Global Biogeochemical Cycles

Supporting Information for

Temperature and organic matter quantity drive CO_2 and CH_4 fluxes in isolated pools of non-perennial rivers

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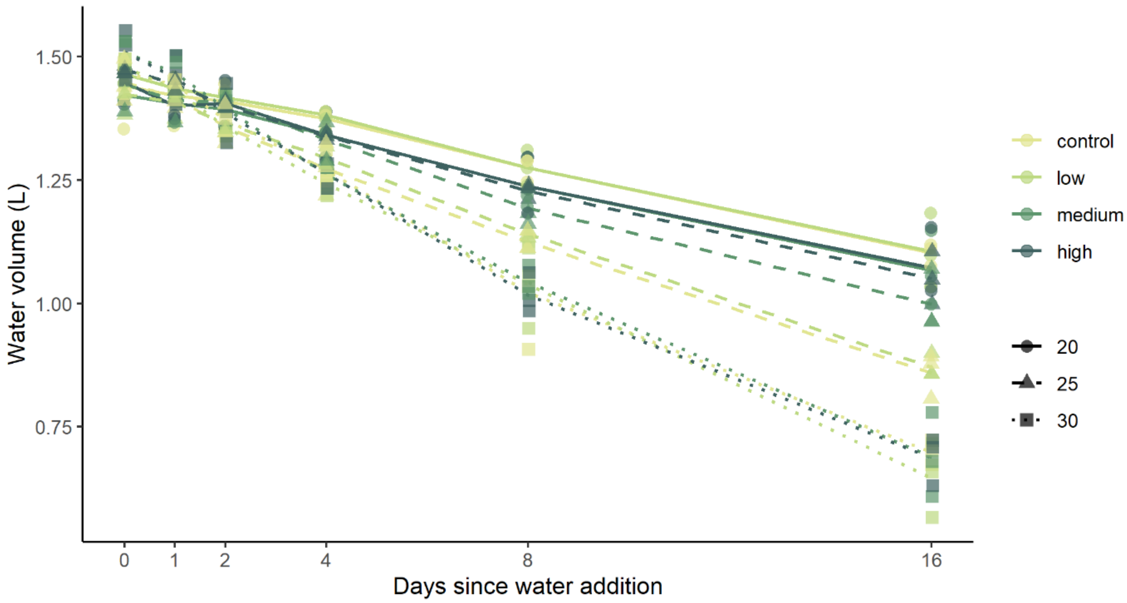

Figure S1. Evolution of the water volume (L) in the mesocosms over time, depicting an decrease in water volume over time, particularly at the 30°C treatment due to water evaporation.

