

**Environmental risk in the Lower Rhône valley:
high water levels and floods**

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translated by David Lambert

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Environmental risk in the Lower Rhône valley: high water levels and floods

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In 1999, a collection of articles devoted to the Roman Rhône in the journal *Gallia* allowed the archaeological and environmental data on the relationship between a river considered dangerous and its riverside cities to be confronted for the first time.¹ The theme has been further developed in subsequent years. Since then, I have examined the particular case of the relationship of Arles with the area of the Rhône delta. Here I focus on another aspect of this relationship: the management of fluvial risk in the region of the lower Rhône.

In defining environmental risk as the intersection between hazard and vulnerability,² the Rhône in the form of its valley comprises the natural component, while Arles and the deltaic plain form the societal component.

The Roman period is generally regarded as one with strong management of natural environments.³ The issue has become very topical following the two catastrophic floods of October 1993 and January 1994, followed in 2003 by a third, even graver flood. These recent floods have profoundly changed perception of the relationship between the river and riverside society by shattering confidence in the embankments built following the great flood of 1856:

From a natural environment threatened by human risks, the delta has swung round in its representation into a human environment threatened by natural risks.⁴

Fear of a worsening flood frequency encouraged the production of works that take account of all the hydrological and geomorphological history of the valley. Understanding the functioning of the water-systems made it possible to intervene in their path of development to head off catastrophes. At the same time, when called upon to reflect on a method of water-management that could be likely to increase the ability of riverside societies to develop a risk culture, historians and geographers approached the archaeologists. The latter were open to these approaches since river sediments had become an archaeological focus. A multidisciplinary approach offered archaeologists the opportunity to describe the environmental context in which a site had been created, together with the processes leading to its burial. For their part, geomorphologists were able to evaluate the rôle of more recent societies whose activities have tended to accelerate or to reduce erosion by either worsening or mitigating climatic influences.

The Lower Rhône: geographical and historical context

From Avignon to Tarascon, between the massif of Les Angles to the west and the Montagnette to the east, the valley is about 5 km wide. At Fourques, the river separates into two branches of unequal size, the Grand Rhône and the Petit Rhône; at Arles, the alluvial plain widens to 12 km between the Crau and the Costière du Gard. At its greatest width, between Fos and Aigues-Mortes, the delta today measures 70 km. Arles is 35 km from these two ports as the crow flies. The delta covers 150,000 ha, of which the Camargue, which separates the two arms of the delta, occupies more than half. F. Benoit believed that during antiquity a W arm would have followed the edge of the Costière du Gard from Beaucaire to Mauguio; its route would have corresponded to that of the

1 Leveau 1999.
2 Bravard 2004.
3 Berger 2003.
4 Picon 2008, 241.

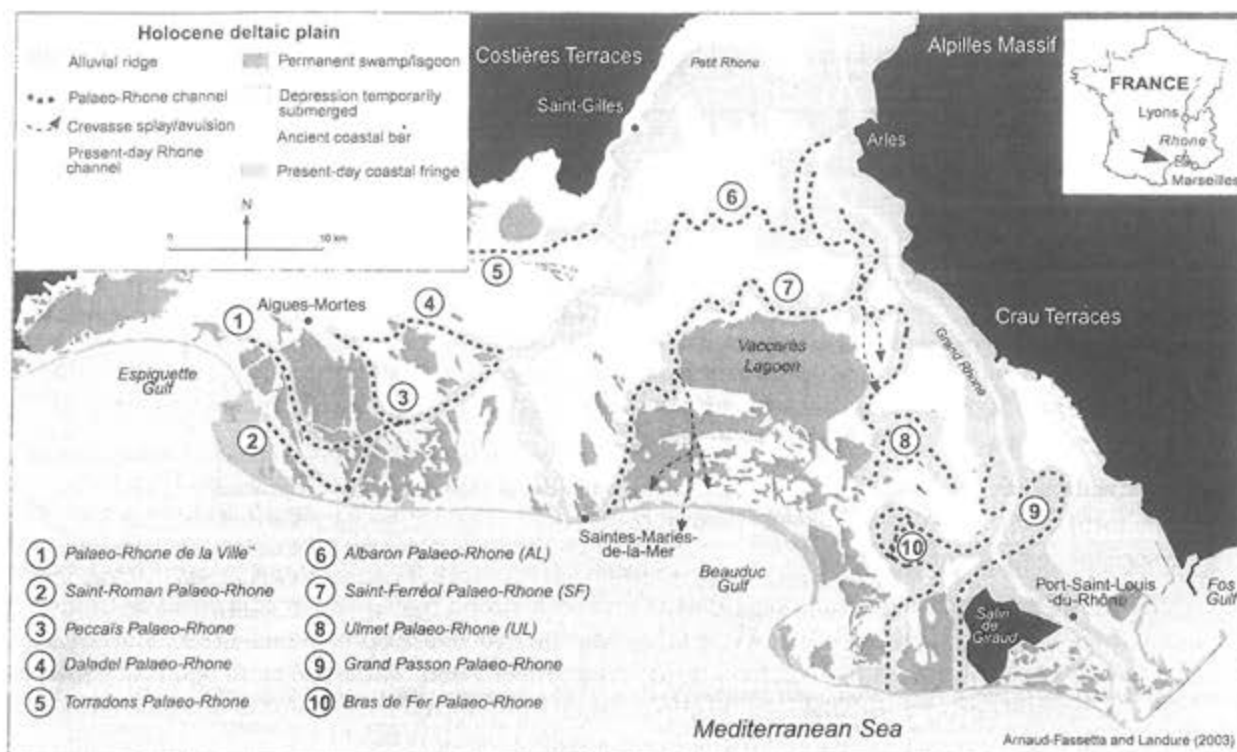


Fig. 1. The Rhône delta: location of the estuarine branches during recent millennia (Arnaud-Fassetta 2004, fig. 2, p. 67). canal from Beaucaire to Sète,⁵ but the hypothesis of a bifurcation of the Rhône at Beaucaire is not now favoured by geomorphologists (fig. 1).

Since earliest antiquity, the Rhône valley has been the main route of entry from the Mediterranean into NW Europe. But maritime access to the river is made difficult by the bar formed at its mouth where the solid sedimentary load the river transports is deposited on contact with seawater. This explains the establishment of Greek trading posts on both sides of the delta. On the W side lies the Phocaean colony of *Rhodanousia*, which is generally agreed to have been located at L'Argentière-Espeyran, at the end of the Costière, 4 km south of Saint-Gilles.⁶ Mentioned by Pseudo-Scymnus (*Periegesis* 206-16), it is described by Stephanus of Byzantium in his *Ethnica* as a "city of Massalia". This site was, with Lattes, one of the two ports of Nîmes; it not only gave access to the Rhône from the west, but it was also the point of departure for "intra-lagoon" navigation along the coastal lagoons of Languedoc, where a succession of them formed a waterway connected to the sea by channels.⁷ In the 19th c., E. Desjardin thought that these lagoons made it possible to reach the lagoons of Narbonne,⁸ but his hypothesis has never been verified. To the east of the delta, the major site is the *oppidum* of Saint-Blaise. Situated between the Étang de Berre and the Rhône, it lies at the start of the land route which, using the series of depressions south of the Crau, leads to the Rhône valley. The extent of Greek and Etruscan material recovered has led some scholars to imagine a port in the lagoons that it dominated, but, since none of the lagoons is in communication with the sea, it is impossible to recognize the elements of a protohistoric port complex.⁹ In the Middle Ages, the site was known by the name of *Ugium* (its ancient name is unknown; it cannot be

