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Proposal method for estimating evaporation rates of water using oxygen-hydrogen isotopic ratio, humidity and temperature

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Recently, water shortage is caused by climate change such as Global warming. Storage pond and lake is important for water reservoir and then to evaluate loss of evaporation and infiltration from lake and pond is necessary. However, it is very difficult to measure evaporation and infiltration respectively because long term continuous measuring for precipitation, water flow in and out of a lake and pond and evaporation is needed and infiltration cannot be measured directly. Then, generally evaporation is measured using evaporation pan however scale effect and residence time are evaluated and long term measuring is needed. And then evaporation is calculated from heat balance. However the difference between actual evaporation value and the calculated value is unknown. Then, the study is easy to measure evaporation of a lake and pond using isotopes change before and after evaporation of lake water.

Research on the evaporation using isotopic ratio is made by Allison et al.[1]or Gibson et al.[2], etc. from before. There are many parameters such as humidity, partition coefficient, oxygen isotopic ratio of vapor, kinetic isotope effect, resistance of diffusion, and so on but 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.

However, actual evaporation process was clarified to be easy to evaluate by humidity, temperature and water isotopic value change from the study. In laboratory test, the relationship between humidity, temperature, evaporation rate and oxygen-hydrogen isotopic ratio of water was clarified. The correlation between the average humidity and the d delta^{18}O/d evaporation rate was found to be - 0.86 and the correlation between the average temperature and deltaD/delta^{18}O was found to be - 0.88.

Evaporation rate in an actual lake and ponds can be calculated from oxygen-hydrogen isotopic ratio, humidity and temperature based on the value of the d delta^{18}O/d evaporation rate and the inclination level from the meteoric water line.

Reference:
1)Allison, G.B., Brown, R.M. and Fritz, P : Estimation of the isotopic composition of lake evaporate., Jour, of Hydrol. , 42, pp.109-127, 1979.
2)Gibson, J.J., Edwards, T.W.D., Bursey, G.G. and Prowse, T.D. : Estimating evaporation using stable isotopes: quantitative results and sensitivity analysis for two catchments in northern Canada, 24, pp.79-94, 1993.