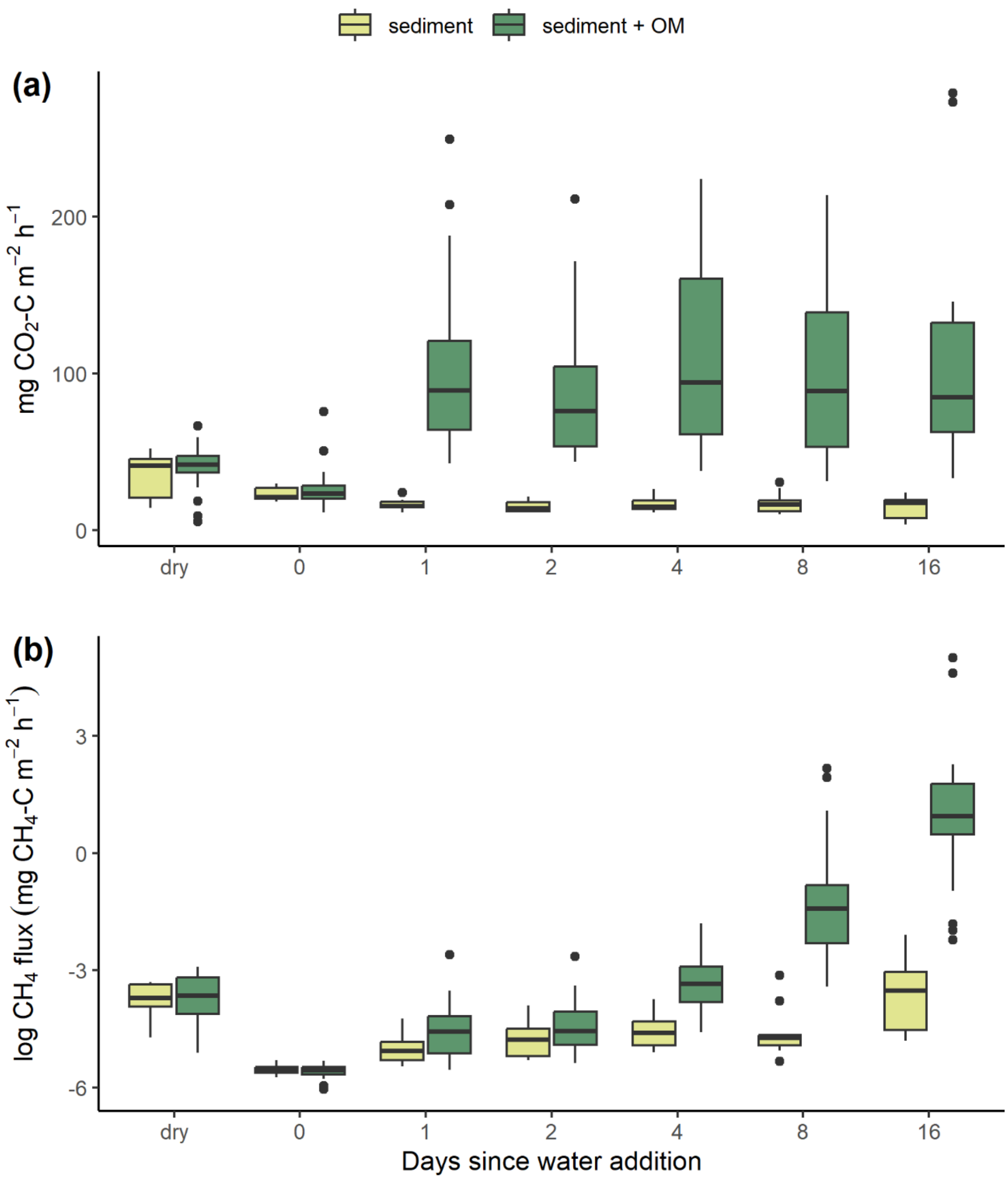

Figure S2. CO_2 (A) and CH_4 (B) fluxes in simulated isolated pools by the presence or absence of organic matter in addition to sediments. Note that CH_4 fluxes are $\log_{(x+xmin)}$ transformed, and one outlying CH_4 value of -0.0034 mg CH_4-C m^{-2} h^{-1} from 2022-07-26 (sediment) is excluded for figure readability.

