Antiquités africaines

Lamasba : an ancient irrigation community

Brent D. Shaw

Résumé

Bien que l'inscription de Lamasba, découverte en 1877 par Masqueray, soit l'un des plus importants documents de l'épigraphie romano- africaine et qu'à ce titre, elle ait déjà fait l'objet de travaux anciens comme ceux de F.G. de Pachtère, cette importance est néanmoins telle pour la connaissance de l'organisation économique et sociale de l'Afrique romaine, les problèmes qu'elle soulève sont si multiples et si complexes, qu'il est souhaitable d'en reprendre l'étude à la base.

Paradoxalement c'est la spécificité même du document en question qui en fait l'intérêt principal. En effet si l'organisation hydraulique qu'elle révèle devait être d'un type courant dans la zone présaharienne, les circonstances qui l'ont fait transcrire sont, en revanche, bien particulières puisqu'il s'agit du règlement par une commission d'arbitrage d'un conflit d'irrigation survenu au sein d'une petite communauté urbaine. Celle-ci était implantée au sud-ouest des Hautes-Plaines constantinoises, dans une région ouverte aux influences extérieures en raison de la proximité de la frontière : on remarque la présence dans l'élite municipale des propriétaires de Lamasba de vétérans venus de l'Afrique romanisée. La procédure, exposée dans le préambule de l'inscription, de règlement du conflit laisse deviner par une action conjointe entre les décurions et les *coloni*, la recherche d'un consensus concernant la répartition des temps d'eau en fonction de celle — très inégale — de la propriété des terres irrigables.

Ce qui reste du libellé du décret proprement dit (1/5 environ du texte primitif) fait apparaître en effet qu'à chaque propriétaire était accordé au prorata de l'importance de sa parcelle, pour une date précise de la saison d'hiver, un certain temps d'eau exprimé en heures ou en demi-heures. Ce système fondé sur une unité de temps et non de volume suppose l'existence d'une source perenne (*Aqua Claudiana*) dont le débit devait être à peu près constant. L'eau devait être distribuée aux parcelles par un canal principal branché sur la source et qui traversait lui- même plusieurs terrasses successives. Mais outre ce réseau d'arrosage par gravité (*aqua descendens*) existait un autre dispositif (*aqua ascendens*) fonctionnant en alternance avec le précédent mais avec un débit moindre, ce qui introduisait dans le schéma de distribution un élément de complexité supplémentaire, au sujet duquel on ne peut faire que des suppositions.

Quant à l'unité de base du système qui sous l'abréviation k est appliquée à la propriété parcellaire, il ne s'agit pas d'une unité de valeur mais de superficie. Divers indices permettent de penser que la surface d'un casier correspondant à l'arrosage normal d'un arbre servirait de référence implicite (soit 25 à 36 m2). Ce qui ressort de l'analyse sociale du système est une grande inégalité dans la répartition de la propriété, une douzaine de familles s'attribuant les 3/4 de la surface, tandis qu'au bas de l'échelle une vingtaine d'autres n'en avaient que 5 %. En revanche, on note une grande fragmentation des parcelles dictée peut-être par des raisons de sécurité en cas d'assèchement de la source. Cette tendance est corrigée toutefois par un regroupement des lots en blocs familiaux, facilité par l'apparentement de la plupart des propriétaires.

La conclusion d'ensemble est qu'on a affaire à un système fondamentalement autochtone, perfectionné grâce à la technologie romaine, mais en cela même la société de Lamasba est très représentative des situations hybrides, tant il est difficile de distinguer le greffon du sujet greffé.

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LAMASBA : AN ANCIENT IRRIGATION COMMUNITY*

by

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A general idea of the principles underlying the origins, development, and modes of operation of rural hydraulic systems in the ancient world can be gained by a careful collation of literary, archaeological, and modern comparative data. But an understanding limited to the knowledge of general principles is no substitute for a more precise analysis of how any *one* such scheme functioned in both social and technical terms. If historians could specify the proprietors, the type of technical operation, the scale of property holdings, the crops farmed, and the methods of water allotment of any one irrigation system, then some real connections between the general theorems of arid-zone irrigation farming in antiquity and the data of individual practices might be struck. For the entire belt of the arid zone extending from Morocco in the west to the Iranian highlands in the east, however, it is extremely difficult to obtain data on the specific function of individual irrigation schemes in antiquity. Of course, the great ancient riverine civilizations of the Nile and the Tigris-Euphrates have left us very detailed records. But these pertain to a distinct form of irrigation tied to the presence of large perennial streams [1]. As such, these cases are the exception rather than the rule for the vast expanse of arid lands in the geographic zone demarcated above. In these lands, only fortunate discoveries such as the papiry from Niṣṣanah in the north central Negev or the so-called *Tablettes Albertini* from the Saharan periphery of the Maghrib have dispersed the generalities, and have given detail and precision to our understanding of ancient arid-farming techniques.

During the first months of 1877 just such a fortunate discovery was made by Emile Masqueray during the course of one of his exploratory journeys through the arid southern regions of Constantine Province, Algeria. While crossing the Bellezma Plain (see map), the geographical antechamber leading from the Hodna Basin to the plains southwest of Constantine, Masqueray discovered two large stone plaques at a site called 'Aïn Merwâna. Each of these was inscribed with the details of a decree concerning a large scale irrigation scheme. The record preserved on these stones remains the sole epigraphical document from North Africa which reveals in a detailed manner the functional, social, and organizational structure of one of the myriad irrigation systems that were to be found throughout the arid zone of the ancient Maghrib. It makes specific the general picture revealed by

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[1] See Butzer (K.W.), *Early Hydraulic Civilization in Egypt: A Study in Cultural Ecology*, Chicago, University of Chicago Press, 1976; and Walters (S.D.), *Water for Larsa: An Old Babylonian Archive dealing with Irrigation*, New Haven, Yale University Press, 1970 (Yale Near Eastern Researches, no. 4), and their bibliographies, for an exemplary set of studies on riverine irrigation systems in the ancient Near East.

remains diligently traced at surface level by archaeologists and so clearly perceived on numerous aerial photographs of the frontier zone [1]. The decree, as preserved on the four surviving fragments of the original stone, records in detail the arrangements for irrigating a large number of agricultural plots in the region of the ancient town of Lamasba (mod. 'Aïn Merwâna) during the reign of the Roman emperor Elagabalus (A.D. 218-222) [2].

The irrigation decree found at Lamasba was originally inscribed on a large rectangular stone, the height and width of which can only be estimated. The two large fragments discovered by Masqueray formed the upper left sector of the original stone (see fig. 1). These two large rectangular fragments form the right and left halves of the document as it survives; a narrow vertical column of stone between the two is missing. A third triangular shaped fragment containing a portion of the preamble, which fitted between the upper halves of the two great blocks, was later recovered and published by Dessau. A small, but very important fourth piece containing part of the detailed contents of the second column of the inscription was subsequently published by Gsell [3]. The general format of the decree is quite clear from its surviving fragments. Across the top an imperial title and a preamble to the decree explaining the reasons for its redaction were engraved in large letters. The body of the decree was arranged in vertical columns beneath this heading, each column containing the names of individual proprietors and their water allotments.

Although it is not possible to be absolutely precise about the size of the original stone, it is necessary for diagnostic purposes to establish the outer limits of its magnitude. From a careful study of the remaining fragments (see Appendix, p. 95), it can be stated with some degree of probability that the decree only covered irrigation during the six months of winter. Further, the lateral portions of the decree which remain only cover about half this time span, and represent a small, though not insignificant, part of the original inscription. In fact, it seems that we possess only about one-fifth of the original (see fig. 2), but this is still a sufficient proportion from which to deduce much valuable information about the structure and function of the entire original irrigation scheme.

1. Lamasba: Town and Territorium

Before considering the contents of the irrigation decree in detail, the geographical and historical context of Lamasba and its territory should be examined. In the heart of the semi-arid lands of the southern Maghrib, Lamasba, the present day town of 'Aïn Merwâna, was located on the southern periphery of the Bellezma Plain

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[1] *Corpus Inscriptionum Latinarum*, vol. VIII), 18587 = 4440 = *I(nscriptiones) L(atinae) S(electae)*, 5793 (cf *Ephemeris epigraphica*, v. 1279; vii. 788). See the better edition of the inscription in the fundamental treatment by Pachtère (F.G. de), *Le règlement d'irrigation de Lamasba*. M.E.F.R., t. 28, 1908, p. 373-400, at 374-75 (A-C), photo. pl. iv-v, which includes the fragment of the preamble discovered by Dessau (*Eph.epigr.* vii. 788) and the fragment of the lower second column found by Gsell (S.), *Recherches archéologiques en Algérie*. Paris, Imprimerie nationale, 1893 (henceforth, *R.A.A.*), p. 82-85. The information on the inscription has also been tabulated by Birebent (J.), *Aquae Romanae: Recherches d'hydraulique romaine dans l'Est algérien*. Alger, 1964 (henceforth, *Aquae Romanae*) p. 403-05, with a line-drawn facsimile of the left block of the inscription. For the original report of the find see Masqueray (E.), *2e Rapport à M. Le Général Chanzy, Gouverneur Général de l'Algérie, sur la mission dans le Sud de la province de Constantine*. RAf., t. 21, 1877, p. 33-45, at 37-41, and his report in Bulletin de Correspondance africaine, t. 3, 1884, 223.

[2] Controversy arose early as to which of two sites, Hr. Ma'fûna (mod. Wed. al-Mâ) or 'Aïn Merwâna was ancient Lamasba (see Masqueray (1884) 219 f. and Revue de l'Afrique française, 1886, 69 f.). Both Gsell, *R.A.A.*, p. 82 and *C.*, p. 1777 were able to confirm that it was the latter site from the evidence of the Roman milestones. Hr. Ma'fûna was later identified as Roman *Lamsorti*.

The dating of the inscription depends on the imperial title at the head of the stone, which reads:

Imp(eratore) Caes(are) M(arco) Aurelio Inv[i]cto Pio Felice Aug(usto) amplissimo [---]

Mommsen (*C.*, p. 448) saw that either Elagabalus or Carus was the only possible alternative. Henzen (*C.*, p. 956), Mommsen and Schmidt (*Eph.epigr., VII, p. 256; C.*, p. 1780), and Dessau (*I.L.S.*, p. 427) established the basic criteria for identifying the emperor in question: 1) no apparent erasures or *damnatio memoriae*, 2) he must be one of the emperors who had the names *Marcus Aurelius*, 3) and the epithet *invictus pius felix Augustus, amplissimus*. The only emperor who meets all these criteria is Elagabalus who bore the title *sacerdos amplissimus Dei invicti Solis* (*C., III, p. 892 = Eph.epigr., II, p. 464 = I.L.S.*, 475, and *C.*, 5827 = *I.L.S.*, 473).

[3] See the photo., fig. 1, and that included in de Pachtère (1908), pl. iv-v.

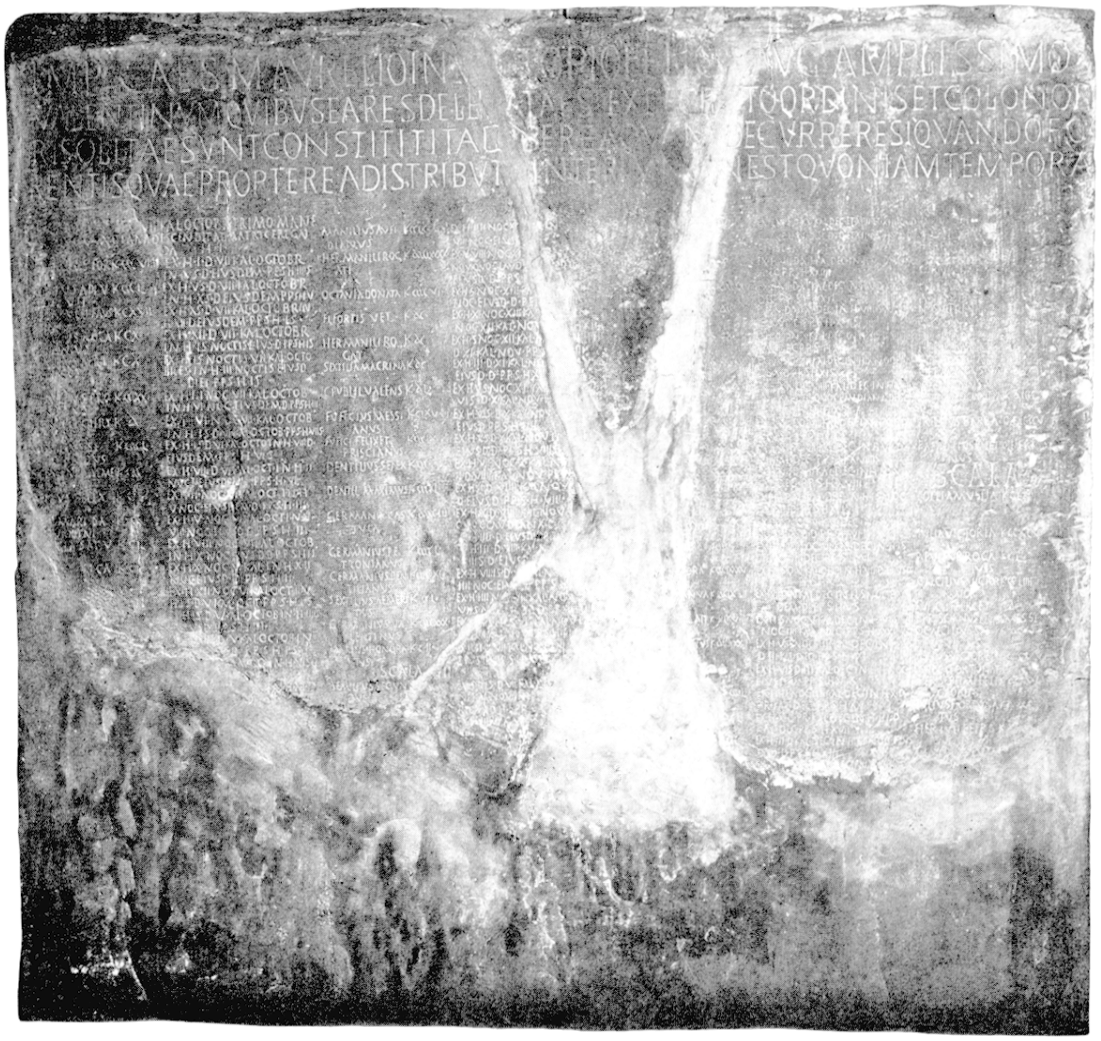

FIG. 1. — The Lamasba decree (*C.I.L.*, 18587).

about 100 km southwest of Cirta and 40 km northwest of Lambaesis [1]. The aridity of the plains and lowlands was ameliorated considerably by the massive mountain blocks that dominated the area: they not only increased precipitation marginally, but also created the potential for irrigation and runoff agriculture. But the rural economy of the region was probably more widely based on dry-farming and herding as well as irrigation [2]. Because of the need for a permanent supply of water, settlements were almost invariably situated in close proximity to the perennial springs that emerged from the lower flanks of the mountain massifs. Hence urbanism revealed a

[1] For the location see GSELL (S.), *Atlas archéologique de l'Algérie*. Alger, Jourdan ; Paris, 1911 (henceforth, *Atl.arch.*) f. 27 (Batna) no. 86 (p. 6) ; cf TISSOT (C.), *Géographie comparée de la province romaine d'Afrique*, t. 2. Paris, Imprimerie nationale, 1888 (henceforth, *Géographie comparée*) p. 503-04; DESSAU (H.), *Lamasba*, *R.E.*, 12.1, 1924, 538; de RUGGIERO, *Lamasba*, *D.E.*, 4.11, 1946, 349, and LEGLAY (M.), *Lamasba*, *Der Kleine Pauly*, t. 3, 1969, 462-63.

