Supplementary Information

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Contents:

1. Location information and data sources

Location and segment number(ID) of key sections mentioned in this paper are shown in Table.S1. location informations are retrieved from Google Earth. Meteorological data, recorded ata three-hour intervals, were sourced from national surface stations in China, provided by China Meteorological Data Service Centre. Daily water level data, hourly flow data, and large cross-section data(2013) were obtained from the China Three Gorges Corporation. Water temperature data were referenced from Hydrological data of Changjiang River Basin, Annual hydrological report P. R. China. Simulated water level data are the modeling results that used for correlation analysis.

Table S1. Location and data information

Sections name	Segment ID	Distance from TGD	Latitude(N) (degree)	Longitude(E) (degree)	Elements
Cuntan	2	604 km	29.6267	106.6000	flow, water temperature,
Changshou	40	528 km	29.8331	107.0667	meteorology, water level
Qingxichang	72	468 km	29.7939	107.4589	simulated water level
Fengdu	102	408 km	29.8501	107.7333	meteorology, simulated water level
Zhongxian	124	364 km	30.3000	108.0331	simulated water level
Wanxian/Wanzhou	166	280 km	30.750	108.4167	meteorology, water level
Yunyang	187	242 km	30.9500	109.0833	water level
Fengjie	226	168 km	31.0428	109.5061	meteorology, water level
Wushan	252	120 km	31.0703	109.8661	water level
Badong	276	76 km	31.0272	110.4161	meteorology, water temperature, water

					level
CJXX*	300	32 km	30.9615	110.7474	water temperature, water level
TGD	315	0	30.8229	111.0030	discharge flow,water level

*CJXX represented the entrance where the tributary XXR joins mainstream

2. Initial conditions and Boundary conditions

Initial Conditions:

The initial conditions required in CE-QUAL-W2 model include the start time, end time, inflow, outflow, velocity of flow and water temperature. This TGR model simulated a hydrological year from 01-Mar-2014 to 30-Apr-2015, reference date (for Julian day=1) is 01-Jan-2014. The waterbodies were specified as fresh water.

The inflow conditions include both upstream flow and water temperature, while the outflow consists of discharges from the reservoirs. Additionally, the volume of water in the reservoir is characterized by water level, and the water is calssified as fresh water in our model. We assume that initial water temperature is 12 ℃, under isothermal conditions, and that initial velocity of the water is zero. The sediment temperature was estimated from local average annual temperature.

Boundary conditions

There are 7 inflows and 1 outflow in the TGR model systerm. Inflows include that uptream inflow from the Cutan station and 6 typical tributary inflows which were simulated as point source loading. These tributaries are Wujiang, Longhe, Xiaojiang, Modaoxi, Daninghe, Xiangxi River (Xingshan station). The system's downstream outflow is the discharge from TGD.(Figure S1)

Surface Boundary Conditions (meteorological data) are required in our model. It contains the following data: air temperature [TAIR], dew point temperature [TDEW], wind speed and wind direction [PHI], cloud cover [CLOUD] and short wave solar radiation. Meteorological data were collected from 5 meteorological stations: Changshou, Fengdu, Wanzhou, Fengjie, Badong(Figure S2 and Figure S3). The dew point temperature, which is influenced by the relative humidity, increases with higher moisture content in the air. The formula is a widely recognized method for calculating the dew point[1,2]：

$$\gamma(T,RH)=\ln(RH)+\frac{b\cdot T}{c+T}\;\;;\;\;T_{dp}=\frac{c\cdot\gamma(T,RH)}{b-\gamma(T,RH)} \qquad \text{(S.1)}$$

Where T is air temperature (in degrees Celsiu); T_{dp} is dew point temperature (in degrees Celsiu); RH is relative humidity (in percent); $\gamma(T,RH)$ is intermediate function; constants: b = 17.27, c = 237.7 °C.

Cloud cover is between 0 (no clouds) and 10 (fully cloudy). The short wave solar radiation for TGR model is computed from the relationships between sun angle and cloud cover.

Meteorological data were input into the model at intervals of every three-hour. The corresponding Julian date, a floating-point number ranging from 1 to 365 for a standard year and 366 for a leap year, must be specified. 'INT' refers to the integer function used in this context. A non-slip boundary condition is applied to the bottom of the reservoir. This means that the tangential velocity at the bottom is assumed to be zero.

