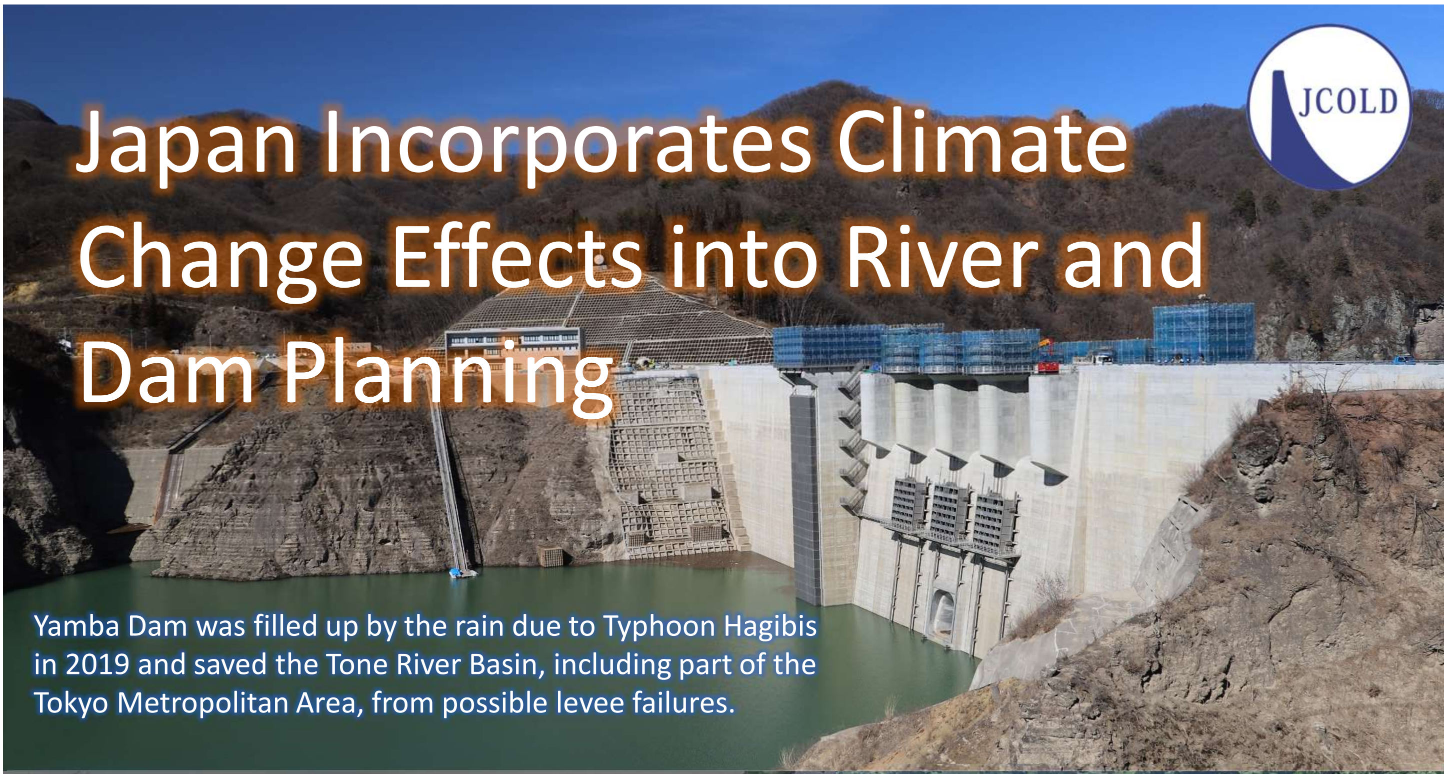
Japan Incorporates Climate Change Effects into River and Dam Planning

