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An Integrated Approach to Chlorophyll Monitoring In Surface Freshwater: The Case-Study of Lake Albano (Central Italy)

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Supplementary Materials

S1. Further Description of the Study Area

To date, the Alban Hills area has been affected by frequent seismic activity, high CO_2 fluxes of magmatic origin, and sudden gas discharges, which pose a serious threat to the local population. Moreover, the lake's considerable depth-to-surface ratio and the high CO_2 concentration (with volcanic rather than biological origin) increase the possibility of CO_2 limnic eruptions [1]. Lake Albano's water intake comes from rainfall and groundwater. This lake lacks outflows, as it only has disused artificial emissaries built by the Romans to regulate the water level and preserve water reservoirs [2,3].

Water transparency in Lake Albano ranged from a minimum value of 1.5 m in March to a maximum value of 7.5 m in June (Table S1). z_{SD} values in mid-June show a strong spatial variation, with lower values at point D and E (5.2 m and 5.1 m, respectively) and higher values at points A and B (7 and 7.5 m). Over the sampling period, epilimnic water temperature showed a gradual increase from its minimum value (11.1°C) from early spring, maximum value in July (30.1 °C), followed by a slow decrease. Salinity and pH values remained quite constant throughout the sampling period, with minor fluctuations. The highest dissolved oxygen (DO) concentration value was recorded in early spring (10.68 mg/L), with a second peak in July (9.880 mg/L) and minimum value observed in September (8.20 mg/L).

Nitrates and ammonium concentration showed an oscillating trend (with values ranging from 0.42 and 0.105 mg/L to 0.17 and 0.008 mg/L, respectively). Nitrites concentration, by contrast, displayed a more evident trend with higher values in spring, followed by a quick drop to lower values throughout summer. Maximum phosphate concentration was observed in May (1.201 mg/L), while its lowest value (0.011 mg/L) was recorded in October.

Table S1. In situ data ranges, mean values, and standard deviation over the sampling period: Secchi Disk depth (z_{SD}), epilimnic water temperature (T), salinity (Sal), pH, dissolved oxygen (DO) concentration, nitrates (NO_3^-), nitrites (NO_2^-), ammonium (NH_4^+), and phosphates (PO_4^-) concentrations.

	z_{SD} (m)	T (°C)	Sal (‰)	pH	DO (mg/L)	NO_3^- (mg/L)	NO_2^- (mg/L)	NH_4^+ (mg/L)	PO_4^- #(mg/L)
Min.	1.5	11.1	0.22	8.04	8.57	0.17	0.000	0.008	0.011
Max.	7.5	30.1	0.25	8.65	10.68	0.42	0.039	0.105	1.201
Mean	3.8	21.1	0.24	8.42	9.52	0.27	0.010	0.018	0.160
SD	1.4	6.3	0.01	0.15	0.65	0.06	0.009	0.027	0.296

According to our in situ data, Secchi disk depth values in Lake Albano were lower than previous observations [4], which may be attributed to episodes of illegal sewage discharge and a constant lowering of the lake water level due to water over-extraction. Indeed, there has been a water level reduction of more than 4 metres from the 1960s, which underwent acceleration from 1984 to 2004 due to an increase of 48% in water extraction from the surrounding towns of the "Castelli Romani". The water level reduction, which is not balanced by groundwater input and precipitation, is thus related to an increase in population and its water needs.

S2. Chlorophyll Concentration Results

Table S2. Total Chl and Chl-a values measured spectrophotometrically, using the Phyto-PAM instrument, and through the Case-2 Regional CoastColour (C2RCC) processor ("-" indicates the absence of suitable satellite data).

