeholder has to pile up the improvement based on monitoring as well as evaluating the effort, as well as share the information at the platform for the coordination.

(7) Utilization of green infrastructure using the various functions of natural environment
- The "River Basin Disaster Resilience and Sustainability by All" should be promoted through utilizing various functions with natural environment, and introducing the concept of green infrastructure which advance the sustainable and attractive land, urban and community planning.
- The-basin water holding, the preservation of the overflow function, the revival and the utilization of the rice paddy and farmland including the abandoned cultivation place are sometimes effective as flood control measures we well as the preservation and creation of natural habitat with the environment.
- The "River Basin Disaster Resilience and Sustainability by All" should contribute to the sustainable community building cooperated with flood prevention appropriately, considering multiple factors of the environment, through preserving and creating natural environment considering ecological network, revitalizing local economy collaborated with river town planning, and creating various activities.
- In the phase of disaster response and recovery, it is desirable to consider the climate change impact, ecological network, and the multiple function of the place for an ecosystem network, be also conscious of a show of the multilateral function a place during the water-related disaster prevention works.

Reference (in Japanese)
1)
https://www.mlit.go.jp/river/shinngikai_blog/chisui_kentoukai/pdf/04_teigenhonbun.pdf
2)
https://www.mlit.go.jp/river/shishin_guideline/pdf/shinsuisoutei_honnbun_1507.pdf

3) https://www.mlit.go.jp/common/001157882.pdf

7. The policy which should be put into effect promptly

Among the concrete water-related disaster countermeasures shown in Chapter 6, those which should be put into effect promptly are indicated below.

(Change on plans and design standards considering future climate change)

-Reconsideration of river basic management policy and the target of river improvement plan

- Target flow setting for unregulated hydrograph by using forecast calculation of rainfall considering the impact of climate change

* The calculation water level of the mouth of a river for river channel planning considering future sea level and the rise of tide

-Promotion of med- and long-term planning of urban flood prevention by sewage considering climate change

* Sewage plan rainfall setting by using rainfall forecast considering climate change

-Reconsideration of a coastal protection basic policy and a coastal protection master plan

* The tide level setting for coastal protection by using forecasted tide level considering climate change

- Design standard change for securement of the function of the facilities and safety

* The designing by reconsidering river erosion and sediment control technical standards and the technological standards on coastal protection facilities, etc., and considering the impact of climate change as of passed duration of facilities

(Acceleration of prepared disaster risk reduction)

- Acceleration of prepared disaster risk reduction so far for early manifestation on the implementation effect

-The "River Basin Disaster Resilience and Sustainability by All" measures which should be put into effect early are indicated for acceleration of prepared disaster risk reduction

* For example, the acceleration of prepared disaster risk reduction combining structural and non-structural measures, by showing the picture of the measure which should be conducted in the whole basin immediately in major river basins in the whole country

(Further embankment reinforcement)

-Embankment reinforcement aiming at "persevering embankment" which is difficult to be burst even when flood and wave overtopping
* Urgent and immediate embankment reinforcement in the narrow part, bridge upstream, merging section and kink section where it takes some periods to ease rising water level
* Urgent reinforcement of coastal dyke based on importance in the back place and the geographical topographical conditions, etc.

(Waterproofing of sewage facilities)
-Deliberate measures based on technological standards setting for waterproofing on sewage facilities

(Various stakeholder participation from private sectors etc.)
-Reinforcement of the flood control function of existing dams including water supply reservoir
* A flood control agreement is concluded for preliminary discharge written in the dam operation rules as well as the clarification of system location of the water supplier dams and the improvement of facilities when necessary on dams where certain effect is expected on the flood control function improvement
* Flood control planning considering the effect of preliminary discharge
* Substantiality of outflow restraint measures and further application in the country
* Establishment of system and support for further rainwater discharge restriction including rainwater storage penetration facilities by local government, the individuals and private sectors and their improvement
* Clarification of systematic placing on the outflow restraint measure as well as outflow restraint measures which shows the water-related disaster reduction and prevention effects according to the basin characteristics in river basins all over the country including the local areas.
* Utilization of green infrastructure using the various functions of the natural environment

(More risk information on land)
-Blank area of water-related disaster risk information to be canceled
* Prompt designation of expected flood area and early announcement of water-related disaster risk on middle and small rivers outside the risk information, coastal area and sewage

* Improvement of the abstraction precision of the district for landslide disaster hazards
- Utilization of water-related disaster risk information like expected inundation zones at urban planning
* Promotion of urban planning, housing and flood proofing by mapping and announcing of multiple flood hazard information such as expected inundation of external force scale with middle and high frequency, and cooperating with stakeholders

(Community building and device of how to live)
-Reinforcement of development restraint in the district where water-related disaster risk is high and promotion of leading policy to the area where the risk is lower
* Information sharing of water-related disaster risk cooperated with stakeholders and consideration of land use planning and flood prevention measures considering water-related disaster risk
- Dissemination of information for the device of how to live based on water-related disaster risk
* The substantiality of information dissemination and tools so that land and house dealer can explain right water-related disaster risk, organize workshops and identify the data of inundation depth by accurate map