5 Benoit 1940.

6 Roure 2010.

7 Raynaud 1999.

8 Desjardin 1876.

9 Trément 1999.

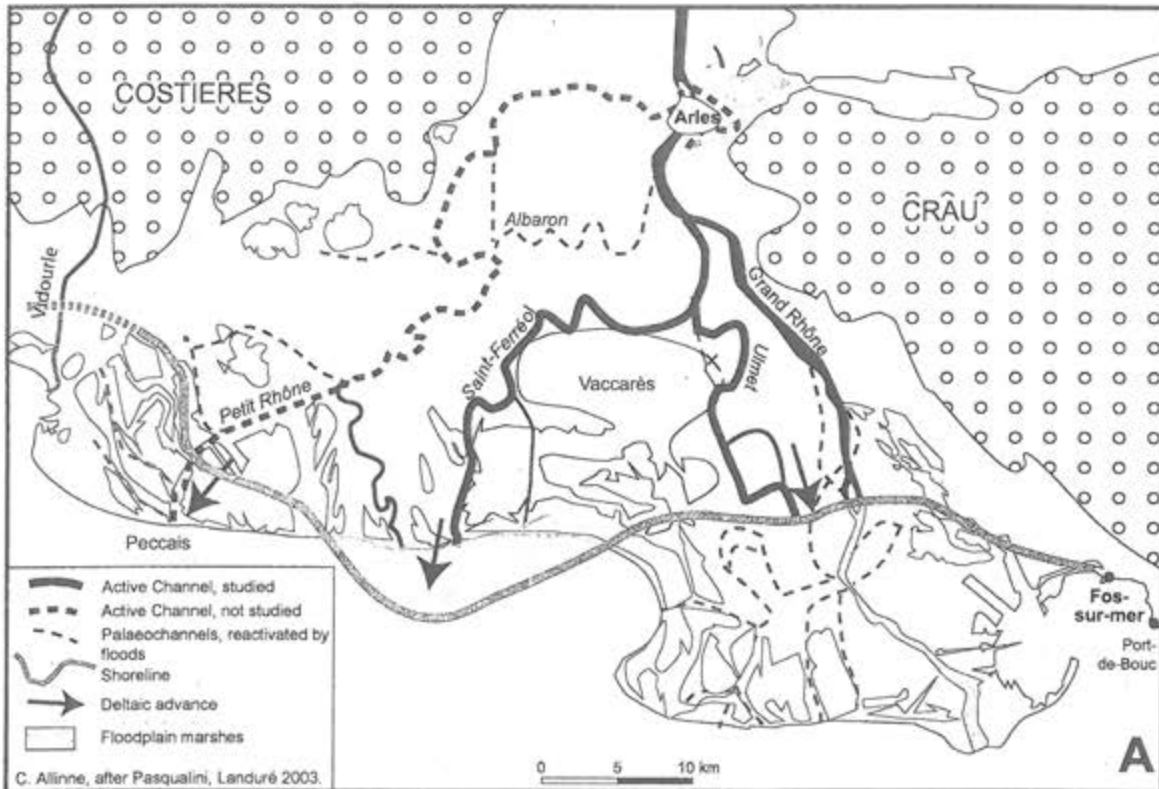


Fig. 2. Reconstruction of the coastline and the branches of the delta mouth in the Roman period, based on the present-day map (Allinne 2011, fig. 1, p. 502).

the *Heraclea* named by Stephanus of Byzantium, for Pliny (NH 3.5.33) places this site in the Rhône delta [fig. 2]).

The mediaeval historian J. Rossiaud described the great difficulty of sailing upstream on a river whose mean gradient downstream from Lyon is more than double that of the Rhine, as it flows downstream from Strasbourg.¹⁰ Apart from a few dozen days during which the S wind blows, the mistral joins its strength to the current's to slow the ascent. Before work was carried out on the river in the late 19th c., there was, on average, a major topographical feature every 9 km. Upstream from Arles, after boats had crossed a first obstacle created by the shallows of the *Trajectum Rhodanis* between Tarascon and Beaucaire, it was necessary to ascend the rapids at the rocky outcrops of the Roque d'Acier, in a sector where the sediments discharged by the Gardon and the Durance made navigation difficult. Between the zones of rapids, the channel divided into branches passing around low islands that were unstable and submersible. When the sedimentary load was substantial, the current divided into different channels between bars of shingle stretching out in the riverbed. Rapids, dangerous for navigation, then formed pebbles between them. The boat-haulers had to be satisfied with a strip of land whose path could change as a result of riverbank erosion.

These difficulties did not prevent navigation in antiquity, although the morphology of the riverbed has not been the same at all periods — the Little Ice Age is very idiosyncratic. G. Pichard says interesting things on this question in connection with the Little Ice Age.¹¹ Relating the crossing of the Rhône by Hannibal in 218 B.C. (the first geographical description of the plain) Polybius (3.45.4) notes the ease with which the Carthaginian leader obtained boats. This demonstrates ancient use of the river for navigation. Scipio, who had landed at the E mouth, loaded his baggage onto ships and set off in pursuit of the Carthaginian army. A century and a half later, Strabo (4.1.2) confirms

¹⁰ Rossiaud 2007.

¹¹ Pichard 2014.

that the possibility of sailing up the Rhône was “very high, even with considerable cargoes”. Urban harbour constructions and some occasional pieces of archaeological or epigraphic evidence testify to this, including the reference to a *portus Crindavinus ad ripam fluminis Rhodani* bequeathed by a rich man of Nîmes (CIL XII 3313) somewhere between the Petite Camargue and the mouth of the Gardon.



Fig. 3. The three branches of the delta mouth and the *statio Fossis Marianis* on the Peutinger Table.

de Saint-Gervais towards the Étang de l'Estomac, an inlet now cut off from the sea that, according to F. Benoit, sheltered an outer harbour of *Fossae*. On the other side to the east, the coast bends towards the branch of water that gives access to the vast lagoon of the Étang-de-Berre.

To the north of the delta, Arles occupies a key position at the start of navigation of the Rhône immediately downstream from Fourques, where the river divides into two branches. The Grand Rhône, the eastern and more important branch, divides the city of Arles into two unequal parts. The river is curved in its uppermost section due to the limestone hill of l'Hauture which overlooks the part of the city housing the public monuments. The other bank, which is lower, held the greater part of the port activities, as well as most of the wealthy houses and tombs. Inscriptions attesting the existence of a sanctuary served by the *ministri Laribus* shows that this urban quarter was constituted as a *vicus*.¹² This explains the name of *Duplex Arelate* (Ausonius, *Ordo urbium nobilium* 73-80). A port city, Arles was also one of the river's two crossing places south of Avignon. It diverted part of the traffic of the *Via Domitia* which, until Arles' foundation, made use of the shallows between *Ugernum* and *Tarusco*, the *Trajectum Rhodani* (Strabo 4.1.3). Crossing the river at Arles was by way of the bridge of boats situated upstream from the city, at the start of the bend in the river. This is probably the bridge known from the story of the miraculous intervention of Saint Genesius during its breach in 428-429.¹³

Arles did not owe its existence solely to the intersection of river and land routes. Suetonius (*Tib.* 4.1) reports that “Tiberius Nero, the father of Tiberius, quaestor of Gaius Caesar, ... was sent into Gaul to establish colonies, among which were those of Narbonne and Arles”, and Pliny (*NH* 3.4.36) specifies that the colonists were the *Sextanorum*, veterans of the sixth legion. According to their place in the military hierarchy, they received lots from land taken from the public domain. The procedures of division, allocation and distribution necessarily entailed a re-organisation of the territory confiscated from its original inhabitants. It was divided into rectangular parcels, *centuriae*, themselves subdivided into 100 *heredia*. In the 1920s, when L. A. Constans wrote his book on *Arles antique*,

12 Tran 2014.

13 Leveau 2011.

The first and most important of the improvements made to navigation was the canal that Marius dug between 104 and 102 B.C. to facilitate the provisioning of his troops stationed nearby. Afterwards, the *statio* of *Fossae Marianae* was constructed at the canal's maritime outlet (fig. 3). In late antiquity, the *Fossae* is shown on the Peutinger Table with an illustration whose size is equal to that of Ostia. Its name is preserved in the village of Fos-sur-Mer. In the 1970s, the construction of an ore port obliterated what remained to the west. It is believed that in antiquity the port-complex extended east of the Pointe

no archaeological data was available to illustrate the material realities of these distributions;¹⁴ he explained the extension of the territory of Arles as far as the boundary of the territory of Fréjus, 100 km to the east, by the lack of arable land in the immediate environs of Arles.¹⁵

Since 1950, the question has been partially re-opened thanks to archaeomorphologists, who have proposed reconstructions of the geometrical organisation that the centuriation imposed on the countryside. The decisive step was taken in 1983 when G. Chouquer located one of the three cadastres of Orange, cadastre A, between Arles and Avignon, based on the concordance between Fragment 7 of plaque E of the Orange cadastre and the fossilised course of the Duransole.¹⁶ The centuriation consisted of double *centuriae* of 709 m by 1418 m, oriented to NG-2^{GR} 30°E. Organised starting from a *locus gromae* near *Ernagium* (Saint-Gabriel) at the W end of the Alpilles, it was bounded by the Aurelian Way. It therefore related to the territory of the Latin colony of *Glanum* and the N part of the territory of Arles. To the east, other fragmentary orientations corresponding to possible centuriations and land assignments have been recognised in the plain of Arles and in the Crau.¹⁷

The contribution of archaeology

The emergence of the theme of fluvial risk

Until the 1980s, Constans' theory, according to which the history of Arles began with the foundation of the colony was accepted.¹⁸ But already C. Jullian, in his review of *Arles antique*, had defended an opposing theory.¹⁹ For him, control of access to the Rhône was an essential objective for Marseille, the principal stake in the conflict against the Salluvii and the motivation for the Massaliotes to appeal to Rome. What he called the "domestication of Arles" by Marseille would have had three stages. The first was in the 6th c. B.C., the Phocaean period, evoked by the controversial verse of Avienus (*Ora maritima* 689-90: Arles was called Theline "when the Greeks dwelt there"). There would have followed a purely Massaliote period, characterised by the juxtaposition of an *oppidum* of the Salluvii on the left bank and a Greek trading post on the right bank, and then a Greco-Roman period, during which the Romans recognised Marseille's control over Arles and the Rhône.²⁰ In the 1990s, through their demonstration that protohistoric Arles was a centre of economic and cultural exchanges, the three excavations of the Cryptoporticus, the Hôpital Van-Gogh and, above all, the old Jardin d'Hiver partially justified Jullian's claims. But he did not recognise the dynamism of the indigenous society. The production of Massaliote goods in favour of "diversified Mediterranean imports, Iberian and above all Italian" appeared to be proof of an emancipation of *Arelate* from its metropolis Marseille. P. Arcelin explained the lasting abandonment of part of the urban area after 175 B.C. as due to economic reasons, combined with military problems.²¹ But he also envisaged the possibility of "an exceptional flood that would have destroyed a good part of the urban area below the present level of 5.5 m NGF" (fig. 4).²² Formulated in the context of the floods of 1993 and 1994, what was then no more than an hypothesis has generated two types of research: one properly geomorphologic — to research on-site the imprint of floods in historical times — and the other more archaeological — to identify the protective systems put in place by the city's inhabitants.