[2] See GSELL, *Atl.arch.*, f. 27 (Batna), no. 108 (p. 8). Jebel) Mastawa, rising above ancient Lamsorti, was a natural fortress and refuge in antiquity. On its abrupt flanks and forested heights were found many *tumuli* of its African inhabitants, see GSELL (S.) and GRAILLOT (H.), *Exploration archéologique dans le département de Constantine (Algérie). II: ruines romaines au nord des monts de Batna*. M.E.F.R., t. 14, 1894, p. 501-609, at 502 f.

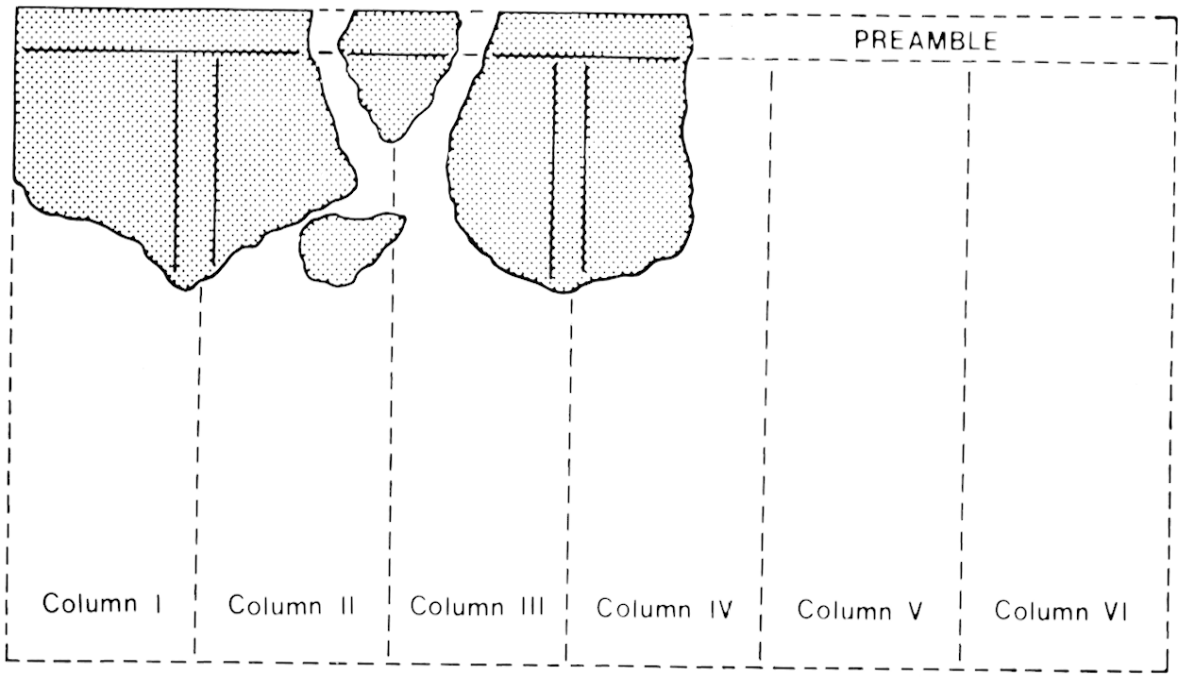

FIG. 2 — Hypothetical reconstruction of the original stone and context of the remaining fragments of the Lamasba decree.

pattern typical of the entire zone of the ancient Maghrib: settlements clung to the highland flanks close to their constant water supply, whereas the plains were left relativity open and were developed into farmsteads. The Bellezma Plain, with Lamasba on its southern periphery, is a salient which extends the Hodna Plains to the northeast. It is circled by blocks of mountains on its north, east and south sides; the plain itself forms a sort of connecting chamber between the Hodna to the southwest and the Constantine Plains to the northeast. For this reason too the plain was traversed by some of the major routes followed by long-range Saharan nomads on their annual trek to their summer pastures in the north [1].

Since it was nestled in the folds of the southern mountain border of the Bellezma Plain (formed by J. Takra, Tikelt, bû-Rhiûl, and the long island of bû-Arî) Lamasba may appear to have been peripheral, though precisely the opposite was the case. Lamasba probably was *the* major urban centre of the whole plain. One reason for its importance, as pointed out above, was the presence of a large perennial spring; another was its strategic location on the boundary between mountain and plain, an ideal location for an economic centre place. It probably dominated all the plains region in the direction of the nearest known ancient settlements: Ras al-Aiûn (ancient name unknown) to the west, Lamsorti (mod. W. al-Mâ) to the east, and Nicivibus (mod. N'gaûs) to the southwest. And it has been conjectured that the modern name for the region, the Bellezma, is merely a distorted form of Lamasba [2]. It is clear from milestones and the Roman itineraries that, because of its position in the

[1] See DESPOIS (J.), *Le Hodna (Algérie)*. Paris, Presses Universitaires de France, 1953, p. 289-90 and map, fig. 30; DARMON (J.P.), *Note sur le Tarif de Zarai*. C.T., t. 12, 1964, p. 6-23; LANCEL (S.), *Suburbures et Nicibes: une inscription de Tigisis*. Libyca (Arch.-épigr.), t. 3, 1955, p. 289-98, and the obvious conclusions to be drawn from these.

[2] LUCIANI (M.), *Le Bellezma*. Revue de l'Afrique française, t. 6, 1888, p. 313-21. The toponymy of the town reveals its part in a peculiar regional nexus. It begins with the phoneme **Lam-*, a prefix shared by numerous other towns in southwestern Numidia. *Lam*sorti, *Lam*baesis, *Lam*bafundi, *Lam*iggiga (mod. Seriana, ex-Pasteur), *Lam*dia (Medea), *Lam*biridi (W. Arif), and an unidentified bishopric called *Lam*fuenses. Further to the west *Lem*ellef (Borj Rhedir) and an unidentified bishopric labelled *Lem*foctensis may be regional variants. The similarity in

Bellezma Plain, Lamasba was at the nexus of the system of roads emanating from the Hodna, Sétif, and Constantine Plains [1].

Unfortunately little is known of the urban history of Lamasba. Although the earliest *dated* Latin inscriptions from the town itself are Severan (i.e., early third century) it seems probable that the inclusion of the region within the network of the central Roman administration occurred under the early Antonines, and was coeval with the development of the Sétif Plains to the northwest in the last decades of the first century and the first decades of the early second [2]. The settlement of discharged soldiers in towns like Diana Veteranorum (mod. 'Aïn Zana) reflects the impress of the military in nascent town development in the area [3]. Closer to Lamasba, the increasing adoption of Roman forms by the new municipal élites can be seen at Lamsorti where an inscription records the *restoration* of a temple of Pluto by the town *curia* in the reign of Marcus Aurelius [4]. Lamasba may have been even more precocious in its development than Lamsorti, principally because of its more favourable geographical siting. Lamsorti is never recorded as having advanced its civic status beyond that of a peregrine *civitas*, whereas Lamasba was the recipient of favours under Caracalla, styling itself the *respublica Antoniniana* [5]. That the imperial *beneficium* reflected in this title was indeed a grant of municipal status appears certain from an inscription discovered at Verecunda (mod. Markûna) which mentions decurions and *flamines* at Lamasba [6]. The same inscription also reveals some of the connections between the old legionary territory around Lambaesis and the western regions around Lamasba. Verecunda was originally a *vicus* settlement of veterans some four kilometres east of Lambaesis; it is here, in his former *patria*, that a decurion and *flamen* from Lamasba spent 4000 HS on the repair of a temple.

The extent of the *territorium* under the aegis of the municipality of Lamasba was probably coterminous with the bounds of the Bellezma Plain. From the evidence of existing milestones it is possible to trace the size of the *territorium* at least as far as six miles in the direction of Diana Veteranorum (the next staging post to the east

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toponymy certainly indicates some regional continuity, whether simply linguistic, social (are they market centres?), or political (fortified places?, cf the Roman *burgus* and *castrum* in the northwestern provinces).

Perhaps a better solution is suggested by Rosen in Geertz (C. et H.). Rosen (L.), *Meaning and Order in Moroccan Society: Three Essays in Cultural Analysis*, London-New York, Cambridge University Press (1979), 32 ff. There he notes that a time-distribution system of irrigation dependent on a spring (*'Aïn Sultân*) near Sefrou which is *précisely* the same as Lamasba in structure and operation is based on a system of distribution known as *l-ma b-sa'a* ('timed water'). The similarity of wording is striking and draws attention to the formulation *al-ma* ('water') which may indeed lie at the base of the toponym *'la-m* and suggest that these palaeoberber place names are in fact springs.

[1] Noted by the *Geogr. Rav.* 3.6 (Tamasgua) and Julius Honorius (ed. Reise, *GLM*, 48), 'Lamasba oppidum'. The Antonine Itinerary reads: « Item a Tamugadi Lamasbua 62 sic: Tamugadi-XXVIII-Tadutti-XVI-Diana Veteranorum-XVIII-Lamasba: item a Lamasba Sitifi 62 sic: Lamasba-XXV-Zarai-XII-Perdicibus-XXV-Sitifi ». The Peutinger Table reads: Lambese-Lambiridi-Lamasbua-10 (actual distance 6)-Ad Centenarium-10-P(rae)sidium-12-Zaras-16-Ad Capsu(m) Iuliani ». See Miller (K.), *Itineraria Romana*, Stuttgart, Streder et Schroder, 1916, p. lvi and 919.

[2] The legionary camp at Lambaesis existed as early as the reign of Titus (A.D. 81), but development of the region within larger Roman imperial market systems was not marked until the Trajanic extension of the *limes* south of the Aurès mountains and into the eastern Hodna Basin. See Gsell et Graillot (1894) 501 f. and Gascou (J.), *La politique municipale de l'Empire romain en Afrique proconsulaire de Trajan à Septime-Sévère*, Rome, Collection de l'Ecole française de Rome, no. 8, 1972 (henceforth *Politique municipale*), p. 97-103, 152-58. For the Sétif Plains see Cagnat (R.), *Le castellum de Kherbet-Ksar-Tir (Algérie)*, (in) *Mélanges Perrot*, Paris, Fontemoing, 1903, p. 37-39 ; Carcopino (J.), *Les « Castella » de la plaine de Sétif d'après une inscription récemment découverte*, R.A.f., t. 59, 1918, p. 5-22 ; and Février (P.-A), *Aux origines de l'occupation romaine dans les Hautes Plaines de Sétif*, C.T., t. 15, 1967 = *Mélanges Saumagne*, p. 57-64.

[3] See Gsell, *Atl.arch.* f. 27 (Batna) no. 62 ('Aïn Zana).

[4] B.C.T.H., 1901, p. CL = A.E., 1901 : 115 (a. 172-75).

[5] *C.*, 22467 (Qsar Bellezma), see Gsell, *R.A.A.*, p. 109, no. 55 : « Lamasba/Antoniniana », with Caracalla's titles; *C.*, 22503 (between N'gaûs and 'Aïn Merwâna at Hr. al-Bir = M'sora), see Gsell, *R.A.A.*, p. 115, no. 6: *res pub(lica)/ Novem[sis? Lamasb(a)]*, a. 214, with Caracalla's titles; *C.*, 22511 (M'serra = Hr. Kerria, on the right bank of W. M'sân): *R(es) p(ublica) Lamasb(ensium)/ M. VIIII*, a. 214.

[6] *C.*, 4253, cf 18501 (Verecunda, mod. Markûna): [---] *fl(amen) p(er) p(etuus), decurio munic(ipii) Lamasben[sium --- / aedem au]ctam et lateribus ornatam ex HS IIII [mil. n. --- / ---]a fecit idemque dedicavit / Innocii*; cf Duncan-Jones (R.), *The Economy of the Roman Empire*, Cambridge, Cambridge University Press, 1974, p. 97, no. 163.

noted on the Antonine Itinerary) some eighteen Roman miles to the northeast, and as far as mile fifteen in the direction of Nicivibus to the southwest [1]. Smaller local settlements within this territory, such as Qsar Bellezma some five kilometres to the north of Lamasba, would have been attributed to the town and local men would have gone to Lamasba to hold municipal office. Such is the case with one C. Iulius Castus, who was *flamen perpetuus* in the municipality of Lamasba, but whose *origo* was Qsar Bellezma [2]. Thus Lamasba had a rather large rural *territorium* embracing most of the Bellezma Plain, an area of approximately 300 km^2.

