

**SI Table S1.** Sampling locations

STT	Location code	Description of location	Coordinates (VN2000, 107 <sup>o</sup> , projection zone 6 <sup>o</sup> )	
			Longitude (X)	Latitude (Y)
1	STT	Ta Trach River, 1 km upstream from the Tuan Junction	561910	1811523
2	SHT	Huu Trach River, 1 km upstream from the Tuan Junction	560644	1811592
3	SH1	Huong River, Tuan Junction area	561364	1812782
4	SH2	Huong River, near Xuoc Du Bridge	556487	1818646
5	SH3	Huong River, Dong Ba Market area	562770	1821190
6	SH4	Huong River, near Hue Fisheries Development Joint Stock Company	561931	1823884
7	SH5	Huong River, Sinh Junction area	561100	1827453
8	SH6	Huong River, upstream of Thao Long Dam	565094	1829665
9	SH7	Huong River, downstream of Thao Long Dam (river mouth area)	567062	1830136
10	SB1	Huong Dien Hydropower Reservoir, dam area	546845	1821297
11	SB2	Bo River, An Lo Bridge area	548382	1829302
12	SB3	Bo River, Huong Can Bridge area	556908	1826358
13	SB4	Bo River, An Xuan Sluice area, Quang An Commune	558825	1831723
14	SPB1	Phu Bai River, 500 m upstream from the discharge point of Phu Bai Industrial Zone	573866	1811232
15	SPB2	Phu Bai River, at Phu Bai Bridge	577011	1810355
16	SPB3	Phu Bai River, before flowing into the Dai Giang River	579112	1812381
17	ĐP1	Tam Giang Lagoon (Con Toc Ferry area)	552899	1835447
18	ĐP2	Sam - Thanh Lam Lagoon (near Mui Han)	572234	1826885

STT	Location code	Description of location	Coordinates (VN2000, 107 <sup>o</sup> , projection zone 6 <sup>o</sup> )	
			Longitude (X)	Latitude (Y)
19	ĐP3	Thuy Tu Lagoon (Truong Ha Bridge area)	582453	1816602
20	ĐP4	Cau Hai Lagoon (Loc An Commune area)	585464	1804478

**SI Table S2.** Overall bootstrap estimates for seasonal VN WQI

Comparison	n	Bootstrap estimate (95% CI)
Dry season	79	89.29 (86.68–91.61)
Rainy season	112	81.79 (78.62–84.77)
Rainy – dry difference	191	-7.50 (-11.44–-3.58)

## Supporting information SI Text. Water quality assessment based on VN\_WQI

Decision No. 1460/QD-TCMT dated 12 November 2019, issued by Vietnam Environment Agency (VEA), regarding the promulgation of Technical Guidelines for calculation and publication of the Vietnam Water Quality Index (VN-WQI).

### 1. Guidelines for calculating the water quality index (VN-WQI)

Data requirements: using reliable and available water quality data obtained from monitoring program conducted in local or regional area; QA/QC process must be regularly implemented.

### 2. Selected parameters: The parameters used to calculate VN-WQI are divided into 5 groups, including:

Group I: pH

Group II: pesticides, including Aldrin, BHC, Dieldrin, DDTs (p,p'-DDT, p,p'-DDD, p,p'-DDE), Heptachlor & Heptachlorepoxyd

Group III: dissolved heavy metals, including As<sup>III,V</sup>, Cd<sup>II</sup>, Pb<sup>II</sup>, Cr<sup>VI</sup>, Cu<sup>II</sup>, Zn<sup>II</sup> and Hg<sup>II</sup>

Group IV: organic and nutrient pollutants, including DO (dissolved oxygen), BOD5 (five-day biochemical oxygen demand), COD (chemical oxygen demand), TOC (total organic carbons), N-NH<sub>4</sub> (ammonium), N-NO<sub>3</sub> (nitrate), N-NO<sub>2</sub> (nitrite), P-PO<sub>4</sub> (phosphate)

Group V: bacteria, including Total coliform and E. coli.