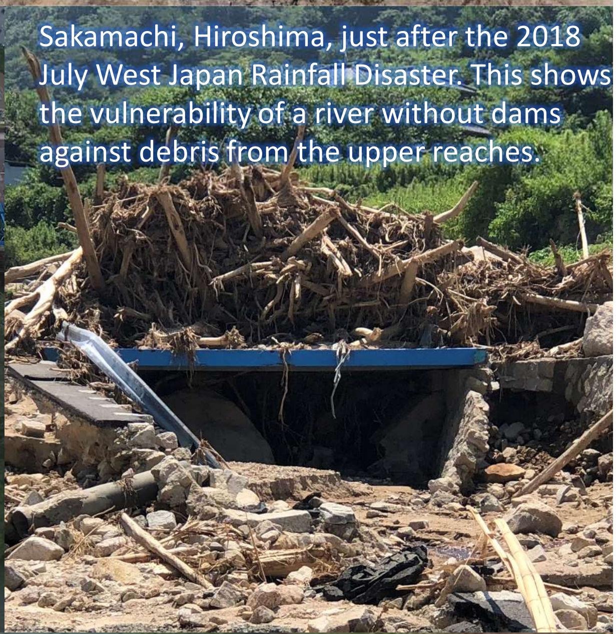
JCOLD



Yamba Dam was filled up by the rain due to Typhoon Hagibis in 2019 and saved the Tone River Basin, including part of the Tokyo Metropolitan Area, from possible levee failures.

Concerted pre-release from dams on the Nakagawa River was conducted on September 8, 2020. Nagayasuguchi Dam (this picture) and three other dams joined this operation.

Photo by Nakagawa River Office, MLIT



Sakamachi, Hiroshima, just after the 2018 July West Japan Rainfall Disaster. This shows the vulnerability of a river without dams against debris from the upper reaches.

Source:Geospatial Information Authority of Japan (GSI)

Japan Commission on Large Dams

Kyushu has suffered from a spate of severe floods. Damage due to the floods differed substantially depending on the availability of flood control dams. For example, in the Chikugo River Basin, tributaries without major dams, such as the Akatani River in this picture, were severely damaged, while the Sada River with Terauchi Dam suffered little damage in the 2017 Northern Kyushu Heavy Rain Disaster. In 2020, a flood in the Kuma River Basin, Kumamoto, Kyushu, caused 50 fatalities and 6,110 houses were inundated. Kawabegawa Dam, which would have been under operation by the time of this flood if the original plan had gone ahead, was reauthorized to be built after this disaster.

The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) manages 109 trunk rivers in Japan. In 2019, MLIT formalized an increase in the amount of rainfall by 10 to 15% in flood control planning to cope with the effects of climate change in the future. In 2020, the Government also established a general rule to change, as far as it is effective, the operation rules of reservoirs to allow for pre-release from dams before the arrival of heavy rains by utilizing weather forecasts. In 2021, "Basin-wide Concerted Measures for Flood Risk Reduction Acts," which consists of amendments of nine affiliated acts, was enacted to tackle the increased rainfall due to climate change.

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MLIT employed two climate change models. One is a 4 ℃ global warming model using the d4PDF (5 km downscaling) dataset comprising simulated weather data assuming weather in around 2090, along with the IPCC's RCP8.5 scenario. The other is a 2 ℃ global warming model using the d2PDF (5 km downscaling) dataset. It is the same as d4PDF except that the assumed weather is in around 2040. With each model, MLIT conducted simulation of rainfall for a duration ranging from 360 to 5,400 years. MLIT also conducted a simulation with current conditions (1951 to 2010) to obtain a baseline, which is not the same as the IPCC's. Considering uncertainty in the future, MLIT set the 2 ℃ warming case to be the main case used for dam and river planning while using the 4 ℃ warming case as a reference case for unmodifiable structures with long-range service duration, for example.
Table 1 shows the projected rate of increase of rainfall. Table 2 shows how much the flowrate and frequency of severe floods will increase. The significant increase in the flowrates makes it almost impossible to absorb the changes within current dam and river planning. Therefore, alternative methods are to be explored.

Climate change seems to be already affecting Japan hydrologically. Improving concerted pre-release from dams with more sophisticated use of weather forecasting, revision of design discharge, and effective sediment control for sustainable maintenance of dams are some of the imminent challenges we need to work hard to resolve.

