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Fu, H, Gaüzère, P, García Molinos, J et al. (2021) Mitigation of urbanization effects on aquatic ecosystems by synchronous ecological restoration. Water Research, 204. 117587. ISSN: 0043-1354

https://doi.org/10.1016/j.watres.2021.117587

Supplementary information

Mitigation of urbanisation effects on aquatic ecosystems by synchronous ecological restoration

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Figure S1. Land use in Yixing in 2007 and 2017

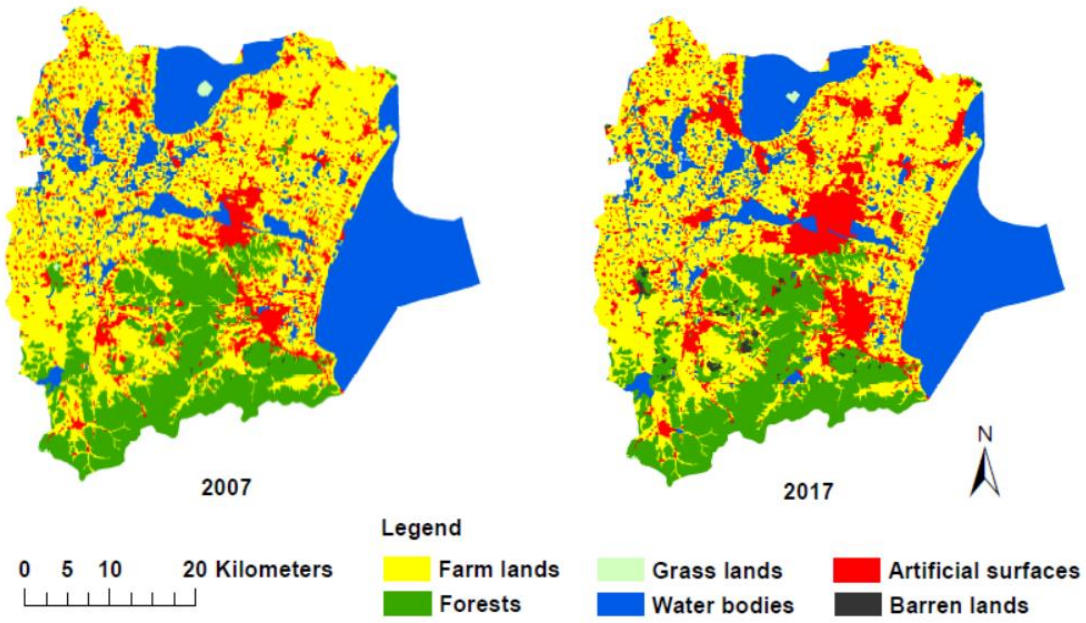

Figure S2 Number of windows containing at least 3 sampling sites and 3-15 restoration project sites. sites over increasing radius size of the region. Green dashed vertical line shows radius size retained for our study (6 km). Red, blue and purple horizontal lines show 25% percentile, 50% percentile, 75% percentile, respectively.

