

Recent Sedimentation in Valencia Lagoon: Preliminary Results

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ABSTRACT

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The Valencia lagoon is one of the most interesting ecosystems on the Valencian coast. Historically it has undergone a considerable reduction in surface area due to natural processes and mostly to human impact. Studies about lagoon sedimentation are of increasing scientific and economic value. This work concerns the sediment characteristics and the rates of sedimentation within the Valencia Lagoon based on sedimentological analyses and ^{14}C dates from cores. The sedimentological analyses confirm the change in the lagoonal environment from a saline situation to that of a freshwater situation. The lower quantities of plant remains in the cores at the same levels where shells are more abundant, as well as the increase in shell size, and accompanying increase in clay content support the hypothesis of a change from marine to a continental environment as the present is approached. The results of the carbon-dating of shell-rich layers establish a sedimentation rate lower than previous estimates and lead to the conclusion that a great quantity of sediments is being trapped in the peripheral marshy area and does not reach the aquatic lagoon.

ADDITIONAL INDEX WORDS: *Marsh, lagoon, sedimentation rate, sedimentological analysis.*

INTRODUCTION

The Valencia Lagoon is situated 10 km to the south of Valencia (Figure 1). At present it is one of the most important wetland zones on the Spanish Mediterranean coast. It is regarded to have a high ecological value because of its biological and geomorphological characteristics. The present day lagoon has an area of 2,350 ha and is rather shallow; its depth ranges from 0.5 to 2.0 metres. There are several ephemeral streams and some springs, *ullals*, that contribute water to the lagoon. A barrier island, extending from 30 km in length and having a width of 500-1,000 m, separates the lagoon from the sea. The barrier has three inlets, two are natural (el Perelló and el Perellonet) and one is artificial (el Pujol) which connect the lagoon with the sea. All of the inlets have sluice gates to control the exchange of water and to control the level of the lagoon surface.

Historically, the lagoon has had many problems. One of these was the reclamation that took place during recent centuries which considerably reduced the surface area of the lagoon. A current problem is the contamination that threatens the natural ecology of the lagoon. The declaration of the lagoon as a Natural Park in 1986 is expected

to bring some of the problems under control and lead to a general improvement of the ecological system. Many authors have voiced concern about the environmental problems and several studies concerning rates of lagoon infilling and sedimentation have been conducted in the past few years. Usually these studies have used and developed theoretical models to determine the sediment budget of the Valencia Lagoon. One objective of this paper is to test the models of infilling by collecting data on the sedimentary characteristics of the lagoon and to give rates of accumulation. The methodology employed is coring, sedimentary analysis, and ^{210}Pb and ^{14}C isotopic dating.

STUDY AREA

The Valencia lagoon is located between two alluvial plains formed by the Túria River and the Xúquer River (Figure 1). There are additional factors such as local subsidence, drainage from the rivers and local springs, and a gentle regional slope that contribute to the development of a lagoonal environment in this location. During the late Quaternary the entire area was probably a marine embayment bounded seaward by a developing barrier island. The barrier probably originated near the mouth of the Túria River and extended southward where it eventually attached to

