Supplementary Information

Reframing water-related ecosystem services flow

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Table S1. Data sources for RSPARROW model

PARAMETRES	TYPES	NAME	SOURCES
Pollution sources	Point source pollution	Sewage discharge Industrial discharge	Longyan, Zhangzhou, Quanzhou Statistical Yearbook-2018(Longyan, Zhangzhou, Quanzhou Municipal Bureau of Statistics, 2018)
	Non-point sources	Fertilizer application Livestock breeding	
		Atmospheric deposition	Field monitoring
	Land use	Built-up area, cropland, forest, shrub, wetlands, barren, grass	http://data.ess.tsinghua.edu.cn/
Land-water delivery factors	Land delivery factor	Precipitation	Longyan Water Resources Bulletin (2017), Zhangzhou Climatic Bulletin (2017), Quzhou Climatic Bulletin (2017)
		Air temperature	http://data.cma.cn/
		Drainage density	Calculated in Arcgis
		Soil clay	http://www.fao.org/home/en/
	Water delivery factor	Riverine delivery Reservoir delivery	Computed by RSPARROW
Others	fixed	Reach length Reach name Headwater reach indicator Station ID Reach total drainage area Reach time of travel Areal hydraulic load for reservoir Alphanumeric station ID	Calculated in Arcgis with Archydro tool

Station name	
Station latitude	
Station longitude	
Mean annual streamflow	By HSPF model
Mean load response variable	By rloadest package in R based on sampling data
Mean load. Response variable standard	

Table S2. Model performance metrics were reported for the conditioned (estimated) and unconditioned (simulated) predictions. Model estimation performance metrics provided the accuracy of the non-linear least square (NLLS) model estimation applied in the Jiulong River watershed while model simulated predictions were computed using mean coefficients from the NLLS model, respectively.

	MSE	RMSE	R^2	R^2_{adj}	R^2_{Yield}	PB
Estimation	0.15	0.39	0.93	0.87	0.92	-5.54
Simulation	0.16	0.40	0.93	0.87	0.92	-7.64

Note: MSE = Mean Sum of Squares of Error, RMSE = Root Mean Sum of Squares of Error, R^2_{adj} = Adjust R2, R^2_{Yield} = Yield R^2 expressed as the R^2 adjusted for the mean log drainage area, PB = Percent Bias, expressed as the ratio of the sum of the model residuals to the sum of the observed load across calibration sites.

Table S3. Parameters selection of the RSPARROW models in the study area.

Type	Selected parameters	Estimate	P-VALUE	VIF
Nitrogen sources	Sewage discharge	2.75	0.04	1.16
	Livestock manure	2.65	0.13	7.47
	Fertilizer	0.40	0.05	5.34
Land delivery factor	Slope	11.37	0.01	6.67
	Drainage density	0.94	0.00	2.92
Water delivery factor	Reach decay1	4.41	0.00	2.30
	Reach decay3	1.67	0.00	3.39

Note: VIF = Variance Inflation Factor, a measure of the importance of multicollinearity in the parameters.

Table S4. Specific information on produced and effluent coefficients.

Items	Livestock		Sewage discharge			Fertilizer application (kg ha^{-1} $year^{-1}$)	Wet deposition (kg $ha^{-1}$$year^{-1}$)
	Cattle (g d^{-1})	Swine (g d^{-1})	Urban (mg L^{-1} $year^{-1}$)	Rural (g L^{-1} $capital^{-1}$ $year^{-1}$)	Industry (kg ha^{-1} $year^{-1}$)		

Produced coefficient	130.62	25.40	32.6-37.8	3.61-4.09	15.5-438.12	0.92-9.63	25.37-38.98
Effluent coefficient	83	12.36	22.67-23.10	3.33-3.74	2-24.45	0.92-9.63	25.37-38.98
Sources	The First China pollution Census		The Second China pollution Census		Statistics Yearbook 2018 in Zhangzhou, Longyan, and Xiamen City		Sampling data