14 Constans 1921.

15 Leveau 2004.

16 Chouquer 1983.

17 Loseby in Talbert 2000, Map 15.

18 Constans 1921.

19 Jullian 1922.

20 Ibid.

21 Arcelin 1995.

22 Ibid. 330.

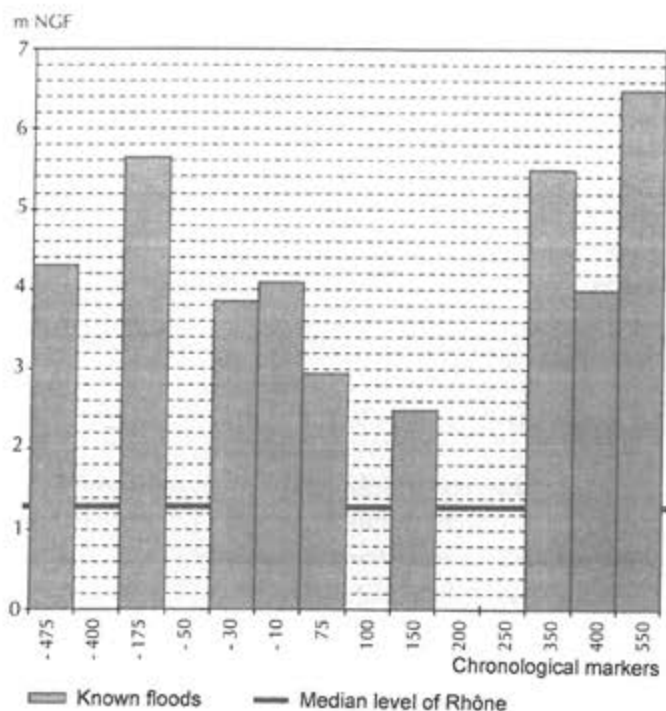


Fig. 4. Distribution of floods at Arles based on alluvial deposits (Arnaud Fassetta in Arcelin *et al.* 2000, p. 125, fig. 47).

"a response to a temporary increase in the activity of the Rhône".²⁴ At Arles, the elevations observed are explained by the rebuilding of buildings ruined over time or destroyed in a fire. There, the search for dykes has also produced a negative result. None of the constructions observed on the riverbanks display the kind of continuity that would allow a dyke to be recognised. Nor was this function fulfilled by a rampart that would have doubled as protection against an aggressor arriving by river, or against the river itself. In the end, "the systems of protection against rising damp in the ground appear more developed than the means of defence against flooding".²⁵ More recently, excavation of a cellar at Place Massillon, in Le Méjan, some metres from the present embankment of the Rhône, has provided proof that the city was open to the river. Two rows of arches parallel to the river formed a quay rising 1.5 to 3 m above a natural bank on which 10 or 11 flood layers alternated with backfill.²⁶

The picture that emerges, that of a city open to the river, had to account for the lack of evidence for relations or connections between the two banks. Indeed, the only bridge attested at Arles by archaeology lies north of the city. On the left bank, its abutment of large stone blocks, long embedded in the modern quay, has again been uncovered. On the right bank, recent excavations have uncovered, if not its downstream abutment, at least the remains of an access road. This bridge permitted travellers and merchants heading towards Nîmes to avoid the centre of the city. But it is certainly not the only bridge. A second existed at the level of the Arc du Rhône, and one should not exclude the possibility of other river crossings. J. Rossiaud, who described the successive displacements of pontoon bridges that linked the two banks of the river in the Middle Ages, emphasises the (relative) ease of this kind of operation (fig. 6).²⁷

Incidentally, these bridges did not constitute the only means of crossing the river; there would have been ferries either rowed or pulled by a rope to either bank. While obvious practices, such

Arles and the Rhône (fig. 5)

Two kinds of defensive measure against floods could have been used: the embankment of low-lying areas and the construction of dykes. Since geomorphologists and archaeologists had developed an exemplary collaboration there, Vienne, the other double city on the Rhône, already provided a point of reference. There, M. Leglay and S. Tourrenc thought that, as at Trier, where an old branch of the Moselle was filled in to obtain land to build within the walls, the purpose of the embankment of an area bordering on the river, carried out in the first half of the 1st c., was to extend the space for building and to withstand waterlogging of the soil.²³ Subsequent researchers dismissed this hypothesis in favour of an environmental one: the embankment was

²³ Leglay 1977.

²⁴ Le Bot-Helly 1999, 79.

²⁵ Allinne and Bruneton 2008.

²⁶ Isoardi 2010.

²⁷ Rossiaud 2007.

installations leave even less of a trace than a bridge of boats, which is why authors say little about them, but they occupied a large part of the activities of the *lenuncularii*, who were responsible for erecting an altar to Neptune (AE 2009, 822) (fig. 7). The members of this corps of boatmen assured both the unloading of boats for the journey up the Rhône and traffic between the two banks of the river.²⁸ Knowledge of the relationship between the two banks of the Rhône has been further enriched by the discovery of lead pipes in the riverbed, which confirm that Trinquetaille received water by several pipes under the river.

The occupation of land in the delta

Since the 1990s, systematic research has been carried out on the occupation in the delta in ancient and mediaeval times, and on the accessibility of the river on either side of the present-day mouth of the Grand-Rhône in the two sectors of Fos and Saintes-Maries-de-la-Mer, together with the W part of the Costière du Gard.

In the sector of Fos to the east, underwater surveys have clarified the nature of the submerged structures that appeared in aerial photographs in the Bay of Saint-Gervais. First interpreted as boat-houses, they probably correspond to warehouses (fig. 8). These structures continue on what is now the shore, where F. Marty excavated a construction composed of wooden crates filled with amphorae and separated by channels.²⁹ The maritime outlet of the canal of Marius remains to be located, but part of its route has been recognised on the edge of the Crau in the marsh of Ligagnau, where a

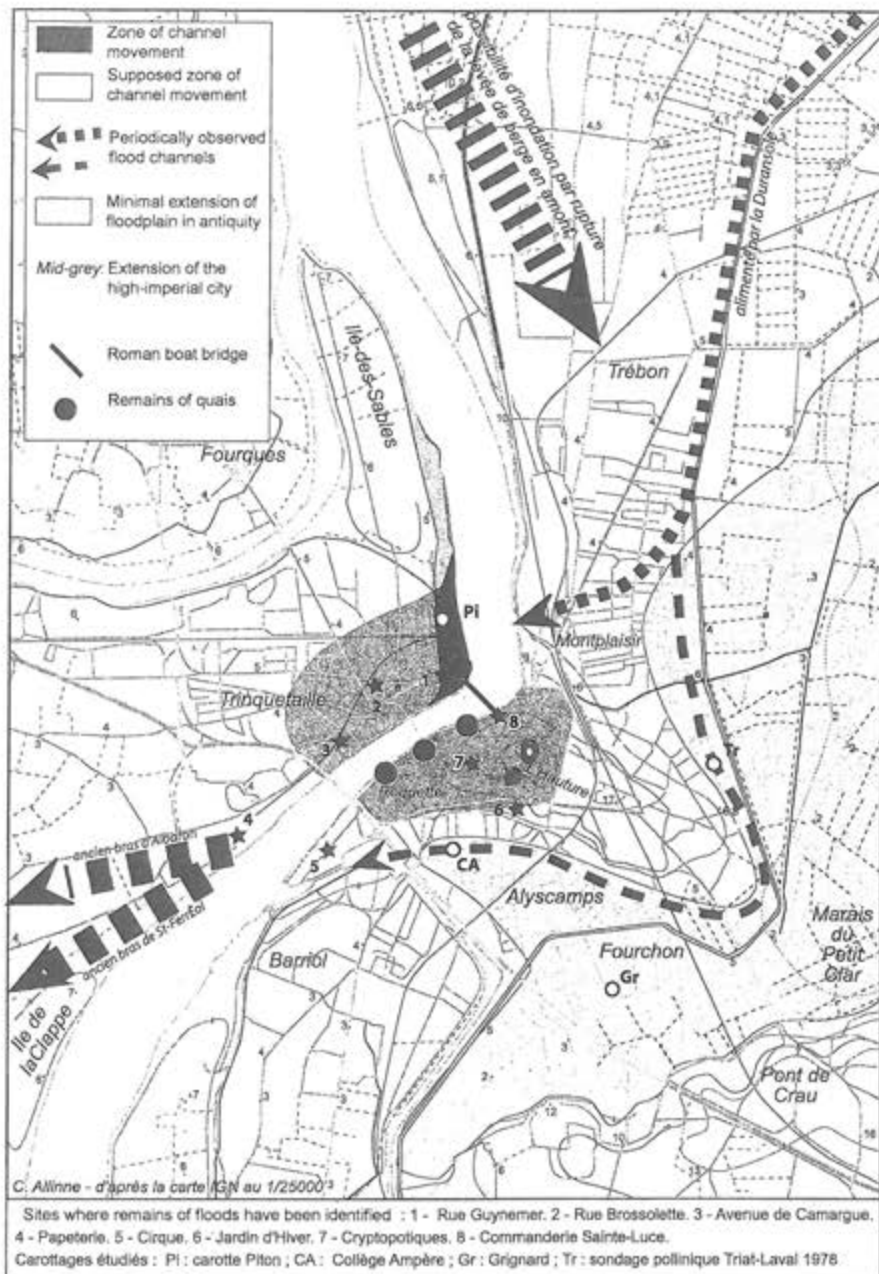


Fig. 5. The fluvial geomorphology of the site of Arles: reconstruction of the route of the channels and extension of wet zones (Bravard and Provansal 2011, fig. 5, p. 437, after Allinne, modified).