(Reinforcement of evacuation system)
- The mechanism to support the independent evacuation ability of the resident
* Making my timeline which describes the disaster management actions by each resident in advance and promoting my disaster risk reduction mapping for evacuation route during the disaster and hazard locations in the map
-Substantiality of disaster prevention information and device
* The substantiality of information to suggest each evacuation behavior and damage reduction actions, improvement of plain terminology and improvement of how to disseminate information
-Securement of safe evacuation
* Building of the system and the mechanism to utilize private buildings for evacuation
* Considering appropriate evacuation cooperated with related agencies which secure evacuation places and infection measures in the evacuation places

(Reinforcement of TEC - FORCE)
- Reinforcement and substantiality of national assistance system
* Reinforcement of national support to affected local government by system reinforcement of MLIT regional development bureaus and capacity building through training and education etc.
* Establishment of the mechanism where TEC - FORCE staffs take actions on behalf of affected local government
* Installment and stock of drone, ICT equipment and other materials and equipment
-Promotion of the TEC-FORCE activities with cooperation of public and private sectors
* The consideration to secure the system performance of the disaster agreement

(Support to disaster emergency measure for affected local government)
-Expansion of support of disaster emergency measures for affected local government by a country
* Expansion of the support rivers where the national government implements on behalf of affected local governments, the damage survey at the rivers and river dredging supports

(Substantiality of observation and new development)
-Substantiality of observation system and advance of forecast technology
* Reinforcement of the observation on rainfall, water level and flow, and monitoring system by CCTV
* Substantiality of dam operation advance and evacuation system by advancing forecast on rainfall and flow etc.

8. Conclusion

Before the River Law was established at Meiji Period, every resident at community joined the water-related disaster risk reduction collaboratively through ordinary embankment improvement, ring dikes or secondary dikes for community protection, flood proofing, temporary evacuation for community, and flood fighting during flooding.

The measures to improve the safety level have been mainly the improvement of river and sewage facilities by the administrators while the developers in the basin have played some roles on establishing storage facilities for discharge restriction in the basin where the change of rainfall and its discharge characteristics has exceeded the flood prevention facilities because of rapid urbanization after the WWII.

However, the torrential rainfalls all over the country, influenced certainly by yearly increased impact of climate change, will further mightier from now on. The research on the change of external force because of climate change, its impact on water-related risk and measures, the effective measure in field, should be promoted and further updated based on the various accumulated observation data and developed research and development in the future. There will be no room around a question that the necessity on effective flood prevention facilities increases. Further, more device and community participation will be desired in order to reduce the damages of more frequent torrential rainfalls even a little.

A basin can be a family. It is desirable that all stakeholders in the basin can cooperate than before, and think what they can do for the total damage reduction, under the recognition of each resident membership.

On the other hand, recently, the planned suspension of railroad service and the other actions preparing for the risk have become recognized widely for promptly responding to the normal. Such movements should be connected with each action by upgrading the social recognition to water-related disaster risk and its dissemination, and further raising the social understanding on water-related disaster risk.

During the argument for this council report, COVID-19 infection expanded coincidently. Under the emergency declaration all over the country, various actions have been taken place for the reduction of contact opportunity. When a disaster occurs, evacuation is essential to avoid the hazards, as well as to advance the actions for infectious risk reduction as possible. While new lifestyle was proposed and remote-working rapidly spread, people’s values of thinking changed dramatically and the society including their way of work and living may also change. Both COVID-19

infection and large-scale water-related disaster occur in very low frequency, but load quite heavily on the social system comparing to the normal once they occur. The concept on the management for both events are similar, and the whole society should well consider preparation in advance and measures for early response and recovery in order to minimize the damage by simulating the worst case scenario in this country vulnerable to natural disaster.

The efforts toward more severe water-related disaster considering climate change should be a long battle. During the efforts, there might be unexpected various change such as social change, people's change on their value conception and technical innovation. However, there is no room for a doubt that sustainable and inclusive response are always necessary as well as continued investment for disaster risk reduction and prevention. Rather, these new challenges should be considered as the opportunity for sustainable economic growth and people's abundance rise during the matured steady growth period, for more privileged and rich society in the world stepping forward toward future generation.

The policy and technology in this council report should become reality as early as possible, under the strong belief for water-related disaster prevention, and hopefully upgraded to better policy and technology under continued validation.

National Land Development Council, River subcommittee
Water-related disaster risk reduction considering climate change Working Group

Member Lists

Akita Noriko, Chiba University
Asahi Chisato, Tokyo Metropolitan University
Ikeuchi Koji, University of Tokyo
Onishi Kazufumi, Mayor of Kumamoto
Oohashi Hiroshi, University of Tokyo
Oki Taikan, University of Tokyo
Kato Takaaiki, University of Tokyo
Koike Toshio, ICHARM (Chair)
Shimizu Yoshihiko, Gunma University
Shuin Yasuhiro, Utsunomiya University
Suzuki Eikei, Governor of Mie Prefecture
Takahashi Koichi, Sompo
Tajima Yoshimitsu, University of Tokyo
Tanaka Risa, The Graduate School of Project Design
Nakakita Eiichi, Kyoto University
Noguchi Kikumi, Hitotsubashi University
Fujisawa Kumi, SophiaBank
Furumai Hiroaki, University of Tokyo
Motomura Yukiko, Mainichi Newspaper
Yamori Katsuya, Kyoto University

WG sessions

- 18 October 2019 MLIT asked for the Council
- 24 October 2019 Council asked for the River subcommittee
- 22 November 2019 WG1
- 17 January 2020 WG2
- 17 March 2020 WG3
- 26 May 2020 WG4
- 26 June 2020 WG5