A measure of the wealth and type of social integration found in the region can be made from a glance at Lamsorti, some eight kilometres to the east of Lamasba. Situated on the periphery of the plain, in close proximity to a perennial spring, and at the base of a mountain massif, Lamsorti is the same type of settlement as Lamasba. The ruins of the site, now known as Hr. Ma'fûna, extend for some distance along Wadi al-Mâ, and numerous olive presses indicate at least one source of agricultural wealth [3]. Local families were prosperous enough to produce several members of equestrian rank within one family unit. One woman, Vettia Saturnina, in making a dedication to the *genius* of the Roman town, was able to speak with pride of being the mother of two sons, both of whom were Roman knights. Her husband, L. Hostilius Felix, was an immigrant to the town from Lambaesis where he had held the post of municipal pontifex [4]. He himself set up a dedication to *Fortuna Redux* in the town. The inscription clearly reveals the mode of social mobility of this local municipal family. Lucius Hostilius Felix originally came from the region of Carthage in the old Roman province of *Africa proconsularis* where he was enrolled in the *tribu Arnensis*. His career illustrates a typical pattern of recruitment for the legion in the early second century: members of the municipalities of the old Roman province of Africa used their possession of citizenship as an entry ticket to the army where a career could later be turned to substantial advantage. Having risen to the 'rank' of *beneficiarius* and having received his *honesta missio*, Hostilius then held the posts of *duumvir* and *pontifex* at Lambaesis. Subsequently he moved west to Lamsorti where he established his home. The speed at which wealth could be accumulated on the expanding frontier is probably indicated by the fact that both his sons achieved equestrian rank [5].

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[1] See above no. 1, p. 65 for the itineraries and no. 5, p. 65 on some of the milestones. For the rest, see *C.*, 22433 (300 m. from Hr. Ghiran, 1.5 mi. from Merwâna): *Res (publica) / Lamasben/s (es)* (Constantinian); *C.*, 22459 (6 mi. towards Diana Veteranorum in the ruins of Hr. Batha, see Gsell, *R.A.A.*, p. 89, no. 30, Galerius); *C.*, 22460, see Gsell, *R.A.A.*, p. 89, no. 31 (Constantius, same loc.); *C.*, 22506 = 10401 (see Gsell, *R.A.A.*, p. 114, same loc.), showing municipal *cura* of the local road system: *commeanti/bus ino[va]vit/ de r (e) p (ublica) sua La/masba* (Severus Alexander); *C.*, 22516 (6 mi. from Hr. Guellil, towards N'gaûs) see Gsell, *R.A.A.*, p. 121, no. 77: *Lamasb (enses) MIL XV* (a. 214). On the extent of the territory attached to the town see Gsell, *Atl.arch.* f. 26 (Batna) no. 86 (p. 6): to the northeast of no. 100 (f. 27), to the west of no. 157 (f. 26), and to the northwest of no. 80 (f. 26). al-Qsar (Qsar Bellezma) was probably an observation post at this time and later the Byzantines built a fort here, in the middle of the plain, hence the name of the place, see Diehl (C.), *L'Afrique byzantine : histoire de la domination byzantine en Afrique (533-709)*. Paris, Imprimerie nationale, 1896 (reprint: New York, Burt Franklin; henceforth *L'Afrique byzantine*), 251 f.

[2] *C.*, 4438 = 18600 (Qsar Bellezma/al-Qsar), a memorial to his wife Aelia Saturnina and his son *C. Iul (ius) Castus* [I]*unior* (both deceased, his son at age one) by *C. Iulius Castus Iun (ior), fl (amen) p (er) p (etuus) m (unicipii) L (amasbae), coniug (i) et filio [f (ecit)]*. His wife's name is revealing of probable enfranchisement of her father under one of the Antonines, her *cognomen* indicating continuing African influences, whereas her husband, C. Iulius Castus, probably has some military background. Though Mommsen supplied L(amsortensi), surely Wilmann's L(amasbae) is correct, so Bassignano (M.S.), *Il Flaminato nelle province romane dell'Africa*. Rome, 1974 (henceforth, *Flaminato*), p. 330-31.

[3] See Gsell, *Atl.arch.*, f. 27 (Batna) no. 108 (p. 8) and *R.A.A.*, p. 103-04 ; Mesnage (J.), *L'Afrique chrétienne. Evêchés et ruines antiques...* Paris, 1912 (henceforth *L'Afrique chrétienne*), p. 260-61 ; and de Ruggiero, *Lamsorti, D.E.*, 4.12 (1946) 360.

[4] *C.*, 4437 = 18596 (Lamsorti, W. al-Mâ), *Genio Lamso/[tensi] Aug (usto) Vet/tia Saturnina / mater duor/um eq (uitum) Roma/ / [n]brum, Hosti/liorum Satur/nini et Felicis, / coniunx L (ucii) / Hostili (i) Feli/ / cio, pontificis / municipi (i) Lamba/esitanorum, / ob honorem fl (amonii) p (erpetui) d (edit)* ; see Bassignano, *Flaminato*, p. 333-34.

[5] *C.*, 4436 = 18595 (Lamsorti, W. al-Mâ): *[--- L (ucius)] Hostilius [L (ucii)] f (ilius) Arn (ensis tribu) Felix [K]arthag (iniensis) vet (eranus) [e]x b (ene) f (iciarius) leg (ionis), duo[v]iralicius et pontifex municipii Lambae (sitanorum), pater Hostili (i) Saturnini eq (uitis) R (omani)*: cf the *Hostilii* at nearby Qsar Bellezma (*C.*, 18591). Bassignano, *Flaminato*, p. 333-34 cites this case, as do many others, to show that Lamsorti was a municipium, though it clearly refers to Lambaesis. The dedication to *Fortuna Redux* places it early in the reign of Septimius Severus (c. 203), cf Romanelli (P.), *Storia delle province romane dell'Africa*. Rome, 1959 (henceforth *Storia*), p. 412-13.

Undoubtedly Lamasba also had a group of such veteran immigrants as the core of its local municipal élite. A study of the nomenclature of the region reveals a total Latinization of the recorded names, though there are clear indications that the majority of persons, if not all, were of African descent [1]. The extent of possession of citizenship is difficult to assess, though a number of persons bear the *tria nomina* [2] and many of those who did possess citizenship seem to have acquired it through army service. Certainly the *Flavii* found in the region would appear to be in the latter category; the two *Flavii* on the irrigation inscription are explicitly listed as *veterani* (see pp. 88 ff below) [3]. The large number of *Iulii* attested in the region (four alone on the irrigation decree) might indicate the same origin of citizenship [4]. One of the *Iulii*, Iulia Victoria from Qsar Sheddi, might be the same person as her homonym on the irrigation inscription [5]. Other names such as the 'occupational' cognomina might indicate army origin, such as Pompeius Adiutor ('assistant'), *adiutor* being an army 'rank'. Flavius Adiutor, one of the proprietors in the irrigation scheme who bears this same cognomen, is specifically attested as a *veteranus* [6]. Just how extensive the influx of veterans into the Lamasba region was and what sort of impact they had on the local community is difficult to estimate. We have already seen how L. Hostilius Felix came to the Lamasba region from Carthage via the army post at Lambaesis, as did another unnamed decurion from the municipality at Lamasba. And two other *veterani* on the irrigation inscription list their *patriae* in the old province of Africa. External ties extended not only in the direction of the army district around Lambaesis but also, quite logically, to the northeast in the direction of Cirta. Fortunatus, Honoratus and Festus, three African peasant cultivators farming near Kherbet 'abd-ar-Rhamân, erected a dedicatory inscription to their patroness, a resident of Cirta [7]. They are clearly of local African stock, whereas she is probably an absentee Roman landlord. The dominant impression is that the majority of the outsiders who settled in the local community were indeed veterans or persons whose direct ancestors had army connections: although their ultimate 'roots' were in the old province of Africa, they had been 'funnelled' through the army centre at Lambaesis before moving further west to settle on the land.

By the early third century Lamasba would appear to be a well established, developing frontier settlement, where hard-working peasant family groups and the new wealthy 'few' found their rewards in this life and confidently prepared their *monumenta* for the next [8]. Although having the encapsulated communality of any isolated locale, Lamasba still displayed a great divergence in wealth between the average smallholder and the more powerful families such as the Hostilii who had managed to accumulate landed riches on the new frontier rather quickly. The number of immigrants, even if small, as well as the geographical location of the town, must have ensured a sort of continuous contact with the outside atypical of similar towns further to the west or south. Hence, Lamasba was a settlement 'in contact' and readily open to external influences. With its own Christian bishop at least by 256 (the date at which the local bishop Pusillus attended the conference at Carthage),

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[1] Cf the transliterated African names: Arrania Spesina (*C.*, 4442 = 18604, Qsar Sheddi), Serrane wife of C. Septimius Florus (*C.*, 4444 = 18608, Qsar Sheddi). And the misspelled Latin variations: L. Vapbricius (*i.e.*, Fabricius, *C.*, 4466 = 18616, Qsar Sheddi).

[2] C. Iulius Castus (above no. 16); L. Hostilius Felix (above nos. 4-5, p. 66); C. Septimius Florus (above no. 20); L. Appius Ianuarius and his son L. Appius Rogatus (*C.*, 4441 = 18603, Qsar Sheddi) and no. 3 below.

[3] Flavius Felix (*C.*, 4446 = 18589, Hr. Tamarit) and his father; and a Flavia (*C.*, 4451).

[4] C. Iulius Castus (above no. 16); C. Iulius Anicetus and Iulia Extricata (*C.*, 4450 = 18592 'Ain Merwâna); C. Iulius Candidus (*C.*, 4451, plain of 'Ain Shellish); Q. Iulius Primus (*C.*, 4452 = 18611, Qsar Bellezma); Iulius Repostus (*C.*, 4453 = 18612, Qsar Sheddi); Iulia Tsala and her son Iulius Restutus (*C.*, 4455 = 18624, Hr. Abid); and a C. Iulius (*C.*, 18610, Qsar Bellezma).

[5] *C.*, 4456 = 18612 (Qsar Sheddi), cf Chart I, no. 20 and II, no. 28.

[6] *C.*, 4459 = 18619 (Qsar Sheddi).

[7] *C.*, 4465 = 18594 (Kherbet 'Abd-er-Rhamân).

[8] C. Iulianus, a tomb 'me vivo feci mihi' (*C.*, 18605, Qsar Bellezma, cf *C.*, 18593, 'Ain Merwâna, a family group):

Coniunx coniugi carissime vivos vivae / tumulus constituit dedicavitque / memoribus futuris heredibus / communibus post mortem nostri / inscribere quod numero annos // exegerimus (*C.*, 18629 = *Eph.epigr.*, v, 1281, Hr. al-Mahras).

Lamasba was one of the few rural communities so deep in the African hinterland to boast an organized Church in the early third century [1]. At the crucial conference of 411 held at Carthage, the town was represented by two bishops, one from each Christian community: the African (the so-called 'Donatist') and the Catholic. The internal religious schism in the community probably mirrored local social divisions; the African Church had at its base the local power structure, the Catholics the residual elements. Avitus, the Catholic bishop, styled himself *episcopus plebis Lamasbuensis* [2].

2. The Irrigation Decree: Conflict Resolution

It is within the above community framework that the Lamasba irrigation decree, issued by the local municipality during the reign of the emperor Elagabalus, must be analyzed. But the question must also be raised: why do we possess this *one* inscription alone which records in great detail the regimen to be followed in the irrigation of (perhaps) hundreds of properties, many of them rather small, in a rather remote region of the ancient Maghrib? From both archaeological surveys and aerial photographs, it is known that such schemes were the ordinary means by which the arid lands of the Maghrib were developed; as such they must have been counted in myriads. If even a fraction of these irrigation systems had operated on the basis of written 'decrees', inscriptions of the type found at Lamasba ought to be very numerous [3]. That this is the singular discovery of its type argues, by sheer force of probability, against any such general regulation of irrigation schemes by written document. Further, we know that elaborate written regulation was probably *not* the normal means of organizing the distribution of irrigation waters at Lamasba itself. It was only *after* the customary controls governing the distribution of water had broken down that specific action was required that resulted in the composition of the irrigation inscription and its engraving on stone.

The preamble to the decree that explains this process reads as follows [4]:

Imp(eratore) Caes(are) M(arco) Aurelio Inv(i)cto Pio Felice Aug(usto) amplissimo [sacerdote Dei Invicti Solis Elagabali, quaesita re per ..... et .....]/ Valentinum, quibus ea res delegata est ex decreto ordinis et colonor[um Lamasbensium, aquarum quae da]/ri solitae sunt, constitit ita debere aquam decurrere si quando fo[ns decurrit, ut monstrat forma infra scripta, aquae decur]/rentis quae propterea distributa interim non est, quoniam tempora [iniqua id prohibuerunt ---]

That is to say, the reason for the formulation of the register was an internal conflict over the times (*tempora*) of watering allotted to each property. That the situation had reached this impasse and that recourse was had to a special commission of arbitration is one measure of the seriousness of the conflict, since most other systems of this type ordinarily functioned without recording the detailed arrangements for water distribution on a publicly displayed stone. The language of the preamble also reveals that a similar system had already existed *before* the implementation of the scheme recorded in the decree. It is possible from the terms of this language to deduce the nature of the earlier system. First, it seems most improbable that the size, type, or arrangement of the individual properties had changed during the interim. The dispute was not over *landed* property, nor do the terms of the

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[1] MAIER (J.L.), *L'épiscopat de l'Afrique romaine, vandale et byzantine*. Neuchâtel, P. Attinger, 1973 (henceforth *L'Episcopat*), p. 24, no. 75; p. 157, 392; the only other inland centres so far removed are Thubunae in the eastern Hodna Basin and Bades, south of the Aurès.