²⁸ Leveau 2011, 462-66.

²⁹ Marty et al. 2016.



Fig. 6. Depiction of the monumental centre of Arles (after J.-C. Golvin).



Fig. 7. Statue of Neptune offered to the divinity of the three Augusti by the corporation of *lenuncularii* (Hermay 2009, 100).

depression parallel to the Rhône and pointing towards Galejon preserves its line.³⁰ O. Badan identified a canal in the marsh of Vigueirat (fig. 9), its edges reinforced by stakes and fascines reaching a depth of 4 m.³¹ Two stakes were taken from Vigueirat and their radiocarbon dates indicate ages between 21 B.C. and A.D. 134 and between 130 and 325, dates confirmed by the amphorae found nearby.³² Badan estimated the width of channel at 35 m, a dimension that makes it plausible that it is the *fossa augusta* depicted in fragment 351 of Orange Cadastre C. The *fossa* occupied an area of 8.66 *iugera* (20,160 m²) across the century, or about 710 m in length. According to G. Chouquer, this corresponds to a canal width of 30.5 m.³³ Badan traced the line of the canal for 7 km: the canal measured c.20 m in width; its banks were reinforced by piles, and its depth reached 4 m.³⁴

In the Camargue, investigations and excavations by a team of archaeologists under C. Landuré and M. Pasqualini have added to the list of sites known in the plain of the delta.³⁵ In the high Camargue, the information assembled shows the presence of domanial centres probably established by the beneficiaries of colonial assignments, some identifiable by epigraphy. Their excavation

30 Rothé and Heijmans 2008, 734-35.

31 Badan 2013.

32 Landuré, Vella, and Charlet 2015.

33 Chouquer 1983, 290.

34 Badan 2013.

35 Landuré and Pasqualini 2003.

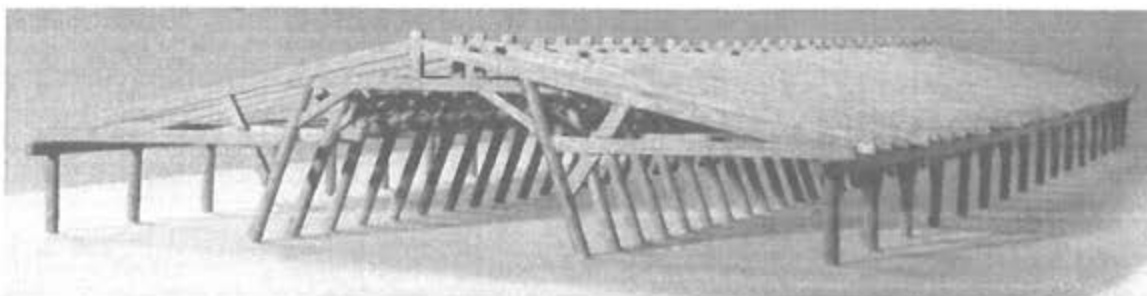


Fig. 8. Reconstruction by Terror of a warehouse from the Gulf of Fos (Landuré and Pasqualini 2003, fig. 11, p. 161).

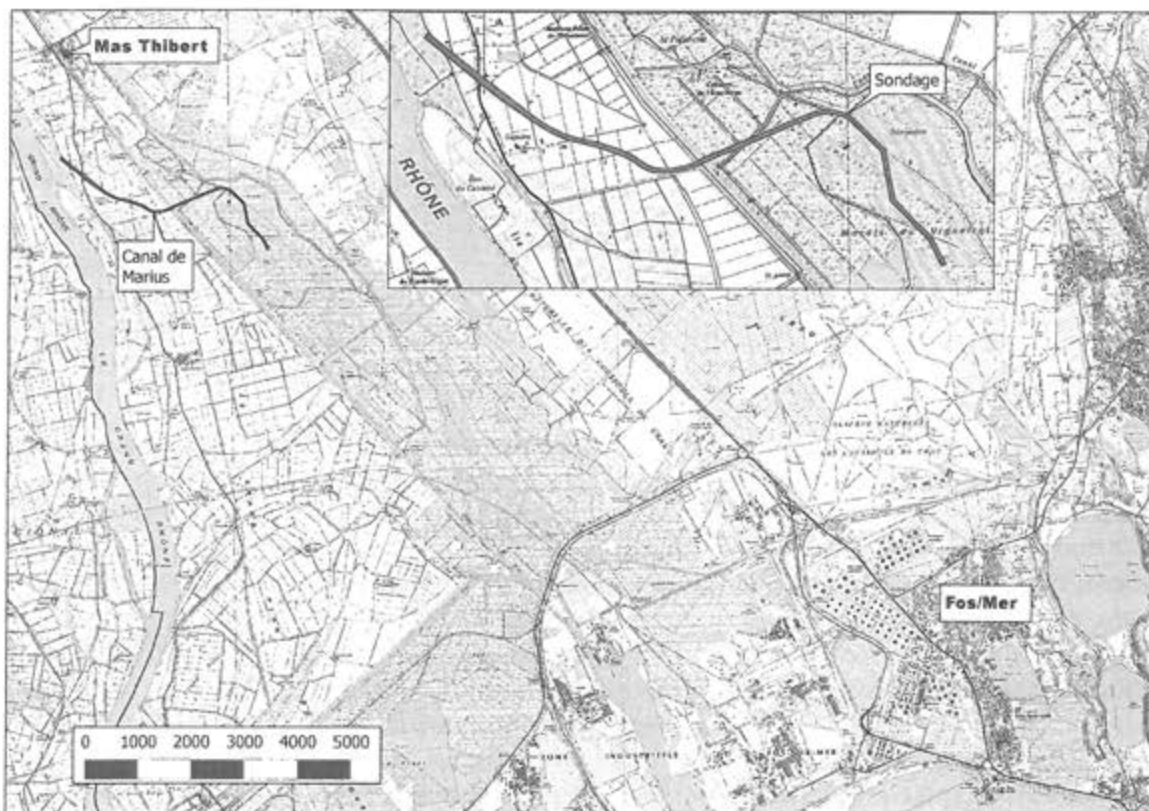


Fig. 9. Course of the canal of Marius detected by O. Badan (2013).

confirmed the place of fish and livestock in the economy of the delta as already emphasised by F. Benoit.³⁶ The sites were located along the channels on the concave side of meanders of the river in a position that protected them from minor floods while allowing them the benefit of proximity to the waterway. The depth of the sediments and the multiplicity of channels, however, have not permitted the traces of centuriation to be identified in the sector where G. Chouquer believed it was possible to place Orange Cadastre C.³⁷

Two recent archaeological operations inform us about Roman settlements at the mouths of the Rhône (fig. 10). Where the accumulations of sediment in the E lobe of the delta left little hope of recovering traces of a site, a land-based excavation has revealed the existence of an outer harbour at the entry point to the Ulmet branch,³⁸ probably the Massaliot mouth, which Pliny (*NH* 2.5.33) described as the most powerful. At the centre of the delta, where he places the Metapine

³⁶ Benoit 1965.

³⁷ Chouquer 1983.

³⁸ Landuré and Vella 2014.