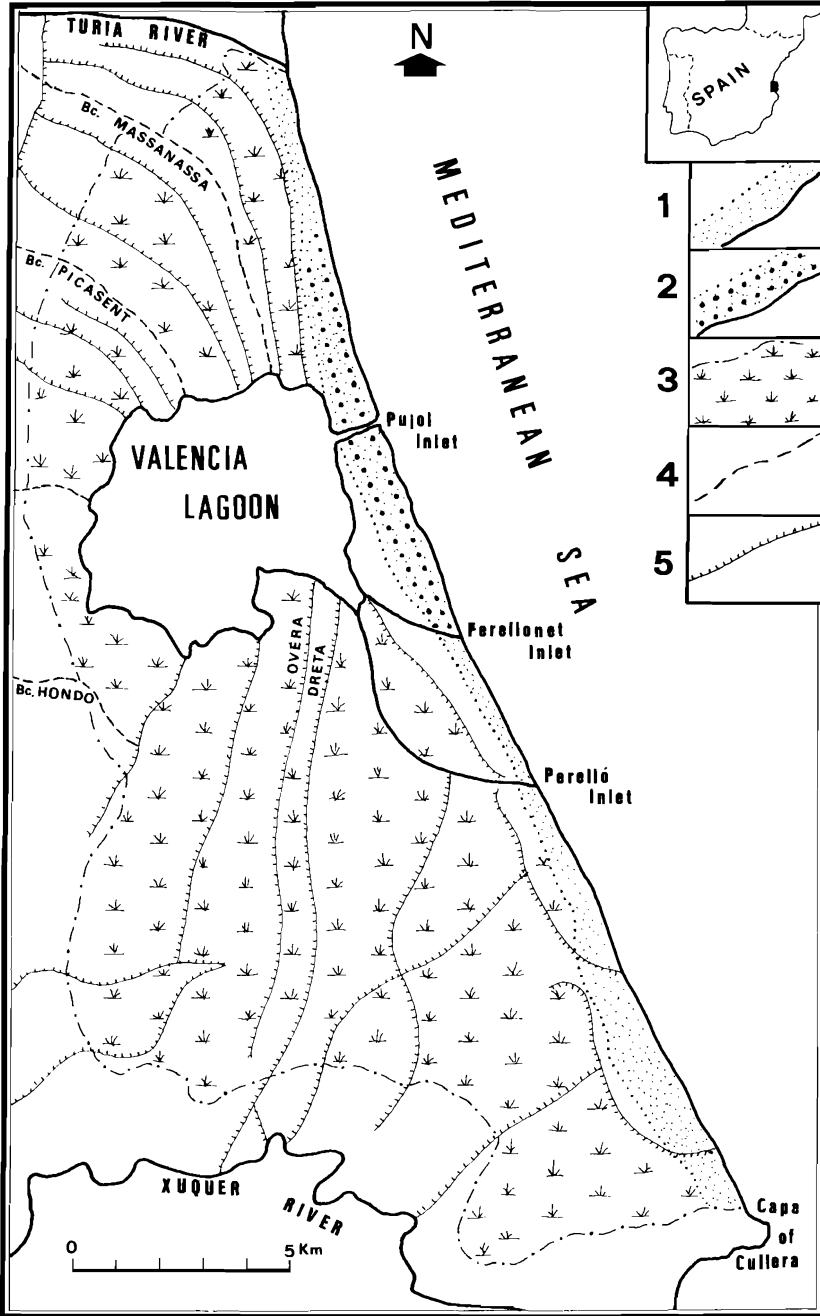


Figure 1. Study area. (1) Barrier island, (2) dune field, (3) marshy area, (4) ephemeral stream, (5) drainage canal.

the cliffs at the Cape of Cullera and closed off the Valencia Lagoon (SANJAUME, 1985).

At the present time, the lagoon receives discharges from several ephemeral streams, drainage

canals (Dreta, Overa, etc.), local springs, and from the two major rivers (Túria and Xúquer) during flood events. It also receives some contributions from several irrigation channels. The lagoon loses

water to irrigation, evaporation, and to the sea when the sluice gates are open in the inlets. The water level is controlled to maintain the fresh-water quality as well as to assist in the draining and flooding of the rice fields located around its periphery in the marshy area. At present, the sluice gates also prevent salt water from entering the lagoon.

From a biological point of view, water quality studies (MIRACLE *et al.*, 1984; SORIA, 1987) have revealed the Valencia Lagoon to be a hypereutrophic system; that is, a very eutrophic environment which is characterized by: (1) shallow depth and limited water circulation; (2) excessive nutrients and a depleted oxygen regime; and (3) a very high productivity (the biomass can exceed 150 mg/l and the chlorophyll-a 600 mg/m³).

Recent studies which have used Landsat 5 (TM) images (LOPEZ GARCÍA and CASELLES, 1987, 1990) to confirm the distribution of water masses in the lagoon presented by SORIA (1987). Two types of water can be identified: (1) waters derived from the drainage systems, generally having a low biomass content and high nutrient levels, and (2) the lagoon water which uses the nutrient load and consequently has a high biomass value. From the images, it has been determined that the most important inputs to the lagoon—in regular conditions—are from the southern channels, the Overa and the Dreta. The second most important source is the contribution of the northern area, from the Massanassa and Port de Catarroja ephemeral streams. Occasionally, there is some input from the southwest. The flows entering the lagoon create a north to south circulation along the eastern part of the lagoon. This circulation pattern together with the discharge through the inlets into the sea is probably responsible for the highest chlorophyll-a concentrations appearing in the west and southwest parts of the lagoon, where the exchange rates are slower.

HISTORICAL EVOLUTION OF THE VALENCIA LAGOON

The area of the Valencia lagoon has been reduced drastically during historic times (Figure 2). Documentation exists, written notices and old maps, attesting to its changes since the fourth century. ROSSELLÓ (1972, 1976) summarizes the historical evolution of the lagoon. In 1579 its boundary was delimited to prevent illegal reclamation, and its area was 15,000 ha. Later, in 1791, the lagoon boundary was delimited once again and