[2] Avitus: MAIER, *Episcopat*, p. 48, no. 124, 157, 264; the « Donatist » was Ianuarius, *ib.*, p. 54, no. 32, 157, 339. There was still a bishop in c. 484 (*Not.Eccl.Afri.*, no 112), cf MAIER, *op. cit.*, p. 157, 414, and MESNAGE, *L'Afrique chrétienne*, p. 279.

[3] So, *e.g.*, HEITLAND (W.E.), *Agricola: A Study of Agriculture and Rustic Life in the Greco-Roman World*. Cambridge, Cambridge University Press, 1921 (Reprint: New York, Arno, 1970) p. 293, who thought that there were many other such decrees in Africa now lost to us « by chance of time ».

[4] The restorations are by the editors of the *Corpus* with slight modifications. In line 3 only *fo[rma* ---] or *fo[ris* ---] or perhaps *fo[ramen* ---] are possible, though not probable, alternatives to *fo[ns* ---]. In line 4 end the general sense is clear: *id non permiserunt* has also been suggested (cf *Eph.epigr.*, VII, 256).

decree reflect any signs of land reform. The only aspect that has been altered is the *time* distribution of the water; and this was only changed in its detail, not in its basic principles. The former scheme was in essence the same as that recorded on the stone, since distribution was still in *time units*.

How long had the quarrels over water been disrupting the relationship amongst the *possessores* at Lamasba? And when did they reach a level serious enough to provoke a total restructuring of the water distribution network in order to ensure its continued function? Conflict is often endemic to irrigation systems, but ordinarily disputes are settled by mechanisms provided by the local society itself and not by external 'official' action [1]. Consensus can be broken, but as long as the proprietors are part of a tightly knit and isolated community, and have their own perceived instruments of justice, the basis for effective social control is considerable. One basic fact of many irrigation systems in early agrarian societies, was a tremendously unequal distribution of property. This alone placed some strain on the system of co-operation.

TABLE I

COMPARISON OF LARGE AND SMALL LANDHOLDERS

Proprietor	*Property Size*	*Ratio**
Germanius Valentinus (nos. 39 and 62)	1094 K	ca. 7 x
Valerius Crassus (no. 81)	1500 K	ca. 10 x
Aemilius Secundus (nos. 41 and 84)	2700 K	ca. 18 x
(Unknown) (no. 85)	4000 K	ca. 25 x

* That is, the number of times it is greater than the average small-hold, which I have arbitrarily set at ca. 150 K. For a system where we have only partial evidence and no meaningful statistical analysis is possible, this is a more indicative figure than either the mathematical average of all the plots (ca. 605 K), or of the remaining plots (ca. 532 K) or the mode (ca. 430 K).

Multiple holdings among the smallholders at Lamasba may have ameliorated this situation somewhat, but large landholders also must have held much additional property not listed on the inscription (note that two of the large property owners have multiple holdings on existing parts of the stone). But such polarisation of property ownership was characteristic of most parts of the Roman empire, and offers no sufficient explanation for the breakdown in the particular irrigation system at Lamasba. In this case, at least part of the additional cause must have been supplied by the growing separation of the community into differentiated groups of outsiders, administrators, and locals, that severely disrupted customary procedures for settling disputes.

[1] On dispute and resolution see GLICK (T.F.), *Irrigation and Society in Medieval Valencia*. Cambridge, Mass., Harvard University Press, 1970, chap. 3, « Intracommunity Conflict and its Resolution », p. 52-93; BERQUE (J.), *Structures sociales du Haut-Atlas*. Paris, 1955, p. 105-08, 121-28, 142-59, and 225-33 ; GEERTZ (C.), *The Wet and the Dry: Traditional Irrigation in Bali and Morocco. Human Ecology*, t. 1, 1972, p. 23-39 ; MILLON (R.), HALL (C.) et DIAZ (M.), *Conflict in the Modern Teotihuacan Irrigation System*. Comparative Studies in Society and History, t. 6, 1961-1962, p. 404-521, whose conclusions should be accepted, even if somewhat tempered by FERNEA (R.), *Conflict in Irrigation*. Comparative Studies in Society and History, t. 6, 1963-1964, p. 76-83. More recently for north Africa see the case of the Sidi Lahcen near Sefrou studied by Rosen in GEERTZ-ROSEN, *op. cit.*, 33 ff.

Whatever the particular cause, the abuses of customary rights eventually destroyed the consensus upon which the system was founded and the *coloni* sought resolution from the government of the local municipality. Although all property holders were members of the municipality, there was a distinct division between the larger landowners who had sufficient wealth to enter the ruling *ordo* and those who remained ordinary members of the *populus* or *plebs*. In this case a common course of action was agreed to by both groups; an element of wider consensus was available in that the *coloni* and *decuriones* of Lamasba would have included a much larger group of farmers and landholders than those who owned land in the irrigation system itself. According to the decree, issued in the name of both the *coloni* and the *ordo*, the entire dispute was handed over to a commission or arbitrators (probably of three or more men) that was to investigate the whole question of distribution and to propose reforms [1]:

> [*Quaesita re per ..... et .....*] / *Valentinum, quibus ea*
> *res delegata est ex decreto ordinis et colonor* [*um* ---]

This bilateral action of the *coloni* and *decuriones* at Lamasba in search of the resolution of a local conflict is rather reminiscent of the co-operation between the same two elements in local communities elsewhere in North Africa, such as at Henshir Snobbûr where the *decuriones* and *possessores* sought mediation of a conflict over pastoral rights and the protection of farmers' fields from the depredations of herds of sheep. Certainly *coloni* are generally known to have acted in concert to obtain or promote common objectives [2]. Although the *possessores* and *ordo* at Henshir Snobbeur did refer to an imperial rescript on the matter of the depredations of grazing animals, they repeatedly sought resolution of the conflict within their community before finally having recourse to the provincial governor. Such seems to be the case at Lamasba. Hence, as one might expect, there was a tendency in these small communities to avoid contacting external authorities to render 'unbiased' judgements. Matters that directly threatened the basic social fabric of the town were kept within the confines of the community. If at all possible, outsiders were not to be involved in potentially explosive internal situations. The fears that motivated them to act in this manner are easy to understand: outsiders, though capable of rendering impartial decisions, might not fully understand local conditions or problems and might inadvertently trample on parochial sensibilities, or worse. Safer and better to keep such affairs within the community and not to let others know [3].

The peasant farmers (*coloni*) and the wealthier decurial class decided to hand arbitration of the dispute to a group of two or, more probably, three men. Yet apart from the imperial name at the head of the preamble, placed there for formulaic reasons, there is no mention of any external supervision by the provincial governor, his legates, an imperial procurator, or any other official. The commissioners, as far as can be deduced from the fact that Valentinus bears no title, were *privati* and were not acting in any higher official capacity [4]. Their supervisory function was a special mandate delegated to them by the local *ordo* and *coloni*. Unfortunately, there is no means of identifying Valentinus and his fellow commissioner(s) with any degree of certainty; it might be

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[1] If we are correct in conjecturing a total width of c. 6-7 columns for the whole stone, there would be c. 35-50 letters in the heading; accepting the phrase *quaesita per re* and the *et* leaves only c. 20-35 letter spaces that must include the *nomen-cognomen* of one commissioner plus the *nomen* of Valentinus. That would tend to indicate no more than three commissioners at the maximum.

[2] See SCHULTEN (A.), *Prozess wegen Weidefrevel (Afrikanische Inschrift)*, (in) *Festschrift zu Otto Hirschfelds sechzigstem Geburtstage*, Berlin, Weidmannsche Buchhandlung, 1903, p. 171-91 on the Henshir Snobbûr inscription; TOUTAIN (J.), *Nouvelles observations sur l'inscription d'Henchir Mettich*, R.H.D., t. 23, 1889, p. 155, on a comparison of the joint actions taken by *coloni* on imperial domains to the southwest of Carthage with those of the farmers at Lamasba; in general on the collective actions of *coloni*, *cultores*, and *possessores* see ESCURAC-DOISY (H. d'), *Notes sur le phénomène associatif dans le monde paysan à l'époque du Haut Empire*, Ant. Afr., t. 1, 1967, p. 59-71.

[3] Cf no. 1, p. 69; many examples could be cited for small village communities in Roman Africa, such as the reactions of the local power structure in the ecclesiastical quarrels in Cirta in the early fourth century (the so-called *Gesta apud Zenophilum*) and the elders of Nova Germania in similar church disputes. See my *The Elders of Christian Africa*, Cahiers des études anciennes, t. 14, 1982.

[4] See *D.E.*, 2.2, *Cura*, (1906) 1324.

noted that his name was not unknown in the community of Lamasba itself. It was borne by a proprietor who held at least two moderately sized plots in the irrigation scheme, Germanius Valentinus (nos. 39 and 62). The *Germanii*, the family to which he belonged, were one of the more important property holding groups, and had many plots affected by the irrigation system (nos. 40, 42, 57, 58; cf the analysis of family groups, p. 89, f. below). It is not inconceivable that one of the *Germanii* could have filled the position of mediator precisely because the economic position of the family itself was medial. Its members held average sized plots and could be looked to by the smallholders as representative of their interests -- at the same time their holdings were not so insignificant as to put them outside the realm of the concerns of the decurions.

3. Hydraulic Technology: the Operation of the Irrigation System

a) Introduction

The scheme proposed by the commission and accepted by the local *coloni* and *decuriones* was recorded in every detail on a large stone erected at Lamasba for all to see. The Lamasba irrigation decree, of which we now have a small part of the original, has acquired a permanent niche in the scholarly literature as an *exemplum* of a type, cited repeatedly, like the famous 'Maktar Harvester', as an illustration of a well known social and economic phenomenon. So perhaps it is ironic that precisely as with the 'Makter Harvester' no detailed studies have been made of its social or économic context, with the result that it has been exploited to 'prove' a wide range of even contradictory historical interpretations. On a more prosaic plane, the one study of its technical operation that has been made since de Pachtère's pioneering paper (1908), that by Jean Birebent (1964) lacks both a rigorous methodological approach and any substantial new insights [1]. A fresh, critical investigation of the social and economic dimensions of the inscription is required to clarify not only the technology employed, but also the relationship of the scheme to the society of which it was part.

TABLE 2

FORMAT OF THE IRRIGATION DECREE

MATTIVS FORTIS	K CCCViII EX H*I*D*VII*KAL*OCTOBR IN H VS*D*EIUSDEM P P S H IIIIS
Which can be resolved as follows :	
Name of proprietor :	Mattius Fortis
Size of property :	308 K(apita)
Time period :	ex h(ora) (prima) d(iei) (septimi) kal(endas) octobr(es) in h(oram) (quintum dimidiam) d(iei) eiusdem. (*i.e.*, from 1 P.M. on the 25th day of September until 5:30 P.M. on the same day)
Total time :	p(ro) p(arte) s(ua) h(orae) (quattuor et) s(emis) (*i.e.*, for his plot, a total of 4.5 hours)*

* Schmidt in *C.I.L.* suggested different readings, such as *p(ro) p(ortione) s(ua)*, but the meaning remains the same.

[1] For just some examples of references to the inscription in the general literature, see BOISSIER (G.), *L'Afrique romaine*, Paris, 1895 (9e éd., 1933), p. 140 ; HAYWOOD (R.M.), *Roman Africa*, (in) *An Economic Survey of Ancient Rome*, ed. T. Frank, vol. 4, Baltimore, Johns Hopkins University Press, 1938, 33 f.; SEMPLE (E.C.), *The Geography of the Mediterranean Region. Its Relation to Ancient History*, New York, Holt, 1931, p. 457; HERSCHEL (C.), *S. Frontinus: Two Books on the Water Supply of Ancient Rome*, Boston, Este, 1913, p. 169-70; WHITE (K.D.), *Roman Farming*, London, Thames and Hudson, 1970, p. 158; HEITLAND, *Agricola*, p. 293; and Glick, *Irrigation and Society*, p. 192-95.

Following the preamble, both the proprietors and the property included in the regulatory scheme are listed in several vertical columns (see figs. 1 and 2). Each entry follows a set format, listing in succession: 1) the name of the proprietor, 2) the size of his property, 3) the time of the day when the plot is watered, and 3) the total duration of time for which the plot receives water. The time period is also recorded according to a set formula: 1) the hour and day when watering begins, 2) the month, 3) the hour and day when the watering ends, and 4) the time is then repeated as the total number of hours to which the proprietor is entitled (see table 2).

b) The Source of the Water

In the preface to the first column (Col. I) of the inscription the water source is named as *Claudiana*, obviously signifying *Aqua Claudiana*. But what was *Aqua Claudiana?* Was it an aqueduct (*C.I.L.* eds.), a water storage dam and canal system (de Pachtère), or the whole ensemble of waterworks in the Lamasba region (Birebent)? And even if any one of these is the answer, what was the source of the water the system distributed? Although an aqueduct can be designated simply by the term *aqua*, the passage just referred to seems to exclude this possibility [1].

