Study on Impact on Water Resources by Climate Change

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1. Introduction

There are concerns over impact on water resources due to increase in no-raining days, increase in evapotranspiration and decrease in snow accumulation caused by climate change.

On the other hand, there are also concerns over uncertainty with the prediction of impact on water resources caused by climate change. In the proposal made by Research and Planning Working Group, Water Resources Development Subcommittee in National Land Council in October 2023, it is stated that there is still substantial uncertainty with the prediction, and it has not reached such level of accuracy as making a quantitative evaluation to be reflected in planning.

Taking such circumstances into account, we assumed that it would be important to provide society with objective evidence based on macro-analysis considering the importance of water resources, even if there is substantial uncertainty with the current accuracy in determining practical plans. Therefore, we calculated changes in occurrence frequency for low-rainfall years with non-exceedance probability of one tenth caused by climate change, for 96 first-class water systems covered by the Honshu area d4PDF downscaling data out of 109 first-class water systems in Japan. Moreover, we calculated changes in occurrence frequency for droughty water-discharges with non-exceedance probability of one tenth, creating flow analysis model for each water system and verifying its reproducibility.

2. Calculation method

We show the calculation flow in Figure-1 and the conceptual diagram of flow analysis model in Figure-2. As shown in Figure-1, we made bias corrections on the Honshu area d4PDF downscaling data using Dual-Window method and then inputted them in flow analysis model. As shown in Figure-2, the flow analysis model is created as tank type flow analysis model (4 layers) and is made into plane division per each flow observation location. In addition, we make the rainfall and the temperature as input values expressing snow accumulation / snow melting, water supply and evapotranspiration in the calculation process, and make the flow volume as output value.

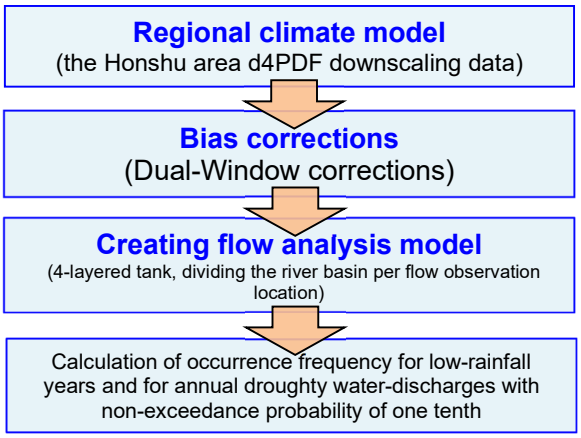

Figure-1 Calculation flow

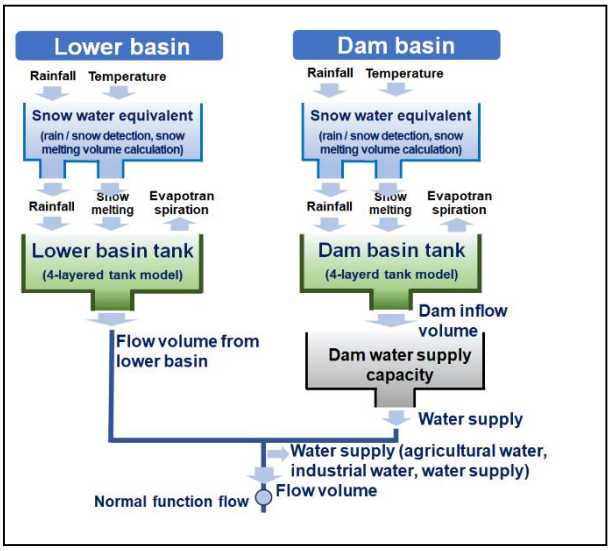

Figure-2 Conceptual diagram of flow analysis model [1)]

3. Calculation results and considerations

To evaluate the impact to water resources caused by climate change, we calculated to what extent the occurrence frequency for low-rainfall years and for droughty water-discharges having the probability level of once in 10 years would increase, which was the criteria for safety level of water use. We show the calculation results in Figure-3.

