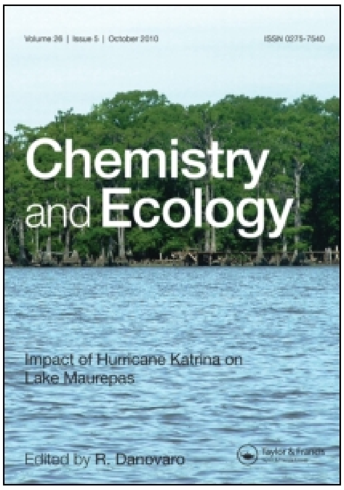

Chemistry and Ecology
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713455114

Geological development of a gypsum lake formed at the beginning of the 20th century in central Sicily, Italy: Integration of historical data with modern survey techniques

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To cite this Article Madonia, Paolo , Naselli-Flores, Luigi , Parello, Francesco , Parlato, Barbara and Viola, Antonella(2006) 'Geological development of a gypsum lake formed at the beginning of the 20th century in central Sicily, Italy: Integration of historical data with modern survey techniques', Chemistry and Ecology, 22: 4, S333 — S347

To link to this Article: DOI: 10.1080/02757540600557728

URL: http://dx.doi.org/10.1080/02757540600557728

Chemistry and Ecology
August 2006, Vol. 22 (Supplement 1), pp. S333–S347

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Geological development of a gypsum lake formed at the beginning of the 20th century in central Sicily, Italy: Integration of historical data with modern survey techniques

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(Received 18 February 2005; in final form 22 September 2005)

A limnological investigation was carried out on the small, endorheic lake, called Lake Sfondato, located in central Sicily (Italy). All the aquatic environments in the central part of the island are rich in salt, with conductivity values above 5 mS cm^{-1}, and are characterized by high alkalinity values and hard waters. In addition, due to intensive agriculture, many of these ecosystems have experienced a strong anthropogenic eutrophication over the last decades. In order to better understand the functioning of these peculiar environments, the morphology, hydrology, and geochemistry, as well as several selected physical and biological characteristics of Lake Sfondato, were studied in the years 2003 and 2004. The results showed that the water body is characterized by meromixis, with permanent water stratification. This condition reduces the eutrophication processes within the lake, which have kept the trophic conditions constant over the last 50 yr.

Keywords: Climate changes; Gypsum; Meromictic water; Salt diapir; Sink hole lake

1. Introduction

Lake Sfondato (figure 1) ('sfondato' in Italian means that it has a hole in the bottom), which has been a protected natural regional reserve since 1997, is a small lake that has a maximum depth of 10 m, a surface of 3404 m^2 and a volume of 20 800 m^3. It is located at 400 m a.s.l. near the city of Caltanissetta (Sicily, Italy). It lies on evaporitic deposits of Messinian age pertaining to the Gessoso Solfifera formation and mainly consists of macro-crystalline gypsum (selenite) associated with clays and small levels of sodium–potassium salts [1, 2]. The origin of the lake can be dated precisely because, although it is not mentioned in a very exhaustive study carried

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Chemistry and Ecology
ISSN 0275-7540 print/ISSN 1029-0370 online
http://www.tandf.co.uk/journals
DOI: 10.1080/02757540600557728

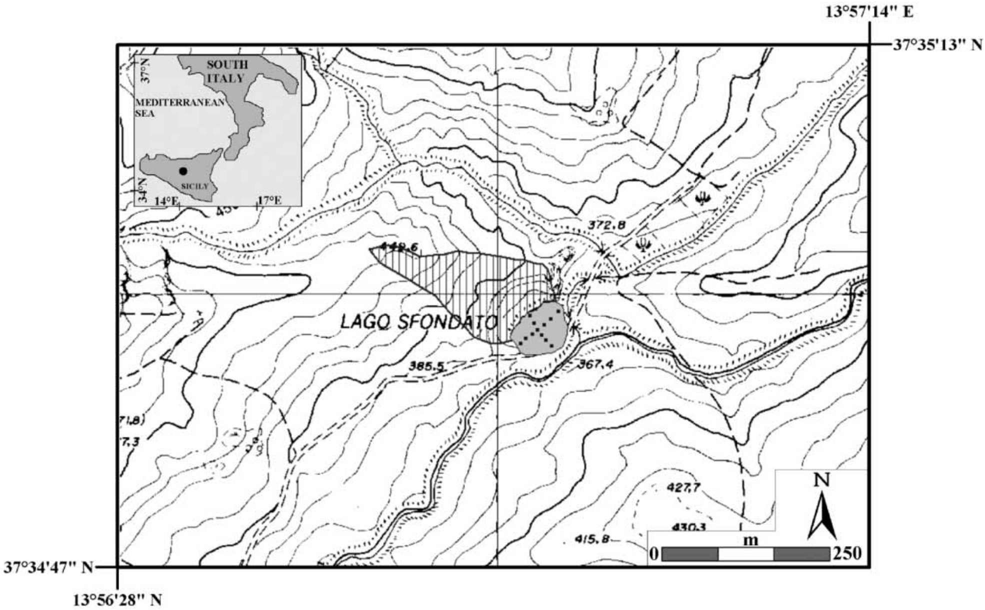

Figure 1. Topographic map of Lake Sfondato with a reconstruction of the catchment area (dashed polygon). The topographic base is section no. 630040 of the Regional Technical Cartography (CTR), reproduced with the authorization of the Regione Siciliana-Assessorato Regionale Territorio ed Ambiente (Environmental and Territorial Department of Sicilian Government).

out by Marinelli [3] on gypsum lakes in Sicily, it is described by De Gregorio [4], who wrote about a sudden land collapse in November 1907 from which the lake originated.

Indeed, this lake represents a very interesting chance to study the evolution of a natural environment right from the beginning of its genesis, albeit from a semi-quantitative point of view. Our work aims at characterizing the genesis and evolution of the lake from different points of view, highlighting the reconstruction of the most probable genetic mechanism, the morpho-bathymetric evolution from its origin to today, and its hydrological, geochemical, and biological characteristics. Particular attention has been paid to a critical review of the historic scientific documents that have been analysed with modern techniques, like the Geographical Information System (GIS), in order to verify the precision and limits of the numeric information contained therein.

