Supplementary material of

The snowball effect of anthropogenic alterations in a karst tropical lake in Yucatán Peninsula, environmental variability and risk assessment.

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Table S1.- Physical, chemical and microbiological variables from Lake La Sabana during the dry and rainy season in Yucatán Peninsula

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Site | N | W | Climatic season | Temp (°C) | Cond (µs/cm) | pH | DO (mg/l) | Transp (m) | BOD5 (mg/l) | TSS (mg/l) | Fecal coliforms | Total coliforms | ortofosfates (mg/l) | Nitrites (mg/l) | Nitritates (mg/l) | sulfates (g/l) | NSF WQI |
| N1 | 18.5514 | -88.3134 | Dry season | 26.4 | 577 | 7.9 | 8.75 | 0.25 | 25.4 | 375 | 310 | 840 | 0.0031 | 0.0031 | 0.0121 | 2.441 | 56 |
| N2 | 18.5512 | -88.3132 | 26.3 | 573 | 7.9 | 7.64 | 0.23 | 24.3 | 467 | 18 | 1100 |  |  |  |  | 56 |
| N3 | 18.5503 | -88.3124 | 26.4 | 583 | 7.7 | 7.9 | 0.25 | 20 | 570 | 18 | 1100 |  |  |  |  | 56 |
| C1 | 18.5479 | -88.3120 | 26.5 | 575 | 7.8 | 8.2 | 0.2 | 26.4 | 420 | 1600 | 16000 | 0.1935 | 0.2437 | 0.301 | 1.405 | 55 |
| C2 | 18.5454 | -88.3148 | 25.9 | 577 | 7.9 | 7.5 | 0.21 | 28.4 | 550 | 620 | 3500 |  |  |  |  | 52 |
| C3 | 18.5443 | -88.3144 | 26.4 | 580 | 7.6 | 8.14 | 0.25 | 30.4 | 530 | 940 | 16000 |  |  |  |  | 54 |
| S1 | 18.5403 | -88.3189 | 26.1 | 530 | 7.8 | 9.6 | 0.3 | 32.5 | 560 | 1600 | 16000 | 0.2817 | 1.0241 | 0.6047 | 1.397 | 51 |
| S2 | 18.5400 | -88.3185 | 26.3 | 560 | 7.8 | 10.6 | 0.28 | 40.2 | 550 | 9200 | 16000 |  |  |  |  | 48 |
| S3 | 18.5395 | -88.3180 | 26.4 | 570 | 7.7 | 3.14 | 0.2 | 38.5 | 480 | 3500 | 16000 |  |  |  |  | 41 |
| W1 | 18.5322 | -88.3263 | 25.9 | 520 | 7.5 | 8.12 | 0.35 | 20.5 | 220 | 40 | 3500 |  |  |  |  | 60 |
| W2 | 18.5298 | -88.3283 | 25.8 | 550 | 7.5 | 7.4 | 0.45 | 18.3 | 245 | 45 | 640 | 0.0043 | 0.0972 | 0.0013 | 3.523 | 60 |
| W3 | 18.5277 | -88.3333 | 26.7 | 498 | 7.7 | 8.23 | 0.55 | 17.5 | 350 | 92 | 1200 |  |  |  |  | 60 |
| W4 | 18.5289 | -88.3331 | 26.6 | 520 | 7.6 | 7.15 | 0.6 | 18.5 | 210 | 260 | 1200 | 0.0028 | 0.0897 | 0.0021 | 2.908 | 60 |
| W5 | 18.5287 | -88.3316 | 26.6 | 560 | 7.7 | 6.85 | 0.55 | 20.5 | 190 | 210 | 230 |  |  |  |  | 59 |
| W6 | 18.5206 | -88.3448 | 26.4 | 573 | 7.8 | 6.7 | 0.7 | 18.5 | 220 | 92 | 230 |  |  |  |  | 60 |
| NS1 |  |  | Rainy season | 31.4 | 583 | 7.5 | 9.75 | 0.25 | 30 | 378 | 180 | 5400 | 0.0026 | 0.0025 | 0.0116 | 1.972 | 53 |
| NS2 |  |  | 32.7 | 423 | 7.4 | 9.25 | 0.25 | 27 | 420 | 200 | 14000 |  |  |  |  | 53 |
| NS3 |  |  | 35.6 | 446 | 7.5 | 10.9 | 0.25 | 32 | 390 | 180 | 9500 |  |  |  |  | 48 |
| CS1 |  |  | 33.4 | 510 | 7.5 | 11.01 | 0.22 | 26 | 410 | 92000 | 160000 | 0.1720 | 0.216 | 0.420 | 1.235 | 47 |
| CS2 |  |  | 34.7 | 443 | 7.6 | 9.85 | 0.24 | 33 | 420 | 28000 | 35000 |  |  |  |  | 52 |
| CS3 |  |  | 35.4 | 518 | 7.6 | 10.21 | 0.25 | 36 | 380 | 160000 | 160000 |  |  |  |  | 47 |
| SS1 |  |  | 32.8 | 565 | 7.4 | 10.87 | 0.2 | 40 | 385 | 24000 | 54000 | 0.1794 | 1.001 | 0.451 | 0.978 | 46 |
| SS2 |  |  | 33.7 | 593 | 7.6 | 10.66 | 0.25 | 41 | 400 | 3300 | 7000 |  |  |  |  | 46 |
| SS3 |  |  | 34.2 | 539 | 7.5 | 6.23 | 0.23 | 41 | 410 | 54000 | 92000 |  |  |  |  | 53 |
| W1 |  |  | 34.4 | 480 | 7.5 | 9.83 | 0.45 | 23 | 210 | 92 | 2500 |  |  |  |  | 57 |
| W2 |  |  | 35.5 | 521 | 7.5 | 7.69 | 0.48 | 23 | 200 | 95 | 750 | 0.0135 | 1.004 | 0.001 | 3.216 | 60 |
| W3 |  |  | 35.2 | 475 | 7.4 | 8.23 | 0.43 | 25 | 180 | 150 | 2000 |  |  |  |  | 58 |
| W4 |  |  | 34.6 | 485 | 7.4 | 7.46 | 0.5 | 25 | 195 | 210 | 550 | 0.0016 | 0.0451 | 0.001 | 2.147 | 60 |
| W5 |  |  | 33.6 | 395 | 7.6 | 7.65 | 0.55 | 20 | 174 | 260 | 540 |  |  |  |  | 61 |
| W6 |  |  | 35.6 | 476 | 7.6 | 8.2 | 0.5 | 18 | 95 | 150 | 640 |  |  |  |  | 60 |