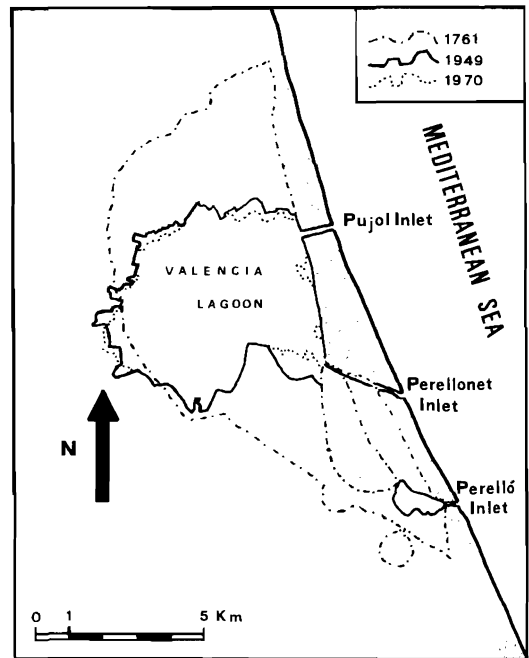


Figure 2. Historic reduction of the Valencia lagoon from 1761 to 1970. (ROSSELLÓ, 1972).

its area covered only 13,962 ha. When JAUBERT drew his map in 1820 the Valencia Lagoon area had been reduced to 10,000 ha. A drainage project conducted in 1863 measured the lagoon area as 8,190 ha. A few years later, in 1877, the area measured by the Hydrological Commission was 5,010 ha. At the beginning of this century, in 1903, the map drawn by the Instituto Geográfico y Estadístico showed a further surface area reduction to 3,391 ha. In 1927, when the lagoon was transferred to the Valencia City Council, its new boundaries encompassed only 3,114 ha. The survey made by the Instituto Geográfico y Catastral gave an area of 2,950 ha in 1944. Later, DAFAUCE (1975) calculated the area to be 2,150 or 1,900 ha depending on whether the seasonal water level was high or low.

Our measurements of the current lagoon area were taken from the Landsat Thematic Mapper satellite images. Band 4, in the wavelength band of 0.76–0.90 μm , was used to discriminate the boundary of the lagoon from the rice fields. Using six different images (16 March, 29 June, 22 July, 17 September and 20 November 1985, and 17 January 1987), the area of the lagoon was calculated

to be 2,349 ha \pm 70, the variation in part is the product of water level in the lagoon.

Over the years, many factors have contributed to the filling of the Valencia Lagoon:

- (1) Sediment blown westward (inner slopes) and eastward from the beach and barrier island.
- (2) Aquatic vegetation growing in the lagoon.
- (3) Sediments carried by river floods (Túria and Xúquer).
- (4) Material discharged by ephemeral streams, locally called *rambles* or *barrancs*, that have their mouths in the lagoon.

The most important reduction of the lagoon surface was produced during the last 125 years due to expansion of rice fields. The maximum filling occurred in the late nineteenth century, especially between 1863 and 1903. The rectilinear facets on the lagoon shore are the product of this reclamation, which stopped a few decades ago (Table 1).

In other marshy areas of the Valencian coast, reclamation was accomplished by drainage canals. However, along the Valencia Lagoon, the reclamation had a special technology. Here the rice fields extended into the lagoon by a system known locally as *aterrament*. This system consisted of filling up small lagoon portions—previously bounded by canes—with material carried to the site by small boats. About 1,200 metric tons of sediments were required to build a new rice field of one hectare.

At present the cultivation of rice has decreased considerably due to its poor economic yield. The rice is being replaced by other crops which require less fresh water. Therefore, this is yet another factor prompting the loss of wetland surface in the peripheral marshy area which will affect the ecosystem evolution.

APPROACH TO THE SEDIMENTATION PROBLEM

The dramatic reduction of the lagoon area has received special attention during the past few years as the high ecological importance of the lagoon has become known. As a consequence of this interest, several studies concerning different aspects of the lagoon have appeared recently. Among them are some focusing on components of the sedimentation.

The majority of these works are based on theoretical models which estimate the inputs of water and sediments entering the lagoon from ephem-

eral streams and a large quantity of irrigation channels. High sedimentation rates have been suggested by several authors (GARCÍA LABRANDERO, 1959; DAFAUCE, 1975; MINTEGUI *et al.*, 1986). They estimate that, according to these rates, the lagoon could be completely filled in less than 200 years.

Other authors, however, indicate that the filling process is much slower. ROSSELLÓ (1976), for example, states that the sedimentation occurs primarily at the lagoon margins in the areas affected by reclamation, whereas the central lagoon depth probably remains stable due to subsidence processes or/and compaction of the accumulated sediments.

Knowledge of the actual sedimentation rates of the lagoon is meager because of the lack of direct measurements. The water budget cannot be easily calculated because there are no gauging stations in the area. Further the exchange of water and sediments between the lagoon and the sea is very difficult to determine. At present, there are no data available concerning the quantity of material which leave the lagoon through the inlets when the sluice gates are opened to assist in drainage of the rice fields. And finally, the quantity of sediments carried by the ephemeral streams and the rivers (Túria and Xúquer) during their floods has not been measured.