2. Materials and methods

Historical morpho-bathymetric information was inferred from bibliographic data and air photographs, ranging from 1987 to 1997, and analysed in a GIS environment.

Four different field surveys were carried out in the months of April 2003, October 2003, November 2003, and February 2004.

A single-frequency GPS Garmin III plus and a laser range finder MDL Mod. Laser Ace, equipped with an electronic compass and accelerometer for horizontal and vertical angle measurements, were used to obtain lake boundary acquisition and the location of bathymetric and geochemical vertical profiles. Differences in elevation were measured by using a total station. Water depths were measured from a boat using a sounding lead. Surface calculations were performed in an ESRI Arc View GIS environment, whereas contour maps and volume determinations were attained by using the Golden Software Surfer together with the kriging interpolation algorithm.

In November 2003, a complete multi-parametric profiling was carried out in Lake Sfondato, including pH and Eh measurements, while water samplings were taken at various depths, using a Multi Probe System YSI 556 MPS. Measurements of water temperature and dissolved oxygen (DO) related to the other surveys were carried out with a YSI-55 Oxymeter.

Samples of water for chemical analyses were collected both in the lake and in the nearby creek (Torrente Stretto) in November 2003 using Kartell plastic bottles with a volume of 100 cm^3, directly in the lake or with the aim of a sampling bottle for the deep samples. Water samples for cation determination were filtered and acidified in the field. Alkalinity was determined by the HCl titration method, while the other ions were determined by means of high-performance liquid chromatography (HPLC) with a Dionex DX 120 instrument.

Phytoplankton samples were collected sub-superficially at a station located in the middle of the lake and fixed with Lugol's solution. For identification purposes, a net sample was taken by towing a 30-cm-diameter plankton net with a 40 μm mesh. Identification was made in accordance with the most updated phycological literature as available in the series 'Suesswasserflora von Mitteleuropa'. The sample was subsequently fixed using a buffered 4% formaldehyde solution. Counting was performed under a Zeiss Axiovert 100 microscope in accordance with Utermöhl [5]. Transparency was recorded with a 30-cm-diameter Secchi disc.

3. Results and discussion

3.1 *Genesis of the lake*

In the original work by De Gregorio (1910), it is clearly indicated that the lake's genesis might have been related to the formation of a sink-hole that occurred in November 1907 and that was suddenly filled with water. The author wrote about a strong smell of sulphur propagating from the water, which suggests an underground origin. The sinking of the topographic surface was caused by the collapse of an underground cavity, the origin of which could be related to two different mechanisms, *i.e.* karst phenomena or dissolution of a salt diapir. The latter is probably more realistic for several reasons: first of all, there is no evidence of any other karst morphologies in the surrounding areas, whereas the presence of salt deposits is well documented [6]. The chemistry of the lake water, as discussed in the next chapters, is compatible with the presence of salt deposits under the lake bottom. Moreover, dipping of the outcropping gypsum strata identifies the existence of an anticline structure, already existing before the formation of the lake, which is located exactly in its nucleus area. In our reconstruction, synthesized in figure 2, the anticline probably formed during a build-in of the salt diapir (phases A–B); thereafter, changes in the underground water circulation caused the partial dissolution of the diapir, generating an underground cavity not very far from the topographic surface (C). The growth of the cavity could have proceeded until the mechanical resistance of the overlying gypsum strata was superseded, causing a sudden sinking of the topographic surface. Underground waters then filled the neo-formed sink-hole, thus completing the genetic process of the lake (D).

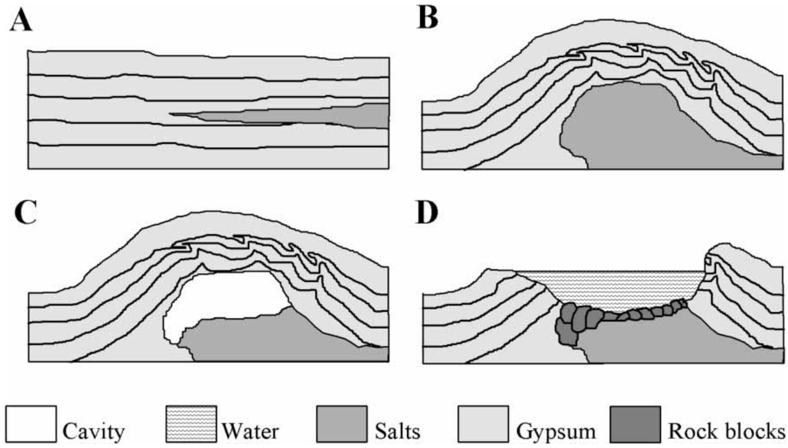

Figure 2. Schematic representation of the origin of Lake Sfondato.

3.2 *Morpho-bathymetric evolution*

In order to reconstruct the morphological evolution of the lake, we compared bibliographic data after De Gregorio [4] and Cumin [7] with the field survey carried out in October 2003 and with air photographs that were taken between 1987 and 1997. The results are reproduced in table 1 and figures 3 and 4, where the evolution of the cross sections and the shape of the lake are shown.

It is evident that modern field-survey techniques strongly influence the quality of the data, so it is difficult to make a comparison with old data from a quantitative point of view. Data after De Gregorio are merely qualitative, whereas Cumin carried out a numeric survey but did not provide any information regarding either methodologies or related errors. This fact is particularly evident in figure 3, where a circular shape of the lake from Cumin's reconstruction is reported. The air photographs and measurements of our survey indicate an elongation along a SW–NE axis. The rounded shape suggested by Cumin seems more to obey the archetypal idea of a lake than a quantitative determination of its real features. Moreover, the map of the lake given in his work does not correspond to the area indicated in the text, as shown in table 1. In particular, the area calculated on Cumin's map (4195 m^2) is 25% bigger than that reported by the author himself, while its value is actually closer to that determined in our

Table 1. Comparison between morphological data from the bibliography and the present survey.