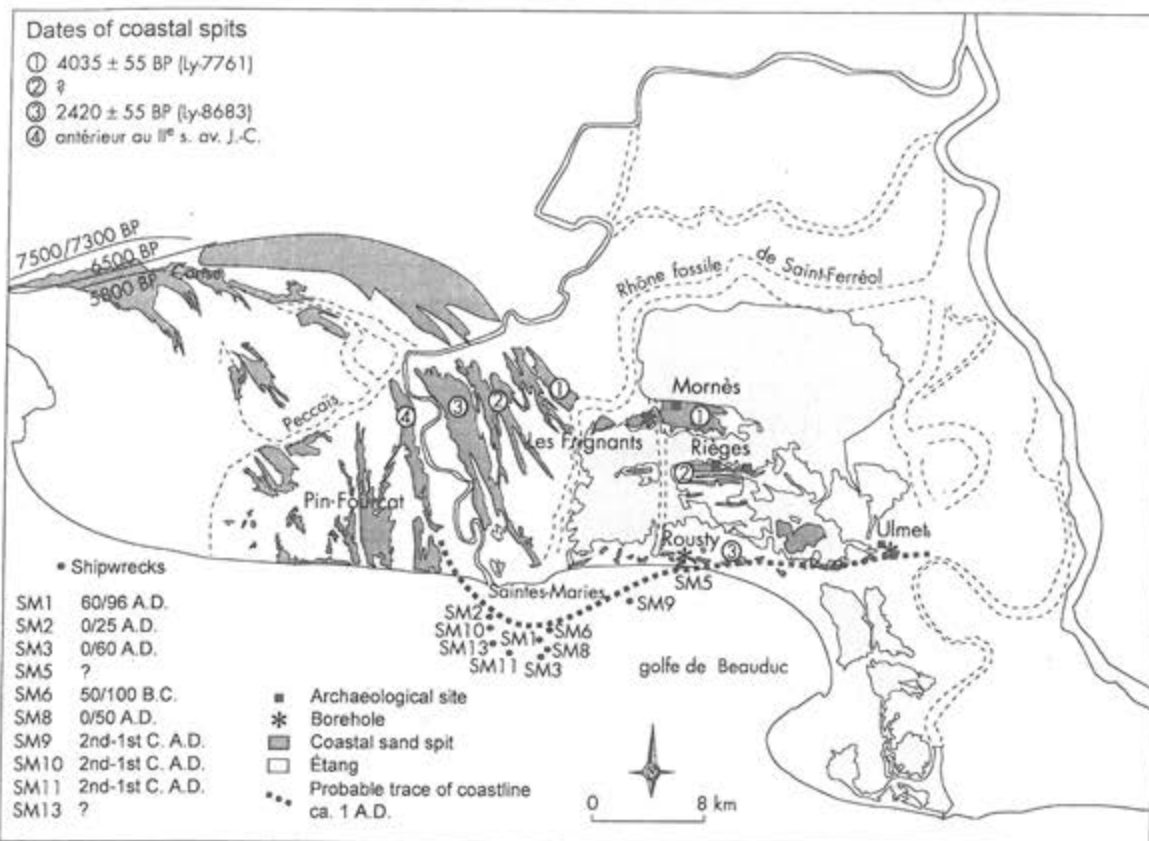


Fig. 10. Chronology of the coastal bars of the deltaic lobe of Saint Ferréol (Metapine mouth) and the E margin of the Rhône delta (Vella 2004, fig. 3, p. 83).

mouth, underwater archaeology designed to map wrecks stranded on the sandbanks that form at the mouths enabled L. Long to reconstruct the ancient coastline.³⁹ Most of the 29 inventoried wrecks are located off the coast of Saintes-Maries-de-la-Mer. This concentration is explained by the difficulties of navigation in the approach to the shallows, which are not obvious at the entrance to the channels. Their position places the line of the ancient coast at a distance of 1 or 2 km south of today's. Some 600 m from the port of Saintes, a large number of Roman anchors scattered across several hectares attests an anchorage for seagoing vessels. Isolated blocks (sometimes part of structures), *tegulae*, nails and fragments of *dolia* suggest the presence of warehouses in a configuration analogous to that of the submerged remains in the Bay of Saint-Gervais.

The *Antonine Maritime Itinerary* informs us that the *Fossis Marianis* was XVII miles from *Ad Gradus*, which was XXX miles from *Arelate*. The term *Gradus* is used for a rudimentary port installation at the entrance of a river, in this case an anchorage in front of the bar at the river mouth. Cargoes were then transferred to barges and transported to Arles by the *lenuncularii*, a corps of boatmen also attested at Ostia (*ILS* 6149 and 6173). In the case of the mouths of Ulmet and Saint-Ferréol, these port zones explain the abandonment of the *Fossae Marianae* after remaining in use for a century and a half.

At the W end of the delta, investigations by archaeologists from the Centre archéologique at Lattes show that the site of Espeyran was occupied well beyond the 1st c. and at least until the 4th c.⁴⁰ All its port facilities are still not known, but from there it was possible to enter a branch of the river to travel upstream to the bifurcation and reach its main channel. On the other hand, the lagoon that it controlled made it possible to reach Le Cailar, c.15 km to the west, which excavations

³⁹ Long 2013.

⁴⁰ Christol *et al.* 2011.

identify as a significant trading post on the lagoon at the mouth of the Rhône and the Vistre, whose course allowed for travel up to Nîmes.⁴¹

Geomorphology: the environmental dynamics

The plain of Arles

The work of the geomorphologists, which has required us to modify our understanding of the plain of Arles, began a few kilometres to the east, in the Vallée des Baux, a depression 12 km long and 1-2 km wide, which sits between the foothills of the massif of the Alpilles and the Crau plain. Its bottom lies at 1.5 to 3 m asl. Three centuries of drainage have turned it into a continental polder (low-lying piece of land reclaimed from flooding). In the 18th c., it was still occupied by a lake communicating with the plain of Arles via a narrow channel. In the late 1930s, F. Benoit excavated the mills at Barbegal, on the S side of a ridge whose escarpment rises c.30 m above the valley bottom.⁴² He supposed that the establishment was linked to Arles by "a navigable route accessible to the rafts of the *utricularii*, a form of water transport particularly appropriate to the shallow waters" which surrounded it.⁴³ But two archaeological observations have contradicted this. In 1990, excavations carried out at the foot of the mills showed unambiguously that the bottom of the valley was not under water in the period when the mills functioned. This conclusion was confirmed in the summer of 1996 by rescue work occasioned by the construction of a gas pipeline across the valley. Surveys established the existence of an establishment (village?) dating from the beginning of the Iron Age, at the bottom of the depression, on the edge of a marshy area.⁴⁴

The sedimentary cores taken by the geomorphologists have shown that an area of water had certainly existed in the E part of the depression from the beginning of the Holocene. But in the W part, the waters naturally drained towards the plain of the Rhône. The low level of the marsh in Roman times finds two explanations. The first is an oscillation in the climate marked by a diminution of rainfall. The second is anthropogenic, the result of control of the mills and of the water flows by proprietors of the estates established in this part of the valley, especially at a villa near Barbegal. At a later stage, the rising water level is explained by the return of torrential runoffs during the "climatic crisis" of the Little Ice Age, and by the accumulation of sediments that blocked the outlets, obstructing drainage and encouraging growth of the marsh. To this natural cause was added an anthropogenic one. In the 16th c., the water level in the basin of the Vallée des Baux was raised from a level of 3 to 5 m NGF (Nivellement Général de la France) by a dam that the Arlesians erected across the gully at Barbegal to retain flood waters. At the same time, to the north of the plain, and for the same reasons, the citizens of Tarascon erected another dam at the end of the Alpilles to divert towards the Rhône the waters which arrived on its territory via the depression of Maillane when a rise in the level of the Durance caused the old quaternary route between the Alps and the Montagne to be submerged. This phenomenon supported the hypothesis of a direct link between the Rhône and its tributary via the Duransole, canalised in Roman times (fig. 11).⁴⁵

The state of the lower plain of the Rhône in Roman times has been reconstructed by H. Bruneton based on data gathered during various operations of rescue archaeology, enhanced by a programme whose objective was "to characterise the climatic crisis of the sixth to seventh centuries" (fig. 12).⁴⁶ Between the tenth and the fourth millennia B.C., the post-glacial rise in sea level led to the inundation of river valleys. In the Neolithic period, its slowing and quasi-stabilisation permitted the shore to advance as a result of sedimentary deposits. Six thousand years ago, Arles was

41 Roure 2010; Raynaud 2010.

42 Benoit 1940.

43 Ibid.

44 Leveau 1999.

45 Ibid.

46 Bruneton *et al.* 2001.

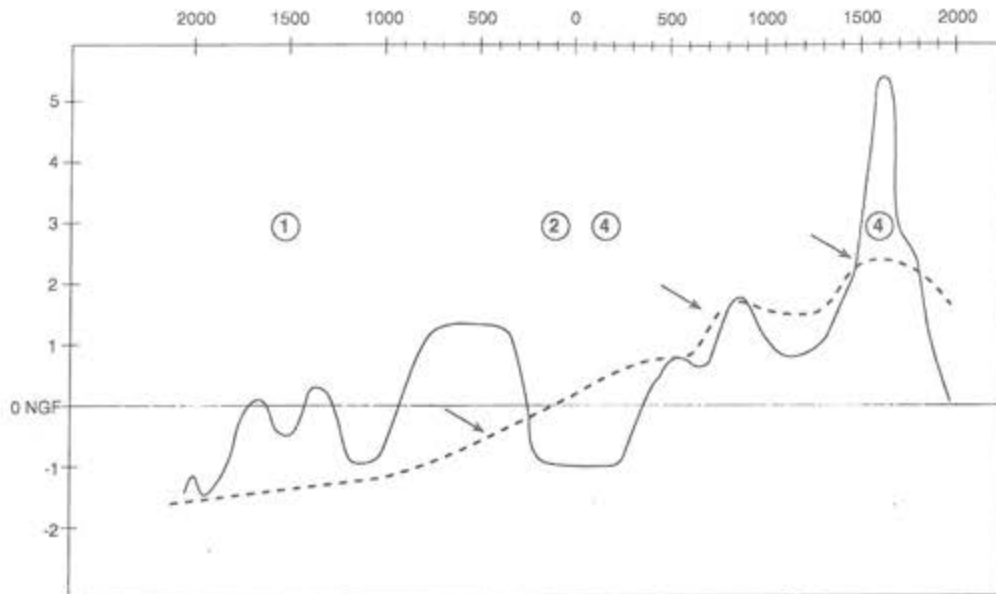


Fig. 11. Rise in water-level in the Vallée des Baux (solid line) and the plain of Arles (broken line). (1) Neolithic period; (2) founding of the Roman colony of Arles and drainage in the Rhône valley; (3) construction of the mills of Barbegal; (4) construction of a dam across the gully at Barbegal. Comparison of the two curves shows the Roman drainage in the Vallée des Baux (after H. Bruneton).