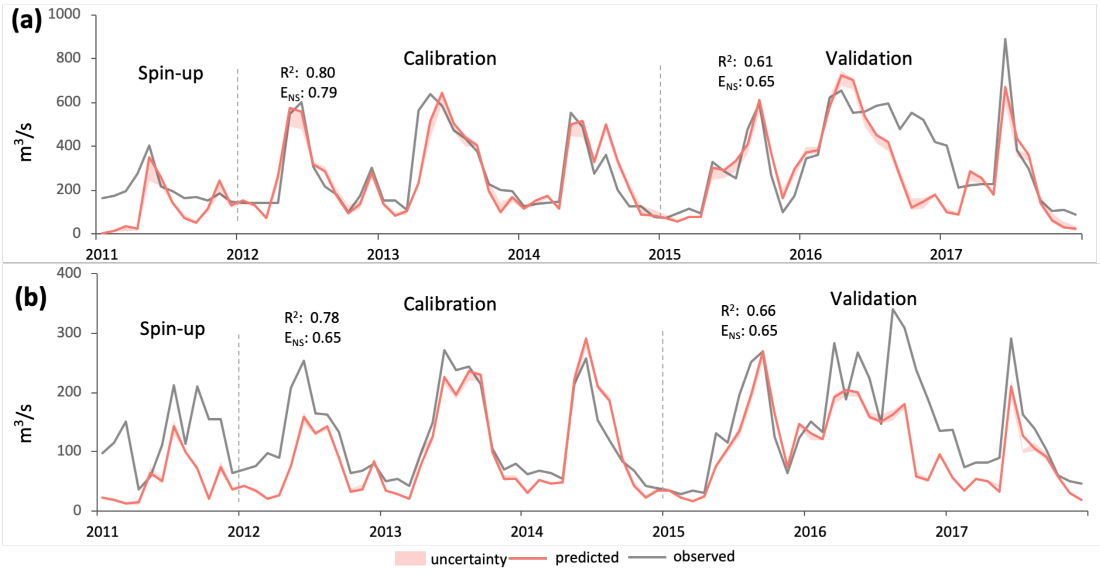

Figure S1. Monthly performance of the Hydrological Simulation Program FORTRAN model in the Jiulong River watershed with uncertainty. Comparison of predicted streamflow with observed data in **(a)** North river and **(b)** in West river from 2011 to 2017. ENS: Nash-Sutcliffe efficiency.

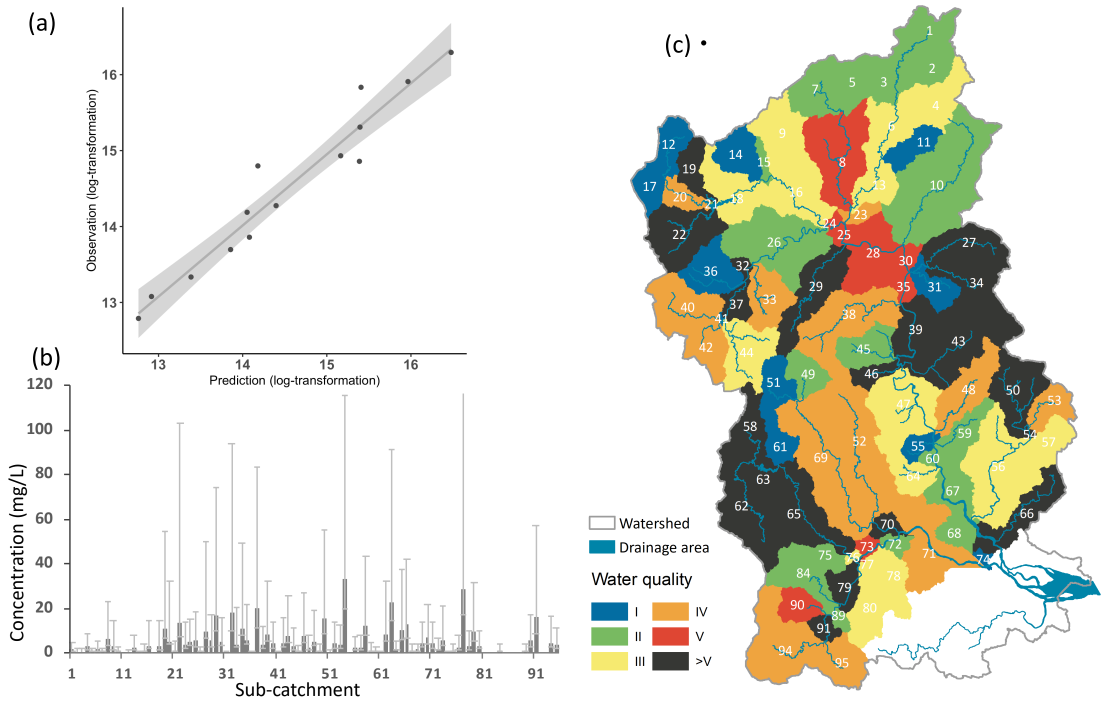

Figure S2. RSPARROW model performance in the study area. Panel **(a)** presents the observed load versus monitoring-adjusted predictions with log-transformation, while panel **(b)** shows the uncertainty analysis (error bar: 90% confidence interval) of total nitrogen concentration in all sub-catchments. Panel **(c)** maps the water quality (under NH_4^+-N). Note: I (NH_4^+-N<= 0.15), II (0.15 < NH_4^+-N<= 0.50), III (0.50< NH_4^+-N <= 1), IV (1.00< NH_4^+-N <= 1.50), V (1.50 < NH_4^+-N <= 2.00), >V (2.00 < NH_4^+-N).