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Table 1. Projected Increase Rate of Rainfall by Regions

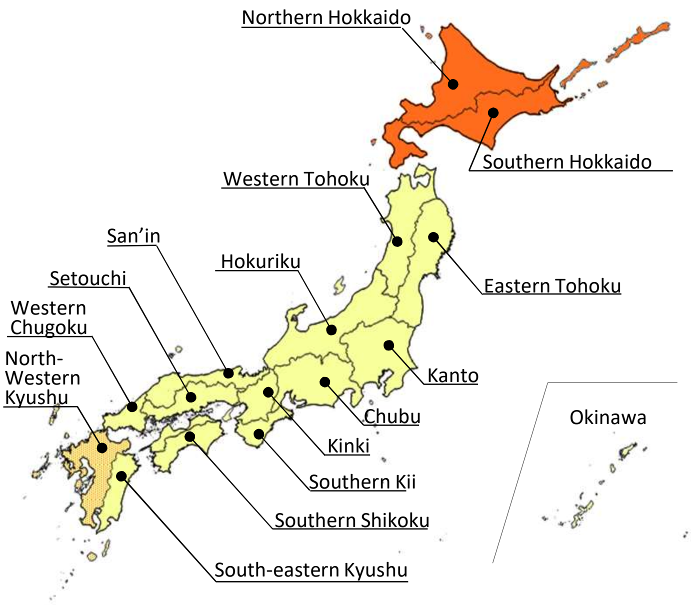
Region \ Case	2℃ Increase	4℃ Increase	
			Short Range
Hokkaido	1.15	1.4	1.5
North Western Kyushu	1.1	1.4	1.5
Rest of Japan	1.1	1.2	1.3

1. "Short-range" corresponds to rainfall within a range of three to nine hours.
2. This table is not applicable to rainfall within a range of three hours.
3. This table is applicable to a catchment area of no less than 100 km² although it can be applicable to a smaller catchment area by taking into consideration the possibility of a higher rate of increase of rainfall.
4. This table is applicable to floods with no more than a 200-year return period.

Table 2. Projected Increase of Flowrate and Frequency of Severe Floods

Climate Change Scenario	Rainfall	Flowrate	Frequency
2℃ Increase	approx.1.1	approx. 1.2	approx. 2
4℃ Increase	approx. 1.3	approx. 1.4	approx. 4

1. The rate of increase of flowrate is the average rate of changes in peak flowrates of design floods, which correspond to floods with a 100- to 200-year return period, at Class A rivers in Japan.
2. The rate of increase of frequency is the average rate of changes in the probability of design flood level rainfall at Class A rivers in Japan.



Basin-Wide Concerted Measures for Flood Risk Reduction

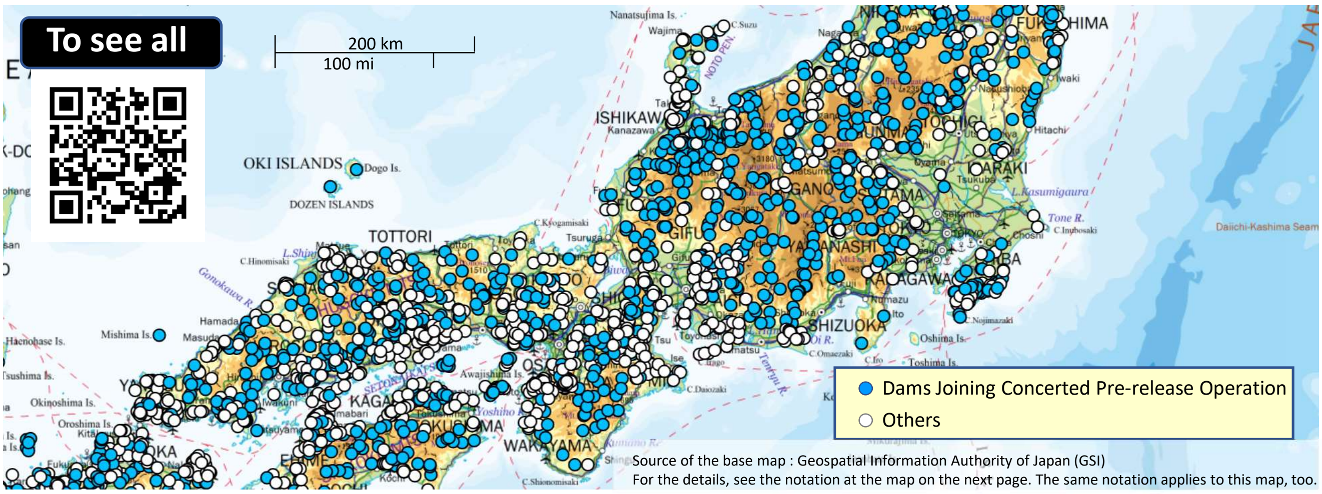
Japan's response to intensified rainfall is "Basin-wide Concerted Measures for Flood Risk Reduction" (which MLIT refers to as "River Basin Disaster Resilience and Sustainability by All"). With this concept, all stakeholders related to flood damage reduction are encouraged to work together to reduce flood disaster risks.