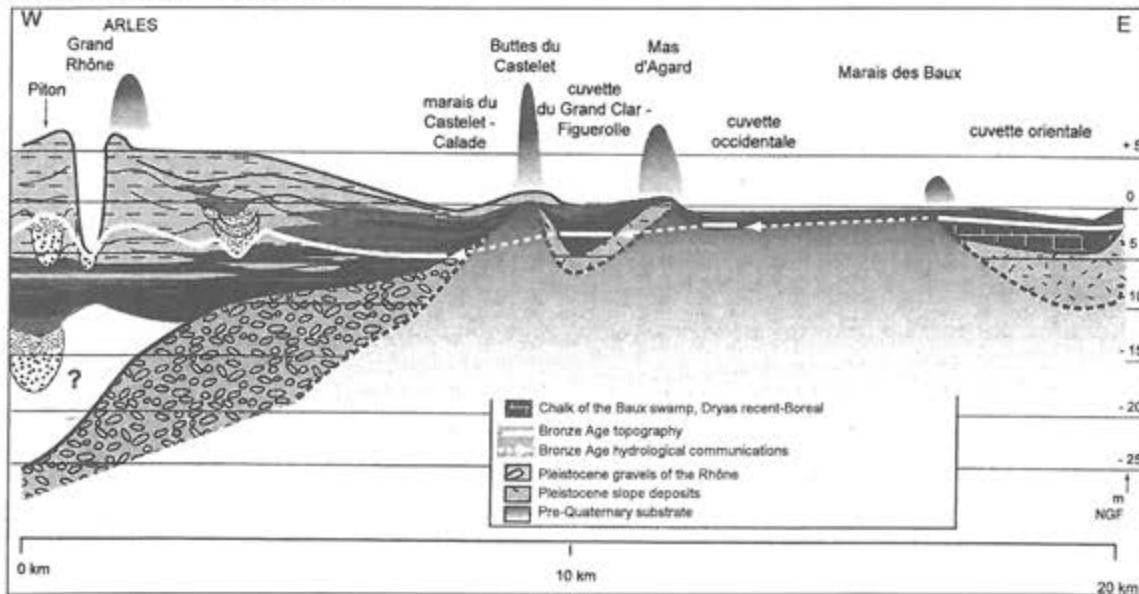


Fig. 12. Geometry of the filling of the fluvial plains and marshland between Arles and the marsh of Baux (Bruneton *et al.* 2006, fig. 4, p. 363).

only a dozen km from the coast. This distance had doubled by the Roman period. There was then a contrast between "the well-drained foothills, situated sub-horizontally outside the floodplain, and an unattractive alluvial plain, consisting of narrow strips of land among the marshes".⁴⁷ The rise in sea level led to the raising of the bed of the river and the diminution of its gradient. The marshy zone was pushed back towards the periphery of the plain, while the alluvial levées grew higher. The hydraulic works that accompanied the centuriation of the territory accelerated this process. In periods of flooding, the canals that facilitated water-management in the plain (irrigation and drainage) distributed the sediments, which encouraged the clogging of the marshes. The excavations in connection with the new railway, the TGV Méditerranée, have shown that in the plain of

47 Bruneton *et al.* 2001.

Orange Roman sites lie beneath 3–4 m of sediments.⁴⁸ Downstream from Tarascon, the sedimentation is significantly less — from 1 to 3 m of fine sediments have been deposited⁴⁹ — but this is still sufficient to prevent sites from being recognised, and it also explains why research on the cadastres has not advanced.

The delta

In the plain of the delta, movement of the channels is determined by their capacity to carry away the flow and the sedimentary load. When they deposit sediment, they raise the level of the riverbed. When a flood causes a breach in the alluvial levée, the river leaves its bed and shifts the position of its mouth. The sediments deposited at the mouth form a deltaic lobe, on top of an underwater accumulation (pro-delta). The coastal currents stir up the sediments and distribute them along the shore. The change in the course of the river causes the break-up of the associated deltaic lobe and the retreat of the neighbouring shoreline. A new lobe forms at the new mouth and the shore advances. These processes are the cause of the dwindling and proliferation of branches, of the shifting of mouths and of advances and retreats by the shore. In this context, the mobility of channels and mouths and the examination of sediment cores has permitted geomorphologists to characterise the sediments, date their deposition and establish a chronology of the associated channels, mouths and deltaic lobes. This, and the quantification of the inflow of sediment, has permitted them to identify the phases of erosion in the river basin.

Their studies show that in Roman times the principal estuarine branch was the Rhône of Ulmet, at the centre of the delta. The *Fossae Marianae* were dug when that branch was about 20 km west of Fos. In the Bay of Saint-Gervais, northeast of the Gulf of Fos, the shoreline was a few hundred metres south of the present one. The later displacement of the mouth 5 km towards the east (creating the mediaeval branch of the Grand Passon) accounts for the difficulties encountered in recognising archaeological sites. Indeed, the oscillations of the shoreline according to the movement of the mouth and the currents have erased the traces of the mouth of the canal in the Gulf of Fos, while the vestiges of Roman structures have been submerged or covered by sediment.

In the W part of the present-day delta, a second estuarine branch, the Rhône of Saint-Ferréol, in Roman times fed the deltaic lobe of the same name. In the age of Polybius (2nd c. B.C.), the Rhône had two mouths. Strabo (4.1.8) and Pliny (*NH* 3.5) say it had three, which makes it possible to date the appearance of the branch. Since then, the shifting of the principal mouth of the river towards the east has caused both the near-disappearance of this lobe and the shore to retreat by 1 or 2 km in the Saintes-Maries-de-la-Mer area, bringing about the destruction of the Roman structures.

At the W end of the delta, the location of the third branch and its mouth remain uncertain. The situation is complicated by the outflow of the Vidourle and the Vistre whose mouths lie west of the Petite Camargue, in a sector where the configuration of the shore has changed profoundly since Roman times. The forms of the sedimentary fills in this part of the delta in antiquity have been reconstructed by T. Rey (fig. 13).⁵⁰ Before the beginning of the 6th c., the Peccais branch neither filled the gulf which existed in the Aigues-Mortes sector nor formed the lobe of the same name; the coastline lay well to the north of the present one. The ancient coastal bar of Sables (or Sylveréal) separated a fluvial-marshy zone to the north and a fluvial-marine zone to the south. In the rear, to the north, the blockage of an area of lagoons by the Touradons branch left intact the Étang de Scamandre and the Étang de Charnier. The Daladel branch, abandoned between the 1st and the 3rd c., ran parallel to this bar to the south. This branch is an extension of the Albaron branch, which formed in antiquity following a breach in the natural levée of the Grand Rhône downstream from Arles. A section of the present-day Petit Rhône lies between the two. A triple fork of the Rhône