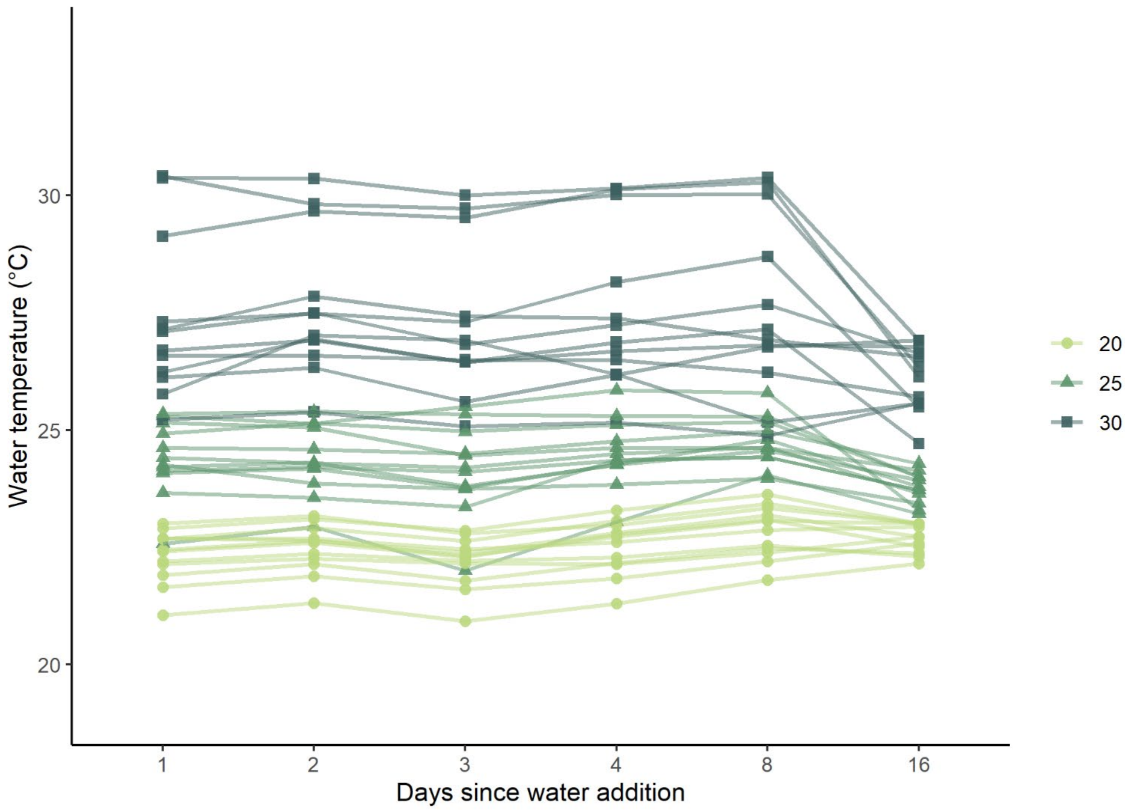

Figure S3. Intra-treatment variability in water temperature (°C) over the experiment grouped by the temperature treatments (20, 25, and 30°C). Daily average iButton datalogger values were used from day 1 to 8, and point measurements (corrected by the linear relationship between the two measurements) during GHG sampling were used for day 16 as evaporation led to some of the dataloggers being out of the water. This evaporation (Figure S1) also resulted in some of the temperature controllers being out of the water, explaining the decline in temperature in the 30°C treatment at the last sampling time.