The least numbers of the parameter groups used for the VN-WQI calculation must be three of the five groups, in which the Group III is completed. If water body is affected by heavy metals, the Group III must be taken into account and if affected by pesticides, the Group II must be taken into account.

### 3. Calculation of parameter water quality index (WQI<sub>SI</sub>) or subindex for each parameter

- Calculation for As<sup>III,V</sup>, Cd<sup>II</sup>, Pb<sup>II</sup>, Cr<sup>VI</sup>, Cu<sup>II</sup>, Zn<sup>II</sup>, Hg<sup>II</sup>, BOD<sub>5</sub>, COD, TOC, N-NH<sub>4</sub>, N-NO<sub>2</sub>, N-NO<sub>3</sub>, P-PO<sub>4</sub>, Total coliform, and E. coli was as follows:

$$WQI_{SI} = \frac{q_i - q_{i+1}}{BP_{i+1} - BP_i} (BP_{i+1} - C_p) + q_{i+1} \quad (\text{Eq.1})$$

In which:

BP<sub>i</sub> : Lower limit concentration of the selected parameter specified in Table 1 corresponding to level i;

$BP_{i+1}$ : Upper limit concentration of the selected parameter specified in Table 1 corresponding to level  $i+1$ ;

$q_i$ : WQI value at level  $i$  given in Table 1 corresponding to  $BP_i$  value;

$q_{i+1}$ : WQI value at level  $i+1$  given in Table 1 corresponding to  $BP_{i+1}$  value

$C_p$ : The value of the monitored parameter used for the  $WQI_{SI}$  calculation.

**Table 1.** The specified  $q_i$ ,  $BP_i$  values for the selected parameters of groups IV and V(\*)

i	$q_i$	$BP_i$ value for each selected parameter								
		BOD <sub>5</sub>	COD	TOC	N-NH <sub>4</sub>	N-NO <sub>3</sub>	N-NO <sub>2</sub>	P-PO <sub>4</sub>	Total coliform	E.coli
		mg/L							MPN/100 mL	
1	100	≤ 4	≤ 10	≤ 4	< 0.3	≤ 2	≤ 0.05	≤ 0.1	≤ 2500	≤ 20
2	75	6	15	6	0.3	5		0.2	5000	50
3	50	15	30	15	0.6	10		0.3	7500	100
4	25	25	50	25	0.9	15		0.5	10000	200
5	10	≥ 50	≥ 150	≥ 50	≥ 5	≥ 15	≥ 0.05	≥ 4	≥ 10000	≥ 200

**Table 2.** The specified  $q_i$ ,  $BP_i$  values for the selected heavy metals (group III)(\*)

i	$q_i$	$BP_i$ value for each selected parameter						
		As <sup>III,V</sup>	Cd <sup>II</sup>	Pb <sup>II</sup>	Cr <sup>VI</sup>	Cu <sup>II</sup>	Zn <sup>II</sup>	Hg <sup>II</sup>
		mg/L						
1	100	≤ 0.01	< 0.005	< 0.02	≤ 0.01	≤ 0.1	≤ 0.5	< 0.001
2	75	0.02	0.005	0.02	0.02	0.2	1.0	0.001
3	50	0.05	0.008	0.04	0.04	0.5	1.5	0.0015
4	25	0.1	0.01	0.05	0.05	1.0	2.0	0.002
5	10	> 0.1	≥ 0.1	≥ 0.5	≥ 0.1	≥ 2	≥ 3	≥ 0.01

(\*) If the  $C_p$  value for a parameter equals to  $BP_i$  specified in the table, the  $WQI_{SI}$  for the parameter is accepted to equal to the respective  $q_i$  value.