48 Provensal *et al.* 1999, 22.

49 Bruneton *et al.* 2001.

50 Rey 2010.

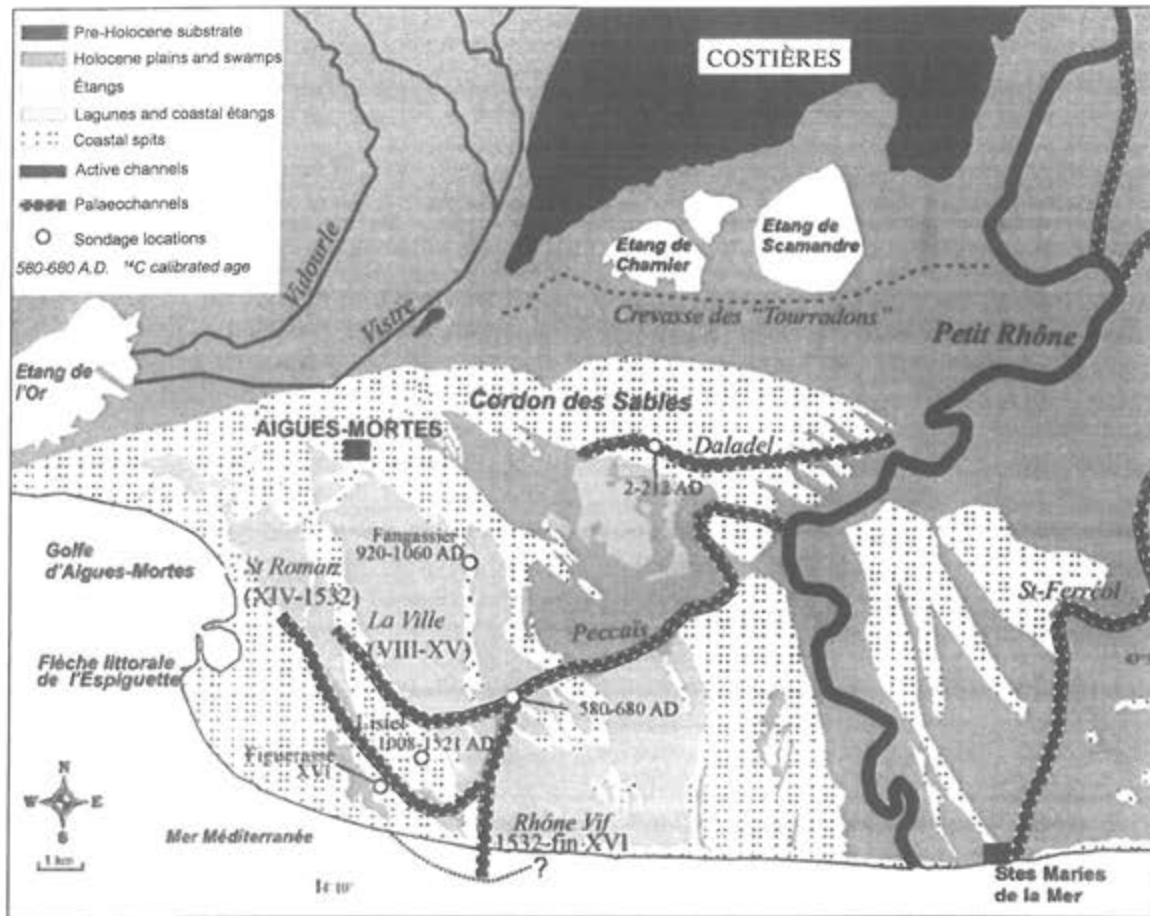


Fig. 13. Chronology of the estuarine branches in the Petite Camargue (Rey 2010, fig. 2, p. 103).

downstream from Arles agrees with the mosaic in the Square of the Corporations at Ostia that has been identified as a symbolic representation of Arles: it shows a bridge of boats crossing a river which divides itself into three estuarine branches.

This configuration, of a delta whose three branches diverge downstream from Arles, raises the question of the date of the existing bifurcation of the Rhône at Fourques. G. Arnaud-Fassetta does not explicitly take a position but it does not figure in his reconstruction of the Rhône branches in Roman times.⁵¹ However, A. L'homer was convinced that it existed in the Roman era.⁵² Between Fourques and the pumping-station at Cavallès, the Petit Rhône would have presented "a more immature configuration" than the other branches.⁵³ In its downstream part, its route is the result of corrections made in the 16th c. The waters would first have been discharged by the Saliers branch (the abandoned E branch) and then by that of Saint-Gilles (the existing W branch). In order to date the functioning of this branch, L'homer used archaeological data for the occupation of the neighbouring plain. But if an item in *Le Midi Libre* dated 21 February, 1973 is to be believed, a wreck of the 1st or 2nd c., filled with amphorae, was found in the river-bed near Saint-Gilles. Its presence points to either a shipwreck or the alteration of a branch of the river passing through this sector. An arm of the Rhône would then have flowed 3 km east of Saint-Gilles. With the protohistoric and Roman site of Espeyran being located 4 km south of Saint-Gilles, at the end of the Costière, in an environment of lagoons, it is tempting to imagine that it was connected to the Rhône, as indeed was Saint-Gilles in the Middle Ages. It is on this side that it is necessary to place an *ostium hispanense*,

51 Arnaud-Fassetta 2004.

52 L'homer 1987.

53 *Ibid.* 46.

well-known to mediaeval seafarers, although it remains difficult to establish a precise relationship between this site and the one mentioned by Pliny.

The archaeological surveys of a team directed by C. Raynaud in the communes of Aigues-Mortes and Grau-du-Roi give credibility to the hypothesis of an anchorage used in the 1st c. B.C. and 1st c. A.D., as formulated at the beginning of the 20th c.⁵⁴ The abundance of archaeological material caused the belief in the existence of a maritime station. But whereas off the coast of Saintes the retreat of the shoreline allows observation of archaeological remains, the sediments of the lobe of Peccais hide the possible wrecks that would confirm its presence.

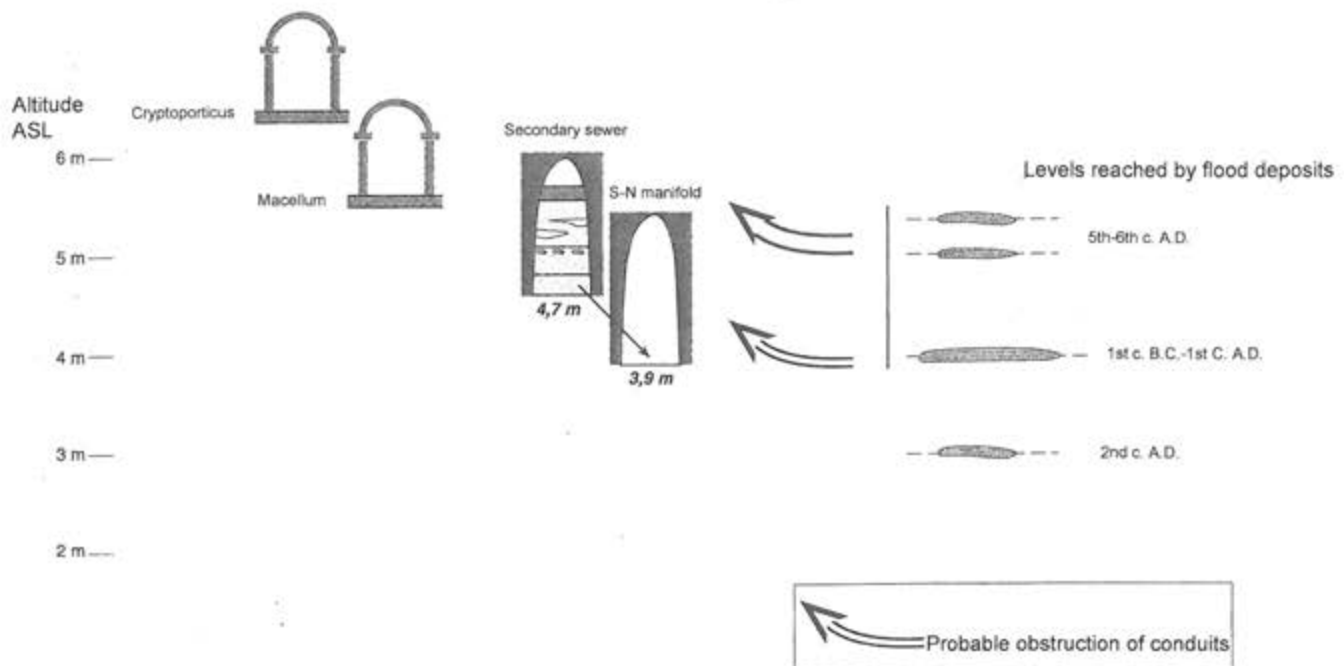


Fig. 14. Drainage of waters from the drain of the cryptoporticus (after Lopez *et al.* 2001).

Prevention of risk and correction of riverbeds

In assessing the floods that affected the urban site of Arles during the millennium running from the 5th c. B.C. to the 6th c. A.D., from collaboration with archaeologists G. Arnaud-Fassetta has identified 7 or 8 important events which fall within the context of very strong river activity at two different moments, one between the 5th c. B.C. and the start of the 1st c. A.D., and the other between the 4th and the 6th c.⁵⁵ From there, he extended his research to the relationship between the river and the habitat in the delta, where archaeologists have developed surveys and excavations. These showed that the great majority of sites were established on high points in the deltaic plain, on fluvial levées, and, to a lesser extent, on fossilised coastal bars. Development on these banks made it possible to withstand floods.⁵⁶ Below, in the floodplain, the digging of ditches encouraged land drainage.⁵⁷ Taking account of a sea level lower than that of today, the dispersal of waters in the delta was easier than it is today.

At Arles, attention has been paid to the ancient drains that evacuated rain water (fig. 14). The discharge into the river of a main drain had been obstructed to prevent it from functioning in

⁵⁴ Raynaud 2010.

⁵⁵ Arcelin *et al.* 1999.

⁵⁶ Arnaud-Fassetta and Landuré 2003.