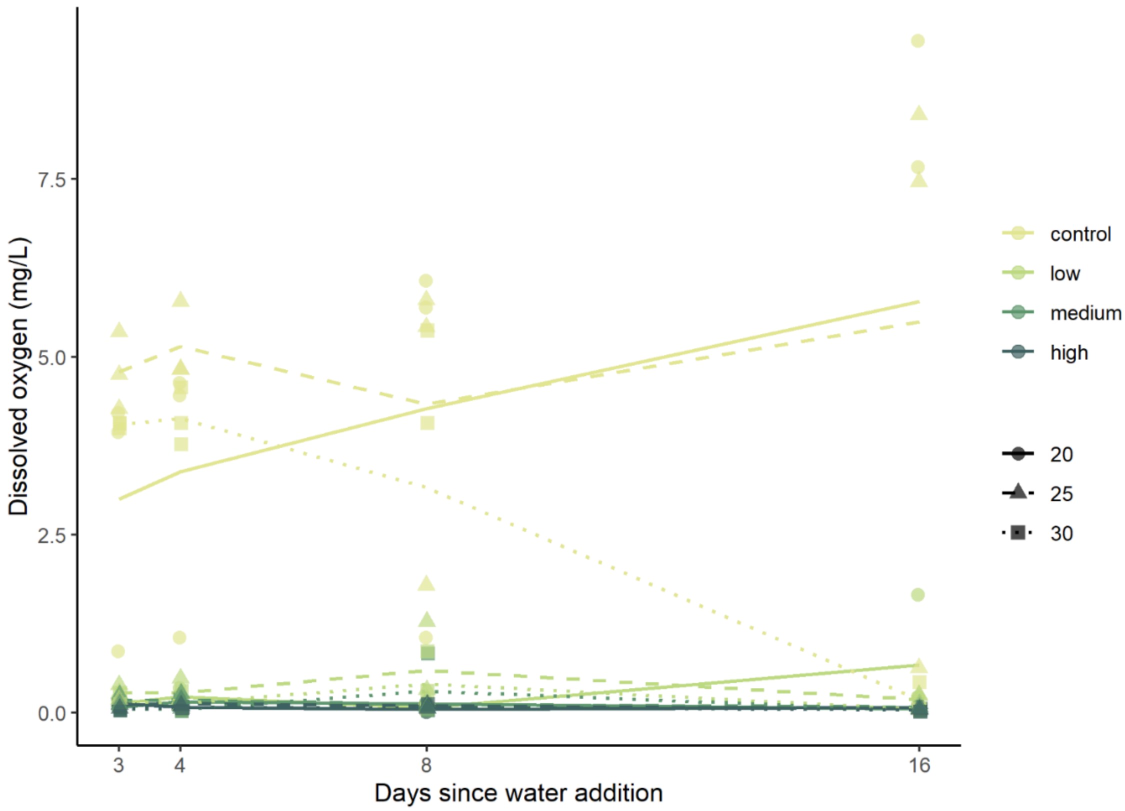

Figure S4. Dissolved oxygen (%) concentrations per treatment from 3 days after the wetting of the sediments to the end of the experiment. Lines connect the mean values per treatment combination.

	Mean ± SD
Organic matter (%)	7.02 ± 0.25
pH	8.46 ± 0.33
Conductivity (µs cm-1)	114.70 ± 53.74

Table S1. Characteristics of the sediments from a non-perennial river reach prior to the mesocosm experiment.

Organic matter	Temperature	mg CO_2-C m^{-2} h^{-1}	mg CH_4-C m^{-2} h^{-1}
control	20	13.34 ± 4.25	0.006 ± 0.01
control	25	12.61 ± 3.71	0.006 ± 0.006
control	30	21.06 ± 4.24	0.025 ± 0.030
low	20	43.64 ± 9.50	0.038 ± 0.052
low	25	53.59 ± 11.56	0.22 ± 0.45
low	30	62.82 ± 10.94	0.57 ± 1.10
medium	20	74.68 ± 16.67	0.36 ± 0.68
medium	25	105.55 ± 26.88	0.54 ± 0.97
medium	30	112.57 ± 25.19	1.89 ± 3.00
high	20	116.06 ± 39.31	0.87 ± 1.83
high	25	144.53 ± 42.69	1.08 ± 2.09
high	30	186.66 ± 53.10	18.13 ± 44.13
Average		78.93 ± 55.06	1.98 ± 4.53

Table S2. Mean (± standard deviation) CO_2 and CH_4 fluxes per temperature (°C) and organic matter treatments, over the entire 16-day experiment, excluding dry sediment and t0 (immediately after wetting) values.

