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Source tracking and temperature prediction of discharged water in a deep reservoir based on a 3-D hydro-thermal-tracer model

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ABSTRACT:

Thermal stratification frequently occurs in deep reservoirs, and discharged water temperature (DWT) is detrimental to the downstream regions. Source tracking of discharged water reveals the flow regularity of stratified reservoir, and provides scientific basis for the prediction of DWT. Taking Sanbanxi Reservoir as a case, a 3-D hydro-thermal–tracer model based on Flow-3D is built, validated and used to investigate the source of discharged water, and a rapid quantitative method of DWT is further proposed. The result shows that: 1) DWT is closely related to the vertical temperature distribution, negatively related to the water level, and positively related to the flow rate. 2) Withdrawal zone is located within 30 m near the intake, which contributes approximately 82% to the discharged water. Among all water layers, the most effective layer which contributes the most to the discharged water is located 7.5 m above the top of intake. Contribution of the surface and hypolimnetic layers to the discharged water is small. 3) Based on source tracking, a forecasting formula of DWT with five parameters is proposed and verified, including elevation of most effective layer (h_{main}=$h_{422.5}$), upper characteristic elevation (h_{up}=h_{430}), lower characteristic elevation (h_{down}=h_{410}), maximum (Q_{full}=870 m^3/s) and actual (q) flow rate of intake. This formula systematically considers the withdrawal zone, most effective layer and discharged tracer proportion, provides a rapid and accurate method predicting DWT, and can be a reference for other deep reservoirs.