International Research (Project No.: 2019W-04)

Project name: Restoring historical long-term meteorological, hydrological and glacier mass balance datasets in the high mountains of Kyrgyzstan
Principal Investigator: Rysbek SATYLKANOV
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Name of DPRI collaborative researcher: Kenji Tanaka
Research period: Jun 01, 2019 ~ March 31, 2022
Research location: Tien-Shan high mountain area of Kyrgyz Republic
Number of participants in the collaborative research: 4 (DPRI staff: 3, non-DPRI staff: 1)
- Number of graduate students: 1 (Master students: 1, Doctor students: 0) (Included number)
- Participation role of graduate students [Support for field observation and data analysis]

Implementation status in FY2020

The Regional Water Environment Systems Laboratory is contributing to the research of the area by establishing an observation network at the southern part of Issyk-Kul Basin from 2017 and maintaining periodic updates. With support from the Academy of Sciences of Kyrgyzstan, the laboratory has already installed 4 meteorological stations (two on Karabatkak glacier located at 3400m above sea level, one on Bordu glacier 4100m and one in the Chon-Kyzyl-Suu river valley 2600m). Thus, the installed precipitation gauge on the glacier at an altitude of 3400m will help understand the precipitation pattern in the mountainous watershed. The number of monitored stations should be increased to cover additional climatic areas. Currently, use of reanalysis data is optimal in large basins, and its downscaling is crucial to improve accuracy. Generalization of precipitation data and climatic patterns should occur based on in-situ observations, which reflect reality, and should be verified carefully. The water balance of the Issyk-Kul Lake basin is assessed using a land surface model (SiBUC) and river routing model (RRI). Results of modeled lake water level are evaluated using satellite altimetry data. The primary focus is to analyze forcing data, especially precipitation reanalysis data of the JRA55, APHRODITE, GSMaP, ERA5, and GPCC, to define spatiotemporal variability of the data.

Reanalysis products are highly dependent on the availability of in-situ data and tend to increase the bias neglecting the local precipitation pattern, especially in mountainous regions. Some of the products with limited in-situ observation were not able to represent the climatology of the area. Using the APHRODITE climatology algorithm and incorporating in-situ observations, a new dataset was created to analyze results. Additionally, historical altitude/precipitation dependency was incorporated into current observation results. The glacier component is modeled using a temperature index model derived from the observed data of the Karabatkak glacier. This model was subsequently applied to simulations of the entire lake basin using GLIMS glacier inventory (RGI) to delineate the glaciers with an accuracy of 100m. Modeled ice melt has a good correlation and relatively low error compared to observed ice melt. Modeled snowpack tends to disappear in the spring season and remains sparse in high altitudes during the summer. Fluctuations of Issyk-Kul Lake level are estimated by satellite altimetry and indicate changes in the water balance of the lake. It shows the seasonal changes and the influence of different water balance components, such as ice and snow melting. The best modeling results are obtained using a combination of ERA5 as forcing, modified APHRODITE data as precipitation input, and glacier component based on observed data.

Implementation plan in FY2021

Field training Workshop will be held at the Tien-Shan High Mountain Scientific Centre. Planned date is from 20 to 25 August 2021. Expected number of participants will be 20 to 30 including researchers, engineers, and students in Kyrgyz republic. Japanese researcher will join through online as lecturer. Field data collection and data analysis procedure will be provided in this training workshop.

If the international travel is possible, two rain gauges with special energy saving heater will be installed at the higher elevation zone of Karabatkak glacier and Bordu glacier to measure the orographic effect of precipitation in those regions.

As for data re-construction, we will keep trying to collect paper-based data and digitize those information with the help of local partners. Then, those digitized information will be additionally combined to improve the downscaled product of reanalysis data.