The studies concerned with lagoon sedimentation cited above did not use direct measurements of sediment input and necessarily inferred their high rates of sedimentation. ROSSELLÓ (1976), on the other hand, suggests that the rate of sediment accumulation is not great at present. In an effort to determine the rate of sediment input and because of the difficulty of collecting direct measurements of sediment and water balance, we approach the problem through an examination of the accumulated materials to determine their past history.

METHODOLOGY

The methodology applied in this work is based on the use of cores. The analysis of core samples provides a wide range of information. First, it is possible to determine the sedimentological characteristics of the lagoon materials, which will allow the identification of sedimentation conditions. Core data will be useful in testing other statements pertaining to the texture of the lagoon sediments (GARCÍA LABRANDERO, 1959; BENET, 1983). Some samples can be used in isotopic dat-

ing. Those parts of the cores containing shells will be used to obtain ^{14}C dates. Moreover, ^{210}Pb and ^{137}Cs analyses of the upper layers will provide sedimentation rates for the last one hundred years.

The gathering of cores by standard procedures was quite difficult because of the characteristics of the lagoon (limited depth and marshy vegetation). It was necessary to try alternative methods in order to obtain samples of the lagoon bottom. PERIS *et al.* (1987), in their study of pollution of the lagoon sediments, used a manual extraction system with satisfactory results. This same system was applied in the present study.

The samples were extracted by "hand core" from a small boat using PVC pipes 7 cm in diameter and 5 m long. The pipes were inserted in the lagoon bottom sediment and plugged before the extraction. Seven cores were obtained which were located within the lagoon (Figure 3). The cores reached a maximum depth of 3.87 m below the lagoon's water surface. The solid sediment cores ranged from 0.8 to 2.08 m in length. Sixty-eight samples have been taken from the seven cores. Grain-size analysis was obtained from all of these samples in the laboratory. Samples from one core have been submitted for ^{210}Pb and ^{137}Cs analysis. From the same core, selected entire shells—entire valves which have not been subjected to much transport and thus are thought to be *in situ*—have been submitted for ^{14}C analysis.

RESULTS

Although seven cores were taken and analyzed, the present report is on the sedimentological results of the four cores considered to be most representative (core numbers 2, 4 and 7). Core number 6 has been used to obtain ^{210}Pb and ^{137}Cs dates as well as ^{14}C analysis because it is the deepest and it contains the maximum quantity of shells.

Sedimentological Characteristics

The four cores analyzed are very similar both in grain-size and color. The main texture is clay, and gray colors are predominant. However, on the basis of plant matter, color, and quantity of shells, it has been possible to distinguish several levels in each core.

The sediments of core number 3 (Xicorro) start at 1.24 m below the lagoon level and the core has 0.935 m of sediments (Figure 3). Twelve levels have been distinguished. They are grouped according to their similarities:

Table 1. Historic surface reduction of the Valencia Lagoon.

Period of Time	Surface Reduction	
	(ha)	(ha/year)
1579–1761	2,038	11.2
1761–1820	3,960	67.1
1820–1863	1,186	42.1
1863–1877	3,180	227.1
1877–1903	1,619	62.3
1903–1927	277	11.5
1927–1988	765	12.5

- (1) From 0 to 24.9 cm in depth (level 1) the sediments present a great quantity of plant remains, silty texture, and gray color.
- (2) From 25 to 60.9 cm (levels 2, 3, 4, 5, and 6) the quantity of plant remains is less abundant. The color is also gray and the texture is silty except in the last 10 cm. Here the quantity of clay increases and shell fragments appear.
- (3) From 61 to 66.4 cm (levels 7 and 8) the color is reddish-brown. The texture of level 8 is clayey, sand is more abundant in level 7. The color and the coarsening suggest a probable flood influence.
- (4) From 66.5 to 93.5 cm (levels 9, 10, 11 and 12) gray and brown colors alternate. The texture is silty again and shell fragments are present.

Core number 4 (Colomera) (Figure 3) starts at 1.72 m depth, it has 2.15 m of sediment and 9 levels:

- (1) From 0 to 32.9 cm (levels 1, 2 and 3) the texture is silty-clayey. The plant remains are very abundant. The color alternates between gray (level 1 and 3) and brown (level 2). Level 2 has some shells.
- (2) From 33 to 215 cm (levels 4, 5, 6, 7, 8, and 9) clay is predominant even though some quantity of sand exists. The color is gray and the plant remains have practically disappeared. There are shell fragments in levels 4 and 5. Complete shells are found in the other levels, whose size increases towards the bottom.

Core number 6 (Massanassa) begins at 2.09 m depth (Figure 3). It has 1.675 m of sediment divided up 10 levels:

- (1) From 0 to 6.9 cm (level 1) it is sandy, possibly due to a flood of the Barranc de Massanassa. The color is brown.