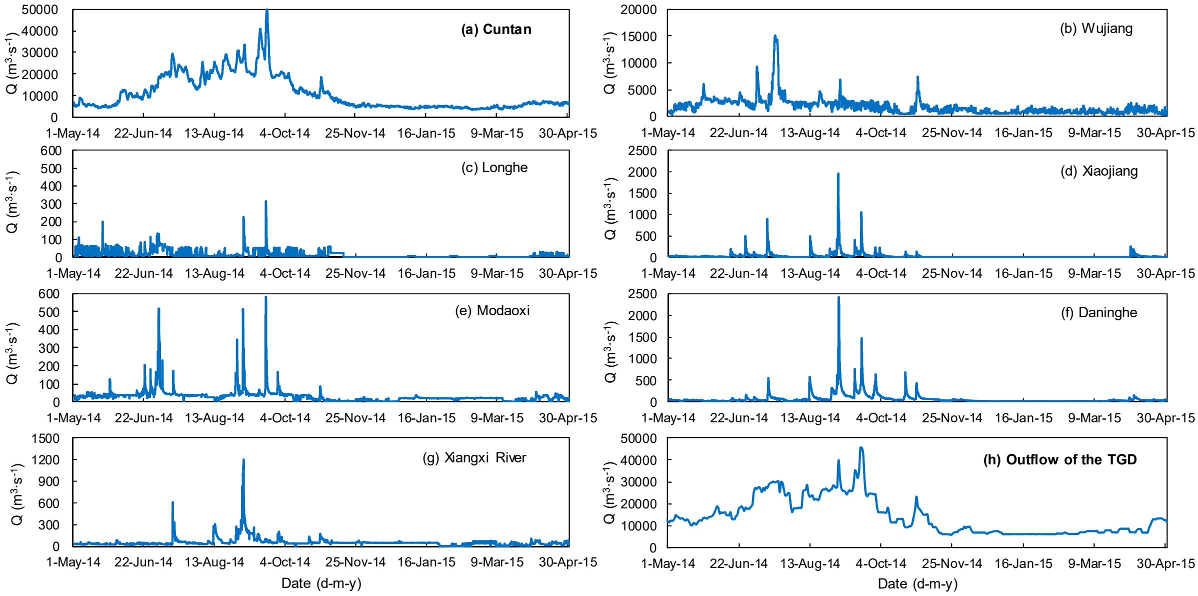

Figure.S1. Inflows and outflows. It presents one main river inflow from Cuntan, alongside six tributary inflows (Wujiang, Longhe, Xiaojiang, Modaoxi, Daninghe, and Xiangxi River). The diagram also showcases one outflow, denoted as the outflow from the TGD.

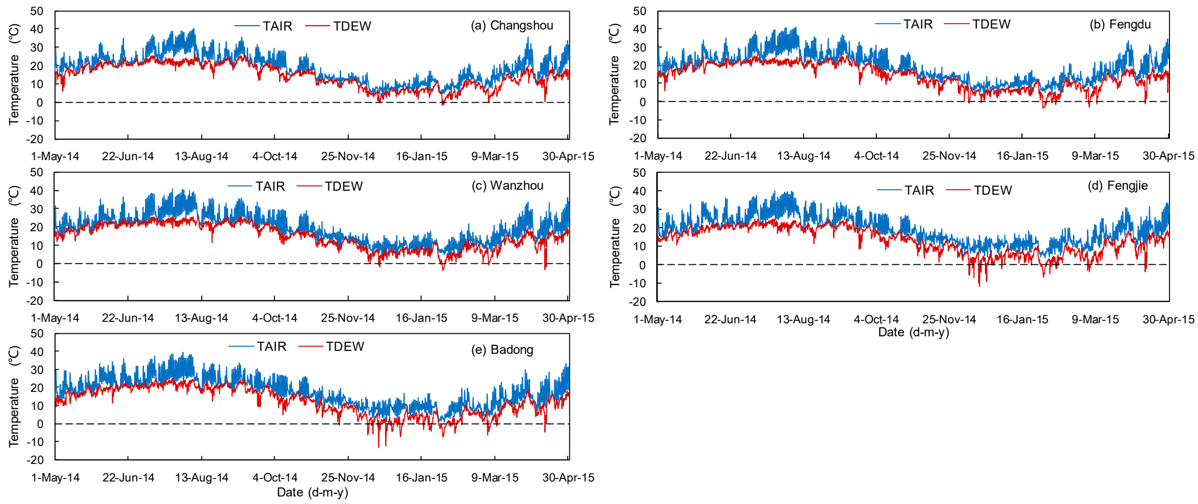

Figure.S2. Air temperature and dew point temperature in typical weather stations of TGR