	β	SE	df	t	p
t2	0.001	0.12	90.44	0.01	0.99
t4	0.002	0.12	90.44	0.02	0.98
t8	0.002	0.12	90.44	0.02	0.98
t16	0.016	0.12	90.44	0.13	0.90
OM_{low}	0.003	0.13	111.30	0.02	0.98
OM_{med}	0.003	0.13	111.30	0.03	0.98
OM_{high}	0.003	0.13	111.30	0.02	0.98
Temp 25	0.001	0.13	111.30	0.01	1.00
Temp 30	0.005	0.13	111.30	0.04	0.97
t2 * OM_{low}	-0.001	0.17	90.44	-0.01	1.00
t4 * OM_{low}	0.004	0.17	90.44	0.02	0.98
t8 * OM_{low}	0.028	0.17	90.44	0.16	0.87
t16 * OM_{low}	0.104	0.17	90.44	0.61	0.55
t2 * OM_{med}	0.001	0.17	90.44	0.01	0.99
t4 * OM_{med}	0.01	0.17	90.44	0.08	0.94
t8 * OM_{med}	0.11	0.17	90.44	0.67	0.51
t16 * OM_{med}	**0.95**	**0.17**	**90.44**	**5.52**	**<0.001**
t2 * OM_{high}	-0.001	0.17	90.44	0.00	1.00
t4 * OM_{high}	0.02	0.17	90.44	0.10	0.92
t8 * OM_{high}	0.17	0.17	90.44	0.98	0.33
t16 * OM_{high}	**1.57**	**0.17**	**90.44**	**9.16**	**<0.001**
t2 * Temp 25	0.001	0.17	90.44	0.00	1.00
t4 * Temp 25	0.001	0.17	90.44	0.01	0.99
t8 * Temp 25	-0.001	0.17	90.44	-0.01	1.00
t16 * Temp 25	-0.004	0.17	90.44	-0.02	0.98
t2 * Temp 30	0.004	0.17	90.44	0.02	0.98
t4 * Temp 30	0.01	0.17	90.44	0.04	0.97
t8 * Temp 30	0.01	0.17	90.44	0.07	0.94
t16 * Temp 30	0.05	0.17	90.44	0.26	0.79
OM_{low} * Temp 25	-0.0001	0.18	111.30	0.00	1.00
OM_{med} * Temp 25	0.003	0.18	111.30	0.02	0.99
OM_{high} * Temp 25	0.02	0.18	111.30	0.11	0.92
OM_{low} * Temp 30	0.004	0.18	111.30	0.02	0.98
OM_{med} * Temp 30	-0.0003	0.18	111.30	0.00	1.00
OM_{high} * Temp 30	0.001	0.18	111.30	0.01	1.00
t2 * OM_{low} * Temp 25	0.001	0.24	90.44	0.00	1.00
t4 * OM_{low} * Temp 25	0.01	0.24	90.44	0.03	0.98
t8 * OM_{low} * Temp 25	0.07	0.24	90.44	0.28	0.78
t16 * OM_{low} * Temp 25	**0.51**	**0.24**	**90.44**	**2.11**	**0.04**

t2 * OM_{med} * Temp 25	-0.004	0.24	90.44	-0.02	0.99
t4 * OM_{med} * Temp 25	0.02	0.24	90.44	0.07	0.95
t8 * OM_{med} * Temp 25	0.11	0.24	90.44	0.46	0.65
t16 * OM_{med} * Temp 25	0.23	0.24	90.44	0.96	0.34
t2 * OM_{high} * Temp 25	-0.02	0.24	90.44	-0.08	0.93
t4 * OM_{high} * Temp 25	-0.01	0.24	90.44	-0.06	0.95
t8 * OM_{high} * Temp 25	0.11	0.24	90.44	0.47	0.64
t16 * OM_{high} * Temp 25	0.16	0.24	90.44	0.65	0.52
t2 * OM_{low} * Temp 30	0.01	0.24	90.44	0.04	0.97
t4 * OM_{low} * Temp 30	0.02	0.24	90.44	0.08	0.94
t8 * OM_{low} * Temp 30	0.15	0.24	90.44	0.61	0.55
t16 * OM_{low} * Temp 30	**1.06**	**0.24**	**90.44**	**4.38**	**<0.001**
t2 * OM_{med} * Temp 30	0.004	0.24	90.44	0.02	0.99
t4 * OM_{med} * Temp 30	0.04	0.24	90.44	0.18	0.85
t8 * OM_{med} * Temp 30	**1.00**	**0.24**	**90.44**	**4.12**	**<0.001**
t16 * OM_{med} * Temp 30	**1.06**	**0.24**	**90.44**	**4.39**	**<0.001**
t2 * OM_{high} * Temp 30	0.01	0.24	90.44	0.03	0.98
t4 * OM_{high} * Temp 30	0.07	0.24	90.44	0.30	0.77
t8 * OM_{high} * Temp 30	**1.44**	**0.24**	**90.44**	**5.96**	**<0.001**
t16 * OM_{high} * Temp 30	**2.93**	**0.27**	**96.32**	**10.73**	**<0.001**