- (2) From 7 to 82.4 cm (levels 2, 3, 4, 5, and 6) the color is gray and plant remains are abundant. The texture is silty (minimum at level 3 and maximum at levels 2 and 4).
- (3) From 82.5 to 167.5 cm (levels 7, 8, 9, and 10) the color is gray. Shells are very abundant, especially at level 9. The texture is clayey although there is sand at level 8.

Core number 7 (Pujol) starts at 1.48 m depth with a sediment length of 1.29 m (Figure 3). Nine levels have been differentiated:

- (1) From 0 to 7.9 cm (level 1) the texture is silty-clayey, with a lot of plant remains. The color is light gray.
- (2) From 8 to 31.9 cm (levels 2, 3, 4, and 5) the color is light gray and there is also a great content of plant remains. Here, the clay predominates. At level 5 there are fewer plant remains and some shells appear.
- (3) From 32 to 129 cm (levels 6, 7, 8, and 9) the color is still gray and the texture is also clayey. Organic matter decreases towards the bottom whereas the quantity of shells increases. Some quantity of sand is present at levels 7, 8, and 9.

Textural parameters (FOLK and WARD, 1957) are similar in all of the analyzed cores. The mean grain-size is between 6 and 8.5 phi. All samples are poorly-sorted. The skewness is always around 0, but usually it is slightly positive at the upper levels where silt predominates and it becomes negative towards the bottom where clay is more abundant. In addition the histograms are bimodal or polymodal. The VISHNER (1969) curves confirm that these sediments are transported primarily by suspension.

In each of the analyzed cores, two major sections can be differentiated:

- (1) The upper section which ranges from the sediment surface to a depth which varies between 60 and 95 cm; its main characteristics would be silty texture, skewness slightly positive or 0, and a great quantity of plant remains. Usually there are no shells, but in some levels shell fragments are found.
- (2) The lower section has a clayey texture, even though there may be a small quantity of sand at some levels. Here the skewness is negative. The plant remains disappear and complete shells are very abundant. The size of the shells increases toward the bottom.

Sedimentation Rates

Unfortunately, we can not provide conclusive results from the ^{210}Pb and ^{137}Cs analysis at present because those results have not been received from the laboratory. However, sedimentation rates have been calculated from the ^{14}C dates on the shells found in the level 6 and level 8 of the core 4 (Colomera).

The dates obtained from ^{14}C analysis are the following:

$$\text{Level 6} = 1,110 \pm 115 \text{ BP}$$

$$\text{Level 8} = 2,810 \pm 245 \text{ BP}$$

The dated shells were selected from the entire zone of level 6, which has a thickness of 210 mm, and from the entirety of level 8, 200 mm in thickness. The dating method required the use of all the valves contained in these levels because of the scarce number of shells found. This selection process could explain the high standard deviation values in the dates. Sedimentation rates were calculated assuming a constant accumulation during the entire period of deposition of the shells. The distance between the two levels is 795 mm, which was calculated from the central point of each level. The mean sedimentation rate obtained is 0.47 mm/yr, which corresponds to the sedimentation in the period between 840 BC and 860 AD. In our opinion, this rate may be used as the natural sedimentation rate because reclamation was not very important during these times.

The rate of sedimentation has also been calculated for the section of the core between the mean depth of level 6 and the top of the core (665 mm in thickness). In this case, the rate obtained is 0.57 mm/yr. The increased rate in the last 1,000 years is not considered to be important. Some small increase may be anticipated if the sediment input were constant and the aquatic area were reduced.

DISCUSSION

According to the textural characteristics of the analyzed sediments, accumulation of fine materials (silt and clay) are dominant even near the lagoon margins. Although the ephemeral streams which flow into the lagoon are carrying coarse material at upstream locations, those materials are not arriving at the lagoon shores. Yet, in other Mediterranean lagoons studied, as at Torreblanca (SANJAUME *et al.*, 1990), coarse materials (pebbles and sand) can be found at the lagoon margins. The lack of coarse material near the present lagoon boundaries could be due to several factors:

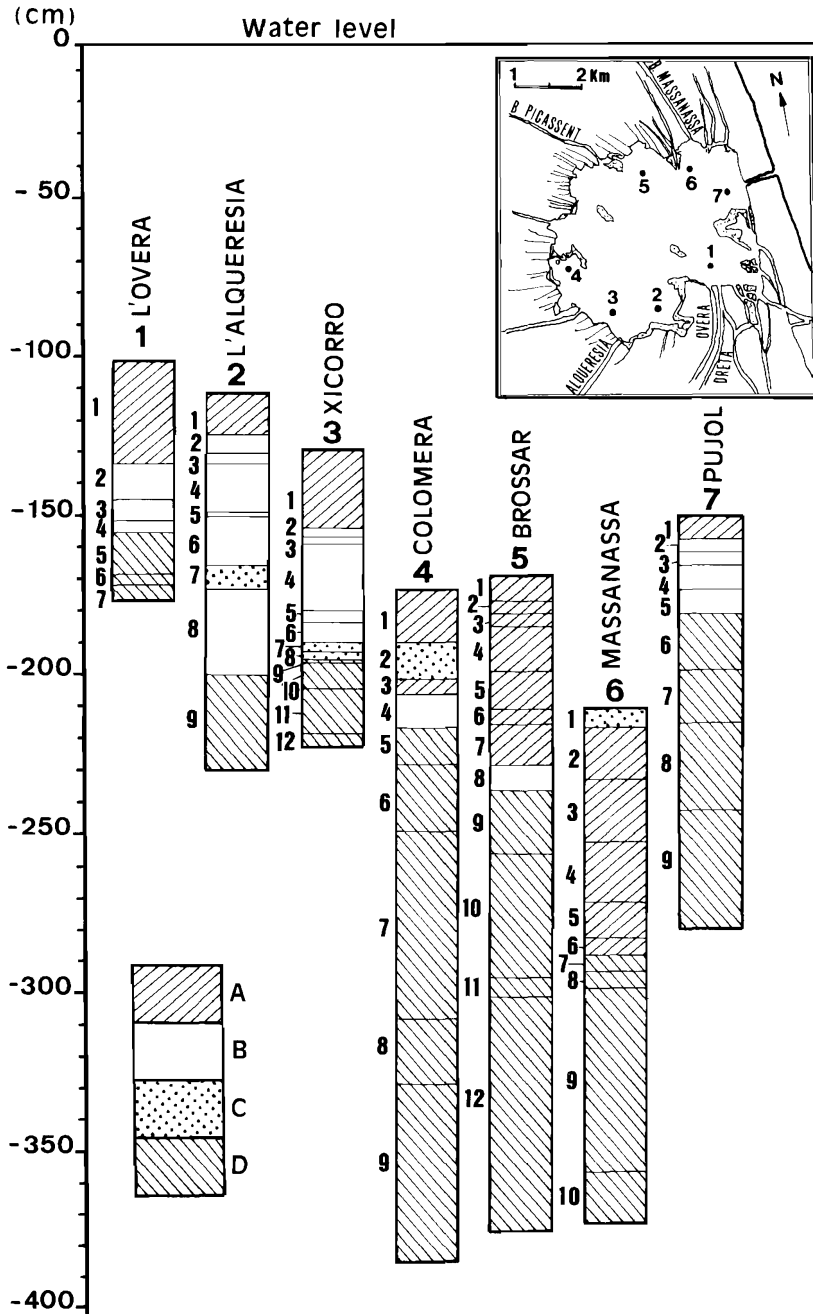


Figure 3. Characteristics of the levels within the Valencia lagoon cores; location of cores shown in inset map. (A) Level with great quantity of plant remains, (B) level where plant remains are less abundant, (C) oxidized level, (D) level with shells.

(1) Dynamic factors: All the ephemeral streams which flow into the marsh area suffer a decrease in their slope. This condition causes a flow velocity diminution and, consequently, a

drop in transport capacity. Thus, coarse materials remain in the inland border of the marsh.

(2) Tectonic factors: Previous studies (SEGURA *et*

Table 2. Sedimentation rates estimated by different authors.

	Sedimentation Rate (m ³ /yr)	Year of Complete Infilling
Garcia Labrandero (1959)	758,000	2,012
Alonso Pascual <i>et al.</i> (1974)	160,000	2,108
Dafauce (1975)	275,000	2,053-2,108
Mintegui <i>et al.</i> (1986)	151,000-357,419	2,066-2,195

al., 1984) suggest the existence of a fault located inland near the marshy area that was probably reactivated during the Quaternary. This fact has provoked drainage disruption and channel disappearance (for example, Barranc de Massanassa) due to the change of the stream gradient. As a consequence bedload is deposited far from the lagoon.

Dynamic factors are the most important ones at the present time and they are enough to explain the dominance of fine-grained accumulations. However, tectonic factors are secondary elements which aid the understanding of the characteristics of the present day deposits.

With respect to sediment texture the most relevant features are the scarcity of sand, and a predominant silt and clay content. Although BENET (1983) indicated that the sand was dominant in the lagoon sediments, there is no evidence of this fact in the analyzed cores. Our data show that the clay content always increases towards the bottom of the cores. According to BOULES (1978) this circumstance is likely to be related to clay flocculation. This process happens in areas where the clay minerals pass from fresh-water to salt-water conditions KRANK (1973) indicated that in salinities of >0.3‰ fine particles in suspension are unstable and flocculate. So, clay mineral accumulation in the core could be an indicator of ancient saltier-water conditions. This hypothesis is supported by the shells found in the cores (*Cerastoderma glaucum*, *Abra ovata*, *Hydrobia ssp.*). According to ROBLES *et al.* (1985) they are marine shells which can exist in salinities ranging from 0.3 to 4‰. The presence of clay and marine shells suggests a time at which the lagoon had free communication with the sea.