Parameter	Cumin (1953) original data	Cumin (1953) reinterpreted data	This work
Principal axis SW–NE (m)	72		95 ± 1
Secondary axis NW–SE (m)	62		75 ± 1
Area (m^2)	3404	4195	4976 ± 400
Volume (m^3)	27 000	25 091	$20\,875 \pm 400$
Maximum depth (m)	12.50		9.70 ± 0.1
Relative altitude (lake surface vs. creek) (m)			$+0.57 \pm 0.05$
Catchment area (m^2)			$20\,970 \pm 1900$

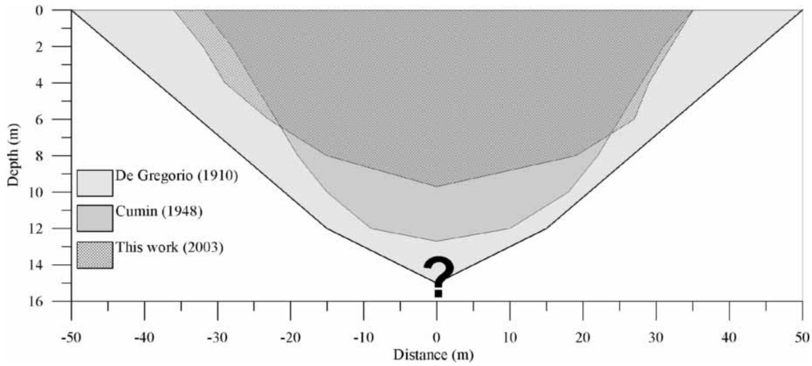

Figure 3. Comparison between cross sections of Lake Sfondato after De Gregorio [4], Cumin [7], and our study.

survey (4976 m^2). Another similar discrepancy was found in the calculations of the volume of the water reservoir.

First of all, we checked the reliability of the bibliographic data, after which we compared these with the present survey. To reduce the effects of different contouring techniques, starting from Cumin's original draft (figure 5A) where the points corresponding to the bathymetric profiles are reported, we resampled Cumin's depths using the same array used in our field campaign. Then, we plotted Cumin's re-sampled bathymetric map (figure 5B) and compared it with our data (figure 5C). The original and resampled map are similar, so any influence on volume calculations due to the different measuring arrays can be excluded. Cumin reported a volume (27 000 m^3) that was higher than the value resulting from our resampling of his data

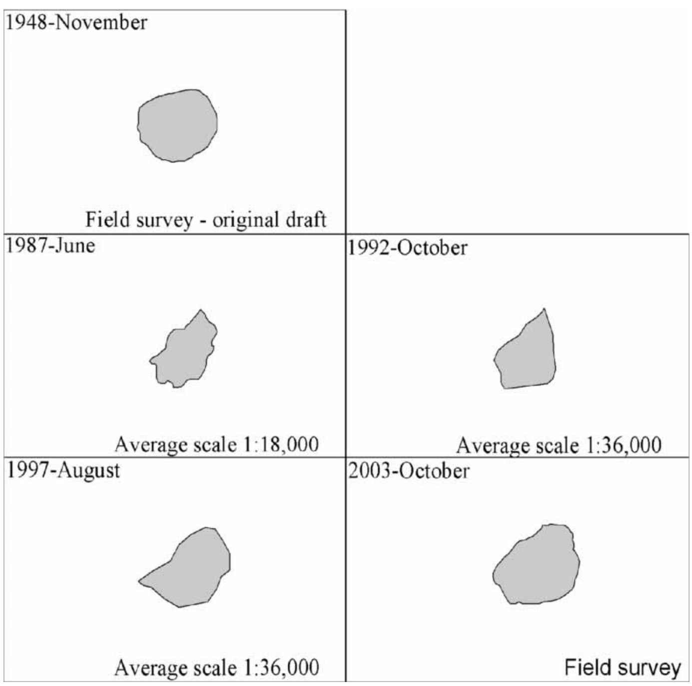

Figure 4. Comparison between different shapes of Lake Sfondato based on bibliographic data, air photographs, and our survey. Scales indicated in the figure refer to those of the relative air photographs and not to the draft scale.

