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Globally elevated greenhouse gas emissions from polluted urban rivers

In the format provided by the authors and unedited

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Supplementary Tables

Supplementary Table 1. Mean ± standard deviation (SD), median, and range of GHG concentrations and fluxes and related physicochemical properties across global urban and non-urban rivers. The n represents the number of samples. Note: Global non-urban data of GHG concentrations and fluxes as well as water chemistry variables are derived from the Global River Methane database (GRiMeDB, measurements from sites apparently affected by human or thermogenic activities were excluded)[1].

	Global urban river dataset				GRiMeDB[1]			
	Mean ± SD	Median	Range	n	Mean ± SD	Median	Range	n
Concentrations								
CH_4 (μmol L^{-1})	4.7 ± 18.8	0.5	0.01–311.4	809	1.3 ± 10.0	0.1	0.0003–398.7	2,106
CO_2 (μmol L^{-1})	191.0 ± 379.0	90.0	0.1–4,250.6	829	126.0 ± 150.0	70.0	0.1–1,894.3	1,282
N_2O (nmol L^{-1})	125.6 ± 317.6	37.7	0.3–4,827.0	644	14.6 ± 25.4	9.0	0.2–343.1	542
Fluxes								
Diffusive CH_4 (mmol m^{-2} d^{-1})	11.4 ± 43.9	1.4	0.01–663.5	914	5.0 ± 24.8	0.3	-136.2–414.5	669
CO_2 (mmol m^{-2} d^{-1})	486.3 ± 1,354.0	160.4	-221.6–16,576.3	1,034	494.2 ± 1,451.0	195.0	-240.0–23,748.5	394
N_2O (μmol m^{-2} d^{-1})	202.8 ± 538.4	37.8	-30.5–6,436.9	860	63.4 ± 305.2	8.7	-177.0–2819.1	112
Water physicochemical properties								
TP (mg L^{-1})	0.5 ± 0.8	0.2	0.01–9.6	669	0.1 ± 0.1	0.03	0.001–1.2	442
TN (mg L^{-1})	6.8 ± 6.1	5.2	0–44.5	608	1.0 ± 1.6	0.5	0.0008–12.7	537
NO_3^- (mg N L^{-1})	3.2 ± 5.2	1.5	0–57.0	947	0.5 ± 1.2	0.1	0.00003–13.3	771
DOC (mg L^{-1})	8.5 ± 10.3	6.0	0.3–109.7	862	8.4 ± 10.2	4.7	0.1–67.7	1,183
NH_4^+ (mg N L^{-1})	3.2 ± 7.6	0.6	0–77.0	789	0.1 ± 0.5	0.03	0.0002–10.1	703
DO (mg L^{-1})	7.7 ± 3.7	7.7	0.2–22.8	1,082	8.0 ± 2.9	8.5	0.1–18.2	841
DOC:NO_3^-	20.8 ± 92.8	5.0	0.2–1,725	670	2405.7 ± 19,780.8	106.8	0.2–437,557.2	591
pH	7.7 ± 0.6	7.8	5.9–10.0	966	6.9 ± 1.2	7.0	2.5–10.7	1,154

Supplementary Table 2. Published estimates for GHG concentrations and fluxes for global river networks.

Reference		2	3	4	5	6	7	8	9	10	11
CO_2	Concentration (μmol L^{-1})	–	139.7	108.2	–	–	–	–		–	–
	Flux (mmol m^{-2} d^{-1})	240.6	–	359	–	–	–	–		–	–
CH_4	Concentration (μmol L^{-1})	–	–	–	1.4	–	–	–		–	–
	Diffusive flux (mmol m^{-2} d^{-1})	8.4	–	–	8.2	4.8	–	–		–	–
	Total flux (mmol m^{-2} d^{-1})	–	–	–	–	–	11.4	–		–	–
N_2O	Concentration (nmol L^{-1})	–	–	–	–	–	–	38.9 (28.9)	51.9	–	–
	Flux (μmol m^{-2} d^{-1})	109.1	–	–	–	65.5–76.4	–	–	41.1	6.8	4.9

Supplementary Table 3. Comparing GHG concentrations and fluxes from paired urban and non-urban rivers from the literature. Number before and after slash (/) denotes the mean, median or range from urban and corresponding non-urban rivers, respectively.