With regard to transport processes, suspension is predominant. This can be related to the low velocities of the flow that discharges into the lagoon. However, there are some very small sand layers in some levels which could be transported

by saltation associated with low flow velocity, or by suspension during high flow velocity flood events. Sand has been found in Cores 4 (Colomera), 6 (Massanassa) and 7 (Pujol). In the Colomera and Massanassa cores, both situated at the mouth of ephemeral streams, the sand layer is related to flood events. In these cases sand was found in the upper levels where the oxidized color of the sediment confirms this fact. In the Pujol core, located next to the barrier island, the presence of sand could probably be related to the sand inflow from the sea through the inlet or by washover during a storm in the past. On the other hand, sand was not present in Xicorro core because of its location far from both ephemeral streams and the barrier inland.

With respect to the sedimentation rates, the volume of the sediments which come into the lagoon had been previously estimated by several authors (Table 2). GARCÍA LABRANDERO (1959) indicated that the Albufera lagoon received 759,500 m³/yr of sediment. He suggested that the filling would be very fast and the lagoon would be completely filled by 2012. Some years later, ALONSO PASCUAL *et al.* (1974) estimated the quantity of sediments carried in suspension by the irrigation channels to the lagoon as 160,000 m³/yr. DAFUCE (1975) calculated that the degradation of the unprotected Albufera lagoon basin was about 859,000 Tm/yr. He obtained this data, using the model given by FOURNIER (1960), from a study about the specific degradation of the entire lagoon drainage basin. The estimated sediment supply would be 345,000 Tm/yr, taking into account that only finer sediments (silt and clay) arrive at the lagoon (approximately 40% of the total transported sediments). This quantity of sediments means a volume of 275,000 m³/yr calculated on the basis of a specific weight of 1,250 kg/m³. From these estimates as well as those obtained by ALONSO PASCUAL *et al.* (1974), DAFUCE (1975) indicated that the lagoon would be completely filled between 2053 and 2108.

MINTEGUI *et al.* (1986), from several theoretical models as USLE, MUSLE, WILLIAMS, and HYMO, simulated the erosion, transport, and sedimentation processes and they predicted the future evolution of the lagoon. From these models they deduced that the solid sediment supply transported into the lagoon has increased from a mean value of 151,134 m³/yr obtained from the period from 1903 to 1976, to a mean value of 357,419 m³/yr calculated between 1976 and 1982. These au-

thors estimated that the lagoon would be completely filled between 2066 and 2195, if this tendency was kept up.

In our opinion, some aspects of the methodology used by these authors can be criticized, as well as some of the results obtained from the application of these models:

- (1) Most of the erosion models employed use mean rainfall values and do not take into consideration the extreme rainfall. However, these extraordinary events, characteristic of the Mediterranean climate, have a relevant geomorphological significance in the area.
- (2) The runoff coefficient included in some models is only an approximation, because there are no gauging stations on the ephemeral streams.
- (3) Further, the runoff coefficient is not a suitable parameter in calcareous lithology, which is predominant in the Albufera area. SEGURA (1987) demonstrated that calcareous basins show a high and variable infiltration capacity depending on the rainfall intensity and the lithological features. Consequently, the runoff coefficient has also a great variability. Thus, the studies which only use one runoff coefficient, as some of those mentioned, can lead to erroneous estimates.
- (4) Generally, these authors did not make direct measurements of the solids which are arriving at the lagoon. Only ALONSO PASCUAL *et al.* (1974) tried to test the solid material in suspension transported by the drainage channels. Although most of the authors agree that the major contributions arrive at the lagoon during flood events, nobody has ever measured the discharge carried by the ephemeral streams.
- (5) Finally, the authors infer that all the fine material discharged by the ephemeral streams arrives at the lagoon, and its filling will occur soon.

Presenting a different point of view, ROSSELLÓ (1976) doubted the short-term lagoon accumulation and suggested that the sedimentation was mainly near the lagoon margin whereas the lagoon depth remained nearly stable. The results and interpretations given in our study are not complete because at the present we only have the sedimentation rates obtained from one core in the lagoon. However, this empirical information supports the idea given by ROSSELLÓ (1985).