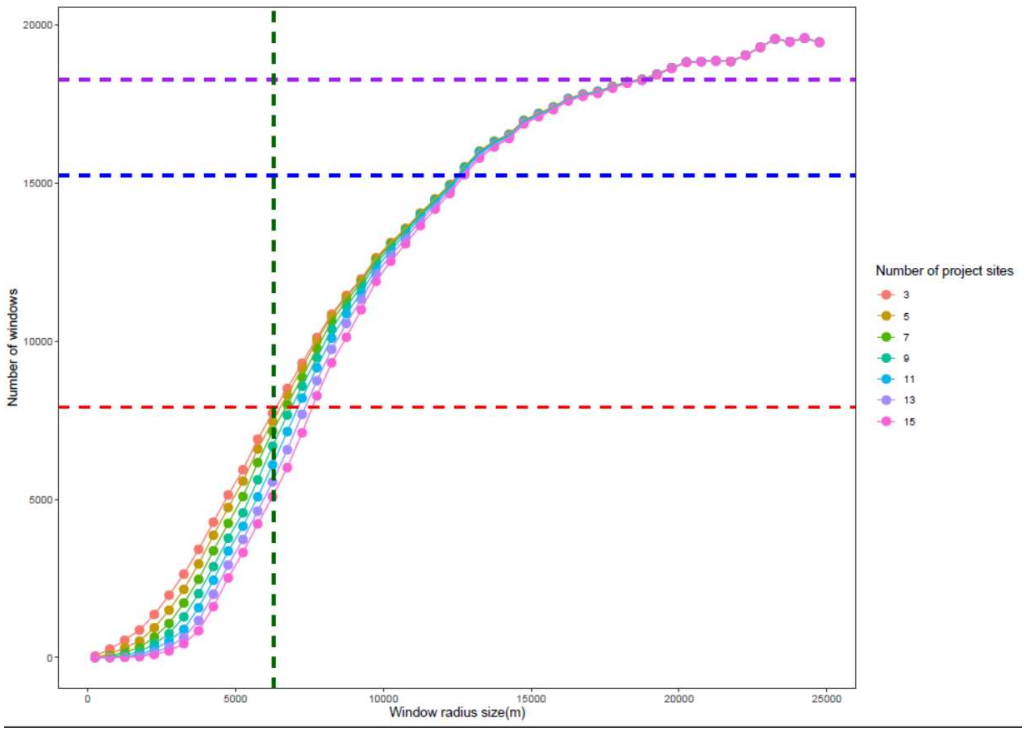

Table S1 Restoration project data collected in Yixing from 2007 to 2017, including type of projects, starting and ending time of every project, the concrete measures, project scale and investments. (Data in grey were not used because there were not specific measures, project scale or those measures can't be calculated and converted into the removal quantity of nitrogen and phosphorus.) (provided as an Excel)

Table S2 Inflation rate, GDP growth, and the real exchange rate of China, during the start year of the restoration projects.

Start year of restoration projects	China (Growth rate, %)		Yuan Real Exchange Rate (RER) (2007 = 100)
	GDP Deflator	Real GDP	
2007	7.8	14.2	100.0
2008	7.8	9.6	115.8
2009	-0.1	9.2	116.7
2011	8.1	9.5	138.1

Note: according to Imai (2018).

Table S3 Land-use transformation matrix of Yixing from 2007 to 2017 (km ^{2})

2017 \ 2007	Farm lands	Forests	Grasslands	Water bodies	Artificial surfaces	Barren lands
Farm lands	849.043	1.482	0.000	0.665	5.643	0.000
Forests	1.380	338.081	0.000	0.003	0.597	0.004
Grasslands	0.000	0.000	2.755	0.006	0.002	0.000
Water bodies	3.115	2.007	0.934	464.320	2.744	0.000
Artificial surfaces	87.097	4.760	0.000	5.172	202.741	0.000
Barren lands	0.758	5.769	0.483	0.001	3.141	0.531

Table S4 Spearman rank (Rs) correlations between ecosystem indices (ΔrNH_4^+-N, ΔrTN, ΔrTP) and project investments of different restoration project categories (***, p<0.001).

Project investments	**Removal quantity of NH_4^+-N**	**Removal quantity of TN**	**Removal quantity of TP**
Pollution sources	0.62***	0.58***	0.56***
Pollution sinks	0.79***	0.83***	0.83***
Agricultural sewage	0.89***	0.89***	0.89***
Industry sewage	0.92***	0.95***	0.94***
Sanitary sewage	0. 70***	0.68***	0.69***

Table S5 Results of the similarity percentage (SIMPER) analysis comparing the composition of macroinvertebrate communities between restored (2017) and degraded (2007). Only the top 8 species contributing the most to overall variation are included (cumulative contribution up to 70%). ava, Average for the restored sites (2017); avb, Average for the degraded sites (2007); cumsum, Ordered cumulative contribution.