Ex vii kal. octobr. primo mane / quo Claudiane descendit matrice (m) rigan/da (m)

The words speak of *Claudiana* 'descending' into the principal irrigation channel and, as will be seen (p. 76 f. below) the terms *ascendere* and *descendere* are employed to described different types of *water*. But there are other arguments. Since the water is distributed continuously to one proprietor after another throughout the entire winter season, the possibility of precipitation alone providing the necessary water is ruled out. Rainfall in the region is far too erratic, even during the winter months, to guarantee a constant level of water predictable enough to be distributed in *time* rather than *volume* units [2]. The fact of distribution in time units by itself assures one aspect of the water regime: the output of the source must have been at a relatively *constant volume*. When this fact is combined with the type of distribution scheme outlined in the inscription, there is only one probable water source that is compatible with the evidence: a perennial spring. Division of water by time rather than by volume is typical only of artesian springs in the *tell* or of oases, both in modern times and in antiquity [3]. *Aqua Claudiana* is not, therefore, a direct reference to a dam or an aqueduct, but to the perennial spring that fed the system, in which case its identification is not difficult. Thousands of settlements in modern day North Africa have place names prefaced by the word *'aïn* (عين) or 'spring'. As has been pointed out above, the association of place name, settlement and perennial spring is no coincidence. In this case the Arabic toponymy succeeded an African place-name system that was expressed in Latin during the Roman period [4]. *Aqua*

[1] Cf *Aqua-Aquaeductus*, *D.E.*, I (1895) 537-65.

[2] The rainfall régime reported by F.G. de Pachtère (1908), p. 397-98 is still valid: c. 400-450 mm p.a., about 75-80 % of which falls in the winter months between October and April, in a typical continental pattern with highs in December (c. 12%) and March (c. 15%); cf Despois (J.), *Le Hodna (Algérie)*. Paris, 1953, p. 25-33. Climatic conditions in Roman times were probably more analogous to those of the present than to those of any intervening period, see Shaw (B.D.), *Climate, Environment and History: the Case of Roman North Africa*, chap. 15 (in) T.M.L. Wigley *et al.* eds., *Climate and History*. Cambridge, Cambridge University Press, 1981.

[3] Cf Kubitschek (W.), *Grundriss der antiken Zeitrechnung*. Munich, Beck, 1923, sect. 58, « Oasenuhr », p. 207-09.

[4] See the place names in Maier, *Episcopat*, p. 102-04, and Mesnage, *L'Afrique chrétienne*, p. 539.

Claudiana was, therefore, the one major spring close to which the irrigation system was found, the modern 'Aïn Merwâna [1]. This is the spring or *fons* upon which the whole system depended, and which is referred to in the latter part of the preamble (*constitit ita debere aquam decurrere, si quando fo [ns decurrit?]*).

Those like de Pachtère who have suggested a water reservoir or dam are compelled to admit that there is no archaeological evidence for such a grandiose construction, or indeed any logical place in the topography of the region where it could have been located [2]. This is not to say that a system of canals and basins trapping and distributing the spring waters did not exist; doubtless such a network *was* constructed and probable traces of it have been found [3]. Our purpose in specifying a spring as the source of the water is simply to make quite clear that we are not dealing with a large water reservoir or with the control of runoff waters, but with the distribution of waters from a source of relatively 'constant' output. Why were the spring and the attendant constructions called *Aqua Claudiana* while the town retained its African name of Lamasba? Probably because of the patronage of an important man who was officially active in the region. Mommsen not implausibly suggested the Severan grand marshal Tiberius Claudius Claudianus, of probable Cirtan origin and a known patron of towns in Africa [4]. There are, however, several other possible candidates, including some provincial governors [5].

c) The Irrigation Network

The waters flowing from the spring of 'Aïn Merwâna were distributed to each proprietor's land in strict sequential order. This mode of distribution suggests that each of the properties were adjacent to one another since the water passed *directly* from one property to the next *without any interruption* in the flow (except for the changes from one *scala* to the next as discussed below). From the spring the water flowed into the main feeder channel that ran through the entire irrigation system (Col. I.2: *Claudiana descendit ad matrice (m) riganda (m)*), and this main channel could be blocked at the end of each level or *scala* in the system (see further, below). The time allotted for the water to fill the channel for the first level or *scala* before it began to be distributed to the plots located on the stage was one hour (Col. I-3: *h(hora) (una)*, that is, from midnight, 24 September, until 1:00 A.M., 25 September). It seems that the properties were arranged in patterns along either side of the *matrix riganda* so that they had direct access to the water in it [6].

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[1] F.G. de Pachtère (1908), p. 376 reports that at the beginning of this century there were two major settlements in the region: Qsar Bellezma, the indigenous village in the middle of the plain some 6 km north of 'Aïn Merwâna, and the French colonial village of Corneille at the base of the mountain from which the spring flowed. 'Aïn Merwâna assured the irrigation of both settlements. He also notes that the French established a new irrigation law to replace the local customary practive of distributing the waters, and that this new law resembled the ancient 'Roman' one almost point by point. In spite of this similarity, de Pachtère continued to reject the identification of *Aqua Claudiana* with 'Aïn Merwâna. Croignet (J.), *L'hydraulique agricole à l'époque romaine en Tunisie*. Tunisie agricole, 1925, p. 76-82, at 80: « Notons, en passant, qu'à Lamasba, qui se nomme aujourd'hui Bellezma, près du village de Corneille, la même procédure préside à la répartition de l'eau de « l'Aïn-Meruana » entre soixante colons qui l'utilisent pour arroser une centaine d'hectares ».

[2] So Pachtère (1908), p. 388, and Birebent, *Aquae Romanae*, p. 390.

[3] For traces of the canal systems see Birebent, *Aquae Romanae*, p. 398: to the west of the road to Qsar Bellezma where small parallel wadis flow east-northeast. There are large channels leaving Corneille in the direction of Qsar Bellezma. A large masonry channel (0.80 m wide × 1.05 m high) was reported to Birebent and he believed this to be the *matrix riganda*; cf Pachtère (1908), p. 388.

[4] *C.*, p. 1780; cf *Prosopographia Imperii Romani*², C. 834 (*C.*, 7977 = *I.L.S.*, 1146, and 7978 = *I.L.S.*, 1147, Rusicade; *C.*, 5349 = *I.L.Alg.*, I.1, 279, Calama).

[5] See Thomasson (B.E.), *Die Statthalter der römischen Provinzen Nordafrikas von Augustus bis Diocletianus*, 2 vols., Lund, Gleerup, 1960, II, p. 193, 202-03, 261.

[6] On *matrix* see *Thesaurus) L(inguae) L(atinae)*, 8 (1966), 481-82, at 482.66 f. *(de fistula aquaeductus)*, cf Paul.Nol. *Carm.* 21.807 and *C.Th.*, 15.2.5 = *C.J.*, 11.43 *(De Aquaeductu)* 3, for the use of the term to denote 'master' or 'main' channel of an aqueduct. Cf the *matrix publica* in Africa (*C.*, 6948).

As has just been stated, the *matrix riganda* or main irrigation channel, and extensions of it, passed directly through a number of stages or *scalae* [1]. There are at least four of these descending levels or steps attested directly in the irrigation inscription, but undoubtedly the system itself had about twice that number. A further piece of information about the *scalae* can be derived from the exception to the standard format of entry for each proprietor and his land that occurs at the head of each *scala* on the inscription. This space records the special additional one hour period during which the irrigation channel for that particular *scala* was filled *before* the water began to be distributed to each of the plots on that level [2]. This one hour period set aside for the filling of the channel is specified at the head of Col. I, and can be computed for *scala III* from the time allotted to the first property holder for that level, Aemilius Secundus. He was given a total time of 35.5 hours to irrigate his land. In this case he should have possessed 2366.6 K of land, which he does not. However, if the one hour for the filling up of the main channel of *scala III* is subtracted, he is left with 34.5 hours for his own purposes and should then possess 2300 K, which is precisely the amount of land recorded on the stone [3]. The final line in the entry under Aemilius Secundus' name indicates that the water was indeed then passing into the subsection of the main irrigation channel: ...inibi a[b matrice] / rigand(a). From these facts, the following may be deduced:

1. that the *scalae* were real territorial units separated from one another but following in sequence as listed on the stone,

2. that the properties within each *scala* were contiguous with one another in descending order, arranged about a principal irrigation channel that crossed each *scala*: this channel was filled with water before the distribution of waters within each *scala* began, and

3. that, as is clear from the fact that *scala III* had an hour set aside to fill it alone, each *scala* had its own irrigation channel that was blocked at the end of the *scala*. One hour was set aside to fill this channel, and the water was not allowed to pass on to succeeding *scalae* (IV, V, VI, etc.).

The same procedure was followed for all the *scalae*. Thus the overall picture of the system is one of a series of descending steps or terraces, each with its own irrigation channel ultimately tapping the waters of 'Aïn Merwâna [4].

This mode of tapping water from irrigation channels in time units, with adjacent plots located along the main canal, is illustrated by an analogous scheme recorded or an inscription discovered near the church of *Santa Maria in Aventino* (Rome) that displayed the names of the proprietors, irrigation times, and a schematic representation of the irrigation system [5].

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[1] DESSAU, *I.L.S.*, p. 427 was confused, « scalae vocabulum obscurum', but unnecessarily: cf the place in Numidia called *Scalae Veteres* (Σκάλαι Βέτερες), Procop. *Bell. Vand.* 4.17.3.

[2] This is even apparent on the inscription where the times of watering are missing, as in the case of Lollia Mustia (Col. IV.19) where her name is followed by the space for three lines as opposed to the usual two.

[3] That is, 35.5 H (/k^{d}) = 2366.6 K whereas 34.5 H (/k^{d}) = 2300 K.

[4] The whole phrase at the head of Col. I.1 is *ad matrice(m) riganda(m)*. The editors of the *Corpus* argued that the *scalae* were placed arbitrarily at one month intervals and that their watering began each month on the basis of a one month interval from the beginning of the irrigation scheme (*i.e.*, scala I, vii kal. oct. and scala III (?) ,vii kal. nov.). But this is merely a coincidence. They did not know that the scala beginning on vii kal. nov. was in fact *scala* III so that *scala* II must begin sometime in early October in a lost portion of Col. I. Additionally, vii kal. dec. (Col. III.21) does *not* mark the beginning of a new *scala*. In any event, the changes from *AqA* to *AqD* which are chronologically periodic do *not* coincide with the changes in *scalae*.

[5] *C.*, VI, 1261 (the original location of the stone is unknown; Fabretti saw it in the gardens of the Church, but it had been brought there from some other place), cf HERSCHEL (1913) 168 and MOMMSEN (T.), *Romische Urkunden, I: Edict Augustus über die Wasserleitung von Venafro*, Zeitschrift für geschichtliche Rechtswissenschaft, t. 15, 3, 1850, p. 287-326 = *Gesammelte Schriften*, 3, Berlin, 1907, p. 75-97, at 87 f.; see *C.*, p. 448.

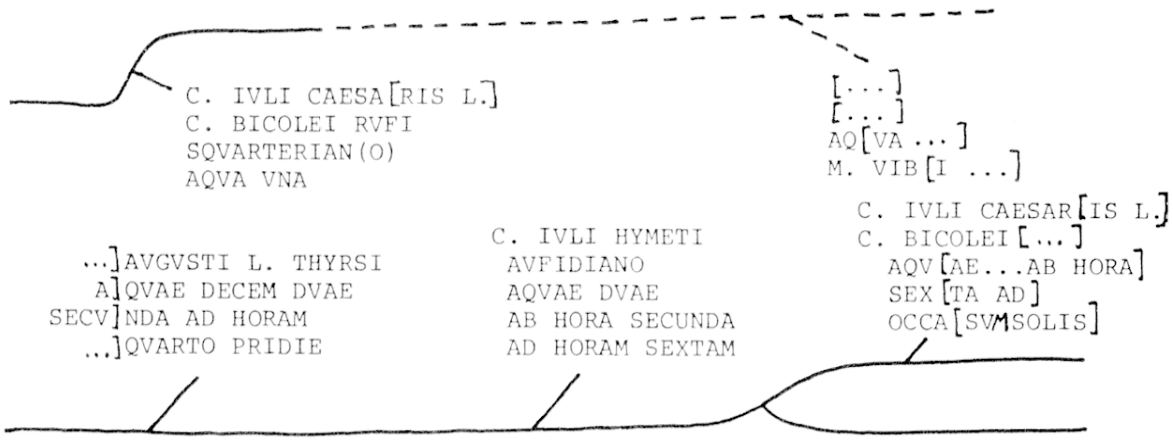

FIG. 3. — The Water Distribution Scheme of the S. Maria in Aventino Inscription.

As a passage from Frontinus and references in the legal codes make clear, the time mode of division represented in this scheme was the normal means of distribution rural irrigation waters. Twelve miles from Rome, near the intake of the *Aqua Iulia et Tepula* built by Agrippa in 33 B.C., flowed a stream called Crabra that watered land near Tusculum [1]:

Praeter caput Iuliae transfluit quae vocatur Crabra... Agrippa ...Tusculanis possessoribus reliquendam credebat; ea namque est quam omnes villae tractus eius per vicem in dies modulosque certos dispensatam accipiunt.

The scheme represented on the diagram above gives: 1) the name of the cultivator in the genitive, 2) the name of the property, 3) the number of water channels leading on to the property (*e.g., aqua una, duae, decem*), and 4) the *time* of water allotted to each plot (*e.g., ab hora secunda ad horam sextam*, a total of hour hours). This type of division of water into time units, dependant on a constant water source, was typical of northern Mediterranean lands and Italy in particular [2]. As the phrase *ad occasum solis* suggests, the watering regime appears to have reached a turning point with the arrival of night. The law codes and the Lamasba decree draw a strict distinction between 'day' and 'night' water régimes, presumably because of the different modes of measuring the *time* units [3]. And, on the schematic diagram, as at Lamasba, the owners receiving irrigation waters are contiguous to one another along the irrigation channels.

A similar inscription was discovered at the church of *San Pietro Fuori le Mure* at Tivoli. The stone, already in bad condition at the time of its discovery, is now lost and and its contents are only known from written copies made before its disappearance. The inscription confirms the same mode of water distribution with the added fact that the size of the openings in the sluice gates (*foramina*) leading from the main aqueduct to each property is measured in digital units. Otherwise the division is in terms of hours with day and night being

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[1] Frontinus, *de Aq.* 1.9.

