

Supporting materials

Synergistic effect of lanthanum-modified bentonite and *Vallisneria spiralis* on antimony immobilization in aquatic environments

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Tables

Table S1 Four-step sequential extraction and pseudo-total digestion protocols.

Step	Extract	Materials and reagents	Extraction time (h)	Heavy metal(loid)s form
F1	40mL 0.01 mol/L CH ₃ COOH	CH ₃ COOH(AR,Shanghai Hushi Laboratory Equipment Co., China)	25°C, 16h	weak-acid extractable
F2	40mL 0.1 mol/L NH ₂ OH·HCl, pH=1.5	NH ₂ OH·HCl(AR,Shanghai Hushi Laboratory Equipment Co., China)	25°C, 16h	reducible
F3	5mL 8.8 mol/L H ₂ O ₂ , pH=2, 2 h, 85°C ± 2°C (near dryness);	H ₂ O ₂ (3%,Shanghai Aladdin Biochemical Technology Co., China)	25°C, 16h	oxidizable
	25 mL 1 mol/L NH ₄ CH ₃ COO, pH=2	NH ₄ CH ₃ COO (AR,Shanghai Aladdin Biochemical Technology Co., China)		
F4	4.5 mL HCl + 1.5 mL HNO ₃	HCL(36~38%,Shanghai Hushi Laboratory Equipment Co., China) HNO ₃ (65~68%,Shanghai Hushi Laboratory Equipment Co., China)	120°C, 1h	Residual= F4-F1-F2-F3

Table S2 Parameters of isotherm models for Sb(III) and Sb(V) on LMB.

Samples	Isotherm models									
	Langmuir			Freundlich			Dubinin-Radushkviech			
	q_m	K_l	R^2	K_f	$1/n$	R^2	q_m	K_d	E	R^2
Sb(V)	17.3011	0.0085	0.9779	0.5773	0.2594	0.8656	11.6845	0.0006	29.0111	0.9266
Sb(III)	30.4475	0.0046	0.9709	0.5920	0.2791	0.9011	17.9648	0.0018	16.8073	0.9329

Table S3 Changes of functional groups before and after LMB adsorption of Sb in XPS spectra.

Functional groups	Ratio of samples(%)		
	LMB	LMB+Sb(V)	LMB+Sb(III)
La-O	65.11	52.20	66.63
La-O-H	34.89	47.80	33.37
Me-O	17.14	27.57	12.44
Me-O-H	54.27	52.54	63.38
H-O-H	28.20	19.89	23.67

Table S4 The effects of lanthanum-modified bentonite (LMB) and *Vallisneria spiralis* (*V. spiralis*) on soluble Sb in overlying water.

Group	Time(day)	Mean value in the whole profile	Sb Reduction rate (%)	Mean Value in the overlying water	Sb Reduction rate (%)
Control	15	0.28	–	1.24	–
	35	0.21	–	1.92	–
	66	0.25	–	2.59	–
LMB	15	0.13	24.97	0.53	57.10
	35	0.37	23.37	1.25	34.75
	66	0.28	20.54	2.10	18.97
<i>V. spiralis</i>	15	0.24	13.23	0.74	40.28
	35	0.23	36.54	0.72	62.38
	66	1.19	–0.13	2.03	21.93
LMB+ <i>V. spiralis</i>	15	0.94	55.33	0.14	88.94
	35	1.19	38.71	0.56	70.75
	66	1.19	0.08	1.96	24.27

Table S5 Changes in the concentrations of Sb, Fe and Mn after adding Lanthanum-modified bentonite (LMB) and *Vallisneria spiralis* (*V. spiralis*) ($\mu\text{g/L}$).

