atmosphere

Supplementary Materials:

Compounding Effects of Fluvial Flooding and Storm Tides on Coastal Flooding Risk in the Coastal-Estuarine Region of Southeastern China

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Table S1. Marginal distribution distributions in McVAT.

Name	Mathematical Description	Parameter
Beta	$F(x)=\frac{\int_0^x t^{\alpha_1-1}(1-t)^{\alpha_2-1}dt}{\int_0^1 t^{\alpha_1-1}(1-t)^{\alpha_2-1}dt}$	α_1: First shape parameter α_2: Second shape parameter
Birnbaum-Saunders	$F(x)=\frac{1}{2\pi}\exp\left(-\frac{x^2}{2}\right)\left[\frac{1}{\kappa}\left(\sqrt{\frac{x}{\alpha}}-\sqrt{\frac{\alpha}{x}}\right)\right]$	α :scale parameter; κ : shape parameter
Exponetial	$F(x)=1-\exp(-(x-\kappa)x/\alpha), x\ge\kappa$	α :scale parameter; κ : shape parameter
Extreme value	$F(x)=1-\exp\left(-\exp\left(\frac{x-\xi}{\alpha}\right)\right)$	ξ : location parameter; α :scale parameter
Gamma	$F(x)=\frac{\alpha^{-\kappa}}{\Gamma(\kappa)}\int_0^x t^{\kappa-1}e^{-t/\alpha}dt, x>0$	α :scale parameter; κ : shape parameter
Generalized extreme value	$F(x)=\exp\left(-\exp\left(\kappa^{-1}\ln\left(1-\frac{\kappa(x-\xi)}{\alpha}\right)\right)\right), \kappa\ne 0$ $F(x)=\exp\left(-\exp\left(-\frac{x-\xi}{\alpha}\right)\right), \kappa=0$	ξ : location parameter; α :scale parameter; κ : shape parameter
Generalized pareto	$F(x)=1-\exp\left(\kappa^{-1}\ln\left(1-\frac{\kappa(x-\xi)}{\alpha}\right)\right), \kappa\ne 0$ $F(x)=1-\exp\left(-\frac{x-\xi}{\alpha}\right), \kappa=0$	ξ : location parameter; α :scale parameter; κ : shape parameter
Inverse Gaussian	$F(x)=\frac{1}{2}\left(1+\mathrm{erf}\left(\sqrt{\frac{\alpha}{2x}}\left(\frac{x}{\xi}-1\right)\right)\right)+$ $\frac{1}{2}e^{2\alpha/\xi}\left(1-\mathrm{erf}\left(\sqrt{\frac{\alpha}{2x}}\left(\frac{x}{\xi}+1\right)\right)\right)$ $\mathrm{erf}(x)=\frac{1}{2\sqrt{\pi}}\int_0^x e^{-t^2}dt$	ξ : location parameter; α :scale parameter;
Logistic	$F(x)=\frac{1}{1+\exp(-(x-\xi)/\alpha)}$	ξ : location parameter; α :scale parameter;
Log-logistic	$F(x)=\frac{1}{\sigma}\frac{1}{x}\frac{e^z}{(1+e^z)^2}, z=\frac{\log(x)-\mu}{\sigma}$	μ : mean of logarithmic values; α :scale parameter of logarithmic values;

Lognormal	$F(x)=\frac{1}{2}+\frac{1}{\sqrt{\pi}}\int_0^{\frac{\ln(x)-\xi}{\alpha}} e^{-t^2}dt$	ξ : location parameter; α :scale parameter;
Nakagami	$F(x)=\frac{\int_0^{\kappa x^2/\alpha} t^{\kappa-1}e^{-t}dt}{\int_0^{\infty} t^{\kappa-1}e^{-t}dt}$	α :scale parameter; κ : shape parameter
Normal	$F(x)=\frac{1}{\alpha\sqrt{2\pi}}\int_{-\infty}^{x}\exp\left(-\left(\frac{(x-\xi)^2}{2\alpha^2}\right)\right)dx$	ξ : location parameter; α :scale parameter
Rayleigh	$F(x)=1-\exp\left(-\frac{x^2}{2\alpha^2}\right)$	α :scale parameter
Rician	$F(x)=1-\left(\int_{x/\alpha}^{\infty} t\exp\left(-\left(t^2+(\upsilon/\alpha)^2\right)/2\right)\sum_{k=0}^{\infty}\frac{(\upsilon t/2\alpha)^{2k}}{(k!)^2}dt\right)$	υ: Noncentrality parameter α :scale parameter
T location-scale	$F(x)=\frac{1}{2}+\frac{1}{2}\frac{\int_0^{y^2/(\kappa+y^2)} t^{-1/2}(1-t)^{\kappa/2-1}dt}{\int_0^1 t^{-1/2}(1-t)^{\kappa/2-1}dt}, x\geq 0$ $F(x)=\frac{1}{2}-\frac{1}{2}\frac{\int_0^{y^2/(\kappa+y^2)} t^{-1/2}(1-t)^{\kappa/2-1}dt}{\int_0^1 t^{-1/2}(1-t)^{\kappa/2-1}dt}, x<0 \quad y=\frac{x-\xi}{\alpha}$	ξ : location parameter; α :scale parameter; κ : shape parameter
Weibull	$F(x)=1-\exp(-(\frac{x}{\alpha})^{\kappa}), x\geq 0$ $F(x)=0\,, x<0$	α :scale parameter; κ : shape parameter

