Analysis of Water Temperature Variations in the Yangtze River's Upper and Middle Reaches in the Context of Cascade Hydropower Development

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Supplementary Materials

Supplementary material **Table S1** shows the sinusoidal fitting function and fitting determination coefficient (R^2) of water temperature in the first period (2009-2010 year), the second period (2013-2015 year), and the third period (2018-2020 year). The minimum value of R^2 is 0.903, and the maximum value is 0.982, indicating that the water temperature rhythms were well represented through the sine function. This suggests that water temperature's intra-annual variation process can be considered as a simple harmonic wave, characterized by its phase and amplitude. It further proves the rationality of I_{EC} (the extreme fluctuation index), I_{BD} (the baseline deviation index), and I_{PO} (the phase offset time index) to quantify homogenization and lagging effect of water temperature.

Table S1. The sinusoidal fitting results for water temperature at hydrological stations in the middle and upper reaches of the Yangtze River

Hydrological	The first period		The second period		The third period	
Station	Fitting Formula	R^2	Fitting Formula	R^2	Fitting Formula	R^2
Gangtuo	Tw=−8.108sin(0.017 *day+1.256)+7.826	0.951	Tw=−7.775sin(0.017 *day+1.305)+7.614	0.964	——	——
Batang	Tw=−7.538sin(0.017 *day+1.391)+9.328	0.959	Tw=−7.316sin(0.017 *day+1.366)+9.473	0.960	Tw=−7.259sin(0.017 *day+1.41)+9.713	0.956

Shigu	Tw=−6.492sin(0.017 *day+1.432)+12.418	0.962	Tw=−6.46sin(0.017* day+1.386)+12.376	0.961	Tw=−6.346sin(0.017 *day+1.483)+12.263	0.956
Jinanqiao	——	——	Tw=−5.492sin(0.017 *day+1.204)+14.526	0.959	Tw=−5.448sin(0.017 *day+1.336)+14.198	0.973
Panzhihua	Tw=−5.802sin(0.017 *day+1.517)+16.05	0.958	Tw=−5.433sin(0.017 *day+1.263)+17.041	0.936	Tw=−4.753sin(0.017 *day+1.133)+16.957	0.955
Sanduizi	Tw=−5.114sin(0.017 *day+1.298)+16.48	0.959	Tw=−4.336sin(0.017 *day+1.122)+16.373	0.932	Tw=−4.125sin(0.017 *day+1.123)+16.3	0.947
Longjie	Tw=−5.328sin(0.017 *day+1.411)+16.806	0.966	Tw=−4.543sin(0.017 *day+1.153)+16.903	0.939	Tw=−4.236sin(0.017 *day+1.101)+16.857	0.971
Baihetan	——	——	——	——	Tw=−4.322sin(0.017 *day+1.211)+18.254	0.968
Huatan	Tw=−5.366sin(0.017 *day+1.428)+17.807	0.957	Tw=−5.073sin(0.017 *day+1.192)+18.149	0.903	——	——
Pingshan	Tw=−5.324sin(0.017 *day+1.362)+19.173	0.957	Tw=−4.698sin(0.017 *day+1.007)+18.686	0.936	Tw=−4.356sin(0.017 *day+0.81)+18.57	0.973
Zhutuo	Tw=−6.69sin(0.017* day+1.367)+17.941	0.926	Tw=−5.806sin(0.017 *day+1.142)+18.478	0.937	Tw=−5.243sin(0.017 *day+1.142)+18.3	0.957
Cuntan	Tw=−6.837sin(0.017 *day+1.303)+18.731	0.958	Tw=−6.591sin(0.017 *day+1.189)+18.991	0.949	Tw=−6.247sin(0.017 *day+1.174)+18.862	0.960
Qingxichang	Tw=−6.736sin(0.016 *day+1.349)+17.86	0.982	——	——	——	——
Badong	Tw=−6.975sin(0.017 *day+0.797)+18.858	0.979	Tw=−6.539sin(0.017 *day+0.727)+19.554	0.948	Tw=−6.148sin(0.017 *day+0.767)+19.415	0.958
Huanglingmiao	——	——	Tw=−6.519sin(0.017 *day+0.583)+19.613	0.946	Tw=−6.179sin(0.017 *day+0.637)+19.324	0.962
Nanjinguan	Tw=−6.164sin(0.017 *day+0.559)+19.059	0.925	Tw=−6.563sin(0.017 *day+0.548)+19.313	0.934	Tw=−6.072sin(0.017 *day+0.658)+19.202	0.956
Yichang	Tw=−7.064sin(0.017 *day+0.697)+18.723	0.978	Tw=−6.434sin(0.017 *day+0.648)+19.131	0.952	Tw=−6.433sin(0.017 *day+0.653)+19.135	0.967
Hankou	Tw=−9.788sin(0.017 *day+1.141)+18.735	0.947	Tw=−9.429sin(0.017 *day+1.081)+18.793	0.957	Tw=−9.86sin(0.017* day+1.104)+18.916	0.951

Note: Tw represents the water temperature, and day is the number of days, for example, the first period, day refers to 1 on January 1, 2009.