Time(day)	Groups	Sb		Fe		Mn	
		Average	Reduction rate	Average	Reduction rate	Average	Reduction rate
15	Control	0.52	–	743.42	–	1588.26	–
	LMB	0.39	–25.37%	544.38	–26.77%	1334.61	–15.97%
	<i>V. spiralis</i>	0.48	–7.32%	404.82	–45.55%	776.22	–51.13%
	LMB+ <i>V. spiralis</i>	0.21	–60.21%	93.82	–87.38%	322.63	–79.69%
35	Control	0.84	–	639.48	–	1783.59	–
	LMB	0.76	–8.73%	479.49	–25.02%	1621.21	–9.10%
	<i>V. spiralis</i>	0.48	–42.55%	594.99	–6.96%	1631.93	–8.50%
	LMB+ <i>V. spiralis</i>	0.41	–50.66%	430.92	–32.61%	918.40	–48.51%
66	Control	2.04	–	740.23	–	1802.07	–
	LMB	1.27	–38.12%	492.15	–33.51%	1665.70	–7.57%
	<i>V. spiralis</i>	1.31	–36.02%	448.30	–39.44%	1073.22	–40.45%
	LMB+ <i>V. spiralis</i>	1.42	–30.63%	121.10	–83.64%	631.85	–64.94%

Table S6 Changes of *Vallisneria spiralis* weight on days 15, 35 and 66.

<i>V. spiralis</i> weight (mg DW)	Initial	15		35		66	
		<i>V. spiralis</i>	LMB+ <i>V. spiralis</i>	<i>V. spiralis</i>	LMB+ <i>V. spiralis</i>	<i>V. spiralis</i>	LMB+ <i>V. spiralis</i>
	31.87	33.91	33.32	56.34	54.21	70.38	93.24

Figures

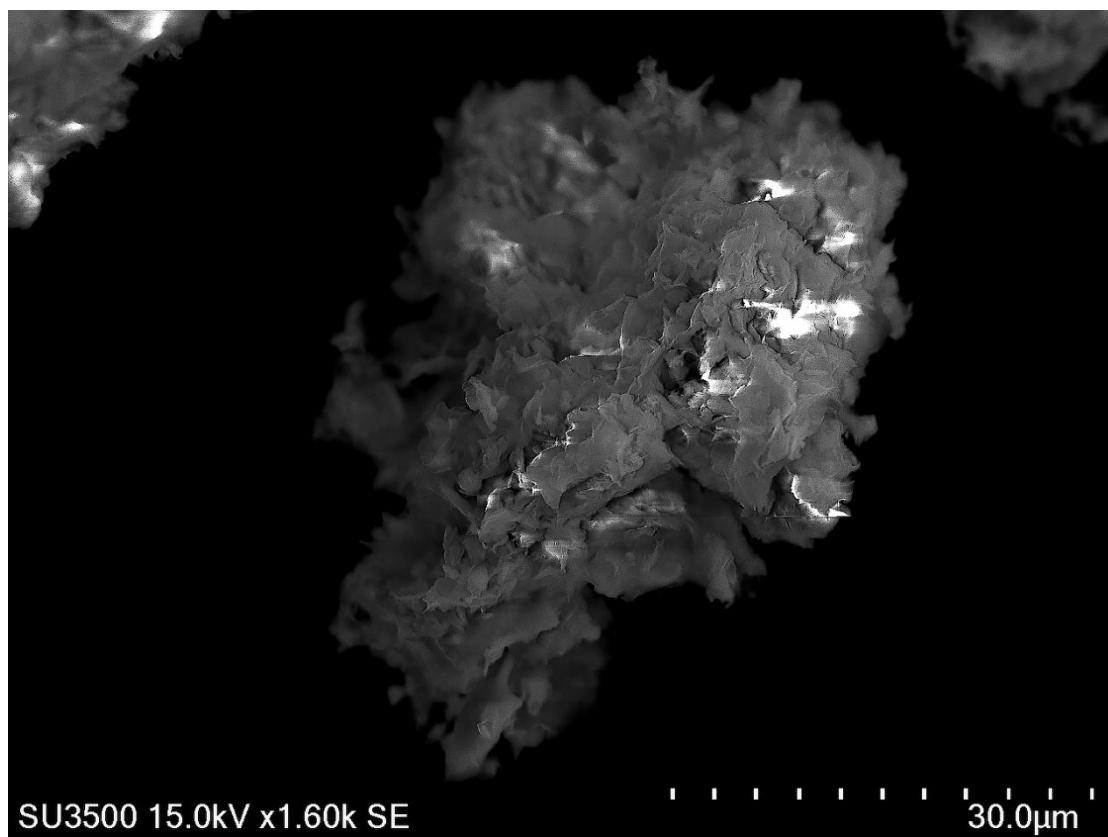


Fig. S1. SEM image of LMB.