Refs.	CO_2		CH_4		N_2O		Non-urban type	Region
	Concentration (μmol L^{-1})	Flux (mmol m^{-2} d^{-1})	Concentration (μmol L^{-1})	Flux (mmol m^{-2} d^{-1})	Concentration (nmol L^{-1})	Flux (μmol m^{-2} d^{-1})		
12	671/231.4–479.3	895.7/501.4	5.5/0.3–0.6	7.1/1.2	408/42.1–99.5	471.2/34.3	Agricultural/Forested/Mixed	Chaohu Lake basin, China
13	–	–	–	–	171/84	160/70	Rural/ Agricultural	Chaohu Lake basin, China
14	–	–	0.4/0.2	45.6/17.5	–	–	Agricultural	Chaohu Lake basin, China
15	–	–	5.5/0.9	9.4/1.2	–	–	Agricultural/Forested/Mixed	Chaohu Lake basin, China
16	281.9/240.8	671.1/642.5	0.9/0.3	4.6/1.0	–	–	Headwater/Suburban/Rrual	Shanghai river network, China
17–19	114.6/60.1	623.7/232.1	1.0/0.2	2.1/0.5	–	391/76.3	Forested & Farmland-dominated	Chongqing river network, China
20	–	–	3.6/0.7	8.9/2.0	–	–	Agricultural/Mixed	Chongqing river network, China
21	–	–	–	–	91.0/6.2	50.4/-5.5	Rural	Tianjin river network, China
22	–	–	–	–	34.7–65.3/ 40.9–118.6	25.1/140.1	Agricultural	Taihu Lake basin, China
23	–	–	–	–	244.5/21.5	521.7/16.2	Agricultural/Forested	Changjiang River basin, China Jiulong River basin, China Chaohu Lake basin, China
24–25	105.8/83.5	388.8/181.2	0.4/0.2	0.9/0.5	19.0/11.4	2.7/1.0	Agricultural/Vegetation	72 streams, USA
26	–	–	–	–	–	140.2/43.9	Till & Clay plain/Recharge	Grand River, Canada
27–28	1,748/907	74.5/34.5	1.1/0.4	1.3/0.4	50.0/14.7	340.1/13.7	Nature/Industry/Agriculture/Road	Cuenca River, Ecuador
29	–	–	–	–	13.9/10.3	26.1/10.3	Agricultural/Forest	Yellow River basin, China
30	152.9/137.3	–	0.8/0.2	–	30.4/24.4	–	Forest/Wetland/Agriculture	Great Bay watershed, USA
31	129.5/125.4	–	0.07/0.03	–	19.6/11.4	–	Agriculture/Forest/Mixed	New South Waters, Australia
32	216.2/130.5	–	2.6/0.2	–	104.8/37.9	–	Agricultural/Forested	Han River, Korea
33	155.9/142.9	–	–	–	–	–	Upstream the city	Acre River, Brazilian Amazon
34	–	–	–	–	–	18.6/3.8	Agricultural/Rural	Xi River, China
35	–	–	64.6/0.8	294.2/2.4	–	–	Agriculture/Forest	Krishna River basin, India
36	49.0/29.1	–	0.1/0.1	–	–	–	Woodland/Grassland/Arable	Kelvin River, Scotland

Supplementary Table 4. Global geospatial datasets used in this analysis.

Variable	Dataset	Spatial resolution	Temporal resolution	Reference
Temperature and precipitation	WorldClim (version 2)	1 km	Month	37
Elevation and slope	Global Topography	1 km	–	38
GDP and GDP per capita	Gridded global datasets for gross domestic product and human development index	5 arc-min	Year	39
Population density	Gridded Population of the World (version 4)	1 km	5-year	40
GPP and NPP	MODIS (MOD17) Gross/Net Primary Production	1/5 km	Year/month	41
Soil respiration rates	Global gridded soil respiration	0.5°downscaled to 1 km (30 secs)	Year/month	42

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