[2] *E.g., D.*, 39.3.17.pr (Paulus), and *D.*, 43.20.5.pr.-1 (Iulianus):

Cum constet non solum temporibus sed etiam mensuris posses aquam dividi, potest eodem tempore alius cottidianus, alius aestivam aquam ducere, ita ut aestate dividatur inter eos aqua, hieme solus ducat is qui cottidianae ius habeat. 1. Inter duos, qui eodem rivo quam certis horis separatim ducebant, convenit, ut permutatis inter se temporibus aqua uterentur.

On the distinction between *aqua aestiva* and *aqua cottidiana*, see MOMMSEN (1850), p. 307 = (1907), p. 87.

[3] *D.*, 43.20.2.1 (Pomponius): *Si diurnarum aut nocturnarum horarum aquae ductum habeam, non possum alia hora ducere, quam ius habeam ducendi.*

distinguished [1]. The same scheme detailed on the Lamasba inscription conforms to the mode of distribution of these two Italian systems except that multiple taps (*fistulae*) off the main irrigation channel are not mentioned, nor are any of the sluice gates (*foramina*) off the main channel measured in terms of height. At Lamasba the tap channels off the *matrix riganda* were probably single and of uniform size so that each owner was receiving the same volume of water as his neighbour. The Italian schemes appear to have been more flexible in this respect. The *scalae* recorded on the Lamasba stone are definitely located at succeeding height levels, though their precise arrangement is unknown. That is to say, *scalae* II and III are subordinate to I, but *may* have been parallel to each other as in the diagrammatic representation on the Aventine inscription. The *impression,* however, is of one continuous irrigation channel running through all the scalae in succession (that is, accepting that *matrix rigenda* is referred to at the beginning of scala III on the inscription). If this is so, the *scalae* recorded on the stone bear a close resemblance to the 'steps' of wadi-terrace schemes of irrigation, although both the water source and the location of the system rule out the wadi flood-zone type of adaptation of this system which is the best known and most studied variation of the type. Rather, the *scalae* would appear to have been a series of stepped terraces along W. Merwâna in which wadi flood waters, hillside runoff, and direct precipitation (all the result of winter rainfall) were utilized in addition to the permanent supply from the spring itself. From the arrangement of the *scalae* on the stone, one can deduce that terrace I was nearest the spring and succeeding terraces were contiguous to one another in descending order, each one being further away from the spring along W. Merwâna and northward in the direction of Qsar Bellezma.

If we accept provisionnaly the hypothetical area covered by each unit of property (K = ca. .01) *iugerum,* see pp. 87 ff. below), a very approximate idea of the size of the terraces might be gained.

TABLE 3

SIZE AND NUMBER OF THE SCALAE

Total property on surviving part of Col. I	=	c. 4 500 K
on missing part of Col. I (see Table 2)	=	c. 32 000 K
Total Col. I	=	c. 36 500 K
plus remainder of property on *scala II* in Col. II	=	c. 7 500 K
Total property in *scalae* I and II	=	c. 44 000 K

If one were to postulate an approximate area per *scala* of c. 20-25 000 K, this would mean that each *scala* would account for c. 200-250 *iugera* and given that the total area under irrigation was 126 000 K (see Table 7), the total land irrigated by the scheme would be in the range of 1 300 *iugera* (that is, ca. 810-820 acres or ca. 325 hectares). That, in turn, indicates a series of six to seven *scalae* in the system. On this basis the unidentified *scala* appearing in the preserved part of Col. IV is probably *scala* 5 or 6.

d) The Water Régimes

The operation of the Lamasba irrigation system (*i.e.,* the network of terraces and canals) would be fairly simple to understand *if* the flow of water through it in terms of time and area units was constant. But unfortunately it was not, and therein arises one of the more difficult and persistently insoluble problems bedevilling any interpretation of the organization of the irrigation scheme. The water flowing in the irrigation

[1] *C.*, XIV, 3676 (Tivoli) in the churchyard of S. Pietro. The stone has disappeared since its discovery at Tivoli. The edition in the *Corpus* is based on the collation of six mss. readings of the stone. Cf MOMMSEN (1850) 309-10 = (1907) 88; *C.*, p. 488 and HERSCHEL (1913) 168-69.

channels was of two distinct types, specified on the inscription as either *aqua descendens* (henceforth *AqD*) or *aqua ascendens* (henceforth *AqA*). At first glance, the meaning of each term seems self-evident; *aqua descendens* would seem to refer to water flowing downslope under the natural force of gravity, whereas *aqua ascendens* would seem to designate water which somehow 'ascends' to higher ground. Without careful investigation of the details of the function of these two different types of water, commentators, have been led quite naturally to the assumption that *AqA must* imply the use of some sort of mechanical lifting device such as the *shadūf*[1]. This hypothesis, however, should have been suspected on two counts. First, any survey of the indigenous rural irrigation systems known from the Maghrib would readily show that any mechanical systems for raising water are confined to very limited types of environment where they make economic sense (*e.g.*, in the intensively cultivated garden plots of oases), and that even in these cases such devices are relatively rare, being employed in subsidiary roles to the principal distributional mechanics of the irrigation system. Secondly, the manpower hours required to operate such mechanical systems in non-riverine regions where fields are large and widespread is entirely disproportionate to the return in produce. Simpler, more efficient gravitational means must be employed. The hypothesis of mechanical devices as an explanation of *AqA*, however, is most improbable once it is seen that *aqua ascendens* refers to a *water type* alone and not to any lifting machine as such. Let us first consider the periodicity of change from one water regime to the other.

TABLE 4

THE PERIODICITY OF AQA AND AQD

No.	*Water Type*	*Time duration*	*Period in days*
1.	AqD	vii kal. oct. (25 Sept.) to at least v kal. oct. (27 Sept.)	
2.	AqD	(unknown) to xiv kal. nov. (19 Oct.)	
3.	AqA	xiii kal. nov. (20 oct.) to ix kal. nov. (24 Oct.)	5
4.	AqD	viii kal. nov. (25 Oct.) to at least v kal. nov. (28 Oct.)	
5.	AqA	xiii kal. dec. (19 Nov.) to ix kal. dec. (23 Nov.)	5
6.	AqD	viii kal. dec. (24 Nov.) to iii non. dec. (3 Dec.)	10
7.	AqA	prid. non. dec. (4 Dec.) to (unknown)	

From this chart it seems reasonably certain that *AqA* begins on *xiii kal.* of each month and that *AqD* begins on *vii/viii kal.* of each month. That such periods were regular seems to be substantiated by the calculation that the two periods of known *AqA* (nos. 3 and 5) both had durations of *precisely five days* (*i.e.*, exactly 120 hours each). It might be hypothesized that the other *AqA* period beginning on *prid.non.* (no. 7) also lasted five days and that there existed two such periods of *AqA* within each month. Two of the periods of *AqD*, on the other hand, begin on the *viii kal.* (nos. 4 and 6), and one of these (no. 6) lasted precisely ten days (*i.e.*, exactly 240 hours). The scheme that now emerges is too well ordered to be coincidental; considering that most months were of 30 days duration the following pattern of alternating regimes of *AqA* and *AqD* logically suggests itself.

[1] See WHITE, *Roman Farming*, 158; HEITLAND, *Agricola*, 293 and no. 3, p. 79. For an introduction to such devices see WHITE (K.D.), *Farm Equipment of the Roman World*. Cambridge, Cambridge University Press, 1975, chap. 6, « Water raising devices », p. 44-48.

AqA: 5 days *AqD*: 10 days *AqA*: 5 days *AqD*: 10 days

for total of thirty days. Given the know perimetres in Table 4, the actual sequential succession of the two water regimes might now be suggested in Roman calendrical terms (*i.e.*, those actually used on the irrigation inscription):

ROMAN DATE	v idus	xiii kal.	viii kal.	kal.
WATER REGIME	⊢ *AqD*	⊢ *AqA*	⊢ *AqD*	
MODERN DATE	9/11	19/20	24/25	
ROMAN DATE	prid. non.	v idus	idus	
WATER REGIME	⊢ *AqA*	⊢ *AqD*	etc.	
MODERN DATE	4/6	9/11		

Hence, the water regimes are purely arbitrary, switching from one to the other at set calendrical dates.

But what were the real effective differences between the two systems of water distribution? As might be expected from its name, *AqA* was of lower output, and the consequence of this can be assessed from the relatively greater time period that it took to water plots of the same size with its waters as opposed to those of *AqD*.

TABLE 5

COMPARISON OF WATER REQUIREMENTS OF AQA AND AQD FOR SIMILAR-SIZED PLOTS

Plot No. (Chart I)	*Size Area in K*	*Water Regime*	*Time Hours (h)*	*% AqA to AqD*
25	300 K	AqA	7 h	64 %
26	308 K	AqD	4.5 h	
28	340 K	AqA	8 h	63 %
29	250 K	AqD	5 h	
30	360 K	AqA	8.5 h	65 %
31	360 K	AqA	5.5 h	
36	406 K	AqA	9.5 h	63 %
35	400 K	AqD	6 h	

Thus the time of *AqA* required to water the same-sized plot as *AqD* is comparably greater (in the ratio of approximately 8:5 or 0.63-0.65 of *AqA* to *AqD*) in order to compensate for the more feeble output of *AqA*. The differential can be calculated more precisely by determining the time allotted (*t* = *tempora*) in terms of the total number of hours required by each plot (*h* = *horae*) as a ratio of the total area of the plot (K, see p. 82 f. below). If this ratio is calculated for all plots watered by *AqD* the result is too consistent to be fortuitous; in fact it appears to be a relatively constant value of t = .015 *h* per K (hereafter k^d). If the same calculation is made for all properties watered by *AqA* the same type of result is obtained, a relative constant of *t* = .024 *h* per K (hereafter k^a) [1]. In short, each unit of property (K) was allotted a set amount of time (*t*) that was constant for either water regime

[1] These coefficients can be established and are repeatedly validated by application, and vitiate the exceedingly complex system developed by PACHTÈRE (1908) 389-90 (cf 390-94) and BRULÉ (G.), *Impossibilité d'établir deux barèmes à chiffre unique pour l'eau descendante et pour l'eau montante*. M.E.F.R., t. 28, 1908, p. 401-05, since the latter is based on the assumption of the water régime being in constant change, which is not true: see our Charts II and III. These results invalidate the approach followed by PACHTÈRE (1908) I and II (p. 390-93) and the types of charts produced by the editors of the *Corpus* (*tabula* A and B) p. 1782 = *Eph. epigr.*, VII, p. 258-59. More accurate measures are obtained, and some of the problems created by their systems (*e.g.*, the troubles encountered at *C.*, p. 1782 notes and *Eph. epigr.*, VII, p. 259 notes) are simply avoided.

(either k^a or k^d). The total time (h) for each plot could be obtained by multiplying this constant time by the total number of land units (K) in the property. This time was then expressed in units of time no smaller than the smallest time unit in which water was measured, the half hour. Since the type of water regime can be deduced from the periodicity of the system, it is possible to calculate the number of units of land area (K) whenever this number is missing from the irrigation inscription, as long as the total watering time (h) of the property is known (see Chart I).

More importantly, an allotment of only .015 or .024 h per K seems to indicate that the output of the source was rather considerable since this allows only about 1-1.5 minutes of irrigation water per land unit (54 seconds *AqD* and 86.4 seconds *AqA* in ideal time measurement). Of course, because the smallest unit of time measurement was the half hour there is a lower limit of applicability for each constant and hence a range of K necessary for each time unit. The basic unit of K watered by *AqA* was (.5 k^a) 21 K, whereas the same unit for *AqD* was (.5 k^d) 33 K, again illustrating the basic differential between the two water regimes.

The arbitrary system of the water types can now be illustrated with even greater accuracy. There are four properties at the juncture of the change from one water regime to the other, so that the plot was first irrigated with some water of one type and then some of the other type. As noted above, each regime extended over a set number of days, five for *AqA* and ten for *AqD*. Given the degree of arbitrariness in the water regimes, it seems a probable hypothesis that the shift from one type to the other might have taken place precisely at midnight of the day concerned [1]. If this hypothesis is true, the calculation of the different times of *AqA and AqD* for the same property, multiplied by their respective coefficients should yield the total number of K or property units known for these particular plots (with the important caveat that a range of variation must be allowed for the basic half-hour watering period; see table 6).

This text further demonstrates that the change was completely arbitrary, taking place precisely at midnight between the two days concerned [2]. The following can then be deduced about the mechanisms of *AqA* ans *AqD*:

1. The source of the water was of rather constant output with irrigation based on a strict time-unit division.

2. The volume output of both water regimes was constant.

3. The above factors rule out the possibility of the fluctuation being due to chance or sporadic changes in the spring itself since a natural flow would hardly shift at such constant rates and at such regular periodic intervals.

4. Equally, the shift from one regime to another has nothing to do with the *scalae* since the periodicity completely ignores the shift from one *scala* to the next. The succession of water regimes is absolutely continuous and even straddles contiguous *scalae* [3].

5. These factors virtually exclude the presence of mechanical devices in the *scalae* or in the *matrix riganda* itself, and point back to some artificial regulatory device near the spring itself. Most probably, given known parallels from the modern day Maghrib, this would have been some type of *captage* basin system.

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[1] Dessau, *I.L.S.*, p. 427 objected that the system of 'day and night' hours did *not* begin at midnight since the preamble to Col. I reads. *scala I: ex vii kal. octobr. primo mane....* and hence, *apparet non a media nocte computatum esse diem usque ad medium sequentem, sed a luce oriente ad alteram.* But *mane* need not be pressed to mean 'morning' in such a literal sense:if it did have this meaning, there would be an obvious conflict between day-night hour periods and calendrical days that is nowhere apparent in the inscription.

[2] A control on this method is to attempt other time divisions of the *AqA-AqD* for properties with 'mixed' watering régimes. They do not provide the same precision of results as those calculated in my charts, cf the method of Pachiere (1908), p. 392-94.