Abbreviations are as follows: temperature (Temp), conductivity (Cond), dissolved oxygen (DO), transparency (Transp), five-day biochemical oxygen demand (BOD5), total suspended solids (TSS), and National Sanitation Foundations water quality index (NSF WQI).

Table S2. Table of pairwise Permutational Multivariate Analysis Of Variance (PERMANOVA) tests. For interaction terms (Lake sections × season) pairwise tests are organized by levels of the corresponding factor as follows: (D) – Within level 'Dry' of factor Season, (R) – Within level 'Rainy' of factor Season, (W) – Within level 'Wetland' of factor Lake sections, (N) – Within level 'North' of factor Lake sections, (C) – Within level 'Center' of factor Lake sections, (S) –Within level 'South' of factor Lake sections. Bold values indicate significant results (*p* ≤ 0.05) after applying Benjamini-Hochberg correction to α.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Term Lake section | | | | | |
|  | Groups | *t* | *p* perm | Unique perms | *p* (MC) | α corr |
|  | north, wetland | 3.988 | **0.001** | 999 | **0.001** | 0.008 |
|  | center, wetland | 4.633 | **0.001** | 999 | **0.001** | 0.017 |
|  | south, wetland | 4.573 | **0.001** | 999 | **0.001** | 0.025 |
|  | north, center | 1.883 | **0.026** | 984 | 0.043 | 0.033 |
|  | north, south | 1.687 | **0.017** | 984 | 0.048 | 0.042 |
|  | center, south | 1.364 | 0.119 | 987 | 0.137 | 0.050 |
|  | Term Season | | | | | |
|  | Groups | *t* | *p* perm | Unique perms | *p* (MC) | α corr |
|  | dry, rainy | 4.785 | **0.001** | 999 | **0.001** | 0.050 |
|  | Term Lake section × Season for pairs of levels of factor Zone | | | | | |
| Levels | Groups | *t* | *p* perm | Unique perms | *p* (MC) | α corr |
| (D) | center, wetland | 3.545 | 0.010 | 84 | **0.002** | 0.008 |
| south, wetland | 3.018 | 0.019 | 84 | **0.002** | 0.013 |
| north, wetland | 3.286 | **0.013** | 84 | **0.003** | 0.021 |
| north, south | 1.253 | 0.177 | 10 | 0.257 | 0.042 |
| north, center | 0.929 | 0.578 | 10 | 0.458 | 0.046 |
| center, south | 0.793 | 0.805 | 10 | 0.549 | 0.050 |
| (R) | center, wetland | 3.775 | 0.011 | 84 | **0.001** | 0.004 |
| south, wetland | 3.751 | 0.015 | 84 | **0.002** | 0.017 |
| north, wetland | 2.687 | 0.010 | 84 | **0.008** | 0.025 |
| north, center | 1.964 | 0.095 | 10 | 0.082 | 0.029 |
| center, south | 1.561 | 0.199 | 10 | 0.119 | 0.033 |
| north, south | 1.523 | 0.088 | 10 | 0.146 | 0.038 |
|  | Term Lake section × Season for pairs of levels of factor Season | | | | | |
| Levels | Groups | *t* | *p* perm | Unique perms | *p* (MC) | α corr |
| (W) | dry, rainy | 3.536 | **0.003** | 414 | **0.001** | 0.013 |
| (N) | dry, rainy | 2.944 | 0.098 | 10 | **0.011** | 0.025 |
| (C) | dry, rainy | 2.795 | 0.107 | 10 | **0.018** | 0.038 |
| (S) | dry, rainy | 1.578 | 0.102 | 10 | 0.116 | 0.050 |