Table S2. Goodness-of-fit tests of marginal distribution in the univariate analysis.

Coastal-Estuarine Region	River Discharge				Sea Level			
	Best Distribution	AIC	NSE	p_value	Best Distribution	AIC	NSE	*p*-Value
Bozhiao	Generalized extreme value	1520	0.986	0.501	Rayleigh	-123	0.987	0.657
Hecheng	Generalized extreme value	1714	0.983	0.603	T location-scale	-145	0.969	0.264
Baita	Generalized extreme value	1708	0.987	0.571	Gamma	-146	0.991	0.516
Yangzhongban	Generalized extreme value	1529	0.986	0.523	Birnbaum-Saunders	-199	0.995	0.886
Shilong	Generalized extreme value	1381	0.974	0.395	Logistic	-136	0.998	0.999
Punan	Generalized extreme value	1552	0.994	0.880	Gamma	-208	0.997	0.990
Zhengdian	Generalized extreme value	1429	0.980	0.426	Gamma	-159	0.997	0.975
Dongqiaoyuan	Generalized extreme value	957	0.988	0.543	Logistic	-92	0.995	0.981
Shuangjie	Generalized extreme value	996	0.973	0.511	Inverse Gaussian	-90	0.986	0.629
Huazhou	Generalized extreme value	1021	0.981	0.632	Inverse Gaussian	-96	0.973	0.471
Changle	Generalized extreme value	1573	0.991	0.725	Logistic	-194	0.984	0.405
Luwu	Generalized extreme value	1418	0.978	0.399	Logistic	-181	0.995	0.942
Longtang	Generalized extreme value	1083	0.987	0.829	Generalized pareto	-93	0.975	0.240
Jiaji	Inverse Gaussian	1117	0.973	0.277	Nakagami	-74	0.991	0.974
Baoqiao	Generalized extreme value	1128	0.977	0.511	Inverse Gaussian	-106	0.983	0.651

Table S3. Goodness-of-fit tests of Copula function in the bivariate analysis.

Coastal-Estuarine Region	Candidate Copulas	AIC	*p*-Value
Bozhiao	Gaussian	-689	**0.444**
	Clayton	-693	0.037
	Frank	-691	**0.476**
	Gumbel	-672	**0.558**
	Ali-Mikhail-Haq	**-696**	**0.063**
	Joe	-655	**0.306**
	Farlie-Gumbel-Morgenstern	-694	**0.600**
	Plackett	-688	**0.362**
	Galambos	-672	**0.474**
Baita	Gaussian	-790	**0.347**
	Clayton	-781	**0.087**
	Frank	-796	**0.197**
	Gumbel	-773	**0.387**
	Ali-Mikhail-Haq	-793	**0.088**
	Joe	-756	**0.231**
	Farlie-Gumbel-Morgenstern	**-801**	**0.437**
	Plackett	-793	**0.169**
	Galambos	-774	**0.304**
Dongqiaoyuan	Gaussian	-468	**0.442**
	Clayton	**-479**	**0.511**
	Frank	-467	**0.407**
	Gumbel	-457	**0.207**
	Ali-Mikhail-Haq	-476	**0.541**
	Joe	-448	0.021
	Farlie-Gumbel-Morgenstern	-468	**0.488**
	Plackett	-467	**0.299**
	Galambos	-457	**0.116**
Luwu	Gaussian	-684	**0.2258**
	Clayton	**-702**	**0.8982**
	Frank	-684	**0.1668**
	Gumbel	-673	**0.0684**
	Ali-Mikhail-Haq	-690	**0.4222**
	Joe	-666	0.0064
	Farlie-Gumbel-Morgenstern	-684	**0.1624**
	Plackett	-684	**0.1294**
	Galambos	-673	0.0292
Baoqiao	Gaussian	-421	**0.235**
	Clayton	**-435**	**0.681**
	Frank	-423	**0.158**
	Gumbel	-411	**0.081**
	Ali-Mikhail-Haq	-434	**0.486**
	Joe	-400	0.014
	Farlie-Gumbel-Morgenstern	-422	**0.555**
	Plackett	-423	**0.124**
	Galambos	-410	0.046