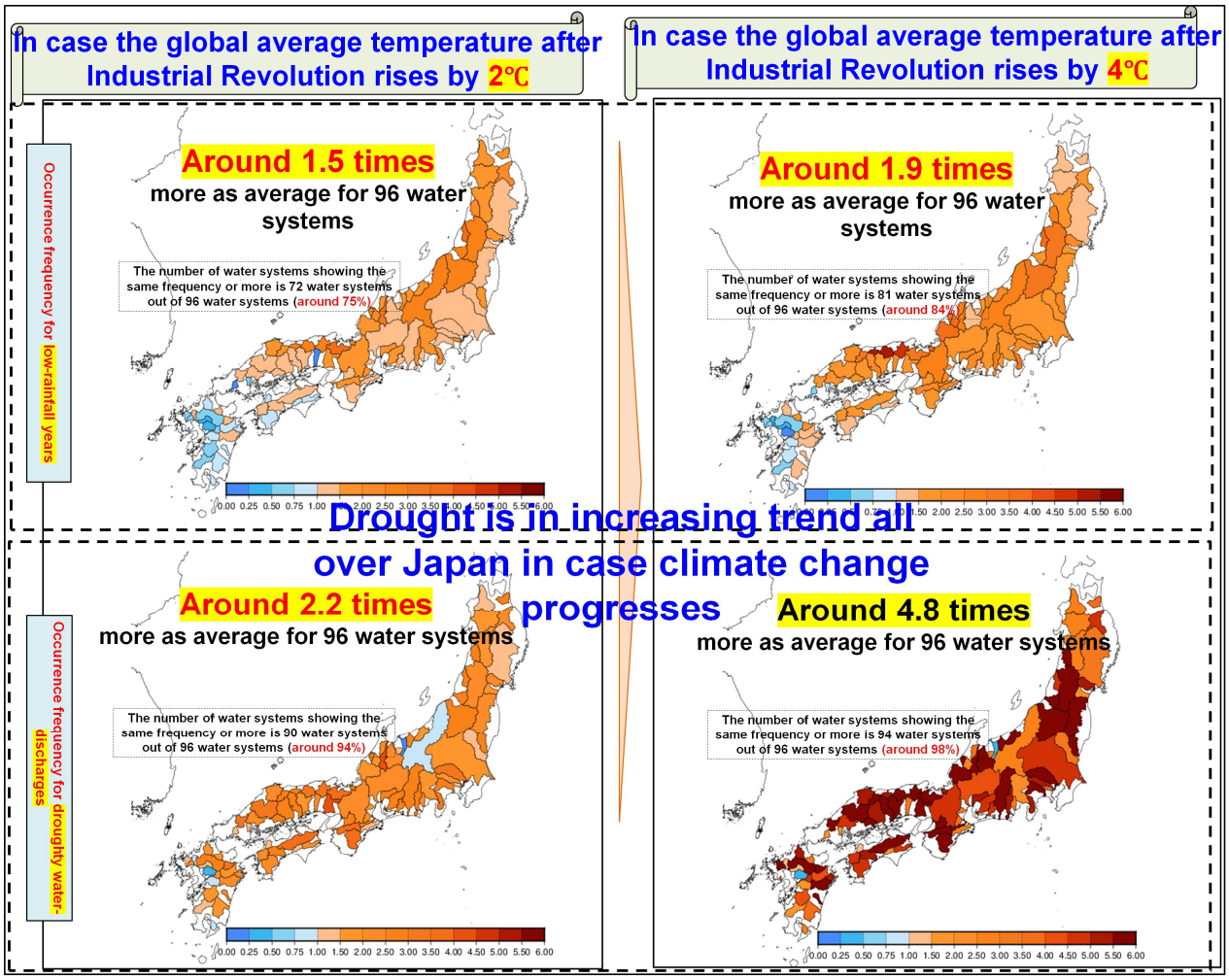

Figure-3 Changes in the occurrence frequency for low-rainfall years and for droughty water-discharges with non-exceedance probability of one tenth caused by climate change [1) 2)]

As a result, the occurrence frequency for low-rainfall years has risen by 1.5 times in case the temperature rises by 2℃ and by 1.9 times in case of 4℃, and the occurrence frequency for droughty water-discharges has risen by 2.2 time at 2℃, by 4.8 times at 4℃.

These results show that the occurrence frequency for low-rainfall years and droughty water-discharges increases in wide areas, having the probability scale for safety level of water use, caused by climate change, and that it is important evidence to indicate a necessity to reduce greenhouse gas emissions as mitigation measure.

On the other hand, even if we can reduce the temperature rise to 2℃, which is the goal of the Paris Agreement, the occurrence frequency will rise to some extent, therefore, we believe it is important evidence to indicate a necessity to promote adaptation measures, in parallel with mitigation measures.

3. Future prospects

In future, we believe it is important to present understandable indicators and goals including the reduction in water supply that may offset the impact of climate change as additional evaluation, and we would like to continuously evaluate the impact of climate change.

☞Detailed information is as follows.

1) NISHIMURA Sorin, TAKADA Nozomu, SAKAI Daisaku, MIZUGAKI Shigeru, TAKESHITA Tetsuya: Calculation of changes in the occurrence frequency for droughty water-discharges with non-exceedance probability of one tenth caused by climate change, collected papers of river technologies, Volume No. 30, pp. 363-368, 2024.

2) NISHIMURA Sorin, TAKADA Nozomu, SAKAMOTO Koji, KOIKE Katsuyuki, KOSHIDA Tomoki, TAKESHITA Tetsuya: Calculation of changes in the occurrence frequency for low-rainfall years with non-exceedance probability of one tenth caused by climate change, collected papers of river technologies, Volume No. 29, pp. 551-556, 2023.