- $WQI_{SI}$  calculation for parameter DO, based on DO% saturation value

- Step 1: calculate DO% saturation value ( $DO_{saturation}$ )

$$DO_{saturation} = 14.652 - 0.41022T + 0.0079910T^2 - 0.000077774T^3$$

In which,

T: water temperature at the time of monitoring, °C

$$DO\%_{saturation} = (DO_{dissolved} / DO_{saturation}) \times 100$$

$DO_{dissolved}$ : the DO value measured at the time of monitoring, mg/L

- Step 2: Calculate  $WQI_{SI}$

$$WQI_{SI} = \frac{q_{i+1} - q_i}{BP_{i+1} - BP_i} (C_p - BP_i) + q_i \quad (\text{Eq.2})$$

In which:

$C_p$ : DO% saturation value

$BP_i$ ,  $BP_{i+1}$ ,  $q_i$ ,  $q_{i+1}$ : the accordant values in Table 3

Table 3. The specified  $q_i$ ,  $BP_i$  values for DO% saturation value

i	1	2	3	4	5	6	7	8	9	10
$BP_i$	< 20	20	50	75	88	112	125	150	200	> 200
$q_i$	10	25	50	75	100	100	75	50	25	10

If DO% saturation value < 20 or DO% saturation value > 200, then  $WQI_{SI} = 10$ .

If  $20 < \text{DO\% saturation value} < 88$ , then  $WQI_{SI}$  is calculated according to Eq.2 and Table 3.

If  $88 \leq \text{DO\% saturation value} \leq 112$ , then  $WQI_{SI} = 100$ .

If  $112 < \text{DO\% saturation value} < 200$ , then  $WQI_{SI}$  is calculated according to Eq.1 and Table 3.

- $WQI_{SI}$  calculation for parameter pH:

Table 4. The specified  $q_i$ ,  $BP_i$  values for parameter pH

i	1	2	3	4	5	6
$BP_i$	> 5.5	5.5	6	8.5	9	> 9
$q_i$	10	50	100	100	50	10

If  $\text{pH} < 5.5$  or  $\text{pH} > 9$ , then  $WQI_{SI} = 10$ .

If  $5.5 < \text{pH} < 6$ , then the  $WQI_{SI}$  is calculated according to Eq.2 and Table 4.

If  $6 \leq \text{pH} \leq 8.5$ , then the  $WQI_{SI}$  is 100.

If  $8.5 < \text{pH} < 9$ , then  $WQI_{SI}$  is calculated according to Eq.1 and Table 4.

- Calculation for the parameters in Group II: Aldrin, BHC, Dieldrin, DDTs, Heptachlor and Heptachlorepoide

Parameter	Measured concentration ( $\mu\text{g/L}$ )	$WQI_{SI}$
Aldrin	$\leq 0.01$	100
	$> 0.1$	10
Benzene hexachloride	$\leq 0.02$	100

(BHC)	> 0.02	10
Dieldrin	≤ 0.1	100
	> 0.1	10
DDTs	≤ 1.0	100
	> 1.0	10
Heptachlor and Heptachlorepoide	≤ 0.2	100
	> 0.2	10

#### 4. Calculation of final WQI

$$WQI = \frac{WQI_I}{100} \times \frac{\left(\prod_{i=1}^n WQI_{II}\right)^{1/n}}{100} \times \frac{\left(\prod_{i=1}^m WQI_{III}\right)^{1/m}}{100} \times \left[ \frac{1}{k} \sum_{i=1}^k WQI_{IV} \times \frac{1}{l} \sum_{i=1}^l WQI_V \right]^{1/2} \quad (\text{Eq.3})$$

In which:

WQ<sub>I</sub>: WQ<sub>SI</sub> calculation results for the parameters in Group I

WQ<sub>II</sub>: WQ<sub>SI</sub> calculation results for the parameters in Group II

WQ<sub>III</sub>: WQ<sub>SI</sub> calculation results for the parameters in Group III

WQ<sub>IV</sub>: WQ<sub>SI</sub> calculation results for the parameters in Group IV

WQ<sub>V</sub>: WQ<sub>SI</sub> calculation results for parameters in Group V

The final WQI is rounded up to be an integer.

#### 5. WQI classification

WQI range	Water quality	Color	RBG color codes
91 – 100	Excellent	Blue	51;51;255
76 – 90	Good	Green	0;228;0
51 – 75	Moderate	Yellow	255;255;0
26 – 50	Poor	Orange	255;126;0
10 – 25	Very poor	Red	255;0;0
< 10	Highly polluted	Brown	126;0;35