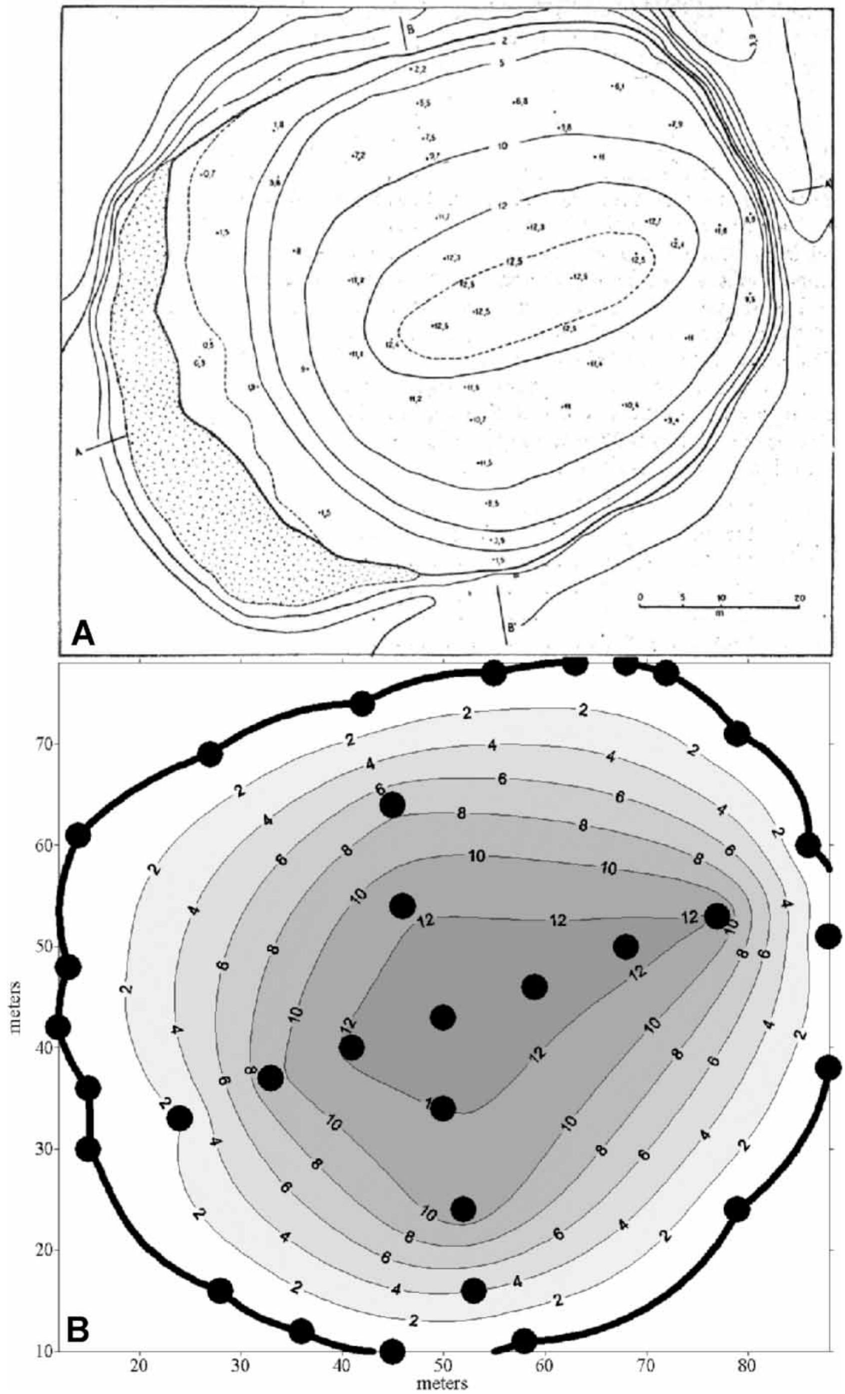

Figure 5. (A) Original draft of the bathymetric contour map after Cumin [7]. (B) Resampling of the original bathymetric contour map after Cumin [7] by a measuring array (circles) having the same geometry as that used in our survey. (C) Bathymetric contour map from data acquired in October 2003 (circles are sampling points).

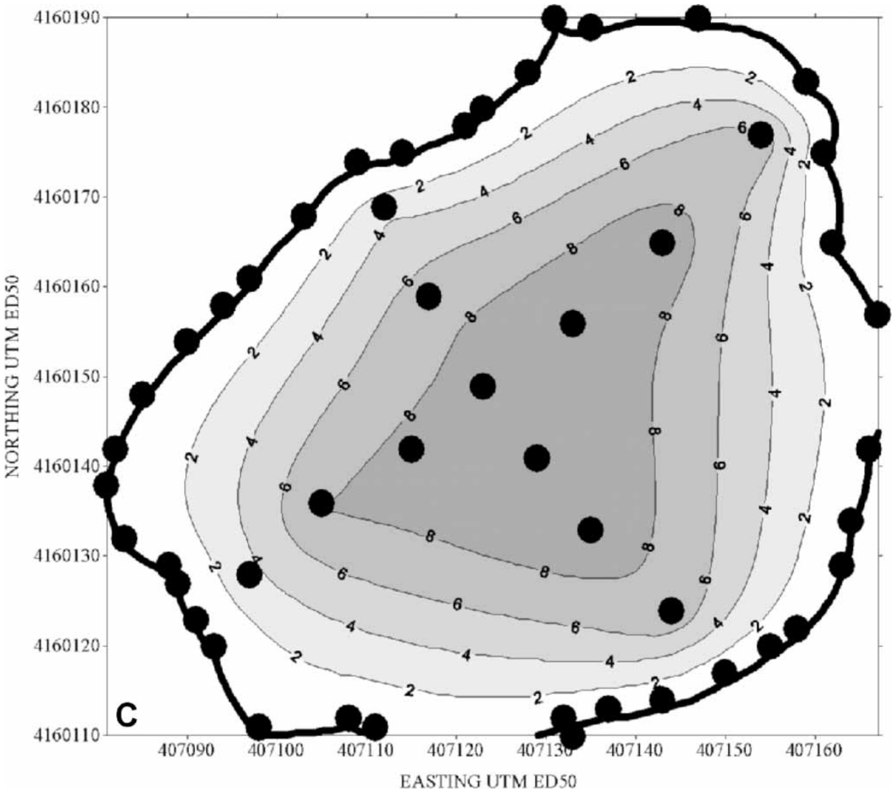

Figure 5. Continued.

(25 091 m^3), although his lake area was lower than that which we recalculated. The present data highlight a lake with a wider area but with a sensibly lower depth (9.7 m vs 12.7 m).

Taking into account the above-mentioned problems that affect both the surface and volume calculations, and presuming that the mechanical sounding of a lake-bottom is not a method that suffers from high measuring errors, the only reliable information is the reduction in the depth of the lake from 12.7 m, measured by Cumin, to 9.7 m measured by ourselves. Although old bibliographic data have been very useful in environmental evolution reconstructions, the lack of reliability of the measuring methods dramatically affects the interpretation of the results. Therefore, the only conclusion that we can infer from the bibliography is the evident landfill, which, in the period from Cumin's survey to date, caused a significant reduction (25%) in the depth of the lake.