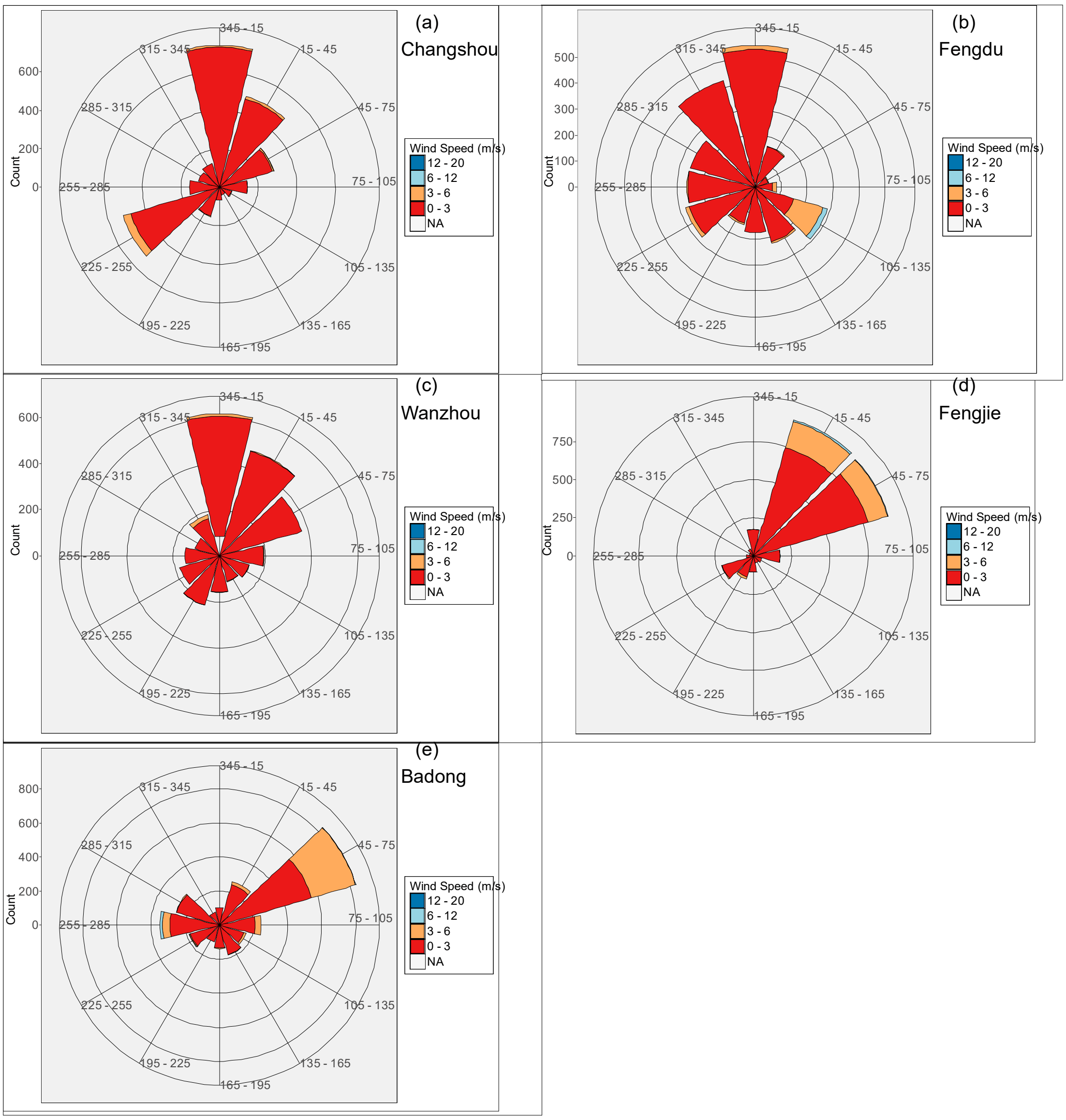

Figure.S3. Wind rose diagrams in typical weather stations of TGR. These include: Changshou station(a), Fengdu station(b), Wanzhou(c), Fengjie(d), Badong(e).

3 Model validation and calibration

The CE-QUAL-W2 model incorporates a variety of coefficients that can be modified during the calibration process, as detailed in Table S2. The majority of these values were selected based on the model's recommended default settings.

Table S2 Calibration parameters in CE-QUAL-W2 for TGR applications

Parameters	Variable name	Default value
Longitudinal eddy viscosity	AX	1（$m^2 \cdot s^{-1}$）
Longitudinal eddy diffusivity	DX	1（$m^2 \cdot s^{-1}$）
Bottom friction solution，Mannings' friction	FRICT	0.01~0.1（$s \cdot m^{-1/3}$）
Wind sheltering coefficient	WSC	0.5~0.9
Dynamic shading coefficient	Shade	0~1.0
Fraction of incident solar radiation absorbed at the water surface	BETA	0.45
Extinction for pure water	EXH2O	0.45（m^{-1}）

(1) Water level calibration in the reservoir area

Water level calibration was achieved by comparing the simulated elevation with the observed elevation. As illustrated in Figure S4, the simulated water elevation closely aligns with the observed elevation, exhibiting a Mean Error (ME) of less than 0.20 and an Absolute Mean Error (AME) of less than 0.37, with the AME increasing upstream. These findings indicate that the bathymetric data is accurate and that the inflow and outflow data are reliable.