[3] Hence it is not possible to accept the convenient explanation of Schmidt, *Eph. epigr.* VII, p. 257 (= *C.*, p. 1781): *...haec descensionis ascensionisque vicissitudo eo videtur facillime posse explicari, quod fonte in mediis fere agris sito, quibus aquam largiebatur, cum ii essent acclives inaequalibilesve...* ». Nor his conclusion that machines were employed: « *Enimvero ad luca inferiora cum certe ex ipso fonte protenus deflueret, ad superiora machina nescio qua in receptaculum levata tubis erat ducenda....* and the plan thereby adduced of *agri acclives* and *declives* (*C.*, p. 1782). Unfortunately, the idea of a mechanical lifting device and of upper and lower fields had now become enshrined in the literature, see no. 1, p. 77.

TABLE 6

PROPERTY UNITS PREDICTED FOR PLOTS OF MIXED IRRIGATION REGIMES

1. *The Heirs of Manilius Rogatus* (no. 65)			
known property size :			790 K
total irrigation time :	(*AqD* then *AqA*)		16.5 h
shift to take place on midnight xiv - xiii kal. nov.			
if so :	*AqA* = 4 h and *AqD* = 12.5 h		
property watered with	*AqD* (4/k^d)	= 267 K	
with	*AqA* (12.5/k^a)	= 521 K	
	Total	= 788 K	
2. *Germania Castula* (no. 67)			
known property size :			803 K
total irrigation time :	(*AqA* then *AqD*)		17 h
shift to take place on midnight ix - viii kal. nov.			
if so :	*AqA* = 14 h and *AqD* = 3 h		
property watered with	*AqA* (14/k^a)	= 583 K	
with	*AqD* (3/k^d)	= 200 K	
	Total	= 783 K	
3. *Unknown Proprietor* (no. 61)			
known property size :			660 K
total irrigation time :	(*AqA* then *AqD*)		10.5 h
shift to take place on midnight ix - viii kal. dec.			
if so :	*AqA* = 2 h and *AqD* = 8.5 h		
property watered with	*AqA* (2/k^a)	= 83 K	
with	*AqD* (8.5/k^d)	= 567 K	
	Total	= 650 K	
4. *Unknown Proprietor* (no. 85)			
known property size :			4 000 K
total irrigation time :	(*AqD* then *AqA*)		71.5 h
shift to take place at midnight xiv - xiii kal. dec.			
if so :	*AqD* = 40.5 h and *AqA* = 31 h		
property watered with	*AqD* (40.5/k^d)	= 2 700 K	
with	*AqA* (31/k^a)	= 1 292 K	
	Total	= 3 992 K	

All the above predicted totals are within the minimum range of variability (25 K) for *AqA* and *AqD* based on the half-hour watering period.

The conclusion reached in point five is also substantiated by the archaeology of waterworks in Roman North Africa. In most of the irrigation systems based on spring waters, there is either a collection basin or derivation system near the spring itself, with sluice gates that could be partially closed for two five-day periods each month thus reducing the output of the waters from the collection basin by a constant amount. Why this procedure was followed one can only guess. One reason might be to conserve spring water to control excessive exploitation of a limited resource. Another alternative is that the settlement of Lamasba also depended for its water supply on the spring, and so the spring had to be tapped for storage water for the town periodically, perhaps via the mechanism of a subsidiary channel to storage basins near Lamasba itself.

Thus *aqua ascendens* and *aqua descendens were names for the two arbitrary types of irrigation waters in the matrix rigenda*, so divided for the purposes of calculating exact proprietory claims on the water itself. The

Africans viewed the water itself as property, divisible into precise time units to be allotted to each proprietor and 'owned' by him. This much is also attested by the so-called *Tablettes Albertini* which detail property transactions in a similar irrigation scheme in a region to the east of Lamasba, some two and a half centuries later. Consider tablet 6B (13 January 494) which records the sale of a number of 'Mancian' plots under the dominium of one Flavius Geminius Catullinus [1]:

...particellas agrorum id est au/mae duas sivi coerentes cum aquaria de gemione / superiore in quibus sunt amigdale arb(ore)s tres, fici / ar(b)ores quatuor pl(us) mi(inus) siteciae arborem unam / cum aquaria de flumine ascendente, hac die.

Iulius Restitutus and his wife Donata, the vendors, are selling two contiguous terrace plots (*particellas agrorum, id est aumas sivi coerentes*). The document of sale specifies the water rights that are part of this property, that is, the irrigation waters that descend from the terrace above that on which the plots of the vendor are located (*cum aquaria de gemione superiore*). The terrace plots are typically planted with arboreal crops: almonds, figs, and one pistachio. Also specified is the *water type* which is attached as property to the plot (*cum aquaria de flumine ascendente*). Here, in a region over 250 kilometres from Lamasba and removed by more than two and a half centuries in time, is found exactly the same irrigation terminology embedded in a series of property transactions; the *flumen ascendens* is, of course, none other than our *aqua ascendens*.

4. Property and Proprietors: Land, Water, and Social Organization

The surviving fragments of the Lamasba irrigation decree preserve information on the extent of property of 85 irrigation plots [2]. What portion this number is of the total number originally recorded on the stone can only be estimated. If one makes the reasonable assumption that the same property received one spring as well as one winter allotment of water, then the 85 known plots represent about half the total property in the irrigation scheme.

TABLE 7

TOTAL AMOUNT OF PROPERTY IRRIGATED AT LAMASBA

On the assumption of a winter irrigation regime of six monthes duration :		
6 (months) × (5 × 2 = *AqA* per month)	= 60 days *AqA*	
	= 1 440 h (/k^a)	= 60 000 K
6 (months) × (10 × 2 = *AqD* per month)	120 days *AqD*	
	= 2 880 h (/k^d)	= 192 000 K
	total property area irrigated	= 252 000 K

The total amount of property recorded on the existing fragments of the inscription is ca. 53.000 K. From this figure and the total calculated in Table 7, one can deduce that the fragments represent approximately one-fifth of the total property irrigated by the Lamasba system. However, if we return to our original supposition that each property probably received two waterings during the winter, the total property receiving irrigation would actually be half the amount in Table 7 (i.e., 126.000 K) and our surviving total is about 40% of this figure. Of course, there were larger and smaller properties that are not known in the missing portions of the stone. For example, in

[1] COURTOIS (C.), *et al.*, *Tablettes Albertini: actes privés de l'époque vandale (fin du V^e siècle)*. Paris, 1955, 223 = ALBERTINI (E.), J.S., 1930, p. 25-26; FIEBERGER-SCHMIDT, *Inschriftsammlung*, no. 9, and *FIRA*, III, no. 139.

[2] See Chart I. The bare details of a further number of properties can be discerned on the fragmented lower edge of the stone (to a maximum of 91), but the area of only 85 properties can be recovered and so this is accepted as the maximum (practical) number with which we shall be dealing.

the upper third of Col. I which is preserved the total property amounts to ca. 4.500 K, whereas in the missing lower two-thirds there was ca. 32.000 K. Given that the size of stone is a constant, the average property size in the missing portion of the column must be larger than in the preserved fragment. Still, the overall variation would tend to average over the whole stone, and there is a satisfactory range of property sizes in the existing columns (representing some 40% of the original plots) to give some confidence in the sample being 'representative' if not statistically valid.

a) The Nature of the Property Holdings

Each proprietor is listed on the stone according to the following format:

MATTIVS FORTIS K CCCVIII (followed by the water time allotted to him)

The 'K' obviously represents the property to be irrigated (in the example of Mattius Fortis, 308 K) and the water granted to the proprietor is always in direct proportion to the amount of property he holds. In this case, the 'K' represents a *land area*... but what precisely does the 'K' mean and what sort of land unit or measurement does it stand for? Mommsen conjectured that 'K' stood for *kaput* (*caput*) and that the figure represented the number of *capita* or value-units possessed by each proprietor. But this measure, associated with the census of the later Roman Empire, does not appear in Africa until the time of Diocletian [1]. Nonetheless, de Pachtère clung to the idea that 'K' could not represent a surface area since, according to his calculations, the rate at which water was dispensed to the individual proprietors varied markedly over twelve hour periods *and* according to the different size of the property. His calculations, however, are demonstrably in error since we have shown that the output of water within each régime is constant and quite predictable in rate. So there is no need to claim, as de Pachtère does, that 'K' *must* be 'value' rather than area, because otherwise certain proprietors would be cheated of their due amount of water [2]. To understand the problem as he saw it, consider properties nos. 2 and 7 on Chart I. They vary from 100 to 120 K and yet both receive the same amount of water time, that is, 1.5 hours. De Pachtère claimed that the man with 120 units is being 'cheated' because he receives the same amount of water as a man who has much less property. To overcome this problem de Pachtère postulated that 'K' meant a 'value unit' so that 100 and 120 K could in fact be the same land area (but different in their productive worth). Aside from the inherent difficulties in this solution (e.g., the apparent fineness of the units of assessment), there are other basic objections. Firstly, the standard time unit for irrigation was the half hour, so there already exists a marked range of variation in the number of 'K' that could be irrigated, *even if 'K' was a value unit.* Additionally, value assessment would be too controversial a base to use for distributing irrigation waters: the standard must be concrete, measurable, and 'visible' for all to understand. Even if the latter conditions are met disputes still erupt, but to exacerbate the problem by accepting a criterion as problematical and subjective as appraised value would be to invite disaster in such finely balanced systems. Then again, there is no obvious correlation between 'value' and the water requirements of a given plot of land; any selection of comparative date shows that it is nonsensical to believe that such a system could function. In fact, one would expect the opposite correlation: the more favourably positioned and more highly productive a plot of land, the less would be its absolute water

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[1] MOMMSEN, *Eph. epigr.* VII. 256 (and *C.*, p. 1781), citing *C.Th.*, 11.20.6 (A.D. 430), though his actual statements have, to a certain extent, been misrepresented by subsequent commentators. What he actually said was: *Postquam allae locum fecerunt oleis, extra dubium est K litteram significare* kaput. He then points out that *kaput* was *later* used as a land measurement for taxation purposes: *...et componitur caput cum olea plane ut in formis Therae et Astypalaeae* ζυγόν *cum* γυρῷ, *id est scrobe*... He then thought that it was *not* applicable in Africa since the technical use of word is not attested there, but thought that it might be connected with centuriation.

[2] PACHTÈRE (1908) p. 396, no. 1. The calculations which he does to show the variation in the number of units watered per hour in variation according to different set time periods (p. 389-90) are simply in error because he has approached the problem by *first* accepting the margins of half-hour units (*i.e.*, our 21 and 33 K range of variation) as *blocks of K units* which he *then* divides into the total number of K to obtain the time/unit measurement for each property. If the operation is properly conducted first to ascertain k^a and k^d, then these function perfectly well for all properties and all water régimes, even those of mixed irrigation (given the half-hour variation). Hence it is a non-problem created by de Pachtère's bad methodology. See BIREBENT, *Aquae Romanae*, p. 397 for a similarly mistaken formulation.

requirements. Hence virtually all types of irrigation systems correlate water distribution with the amount of land owned in terms of surface area [1]. De Patchère, however, did draw attention to a central problem in these calculations at Lamasba, namely, that the basic measuring unit of one half hour did mean that there would be slight inequities of distribution, especially for small holders, since one owner might have up to 33 K more than another and still receive the same time allotment of water. Perhaps it was some matter such as this, a major problem for small holders but only a minor irritation to the large land owners, that sparked the dispute at Lamasba. For example, if the pre-redaction time units had been one hour instead of one-half hour, the resulting disparity of up to 65 K would have placed a severe strain on some of the smaller plots.

The 'K' must represent, if only indirectly, the physical area size of the holding. Many possibilities come to mind. It could be a local customary measure not known to us from any other documents. Many such purely regional systems of land measurement existed that were connected with regionally specific types of land exploitation, as for example the Egyptian standards that were related to the riverine irrigation systems found in that country alone. There is a closer parallel to Lamasba found in the papyri from Nissanah in the north-central Negev. These records dating to 512-590 record in detail land transactions of wadi terrace plots in the arid zone of southern Palestine. One document, dated 26 November 569, mentions a unit of 5 *kabiaiai* (καβιαῖαι). Before the publication of the Nissanah papyri the term was known only in the singular (καβιεῖον) from Syriac documents. Apparently, the καβιεῖον was an *area* of land which could be sown by one *kab* (four *sextarii)* of grain. This is but one example of an arid zone land measurement limited to one regional context [2]. The 'K' at Lamasba could be something similar, like the unique African measurement for land in oases reported by the Elder Pliny at Tacape... a unit of 16 square cubits, where even the cubit was 'not standard' [3]. The main significance of the example from the Negev is that it demonstrates the way in which a land measurement could be made indirectly. As was noted above, the distribution of waters at Lamasba probably covered the winter season and thus suggests a concern with particular types of crops. Probably they included winter cereals, principally hard wheats and barley, but undoubtedly *the* characteristic plants of all terrace schemes of this type (compare Nissanah and the *Tablettes Albertini* for antiquity) were xerophytic arboreal species, notably the olive, fig and vine, and, of lesser importance, the almond and other fruit bearing trees. These must have been an important part of the economy of the Lamasba *coloni;* prolific archaeological remains of olive presses and mills attest this and the text of the decree itself confirms it [4].

If we accept that the terraces were planted with trees, then a clear answer to many of the problems with the inscription emerges from known traditional North African arid zone farming practices. In the Tunisian Sahel, for example, irrigation is carried on under analogous meteorological and soil conditions. In this region, each olive tree and the land around it constitutes a single irrigation unit, even though other cereal crops such as wheat

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[1] A principle also enshrined in Roman law, see *D.*, 8.3.17 and 8.3.25.

[2] See Kraemer (C.J.), *Excavations at Nessana*, vol. 3: *Non-Literary Papyri*. Princeton, Princeton University Press, 1958, p. 79, no. 24: one καβιαῖον = 0.0866 *iugera*, a rather small land area. Cf Dean (J.E.), *Epiphanius' Treatise on Weights and Measures: The Syriac Version*. Chicago, University of Chicago Press, 1935, XII on xx.59, 68, cf 144: the word is now noted in *L and S, Suppl.* 76.