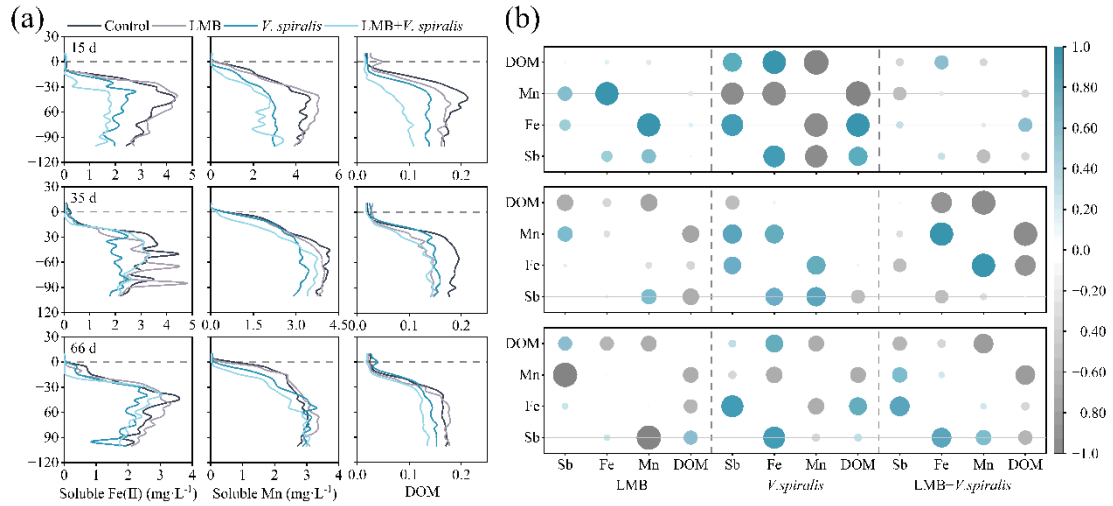


Fig. S2. (a) Changes of soluble Fe(II), Mn and DOM after the combined use of LMB and *Vallisneria spiralis*. (b) Correlation analysis among Sb, Fe, Mn, and DOM concentrations in the surface sediment during the incubation experiment.

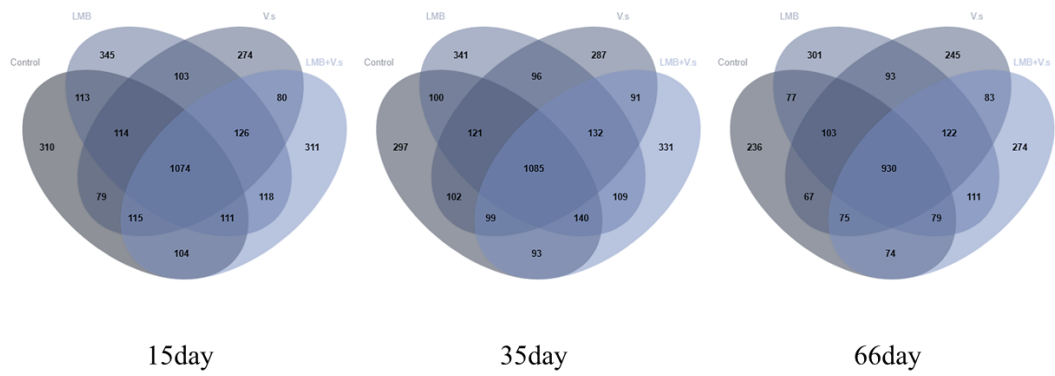


Fig. S3. Venn diagram of the sediment microbial OTUs under the four treatment scenarios.



Fig. S4. Metallic patches at the root zone of *Vallisneria spiralis*.