The Taskforce to Promote River Basin Disaster Resilience and Sustainability by All, which includes members from 16 ministries and agencies, was established at the central government level in 2020. The Taskforce drew up the "Action Plan to Promote River Basin Disaster Resilience and Sustainability by All" in 2021. It comprises various measures such as paddy-field dams (floodwater storage in paddy fields), relocation to low-risk places, delineation of inundation areas by PMF (probable maximum flood), and flood defense measures for key infrastructure as well as traditional flood control measures such as dams, levees, and retarding basins.

Image of Basin-wide Concerted Measures For Flood Risk Reduction

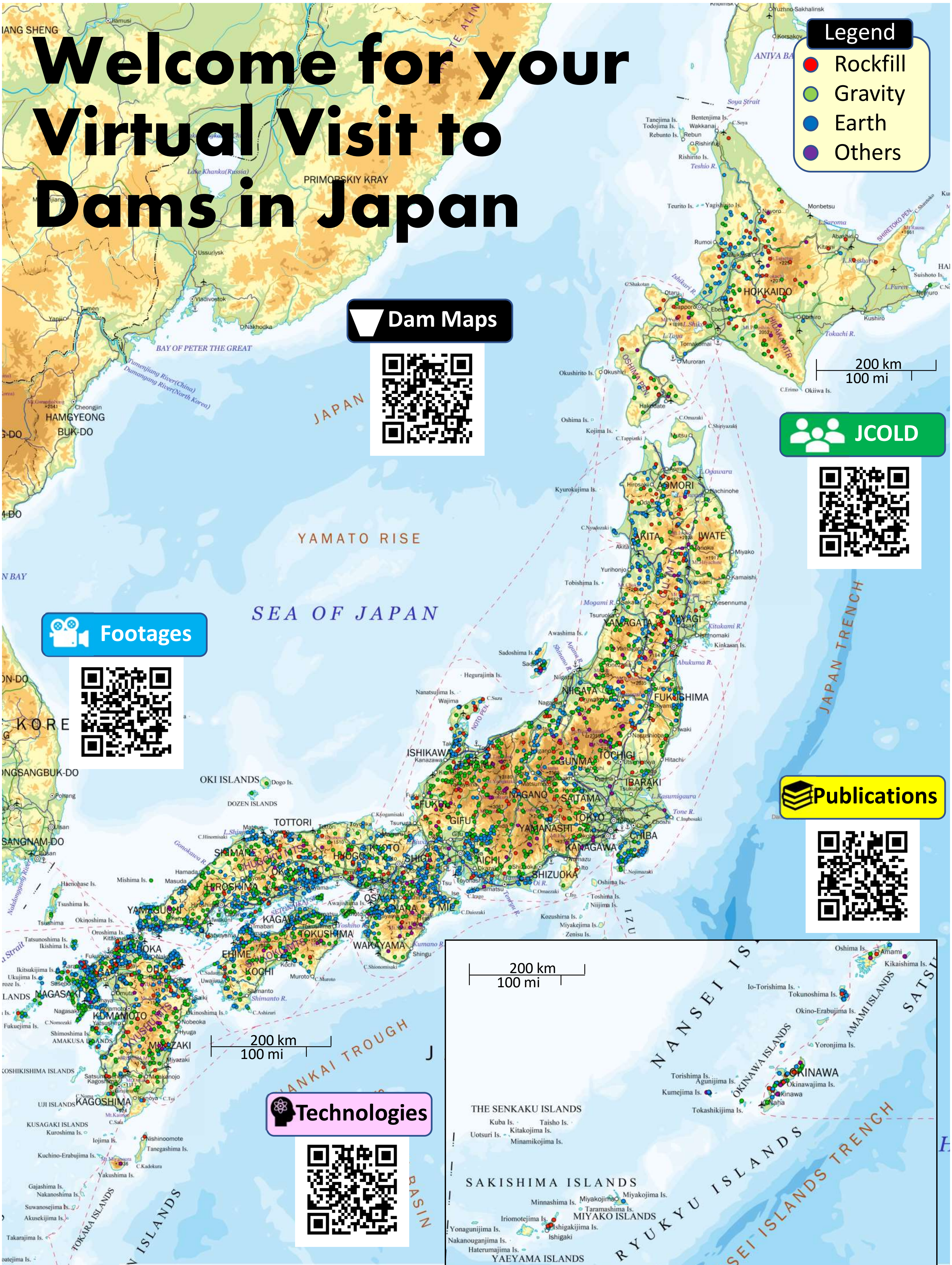
Concerted Pre-release from Dams

A highlight of the basin-wide concerted measures for flood risk reduction is "concerted pre-release from dams." Under this scheme, various dam owners such as MLIT, MAFF, prefectures, power generation companies and irrigation organizations work together in each river basin to cope with heavy rains in the basin. By lowering the water level of a dam reservoir further below the top of the conservation pool, in effect, flood control capacity can be expanded or created. The Government has issued "Basic Policies for Enhancing Flood Control Function of Existing Dams." Under this new policy, based on "flood control agreements" among dam owners and river managers, the pre-release operation is conducted when an expected amount of rainfall in the upper reaches of a dam reaches a threshold beyond