The two sedimentation rates obtained are average long-term rates from 2,810 to 1,110 BP (0.47 mm/yr) and from 1,110 to the present (0.57 mm/yr). The difference between these two rates means a relative increment in the vertical accumulation of only about 20%. We assume these rates are representative of the sedimentation occurring in the present lagoon area, although we have no further data which confirm this rate. We believe that the rate obtained in the period from 2,810 to 1,110 BP corresponds to the natural sedimentation rate, but the accumulation from 1,110 BP to the present was obtained in the times when the lagoon area had a rapid reduction due to reclamation; the surface area was reduced about 80% from 1761 to 1927. Our data suggest that the reduction in the area is not proportional to the vertical accumulation, which should be much higher if the same amount of sediment was accumulating over the period of a decreasing lagoon. The low vertical accumulation rate could be explained if a reduction in the sediment supply had happened. But we do not have any evidence of a change in the volume of sediment carried by rivers and ephemeral streams. On the contrary, research in the neighboring area (CARMONA, 1986) proved that the sediment load in the Túria River has been increasing in from the eleventh century. Therefore, the explanation for the low relative increment in sedimentation rates in the Valencia lagoon could be, as was suggested by ROSSELLÓ (1976), that the sediments are being accumulated primarily in the marshy area and not in the lagoon.

The verification of this hypothesis requires additional information from cores in the marshy area. However, according to our preliminary results, the filling of the lagoon is probably not as rapid as previous studies indicated because most of the sediments are not arriving at the lagoon but are retained in the neighboring area.

CONCLUSIONS

According to the preliminary results obtained in our study we can conclude the following:

- (1) The lagoon sediments are mainly silt and clay.
- (2) The extinction of shellfish habitat, the decreasing clay content and increasing plant remains from depth to the surface indicates that the lagoon was transformed from saline to a fresh water environment.
- (3) According to the dated shells the change caused by the closure (natural or artificial) of

the lagoon occurred between $1,110 \pm 115$ BP and the present.

- (4) Two sedimentation rates have been obtained from the core Colomera: 0.47 mm/yr from 2,810 to 1,110 BP; 0.57 mm/yr from 1,110 BP to the present.
- (5) A great quantity of sediments carried by ephemeral streams and rivers are retained in the marshy area. This has been deduced from the comparison of the similar sedimentation rates and the lagoon area reduction.

The sedimentation rates presented in this study need to be confirmed with data obtained in other cores. In addition, the assessment of the ancient and present sedimentation rates would require further ^{14}C dating in other parts of the lagoon and marsh, and ^{210}Pb and ^{137}Cs dates in order to establish sedimentation rates during the last 100 years. If the new dates support these conclusions the complete filling of the lagoon will not occur in the short term, even if the overland sedimentation fluxes deduced from theoretical models by other authors are accepted.

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□ RESUMO □

A laguna de València constitui um dos mais interessantes ecossistemas da costa Valenciana. Durante a sua evolução histórica ela tem sofrido uma redução na sua superfície, devida a processos naturais e, sobretudo, ao impacto humano. Os estudos científicos sobre a sedimentação na laguna são cada vez mais numerosos, dado o valor económico desta. Este trabalho ocupa-se das características dos sedimentos e das taxas de sedimentação na laguna de València, baseado em análises sedimentológicas e datações isotópicas de C^{14} . As análises sedimentológicas confirmam variações no ambiente lagunar, de uma situação de fácies salina que evolui para uma situação de fácies de água doce. Nas amostras, a fraca quantidade de restos vegetais coincide com os níveis em que as conchas são mais abundantes e com dimensões maiores, e em que a fracção argilosa aumenta; isso acentua a hipótese da mudança de um meio marinho para um ambiente continental, à medida que se aproxima a situação actual. Os resultados da datação dos níveis ricos em concha pelo C^{14} permitiram estabelecer uma taxa de sedimentação inferior à previamente estimada, e levaram a concluir que uma grande massa de sedimentos se está a depositar nos pântanos da área periférica, sem atingir o ambiente aquático da laguna.

□ RÉSUMÉ □

La lagune de València est un des écosystèmes les plus intéressants de la côte valencienne. Pendant son évolution historique sa surface a été réduite par des processus naturels et, surtout en conséquence de l'occupation humaine. Les études scientifiques sur la lagune sont de plus en plus nombreuses, au fur et à mesure qu'augmente la valeur économique de la région. Dans ce travail, nous présentons les caractéristiques des sédiments et le bilan de la sédimentation dans la lagune de València. Ces phénomènes sont étudiés à partir des analyses sédimentologiques et des datations au C^{14} . Les analyses sédimentologiques confirment des changements du milieu lagunaire, qui passe d'un milieu marin salé, à un milieu lacustre d'eau douce. L'étude des échantillons a montré qu'une petite quantité de débris végétaux apparaît dans les niveaux riches en gros coquillages, dont la fraction argileuse est très abondante. Cet argument appuie l'hypothèse d'un changement du milieu marin en un milieu continental plus récent. Les résultats de la datation des niveaux de coquillages au C^{14} , nous ont permis d'établir un bilan de sédimentation inférieur à ce qui était estimé jusqu'ici parce que l'accumulation de la plus grande partie des sédiments se fait actuellement dans les marais périphériques, et non dans le milieu équatique de la lagune, qu'ils n'atteignent plus.