⁵⁷ Landuré and Pasqualini 2003.

reverse during a temporary elevation of the water level. On average, this was at a lower level than the low-water mark of the Rhône today. The river also had a deeper, well-calibrated channel. The risk of flooding was therefore less significant than it had become by the 19th c. The rise in the waters was seasonal, their overflows limited to exceptional events. The time between two floods does not appear to have exceeded 25 years, which was sufficient for their memory to be forgotten. A similar observation has been made in Alsace, where some archaeological data provides information on the hydrology of the Rhine: the excavations at Oedenburg in the floodplain of the river have shown that the four floods which the site suffered between A.D. 20 and 145/146 were followed immediately by re-occupation.⁵⁸

In the plain of Arles, the study conducted by C. Allin and H. Bruneton on flood-management in antiquity shows that the chief danger comes not from the river, but from the rise in the water-table and from difficulties in evacuating the waters.⁵⁹ Archaeological study of this environmental risk could be carried out at Orange, another Roman colony close to our area of study. The city is surrounded by wetlands whose natural drainage by secondary watercourses is hindered by the hill of Saint-Eutrope. In 1962, the city centre was flooded under 1.2 m of water. The excavation of an area where the sediments had been identified as silt from flooding had supported the hypothesis of an abandonment resulting from a flood in the 1st c., but a micro-morphological examination of this deposit has shown that it was formed by the decomposition of "briques de terre" from collapsed houses. Torrential rain in the basin of Orange would have led to a rise in water exceeding the height of the stone flashings (0.7 m) on which the walls rested. Pooling would have softened the foundations and caused the collapse.⁶⁰ In this case, the inundation came neither from the Rhône nor from its tributary the Ouvèze; it was linked to the (combination of) climatic hazard and difficulties in lowering the level of the fallen rainwater. This type of risk is illustrated by the catastrophic flood that Montpellier, capital of Languedoc, experienced in September 2014; the city was not flooded by a rise in waters coming from the upstream basin of the Lez, the small river which runs through it, but by its inability quickly to evacuate the level of water poured into it by an unforeseeable torrential rainstorm.

These remarks lead to wider reflections on the management of fluvial risk on the lower Rhône, from the prevention of risk to alteration of the river. Risk-prevention measures date from well before the great flood of 1856. Comparing old maps of the delta and the archives of the engineers who directed the alterations to the Rhône with geomorphological data on episodes of flooding during the Little Ice Age, G. Pichard, M. Provansal and F. Sabatier highlight a "rising corrective will", responding to the needs of navigation and for the protection of occupied areas. In the 17th c., the city of Arles carried out works to return the river to its old navigable branch, the Grand Passon.⁶¹ In the same period upstream, in an area where the flow is disturbed by the obstacle of the Roque d'Acier and by the inflow of the Gardon, a branch of the Rhône threatened to destroy the village of Vallabrègues. Boats loaded with spoil were sunk in the Provençal arm to divert the river to the west.⁶² The evidence of documents and maps diminishes as we go back in time. The mediaeval period still preserved the memory of a certain number of alterations of which the river and its mouths had been the object (fig. 15).⁶³

For ancient times, we possess only the text of Plutarch on the canal of Marius and the fragment of Cadastre C of Orange, mentioning a *fossa augusta* that permitted navigation to avoid a sector in the plain of Orange impeded by islands (fig. 16). But the capacity of archaeology to renew our

58 Ollive *et al.* 2006.

59 Allin and Bruneton 2008.

60 Allin *et al.* 2005.

61 Pichard *et al.* 2014.

62 Sudres 1994-95.

63 Rossiaud 2007, 614-15.

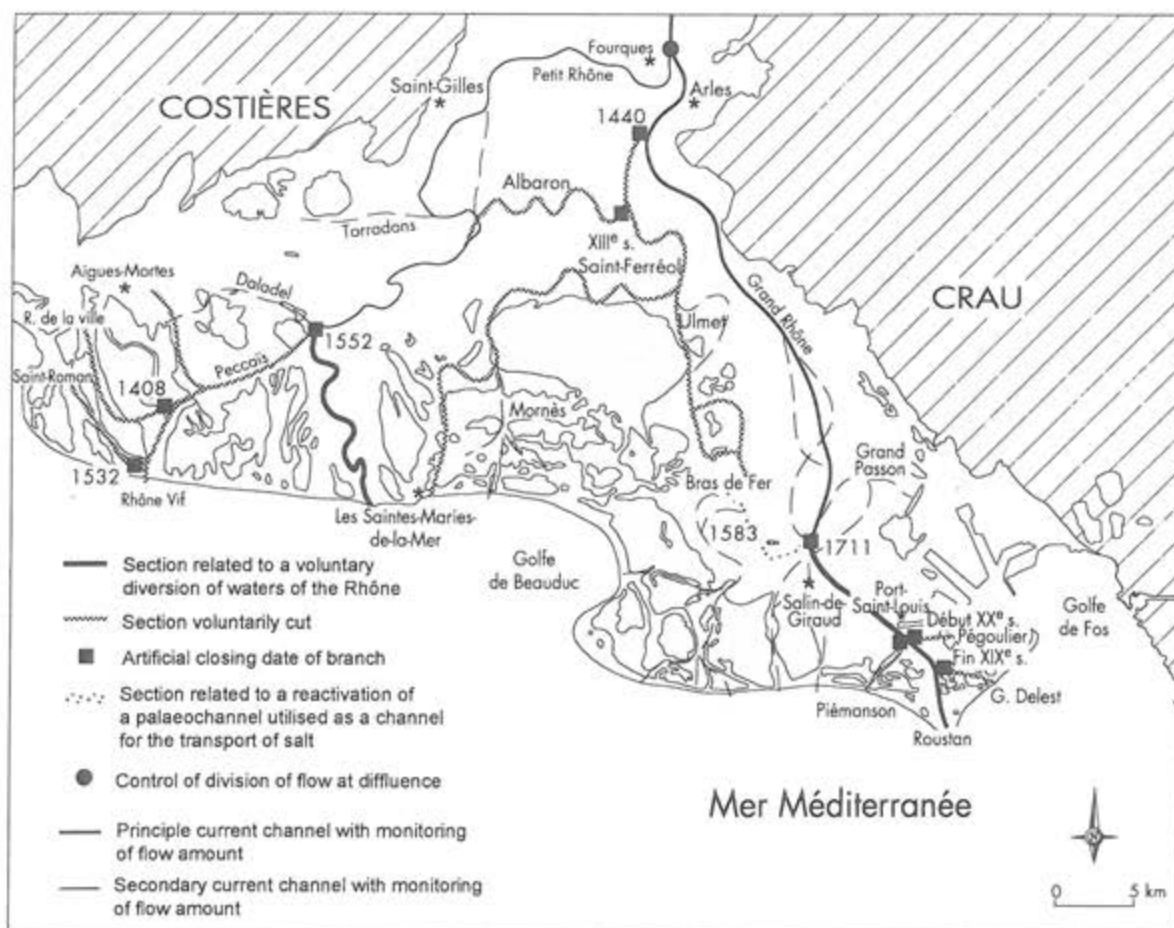


Fig. 15. Human alterations to the hydrographic network in the delta (Arnaud-Fassetta 2004, p. 75, fig. 9).

knowledge has been confirmed by the ongoing operations in the lagoon of Narbonne, south of La Clape and west of the Étang de Gruissan. Two piers, 15 to 25 m in width, converted into dikes, channelled the estuarine branch of the Aude for almost 2 km. A bed 3.5 m deep permitted the passage of boats with a deep draft. In the 4th c., they were further elevated with the help of architectural blocks brought from Narbonne (fig. 17).⁶⁴

Conclusion: the Lower Rhône, Rome, the wetlands, and the paradigms of geo-history

At the end of this historiographical presentation, a first conclusion focuses on the rôle of natural constraints in historical and geographical reasoning. Seen from this point of view, fluvial risk takes its place among the geo-historical paradigms that exploit the danger of the Rhône. J. Rossiaud has shown that the French geographical school used it to justify the division of France into large regions.⁶⁵ In the 1970s, this explanation served to account for the segmentation of the lands of the Rhône.⁶⁶ A rhetorical use of the theme of risk leads even a geographer to ask whether, downstream from Lyon, cities did not exist "in spite of the river!"⁶⁷ On their side, epigraphers willingly yield to the temptation to make cities the natural frontier. Some historians have applied to the delta, and more generally to the Rhône wetlands, the concept of "frontier" already used by W. H. TeBrake to

⁶⁴ Sanchez 2014.

⁶⁵ Rossiaud 2007.

⁶⁶ Béthémont 1972.

⁶⁷ Delahaye 2004.

case documented by written sources. In the early 1st c. A.D., the city of Rome was ravaged by catastrophic floods, and the political powers appeared helpless to stop them. Tiberius assembled a senatorial commission, whose recommendations he then refused to implement under a religious pretext. To restore to the Velino its function of absorbing floodwaters, to create drainage outlets on the Nera and to divert a tributary of the Tiber to the Arno all angered landowners. However, the historian is not obliged to follow the criticisms of Tacitus. Instead, it is necessary to recognise the correctness of the measures taken within Rome: maintaining the network of sewers evacuating water from the city, cleaning up the river banks and encouraging the dispersal of floodwaters downstream from Rome. Tiberius put in place a system whose effectiveness is undeniable, one which was followed by Claudius (*ILS* 207 = *CIL* XIV 85) and later Trajan (*ILS* 5797a = *CIL* XIV 88).⁷¹ Thus the archaeology of the provinces allows the addition of a chapter to a history that is principally documented for Italy simply by written sources.⁷²

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