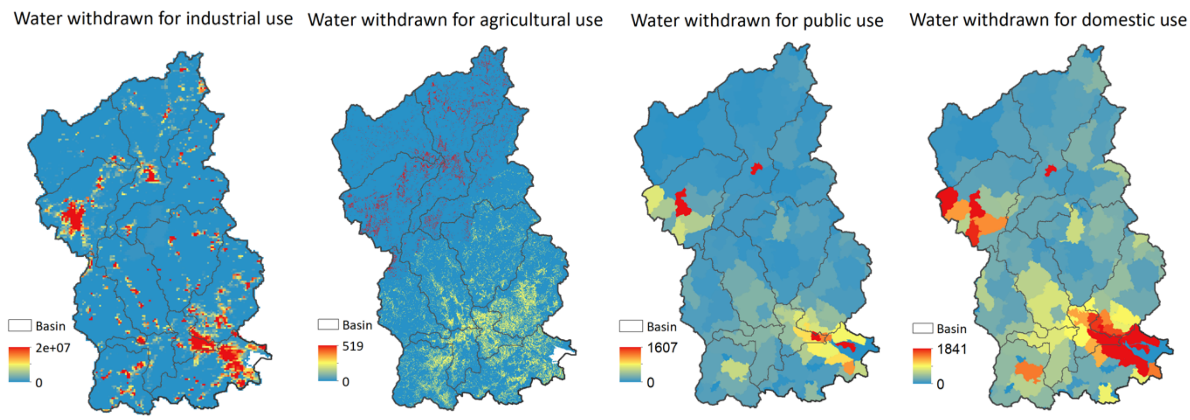

Figure S3. Water withdrawn for industrial use, agricultural use, public use and domestic use (unit: Gigalitre, GL).

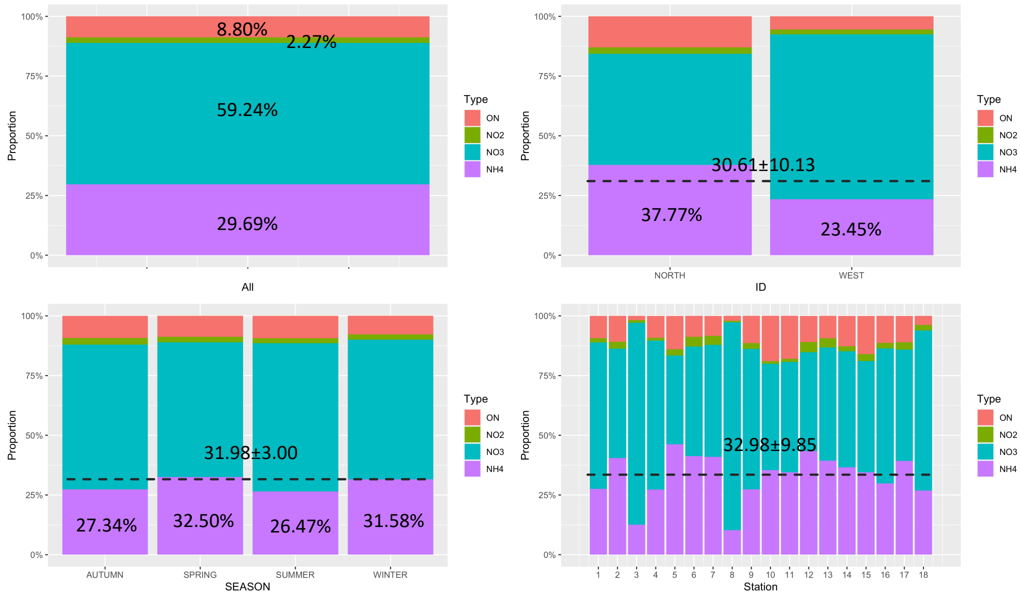

Figure S4. Nitrogen composition in Jiulong River watershed. Numbers in each box show the mean ± 1 standard deviation.

Detailed information of water samples experiment:

The water samples were kept at 4°C and transported to the laboratory. Water samples were immediately filtered through 0.45 μm nucleopore membranes before N analysis. Total nitrogen (TN), ammonia nitrogen (NH_4^+), nitrate (NO_3^-) were determined following standard methods and completed within 24 hours after sampling.

Detailed information of socio-economic data:

All socio-economic data were collected from the Statistics Yearbook in Longyan (2018) and Zhangzhou (2018), the Statistical Communique of Zhangzhou, and Longyan on National Economic and Social Development (2018). We computed an aggregated spatial demand layer according to equation (1) and used the Zonal Statistic tool in ArcGIS to calculate water demand for each basin.