Species	**average**	**sd**	**ratio**	**ava**	**avb**	**cumsum**
Limnodrilus hoffmeisteri	0.209	0.258	0.811	5.539	16.290	0.245
Bellamya aeruginosa	0.149	0.145	1.027	6.211	2.556	0.419
Corbicula fluminea	0.069	0.101	0.678	1.804	1.617	0.499
Branchiura sowerbyi	0.059	0.078	0.750	1.760	2.363	0.567
Parafossarulus eximius	0.048	0.061	0.785	2.014	0.326	0.623
Neocaridina denticulata denticulata	0.030	0.053	0.573	1.531	0.000	0.659
Exopalaemon modestus	0.026	0.049	0.531	1.060	0.045	0.689
Nephtys oligobranchia	0.022	0.059	0.365	0.563	0.571	0.715

Table S6 Results of GLMM and LMM for investment of different restoration project categories on each nutrient (ΔrNH_4^+-N, ΔrTN and ΔrTP), with the response ratio of impervious surface area (rISA) as a covariate. Variables are given when a correlation was significant ($P < 0.05$). s_Livst_inv, investment targeting agricultural sewage; s_san_inv, investment targeting sanitary sewage; s_ind_inv, investment targeting industry waste water; sinkPinvstm, investment targeting pollution sink, sourcePinvstm, investment targeting pollution source.

NH_4^+-N	**GLMM (Gamma, link="log"), N=3898, Marginal R^2: 0.20**			
Variables	Estimates	SE	t	P
(Intercept)	-0.72	0.06	-12.18	<0.001
sourcePinvstm	0.42	0.02	26.94	<0.001
sinkPinvstm	-0.12	0.01	-8.85	<0.001
sourcePinvstm: rISA	-0.29	0.02	-13.09	<0.001
sinkPinvstm:rISA	0.25	0.02	11.30	<0.001
TN	**LMM, N=3898, Marginal R^2: 0.21**			
Variables	Estimates	SE	t	P
sourcePinvstm	0.03	0.01	2.55	<0.05
sinkPinvstm	0.28	0.01	22.88	<0.001
rISA	1.09	0.11	9.66	<0.001
sinkPinvstm:rISA	-0.45	0.02	-18.42	<0.001
TP	**LMM, N=3898, Marginal R^2: 0.19**			
Variables	Estimates	SE	t	P
(Intercept)	-0.68	0.09	-7.18	<0.001
sourcePinvstm	0.47	0.02	25.57	<0.001
sinkPinvstm	-0.19	0.02	-9.22	<0.001
rISA	0.56	0.19	2.93	<0.01
sourcePinvstm: rISA	-0.57	0.04	-15.68	<0.001
sinkPinvstm:rISA	0.50	0.04	-15.68	<0.001
NH_4^+-N	**GLMM (Gamma, link="log"), N=3025, Marginal R^2: 0.12**			
Variables	Estimates	SE	t	P
s_Agric_inv	0.24	0.02	11.15	<0.001
s_ind_inv	-0.17	0.04	-4.40	<0.001
s_san_inv	0.12	0.02	7.28	<0.001
rISA	-2.35	2.28	-8.49	<0.001
sinkPinvstm:rISA	0.20	0.03	7.33	<0.001
s_san_inv:rISA	-0.38	0.03	-12.05	<0.001
s_ind_inv:rISA	1.05	0.09	11.93	<0.001

TN	LMM, N=3025, Marginal R^2: 0.30			
Variables	Estimates	SE	t	P
(Intercept)	0.28	0.06	4.45	<0.001
s_san_inv	-0.09	0.01	-8.04	<0.001
sinkPinvstm	0.27	0.01	18.76	<0.001
rISA	0.61	0.16	3.80	<0.001
sinkPinvstm:rISA	-0.43	0.03	-13.80	<0.001
s_san_inv:rISA	0.11	0.02	4.87	<0.001
s_ind_inv:rISA	-0.16	0.02	4.87	<0.001
TP	**LMM, N=3025, Marginal R^2: 0.19**			
Variables	Estimates	SE	t	P
(Intercept)	0.87	0.01	5.53	<0.001
s_Agric_inv	0.25	0.04	5.37	<0.001
s_ind_inv	-0.69	0.04	-18.11	<0.001
s_san_inv	0.26	0.02	14.24	<0.001
rISA	-2.20	0.35	-6.33	<0.001
sinkPinvstm:rISA	0.23	0.05	4.67	<0.001
s_san_inv:rISA	-0.41	0.04	-11.36	<0.001
s_ind_inv:rISA	1.35	0.09	15.39	<0.001

References

Imai, H. 2018. China's rapid growth and real exchange rate appreciation: Measuring the Balassa-Samuelson effect. Journal of Asian Economics 54, 39-52.