3.3 *Hydrological balance*

From a hydrological point of view, Lake Sfondato could be divided into two subsystems: the lake itself and the catchment area feeding it. The comprehensive hydrological balance D_{tot} is expressed by the formula:

$$D_{\mathrm{tot}} = D_{\mathrm{l}} + D_{\mathrm{c}}, \tag{1}$$

where D_{l} and D_{c} are the water deficits of the lake and of the catchment area, respectively. The lake deficit is given by the formula:

$$D_{\mathrm{l}} = (R - E_{\mathrm{d}}) \times A_{\mathrm{l}}, \tag{2}$$

where R is the yearly rainfall, E_d the yearly evaporation, calculated by the Meyer formula [8], and A_l the lake surface.

The contribution of the catchment area was estimated under two limit conditions within which the real value has to be comprised: the absence of significant infiltration ($I \approx 0$) and infiltration equal to runoff. The values of runoff that exceed this limit do not appear to be realistic due to the dominance of clays outcropping in the catchment area. Under these conditions, we have two different equations:

$$D_c^{(I \approx 0)} = (R - E_c) \times A_c \tag{3}$$

$$D_c^{(I \approx \mathrm{Roff})} = (0.5 \times R - E_c) \times A_c, \tag{4}$$

where E_c is the potential yearly evapotranspiration after Thornthwaite [9] and A_c the planar surface of the catchment area. In the calculus of the yearly values of E_c, the monthly contributions E_i have to be equal to the monthly rainfall R_i when $R_i < E_i$.

The data source and values used in the above-mentioned hydrological equations are described in table 2. The results of the hydrological calculations highlight a negative balance for the lake ($-3795\,\mathrm{m^3\,yr^{-1}}$) that becomes positive if we refer to the whole lake-catchment area system in the case of $I \approx 0$ ($965\,\mathrm{m^3\,yr^{-1}}$), whereas it remains negative ($-1550\,\mathrm{m^3\,yr^{-1}}$) if $I = \mathrm{Roff}$. In the first case, taking into account (see table 1) the fact that the surface of the lake is located at a higher altitude than the contiguous creek, and that there are no emissaries, the water in excess might well be lost as underground flow from the reservoir to the surrounding terrains. The role of the catchment area appears to be fundamental in ensuring the stability of the water input/output balance; therefore, changes in soil use have to be avoided in order to preserve the lake's ecosystem.

The difference between water inputs and outputs in the two hypotheses of Roff led us to evaluate the effect of possible climatic changes on reservoir stability. In figure 6, we report the possible scenarios of water deficits, for both the conditions $I \approx 0$ and $I = \mathrm{Roff}$, related to changes in air temperatures and rainfall. As can be seen in figure 6, the increase in air temperature and scarcity of rainfall could dramatically affect water accumulation in the lake, especially in the case of a decrease in rainfall.

3.4 *Water chemistry*

The main geochemical characteristics of the waters under study and the results of DO and temperature vertical profiles are reported in tables 3 and 4, together with a sample collected from the little creek flowing around the southern boundary of the lake (Stretto creek).

Figure 7 shows the vertical profiles of water temperature and DO, compared with the average values of monthly air temperature (table 2). As shown in the figure, no significant seasonal variations in DO were observed in the four surveys. The values move from a good oxygenated surface environment (up to 140%) to an anoxic state in the deeper part of the lake (less than 10%). Lowering of DO is not constant with depth, but there is a sudden decrease between the depths of 4 and 6 m. The huge values of dissolved oxygen in shallow depths can be explained (see next chapter) by the high algal production that is however confined to the first 5 m of the water column. On the other hand, the thermal state of the upper layers is strongly dependent on atmospheric temperatures (from a measured minimum of less than 11 °C in February to a maximum of more than 19 °C in October), whereas the temperature of the water at the bottom is more stable (with a range of 12.5–15.5 °C). Temperature profiles clearly highlighted the existence of a picnocline, located at a depth of 4–6 m, which shows the meromictic character of the water body. This was particularly evident in February 2004, when temperature values below the picnocline were about 3 °C higher than those recorded in the upper layers.

Table 2. Monthly and yearly values of hydrological data and calculations.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	70	52	45	38	25	8	10	16	43	72	59	72	510
Minimum air temperature (°C)	5.6	5.8	7.2	9.2	13.3	17.1	20.1	20.6	17.9	14.1	10.3	6.8	12.3
Maximum air temperature (°C)	13.1	13.9	16.1	19.3	24.5	29.3	33.2	33.6	29.0	23.7	18.3	14.0	22.3
Average air temperature (°C)	9.4	9.9	11.7	14.3	18.9	23.2	26.7	27.1	23.5	18.9	14.3	10.4	17.3
Rh (%)	76	75	66	66	56	41	46	46	64	72	76	81	63.9
Average wind speed ($m\,s^{-1}$)	10.8	10.8	9.8	10.4	9.6	8.3	9.3	8.7	8.8	9.5	8.7	9.9	9.6
Potential evapotranspiration (mm)	20	20	30	38	25	8	10	16	43	50	30	20	62
Surface lake evaporation (m^3)	33	37	52	65	116	203	246	248	130	73	43	27	1273
Hydrological deficit lake (m^3)	182	77	−35	−133	−451	−971	−1174	−1155	−434	−6	81	223	−3795
Hydrological deficit catchment area ($I \approx 0$) (m^3)	1130	731	386	5	0	0	0	0	0	482	630	1126	4490
Hydrological deficit catchment area ($I =$ Roff) (m^3)	565	366	193	3	0	0	0	0	0	241	315	563	2245
Total hydrological deficit ($I \approx$ Roff) (m^3)	1312	808	350	−127	−451	−971	−1174	−1155	−434	476	711	1350	695
Total hydrological deficit ($I =$ Roff) (m^3)	747	442	158	−130	−451	−971	−1174	−1155	−434	235	396	787	−1550

Note: Air temperatures and rainfall are averages from the last 30 yr published by the Agrometeorological Unit of the Regione Siciliana-Assessorato Territorio ed Ambiente (1998). Wind speed and Rh data, used in the Meyer (1915) formula for lake evaporation, refer to average values collected in the years 2002–2003 from the Caltanissetta station of the Sicilian Agrometeorological Information System (SIAS).

