Supplementary Information for

Machine learning-constrained projection of bivariate hydrological drought magnitudes and socioeconomic risks

Rutong Liu[1], Jiabo Yin[1*], Louise Slater[2], Shengyu Kang[1], Yuanhang Yang[1], Pan Liu[1], Jiali Guo[3,4], Xihui Gu[5], Aliaksandr Volchak[6]

[1]State Key Laboratory of Water Resources Engineering and Management, Wuhan University, Wuhan, Hubei, 430072, P.R. China

[2]School of Geography and the Environment, University of Oxford, Oxford, UK

[3]Engineering Research Center of Eco-environment in Three Gorges Reservoir Region, Ministry of Education, China Three Gorges University, Yichang, Hubei 443002, China

[4]College of Hydraulic and Environmental Engineering, China Three Gorges University, Yichang, Hubei 443002, China

[5]School of Environmental Studies, China University of Geosciences, Wuhan 430074, China

[6]Engineering Systems and Ecology Faculty, Brest State Technical University, Moskovskaya 267, 224017 Brest, Belarus

*Correspondence: Jiabo Yin (jboyn@whu.edu.cn)

Table S1. Classification of drought and threshold values of the drought events.

Drought Classes	Drought Index (DI)
No Drought	DI>-0.5
Mild Drought	-1.0< DI≤-0.5
Moderate Drought	-1.5< DI≤-1.0
Severe Drought	-2.0< DI≤-1.5
Extreme Drought	DI≤-2.0

Table S2. Seven candidate distributions to the marginal distributions of drought duration and severity.

Candidate distributions	Probability density functions
Gamma	$f(x) = \frac{x^{\alpha-1}}{\beta^{\alpha}\Gamma(\alpha)} e^{-\frac{x}{\beta}}$
Generalized Extreme Value	$f(x) = \exp\left\{-\left[1 + \gamma(\frac{x-\mu}{\sigma})\right]^{-\frac{1}{\gamma}}\right\}$
Inverse Gaussian	$f(x) = \frac{\sqrt{\lambda}}{\sqrt{2\pi x^3}} \exp\left\{-\frac{\lambda(x-\mu)^2}{2\mu^2 x}\right\}$
Log-normal	$f(x) = \frac{1}{x\sigma\sqrt{2\pi}} \exp\left\{-\frac{(lnx-\mu)^2}{2\sigma^2}\right\}$
Normal	$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left\{-\frac{(x-\mu)^2}{2\sigma^2}\right\}$
Pearson type-III	$f(x) = \frac{\beta^{\alpha}}{\Gamma(\alpha)} (x - a_0)^{\alpha-1} e^{-\beta(x-a_0)}$
Weibull	$f(x) = \frac{k}{\lambda}\left(\frac{x}{\lambda}\right)^{k-1} e^{-\left(\frac{x}{k}\right)^{k}}$