which flooding is likely to cause damage downstream. MLIT calculates the expected rainfall with weather forecasts supplied by the Japan Meteorological Agency (JMA). Larger estimates produced either by an 84-hour range Global Spectral Model (GSM) or by a 39-hour range Meso-Scale Model (MSM) are used for comparison with the threshold. MLIT has also formalized a compensation scheme in the event that pre-release operations happen to have adverse impacts on water supply and hydropower.



Dams Joining Concerted Pre-release Operations Based on Flood Control Agreements

Welcome for your Virtual Visit to Dams in Japan



Source of the base map : Geospatial Information Authority of Japan (GSI)
（https://maps.gsi.go.jp/#5/37.932645/138.251953/&base=english&ls=english&disp=1&vs=c1g1j0h0k0l0u0t0z0r0s0m0f1）
Japan And Its Surroundings (Zoom Level 5-8), 1:1,000,000 INTERNATIONAL MAP (Zoom Level 9-11)
The bathymetric contours are derived from those contained within the GEBCO Digital Atlas, published by the BODC on behalf of IOC and IHO (2003) (https://www.gebco.net)
海上保安庁許可第292502号（水路業務法第25条に基づく類似刊行物）
Shoreline data is derived from: United States. National Imagery and Mapping Agency. "Vector Map Level 0 (VMAP0)." Bethesda, MD: Denver, CO: The Agency; USGS Information Services, 1997
Location of the dams on the map is basically derived from MLIT (https://nlftp.mlit.go.jp/ksj/gml/datalist/KsjTmplt-W01.html). Modification and addition of data are conducted by JCOLD and Campo Salado. QR codes on this map are added by JCOLD. Web design and programs are powered by Campo Salado.