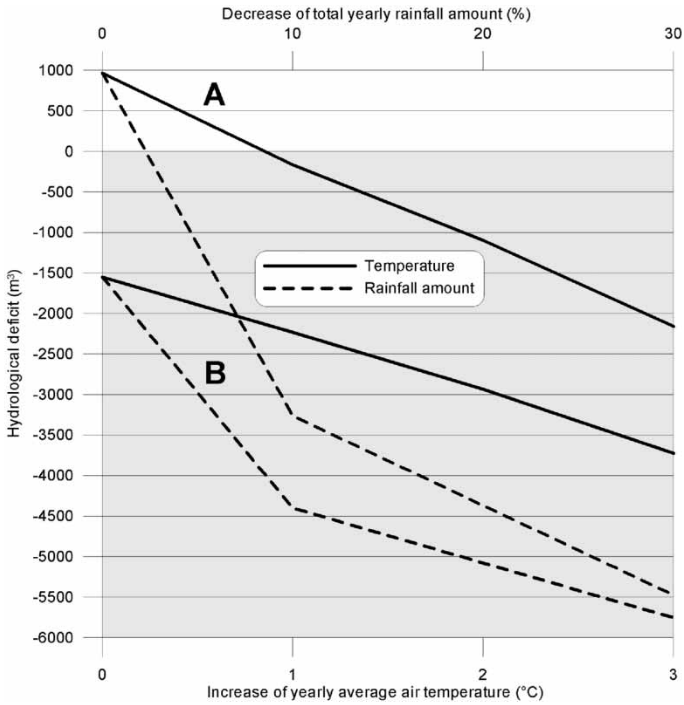

Figure 6. Forecasting of the hydrological balance of Lake Sfondato under different scenarios of climatic change. A is the scenario where $I \approx 0$, whereas in B, $I = \text{Roff}$.

Table 3. Geochemical characteristics of the Sfondato Lake waters collected at various depths.

Depth (m)	0	2	4	6	8	Stretto creek
Li^+ (mEq l^{-1})	0.40	0.38	0.39	0.38	0.40	0.25
Na^+ (mEq l^{-1})	154.91	164.83	167.04	204.68	210.57	74.12
K^+ (mEq l^{-1})	1.50	1.35	1.35	1.50	1.48	0.88
Mg^{2+} (mEq l^{-1})	31.27	32.86	32.02	34.13	35.82	17.43
Ca^{2+} (mEq l^{-1})	54.09	57.60	59.96	61.71	63.41	37.96
F^- (mEq l^{-1})	0.29	0.29	0.27	0.25	0.28	0.12
Cl^- (mEq l^{-1})	184.98	199.48	202.90	248.01	253.64	81.79
Br^- (mEq l^{-1})	0.29	0.32	0.32	0.27	0.40	0.12
NO_3^{2-} (mEq l^{-1})	0.00	0.00	0.00	0.00	0.00	0.00
SO_4^{2-} (mEq l^{-1})	53.60	56.67	57.04	55.41	56.60	47.62
HCO_3^- (mEq l^{-1})	4.60	4.70	4.80	6.00	6.80	1.45
pH	7.75	7.2	7.4	6.6	7.1	7.55
Eh (mV)	84	76	67	−275	−289	111
TDS (mg l^{-1})	15 982	17 053	17 202	19 904	20 464	9001.32

The presence of a picnocline is further confirmed by the results of the November 2003 multi-parametric profile, shown in figure 8. We can distinguish a well-oxygenated mixolimnion, with corresponding high values of pH and Eh and a lower salinity, separated by a monimolimnion from the deep anoxic environment, with low values of pH and Eh and higher dissolved salt concentrations. The vertical stratification of the lake water, as already evidenced by DO profiles, is not influenced by the seasonal cycle: in fact, additional data of Eh and electrical conductivity (figure 9) acquired in April 2003 and February 2004 clearly confirm the persistence of the picnocline at depths between 4 and 6 m.

Table 4. Values of water temperature and dissolved oxygen (DO) along vertical profiles.

	Apr 2003		Oct 2003		Nov 2003		Feb 2003	
Depth (m)	*t* (°C)	DO (%)	*t* (°C)	DO (%)	*t* (°C)	DO (%)	*t* (°C)	DO (%)
0	16.47	99	19.2	108	12.7	90	10.4	74
2	16.43	104	18.6	98	13	101	10.4	70
4	15.23	126	18.5	83	13.1	70	10.7	68
6	15.49	0	16.8	4	13.7	13	13.3	11
8	15.5	0	12.8	2	13.5	5	13.4	9

Chemical data are presented in a Langelier–Ludwig diagram (figure 10). All the samples belong to the sulphate–chloride–alkaline group, with a cationic composition where sodium–potassium species prevail on alkali ions, whereas chloride–sulphates are prevalent with respect to bicarbonates. This chemical facies is completely different in respect of another point that is representative of the outcropping areas of the Gessoso Solfifera formation, where salt deposits are absent (MDP, Marina di Palma city, on the south coast of Sicily) and where calcium ions are dominant. The interaction of the surface waters with salt deposits, outcropping or suboutcropping in the study area, seems therefore to be confirmed by the geochemical data; this fact represents further evidence of the salt diapir dissolution hypothesis of the genesis of the lake.