Note: The number in bold in "AIC" column represents the corresponding copula is the best copula; The number in bold in "*p*-Value" column represents the corresponding copula passed the CM test at 95 confidence level.

Table S4. The best fitted Copula function in 5 coastal-estuarine regions.

Coastal-Estuarine Region	Best Fitted Copula	Equations
Bozhiao	Ali-Mikhail-Haq	$C(u_1,u_2;\theta)=\prod_{i=1}^{2}u_i/(1-\theta\prod_{i=1}^{2}(1-u_i)),\ \theta=0.849$
Baita	Farlie-Gumbel-Morgenstern	$C(u_1,u_2;\theta)=\prod_{i=1}^{2}u_i\left[1+\theta\prod_{i=1}^{2}(1-u_i)\right],\ \theta=0.991$
Dongqiaoyuan	Clayton	$C(u_1,u_2;\theta)=\max\left(\sum_{i=1}^{2}u_i^{-\theta}-1,0\right)^{-1/\theta},\theta=0.489$
Luwu	Clayton	$C(u_1,u_2;\theta)=\max\left(\sum_{i=1}^{2}u_i^{-\theta}-1,0\right)^{-1/\theta},\theta=0.362$
Baoqiao	Clayton	$C(u_1,u_2;\theta)=\max\left(\sum_{i=1}^{2}u_i^{-\theta}-1,0\right)^{-1/\theta},\theta=0.813$