Table S3. The complete model output including the estimate (*β*), standard error (*SE*), degrees of freedom (*df*), t-value (*t*), and p-value (*p*) of the fixed effects from the top linear mixed model (LMM), ranked by AIC, explaining the effects of organic matter (OM) quantity, water temperature (Temp; °C), and time (t; days since wetting) on CH_4 fluxes from mesocosms simulating isolated pools. Note that this analysis excludes data from the reference period (dry) and initial wetting (t0). CH_4 flux was log(x) transformed, and two outliers were removed from the CH_4 dataset based on Cook's Distance. Statistical significance of a model term is indicated in bold.

	β	SE	p
Temp 25	0.43	0.46	0.36
Temp 30	-0.89	0.46	0.06
OM_{low}	**-2.93**	**0.46**	**<0.001**
OM_{med}	**-3.41**	**0.46**	**<0.001**
OM_{high}	**-3.68**	**0.46**	**<0.001**
t4	0.04	0.21	0.84
t8	-0.13	0.21	0.55
t16	**-0.66**	**0.21**	**0.003**
Temp 25 * OM_{low}	0.10	0.65	0.87
Temp 30 * OM_{low}	0.56	0.65	0.40
Temp 25 * OM_{med}	-0.20	0.65	0.76
Temp 30 * OM_{med}	0.22	0.65	0.73
Temp 25 * OM_{high}	-0.21	0.65	0.75
Temp 30 * OM_{high}	0.51	0.65	0.44

Table S4. The model estimate (β), standard error (SE) and p-value (p) of the fixed effects from the linear mixed model (LMM) the effects of temperature (Temp; °C), organic matter (OM) quantity, and time (t; days since wetting) on dissolved oxygen concentration (DO; mg L^{-1}) in mesocosms simulating isolated pools. The model has a marginal R^2 of 0.69. Note that the reference date is 2022-07-29, the 3rd day of our experiment. Dissolved oxygen concentration was log(x) transformed. Statistical significance of a model term is indicated in bold.

Watercourse type/ Location	CO_2 flux (mg CO_2-C m^{-2} h^{-1})	Reference	CH_4 flux (mg CH_4-C m^{-2} h^{-1})	Reference
Dry streambeds/ Global	64.09	Keller et al., 2020	0.29	Paranaíba et al., 2021
Lentic/ Global	13.51	Raymond et al., 2013; Deemer et al., 2016	-	-
Lotic waters/ Global	331.50	Raymond et al., 2013	-	-
Inland waters/ Global	-	-	1.29	Zheng et al., 2022
Temporary ponds/ Mediterranean	53.94	Obrador et al., 2018	0.18	Obrador et al., 2018
Temporary ponds/ Mediterranean	60.10	Catalán et al., 2014	-	-
Isolated pools/ Mediterranean	8.61	Gómez-Gener et al., 2015	0.05	Gómez-Gener et al., 2015
Isolated pools/ mesocosms	78.93	This study	1.98	This study
Isolated pools/ mesocosms	15.67	This study – only sediments	0.04	This study – only sediments

Table S5. Comparison summary of mean CO_2 and CH_4 fluxes for isolated pools, temporary ponds, dry streambeds, and perennial lotic and lentic waters worldwide.