These changes are related to an evolution of the waters towards a chemical composition which is more enriched in sodium and potassium at deeper depths. To better understand the chemical processes affecting the ion concentrations, the software PHREEQC [10] was used to calculate the activity of the ions and saturation indexes of the related mineralogical phases; attention was particularly focused on halite (NaCl) and gypsum ($CaSO_4 \times 2H_2O$), which represent the main constituents of the outcropping rocks interacting with the surface waters. The results of the calculations are reported in table 5 and integrated in figure 10; here, the

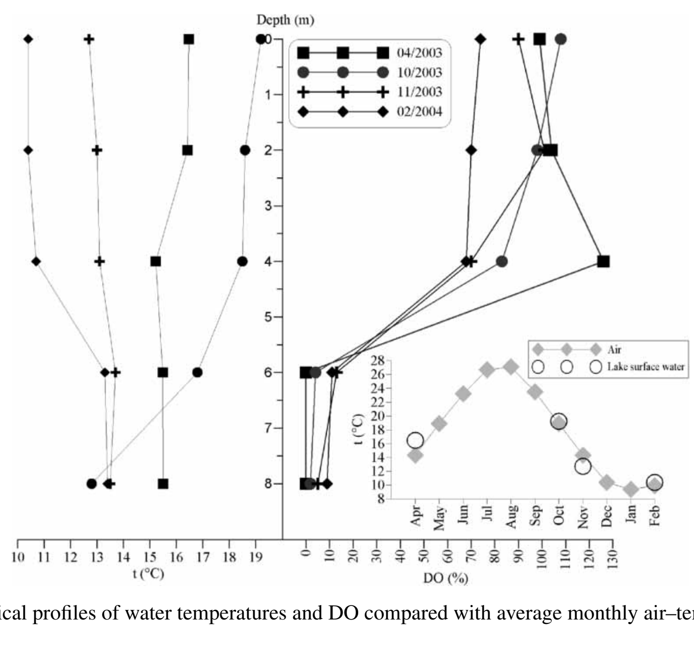

Figure 7. Vertical profiles of water temperatures and DO compared with average monthly air–temperature values.

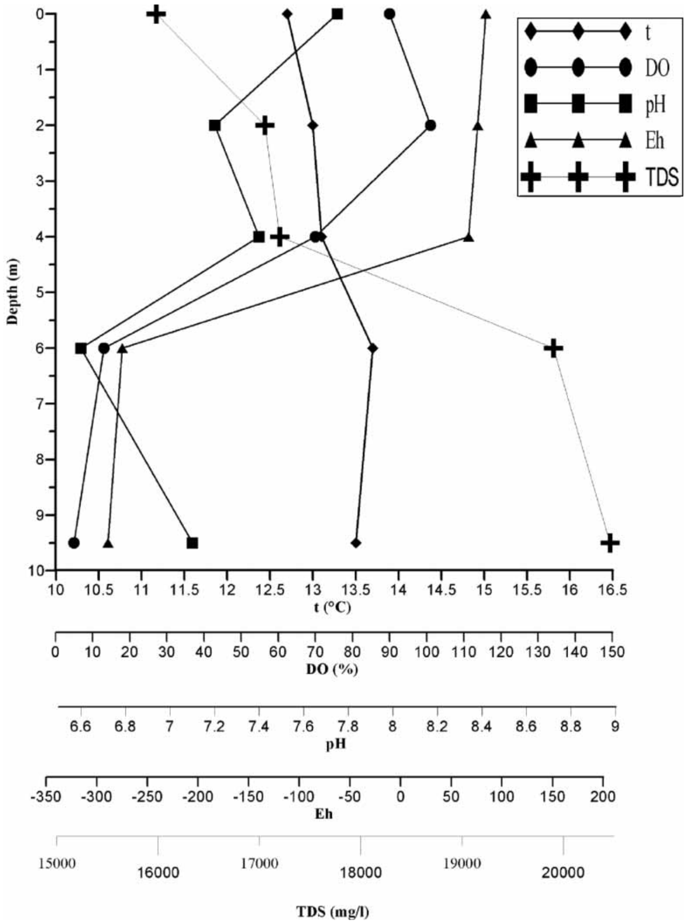

Figure 8. Vertical profiles of temperature, DO, pH, Eh, and TDS in Lake Sfondato in November 2003.

vertical variations of the ratios between ion couples sodium/chlorine and calcium/sulphate are shown.

Independently of depth, the lake waters are always undersaturated with respect to halite and oversaturated in respect of gypsum. The concentration ratios between sodium and chlorine are not affected by depth and are very similar to sea water [11]. On the contrary, the couple calcium/sulphate shows relative abundances close to the stoichiometric ratio of gypsum in the first 4 m, whereas a marked calcium excess is present below this depth.

In our interpretation, the progressive increase in dissolved sodium chloride with depth is made possible by the undersaturation of the lake water in respect of this phase, and it is the expression of an evaporation process. Surface waters are subjected to evaporation, and their density increases as far as the concentration of the dissolved salts rises, until they become heavier than the underlying water strata. At this point, the high-density surface solutions sink to the bottom of the lake.

The evaporation process is not reflected by calcium sulphate concentrations because the waters are oversaturated as regards gypsum, and the exceeding ions are deposited as solid phase. The calcium excess below the 4 m limit is probably to be referred to the reduction in hydrogen sulphide, induced by the redox conditions of the anoxic environment.

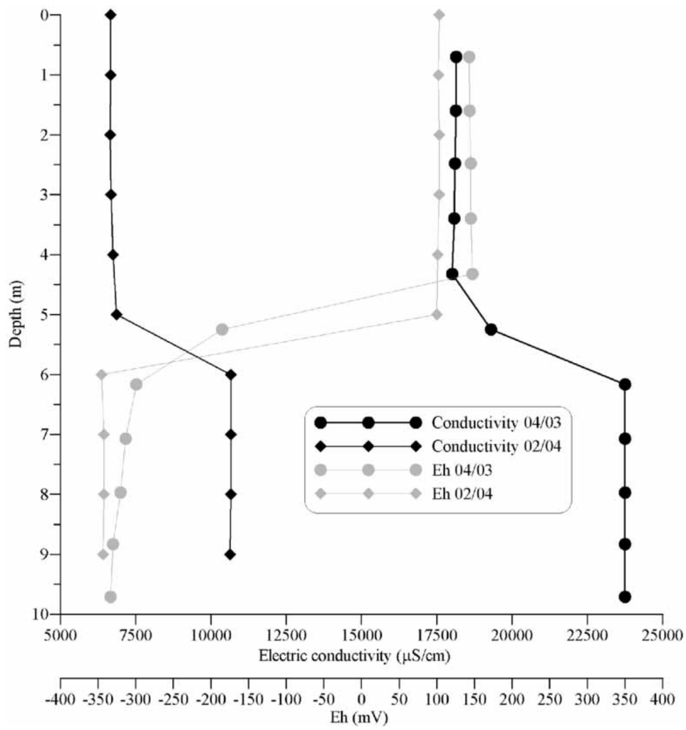

Figure 9. Additional data of Eh and electric conductivity acquired along vertical profiles in April 2003 and February 2004.

