

AHW023-16

Room:102

Time:May 25 14:30-14:45

Proposal method for estimating evaporation rates of water using characteristic of change of oxygen isotopic ratio

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Recently, water shortage is caused by climate change such as Global warming. Therefore, estimation of amount of evaporation for dam, reservoir and irrigation water is important for preservation of water resources.

There are various methods to calculation of the amount of evaporation such as Thornthwaite method (Thornthwaite, 1948), the Penman method (Penman, 1948), etc. The estimation method of evaporation rate using isotopic ratio was made by Allison et al.¹⁾ or Gibson et al.²⁾, etc. from before. However the method included many parameters such as humidity, partition coefficient, oxygen isotopic ratio of vapor, kinetic isotope effect, resistance of diffusion, and so on and then the some parameter is very difficult to estimate. Therefore, estimation method of evaporation rate to calculate from isotope is very difficult because evaporation rate is controlled by many parameters.

The purpose of this study is to develop simple method for estimating evaporation rates of water using oxygen isotopic ratio and to verify which parameter affects isotope ratio change and isotopic separation effectively. Then, we can estimate the isotopic ratio of the residual water when the evaporation rate of water reaches 1%.

In laboratory test, amount of average evaporation of day, temperature, humidity, and saturation deficit were measured and then the relation of isotopic ratio of water and their parameters was analyzed. From the test, negative correlation ($R = -0.84$) between the average humidity and the amount of change of the $\delta^{18}\text{O}$ per rate of unit evaporation was clarified and then the humidity change accompanying seasonal change was clarified to affect apparently the $\delta^{18}\text{O}$ per rate of unit evaporation. With the increase in an evaporation rate, the amount of change of the $\delta^{18}\text{O}$ per rate of unit evaporation with humid change was clarified to decrease.

The amount of evaporation in the Inawashiro lake in Fukushima was estimated from the relation of the amount of change of the $\delta^{18}\text{O}$ per rate of unit evaporation and humidity and the estimated values, 595 mm/year was good agreement with the calculation result of previous research. Therefore, the simple estimation method of this research is effective for estimation of evaporation rate of an actual lake or a pond.

Keywords: water resources, evaporation rates, oxygen isotopic ratio, humidity, lake