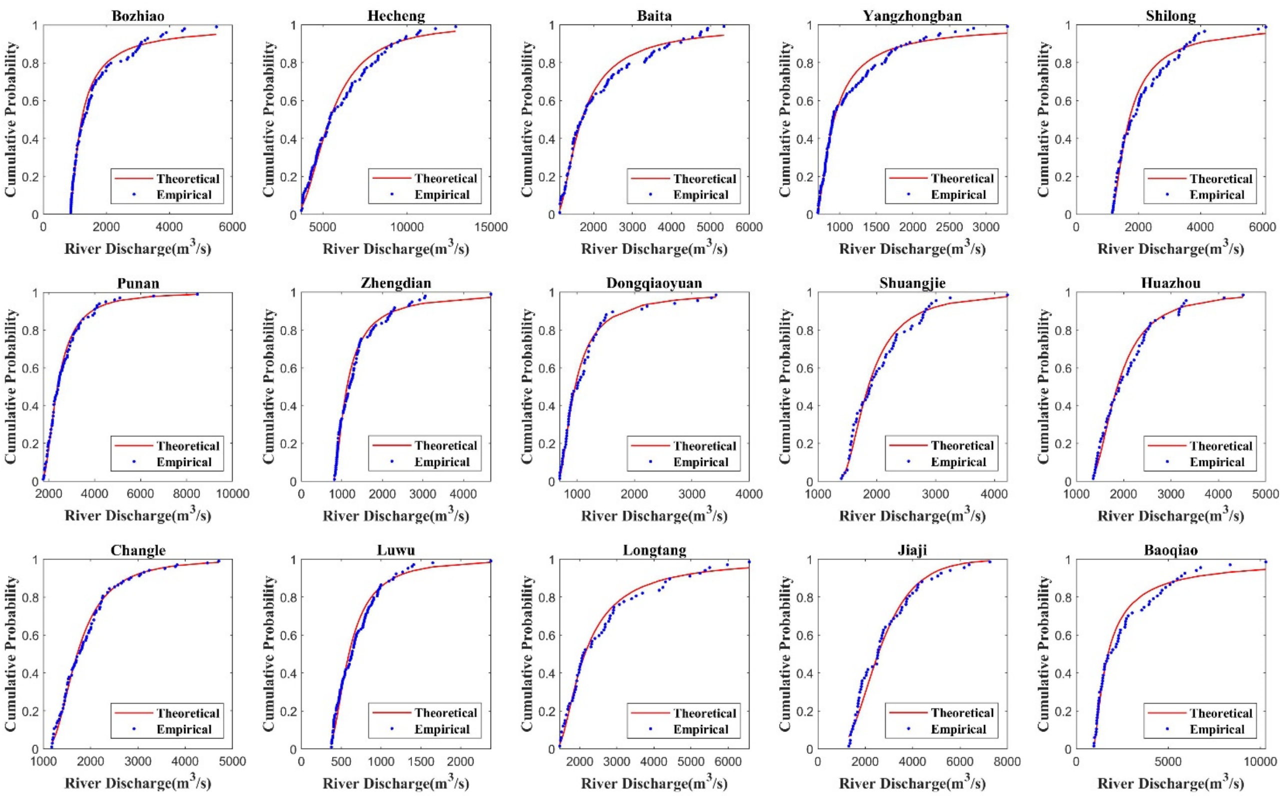

Figure S1. Empirical distribution functions (blue markers) and theoretical distribution function (red lines) of river discharge.

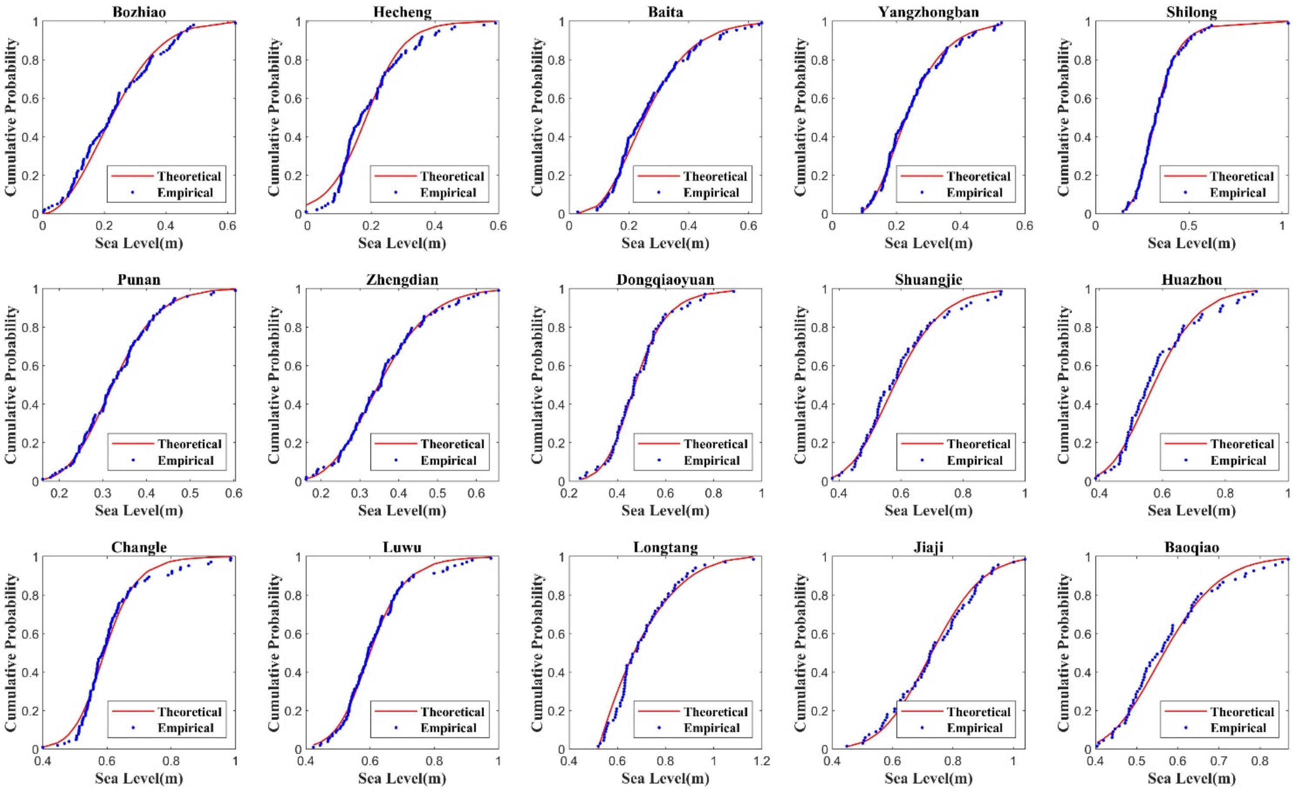

Figure S2. Empirical distribution functions (blue markers) and theoretical distribution function (red lines) of sea level.