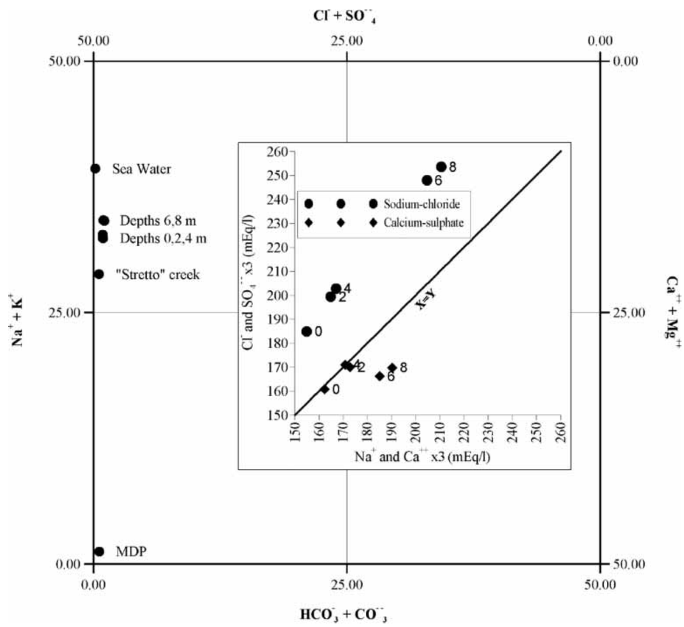

Figure 10. Langelier – Ludwig diagram (inset, with depth labels) and ratios between sodium chloride and calcium sulphate (for drafting reasons, ratios were calculated in respect of sulphate and calcium concentrations multiplied by 3); data from water samples collected at various depths are plotted with points representing sea water, the Stretto creek, and runoff waters from another outcropping area of the Gessoso Solfifera formation (MDP) where salt deposits are unquestionably absent.

Table 5. Values of saturation indexes of gypsum and halite corresponding to the geochemical conditions recorded at various depths in Lake Sfondato.

Depth (m)	0	2	4	6	8
Gypsum saturation index	0.05	0.08	0.07	0.05	0.07
Halite saturation index	−3.39	−3.33	−3.32	−3.16	−3.13

3.5 *Water biology*

The composition of the phytoplankton assemblages in the studied period is shown in table 6. Density values, integrated down to the first 5 m, ranged between 3.5×10^6 and 12.7×10^6 cells l^{-1}. The lowest values were recorded in spring, and the highest in winter. The diatom *Chaetoceros muelleri* dominated during winter, accompanied by cryptomonads, while spring. *Synedra* sp. and Chlorococcal green algae were the most abundant organisms in summer.

In spite of the availability of light, only a small amount of phytoplankton was present below the first 5 m. In fact, meromixis permanently divides the water body into two compartments: the anaerobic monimolimnion, in contact with the sediments, where nutrients are trapped, and the upper mixolimnion where algae can grow. The possible nutrient segregation in the monimolimnion is confirmed by the transparency values recorded (about 2.1 m), which are analogous to those measured by Cumin [4] more than 50 yr ago in spite of the intense farming carried out in the catchment. This, along with the endorheic nature of the lake, should have caused an increase in the trophic state of the water body. Such an increase probably did not take place thanks to the nutrient trapping by the monimolimnion.

On the basis of the density values recorded and of the taxonomical composition of the phytoplankton assemblages, the lake can be classified as meso-eutrophic. Moreover, the abundant presence of diatoms in the lake suggests a high availability of soluble reactive silica. *Chetoceors muelleri* is also a typical inhabitant of brackish water with conductivity values higher than 4 mS cm^{-1}, which is commonly found in Sicily.

Table 6. Taxonomic composition of phytoplankton assemblages in the samples collected in April 2003, October 2003, and February 2004.

16 Apr 2003		2 Oct 2003		13 Feb 2004	
Species	Density	Species	Density	Species	Density
Chaetoceros muelleri	3 489 000	*Synedra* sp.	4 210 000	*Chaetoceros muelleri*	6 340 000
Synedra sp.	70 000	*Ceratium hirundinella*	725 000	*Navicula* sp.	22 000
Navicula sp. 1	3000	*Scenedesmus* spp.	420 000	*Synedra* sp.	45 000
Navicula sp. 2	3000	*Oocystis* sp.	175 000	*Gyrosigma* sp.	11 000
Cryptomonads	29 000	*Pediastrum simplex*	890 000	*Oocystis* sp.	120 000
		P. duplex	1 210 000	*Monoraphidium* sp.	60 000
		Phacotus lenticularis	72 000	*Cryptomonads*	6 120 000
Total	3 594 000	Total	7 702 000	Total	12 718 000

Note: Densities are expressed in cell l^{-1}.

Meromixis may contribute, in some ways, to maintaining this small lake in its present condition, preventing eutrophication which is strongly affecting Sicilian inland waters at the moment.

4. Conclusions

In conclusion, Lake Sfondato is a brackish, endorheic, meromictic water body which is fed by superficial flow and direct water charge and which originated from the collapse of a saline diapir. Furthermore, it shows a meso-eutrophic state. These features are typical of the water bodies located in dry climates, which warrant particular attention and protection due to their sensitiveness to climatic and anthropic impacts.

Acknowledgements

We wish to express our gratitude to the staff of Legambiente-Gestione Riserva Naturale Lago Sfondato, who helped and assisted us during the field surveys.

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