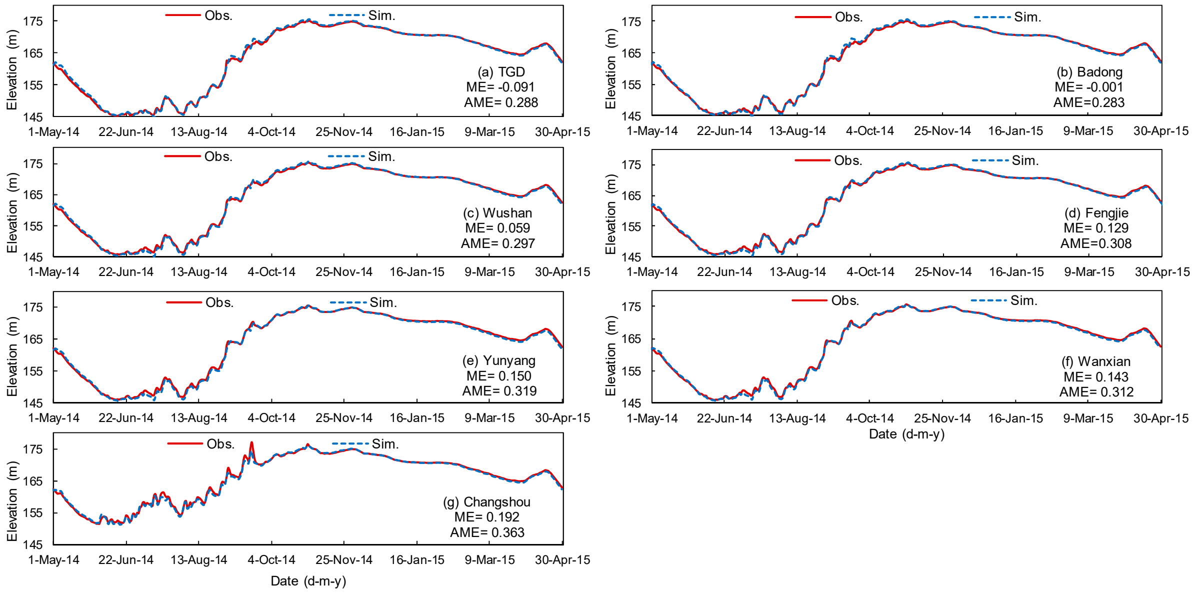

Figure.S4. Comparisons of the simulated and observed water level (a.TGD; b.Badong; c.Wushan; d.Fengjie; e.Yunyang; f.Wanxian; g.Changshou)

(2) Surface water temperature calibration

The simulated surface water temperature closely matches the observed water temperature (Figure S5). For Badong, the Mean Error (ME) is -0.50°C, and the Absolute Mean Error (AME) is 0.91°C. In the case of CJXX, the absolute value of ME is less than 0.20°C, and the AME is approximately 0.52°C.

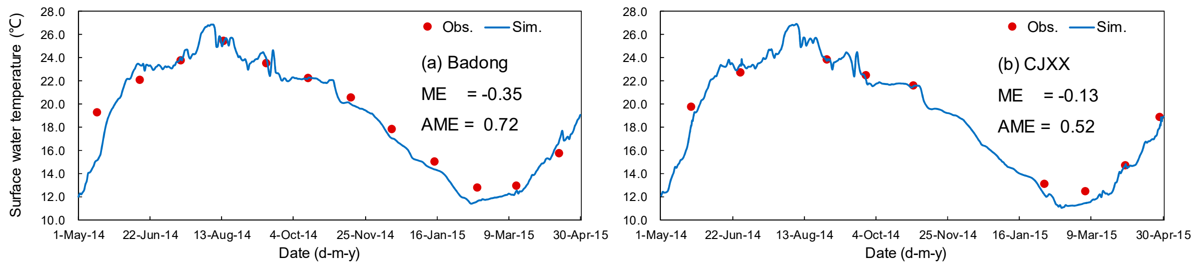

Figure.S5. Comparisons of the simulated and observed surface water temperature (a.Badong; b. CJXX)

References

1. "MET4 and MET4A Calculation of Dew Point". Archived from the original on May 26, 2012. Retrieved 7 October 2014.

2. Barenbrug, A.W.T., Psychrometry and Psychrometric Charts, 3rd Edition, Cape Town, S.A.: Cape and Transvaal Printers Ltd., 1974.