Sampling Point	Sampling Date	Image Acquisition Date	Chl_PAM (mg/m³)	Chl_sp (mg/m³)	Chla_sp (mg/m³)	Chla_C2RCC (mg/m³)
A1	19/03/2019	22/03/2019	31.78	14.82	14.82	5.451703
A2	19/03/2019	22/03/2019	39.95	19.99	18.84	2.4271698
A3	19/03/2019	22/03/2019	30.90	19.10	16.10	2.644661
A4	19/03/2019	22/03/2019	31.35	17.89	16.43	3.3189268
A5	19/03/2019	22/03/2019	31.69	20.21	19.12	2.3466384
A1	02/04/2019	01/04/2019	5.27			0.9736503
A5	02/04/2019	01/04/2019	5.47			0.8438312
A2	02/04/2019	01/04/2019	6.27			0.97854
A3	02/04/2019	01/04/2019	5.76			0.42566675
A4	02/04/2019	01/04/2019	6.39			0.5265748
A1	16/04/2019	-	10.48			
A5	16/04/2019	-	7.88			
A2	16/04/2019	-	8.47			
A3	16/04/2019	-	9.92			
A4	16/04/2019	-	7.50			
A1	16/05/2019	-	8.38			
A5	16/05/2019	-	9.31			
A2	16/05/2019	-	8.42			
A3	16/05/2019	-	8.05			
A4	16/05/2019	-	8.28			
A5	28/05/2019	05/06/2019	6.65	4.09	2.54	1.0039511
A2	28/05/2019	05/06/2019	6.32	2.15	1.68	1.0389771
A1	28/05/2019	05/06/2019	6.98	3.05	1.85	1.068452
A3	28/05/2019	05/06/2019	6.99	2.15	1.59	0.56223553
A4	28/05/2019	05/06/2019	5.99	2.79	1.87	0.9945859
A5	12/06/2019	15/06/2019	3.18	2.37	2.26	0.2557874
A2	12/06/2019	15/06/2019	3.14	2.29	2.29	0.5509457
A1	12/06/2019	15/06/2019	3.22	3.09	2.50	0.23402104
A3	12/06/2019	15/06/2019	3.08	2.25	2.18	0.561868
A4	12/06/2019	15/06/2019	3.46	3.25	3.29	0.29764056
A5	27/06/2019	25/06/2019	3.11	2.78	2.45	2.2326465
A2	27/06/2019	25/06/2019	2.30	1.27	1.27	2.786846
A1	27/06/2019	25/06/2019	2.18	1.96	1.42	2.5952797
A3	27/06/2019	25/06/2019	2.03	1.40	1.12	1.7703109
A4	27/06/2019	25/06/2019	2.08	1.65	1.65	2.0234716

A5	09/07/2019	05/07/2019	3.93	3.96	2.97	1.0115007
A2	09/07/2019	05/07/2019	4.85	4.18	3.70	0.91956955
A1	09/07/2019	05/07/2019	3.86	4.05	2.92	0.7938514
A3	09/07/2019	05/07/2019	3.66	4.51	3.77	0.79081964
A4	09/07/2019	05/07/2019	3.77	3.81	3.19	0.687188
A5	23/07/2019	25/07/2019	2.83	3.76	3.11	0.79994684
A2	23/07/2019	25/07/2019	2.69	2.77	2.63	0.59663844
A1	23/07/2019	25/07/2019	2.05	3.16	2.32	0.57374144
Sampling Point	**Sampling Date**	**Image Acquisition Date**	**Chl_PAM (mg/m³)**	**Chl_sp (mg/m³)**	**Chla_sp (mg/m³)**	**Chla_C2RCC (mg/m³)**
A3	23/07/2019	25/07/2019	2.09	2.32	2.05	0.885982
A4	23/07/2019	25/07/2019	2.44	2.33	2.26	0.5359883
A5	05/09/2019	03/09/2019	12.53	8.14	6.88	0.65893656
A2	05/09/2019	03/09/2019	10.75	7.37	6.39	0.6236173
A1	05/09/2019	03/09/2019	10.76	7.60	6.05	0.75332785
A3	05/09/2019	03/09/2019	10.73	8.19	6.82	0.8024993
A4	05/09/2019	03/09/2019	8.50	6.93	6.10	0.664929
A5	21/10/2019	23/10/2019	5.92	6.22	5.19	2.0586927
A2	21/10/2019	23/10/2019	10.85	7.87	6.83	2.18615
A1	21/10/2019	23/10/2019	9.87	7.59	5.99	2.4988492
A3	21/10/2019	23/10/2019	10.85	7.67	6.63	0.6947597
A4	21/10/2019	23/10/2019	11.21	7.81	6.77	0.7239619

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