[3] Pliny, *N.H.*, 18.51.188-89; the cubit was less the 'normal' measurement by one finger's length.

[4] For the present economy see Benoit (M.J.), Lambert (B.), Letulle (J.M.), and Rabec (A.), *La plaine de Merouana et son encadrement montagneux. Algérie*. Mém. maitre, Caen, 1970-71. For the ancient remains see Gsell, *Atl. arch.*, f. 27 (Batna), no. 108 (Hr. Ma'fûna, p. 8), no. 115 (Hr. Fegûsia, p. 9), and no. 138 ('Ain al-Qsar, p. 10). Gsell and Graillot (1894) 501 f.; Gsell, *R.A.A.*, 103 f. at Hr. Merwâna itself (p. 82: 'il y a de nombreux restes de pressoirs'); Pachtere (1908) p. 397; Birebent, *Aquae Romanae*, p. 390. Masqueray (1877) p. 35: « Le Bellezma, dont les montagnes sont aujourd'hui revêtues de genevriers et de cèdres, était couvert d'oliviers dans l'antiquité. On trouve encore quelques pieds d'olivier sauvage dans la passe de Djerma et aux environs de la Merouana. La fabrication de l'huile faisait la richesse des petites villes et des villages dont on y trouve les ruines en si grand nombre », cf p. 37. « ...les pressoirs à huile étaient extrêmement nombreux *FIRA*, III, no. 139.

Also note the mixture of dry-land cultivation, garden production, and the large-scale implantation of olive trees as a cash-crop, and the various forms of property régimes attached to these, as evidenced in the similar scheme studied at Sefrou in modern Morocco by Rosen in Geertz and Rosen, *op. cit.*, 31, with precisely the same spread in property between the three economic types as a form of 'primitive insurance', cf no. 2, p. 90.

and barley may be intercalated between the trees. The principal reasons for accepting the tree as the basic unit of measurement are two: 1) intercalated crops are not permanent and are subject to systems of crop rotation that the trees are not, and 2) the trees are spaced in a rather rigid 'chequerboard' pattern in order to provide root space; this regular arrangement creates a 'square' area around each tree of rather constant size. An additional factor is that the trees are usually the object of special irrigation that is directed to the base of the three in channels excavated for the purpose. The standard procedure for irrigation is to erect four levées or embankments in a square about the tree at some distance from the root base, thus forming an artificial shallow basin; this depression is then flooded with the irrigation waters. The tree is at centre of two forms of irrigation: flood zone for the land and cereal crops about the tree, and direct irrigation to the tree itself [1].

In this context an ancient agricultural practice known as *ablaqueatio* should be considered. The noun *ablaqueatio* and the verb *ablaqueo* are found only in the ancient agricultural writers and ordinarily denote a process of trenching about the base of an arboreal plant (e.g., olives, vines, pears, almonds) for the purpose of irrigation [2]. Note the following advice proffered by the Elder Cato in his treatise on agriculture [3]:

Amurcam spargas vel inriges ad arbores; circum capita maiora urnas cum aquae dimidio addito, ablaqueato prius non alte.

Trees which have been so prepared are called 'ablaqueati' [4]:

Stercus dividito sic. Partem dimidiam in segetem, ubi pabulum seras, invehito, et si olea erit, simul ablaqueato stereusque addito: postea pabulum serito. Partem quartam circum oleas ablaqueatas maxime opus erit...

Columella, in his treatise on agriculture, however, informs us that the process was not solely associated with the upkeep of the trees: the ditches around the trees also served to help in general irrigation of other crops, *e.g.* of vines and trees [5]:

Vineam novellam ante brumam ablaqueatam habeto, ut omnes imbres limumque concipiat. Vites arboresque quo citius ablaqueaveris erunt valentiores. Sed quaecumque in clivis erunt positae, ita ablaqueandae sunt, ut a superiore parte secundum codicem lacusculi fiant, ab inferiore autem pulvilli alteriores excitentur, quo plus aquae limique contineant.

This passage is singularly striking in that it so closely matches the brief description given above where irrigation channels and earthen levées are employed in the arid lands of the Sahel in the present day in the irrigation of trees and intercalated crops. In the description given by Columella, *ablaqueatio* is to be performed just before winter to force flood and runoff waters and silt to collect in the depression (*lacus*) formed around the tree. In lands where the winter season ordinarily signalled the beginning of attempts to drain excess water, the whole passage seems slightly incongruous; and, in this precise context, the following passage from Columella is even more striking [6]:

Sed id (i.e., the olive grove*) minime bis anno arari debet et bidentibus alte circumfodiri. Nam post solstitium cum terra aestibus hiat, curandum est, ne per rimas sol ad radices arborum penetret. Post aequinoctium autumnale ita sunt arbores ablaquendae, ut a superiore parte, si olea in clivo sit, incilia excitentur, quae ad codicem deducant aquam.*

There can be no doubt. The whole procedure described by Columella is the classic combination of dry farming techniques and arid zone flood irrigation. The dry farming techniques specified are: deep ploughing at least

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[1] See nos. 1-2, p. 91.

[2] Mentioned once, but not discussed, by WHITE, *Roman Farming*, p. 238. For pears see Columella, *R.R.*, 5.10.17; *de arbor.* 24; for vines, *R.R.*, 11.2.79; employed to revive old or unproductive trees: Cato, *R.R.*, 93 (olives), 27 (olives); Columella, *R.R.*, 5.9.17 (olives).

[3] Cato, *R.R.*, 36 (cf 5.8, olives at autumn; 27).

[4] Cato, *R.R.*, 29 (cf 37.2).

[5] Columella, *R.R.*, 10.4.

[6] Columella, *R.R.*, 9.5.12-13.

twice during the summer season (*minime bis arari debet et bidentibus alte circumfodiri*), and careful weeding and maintaining the seal of the surface soil (the mulch) to prevent the action of the sun's heat from harming the roots through excess evaporation due to fissuring of the soil surface (*ne per rimas sol ad radices arborem penetrat*). Then there is a sudden switch from these practices with the autumn equinox, just as on the Lamasba inscription (*post aequinoctium autumnale*), when the olives are trenched around (*ablaquendae*) so that if there is a downhill slope (*si olea in clivo sit*) levée banks may be raised (*incilia excitentur*) to trap the water and lead it to the tree root (*codex*). Ordinarily *incilia* ought to mean ditches or trenches excavated for the purposes or irrigation or drainage [1], but the use of the verb *excitare* is then out of place since it means 'to throw up', 'to build', 'to erect', or 'to raise' [2]. So although Columella says *incilia* it is clear from the context of the passage that the therm refers less to the ditch than to the earthen embankments created by the excavation process. The passage cited earlier from the *De re rustica* (no. 5, p. 84) through discussing vines is so strikingly similar in its language that a common source or a very clear idea of a common technology must lie behind that passage and the one just quoted. If we return to the *De Arboribus* passage the meaning of the paragraph just quoted from Columella's *De re rustica* becomes clearer. The process calls for the formation of depression on the uphill face of a slope (*a superiore parte... lacusculi*) and then the construction of earthen levées on the slope downhill from the plant (*ab inferiore autem pulvilli alteriores excitentur*, where *pulvilli alteriores* are the *incilia* of the latter passage). In both cases the verb *excitare* is employed to designate the process of building the levées. Also in both cases, the process is tied to downslope runoff irrigation (*quaecumque in clivis erunt positae...* of vines in the first passage; *si olea in clivo sit...* in the second). There is too much coincidence to be fortuitous; the passage on the olives, with its enunciation of the principles of runoff irrigation and dry farming techniques, in all probability ultimately derives from Mago, the Carthaginian agronomist, upon whom Columella drew so heavily. Mago is quite conceivably also the ultimate source for the passage in the *De Arboribus* on vines [3].

Mago would have been concerned with precisely the sort of irrigation problems connected with fruit trees, the vine and the olive, and the Carthaginians could not help but have noticed the dry farming techniques employed by Africans in the arid lands of the Tunisian Sahel and Tripolitania. Our interest here is not in the full description of these techniques, but in how they might give us an explanation for the land unit 'K'. One possibility immediately suggests itself. As noted in both the Columella passages above, the *arbores ablaquendae* are prepared in such a way that irrigation waters can be directed to each tree which is *not* referred to by the term *arbor*, but by metonymy, as a 'root' or 'base' because it is this part of the tree to which the irrigation waters are directed (...ut a superiore parte *secundum codicem* lacusculi fiant; ...quae (sc. incilia) *ad codicem* deducant aquam...). So it is possible that the 'K' in our inscription stands for *codex* in the sense of one tree unit since *codex/caudex* could begin with a 'k' in Latin [4]. More interesting is the fact that the process of *ablaqueatio* connected with the *codex* appears to be a foreign practice to the Roman agronomists and the term itself seems to be strange to them, as the late fourth century agronomist Palladius tells us [5]:

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[1] So Cato, *R.R.*, 155.2; Pliny, *N.H.*, 18.62.230, and *D.*, 42.21.1.5, in a section defining irrigation terminology: *rivus, specus* etc. See *T.L.L.*, *s.v.* 'incilia', 7.1 (1934-64) 913.

[2] See the examples in *O.L.D.*, *s.v.*, 'excito, -are', ss. 8.

[3] For Mago see Columella, *R.R.*, 1.1.13 (cf Varro, *R.R.*, 1.1.10). Cf Mahaffy (J.P.) *The Work of Mago in Agriculture*. Hermathena, t. 7, 1890, p. 29-35; Martin (R.) *Recherches sur les agronomes latines et leurs conceptions économiques et sociales*. Paris, 1971, chap. 1, « Economie rurale et technique agricole à Carthage : Magon et son traité d'agriculture », p. 37-52 ; and, more recently, Heurgon (J.) *L'agronome carthaginois Magon et ses traducteurs en latin et en grec*. C.R.A.I., 1976, p. 441-56.

[4] For *codex* with this meaning see *T.L.L.*, 3 (1906-12) *s.v.* 'codex', 1403-04 (Gk κορμός), and 'Caudex', 1403.50-72. Cf Verg. *Georg.* 2.30 (of olives); cf Pliny, *N.H.*, 16.53.121:

Arbores quaedam simplices, quibus a radice caudex unus et rami frequentes, ut olivae, fico, viti...

Columella, *R.R.*, 4.8.2 in connection with the process of *ablaqueatio* of vines:

Quod ne fiat, recedere ab ipso codice instar unius digiti spatio conveniet...

Cf *R.R.*, 5.6.21.

[5] Palladius 2.1 (*mensis Ianuarius - de ablaqueandis vitibus*); cf Tert. *de Pud.* 16 (*silvam libidinem caedat et eradicat et excaudicet*), and Frontinus *de Aq.* 129. Compare the *menologia* or 'almanac' calendars known from rural Italy, see Degrassi, *Inscr. Ital.* XIII.2, 280 f.

Ianuario mense locis temperatis ablaqueandae sunt vites, quod Itali excodicare appellant, *id est circa* codicem *dolabra terram diligenter aperire et purgatis omnibus velut lacus efficere, ut solis teporibus et imbribus provocetur.*

Palladius, and other agronomists treating Italy, place the process in January or early spring and are careful to specify the temperate régime, whereas Columella places it at the time of the *autumn equinox*. And Palladius says that the Italians themselves call the process 'excodicare' rather than *'ablaquere'* [1].

There is, of course, another possibility that yields the same result, and one which conforms even more closely to the given data. The agronomists often speak of trees being irrigated as *capita* because of their concern with the water being directed to the root or base of the tree; as we have already seen Cato mention [2]:

"*...capita vitium per sementim ablaqueato...*"

So the 'K' could stand for *caput (kaput/kapita)* in this sense (*i.e., not* Mommsen's unit of valuation) with the same meaning of tree-area [3]. In this case, each of the plots to be irrigated were planted either to the various species of tree typical of arid zone terrace farms (*e.g.*, olives, vines, figs, almonds) or to cereal crops, but all plots were 'measured' in tree units regardless of their specific produce. This hypothesis finds further support in the fact that two of the plots in the Lamasba inscription are not measured in general terms of 'K', but in the number of *olive trees:*

TREBIVS BARBARVS	OLEAE	CCVI
P. AEMILIVS RVFINVS	OLEAE	CCCCLXXXI

The lands to be irrigated that belonged to Trebius Barbarus (no. 18) and P. Aemilius Rufinus (no. 43), which were located at the end of a *scala*, are measured not in general terms of 'K' but specifically in terms of the number of olive trees. This establishes two facts. First, *oleae* may be substituted for 'K' as a mode of measurement for purposes of irrigation. That is to say, their water allotment can be calculated precisely *since the water régime is constant*, and this means that, in effect, *'olive units' must be the same as or directly equivalent to 'K' units'* otherwise the calculations of the irrigation system would not function. For this to be possible, there must be some common denominator between the specificity 'olive tree' and 'K'. The obvious correlate is that both must be 'tree units' or at least notionally so. Secondly, since the water régime of *Aqua Claudiana* only allowed (at most) two waterings per winter season, the olive trees and hence the 'K' in the narrower sense of 'trees' could not have been the *primary object* of the irrigation. The main object must have been the winter cereal crops intercalated between the trees. But *indirect measurement* of ground area in this fashion should not surprise us: we have already cited a good example of it in practice in an arid zone terrace farming community at Nissanah in the Negev.

Finally, we might ask if it is possible to gain even a general impression of the size of the plots irrigated at Lamasba. An attempt has been made based on the assumption that properties possessed by *veterani* at Lamasba seem to be of rather consistent size and hence may represent a standard amount of land acquired by soldiers on their discharge from the army [4]. Even if this equation is acceptable, the further assumption that must be made in order to wring a final estimate from the Lamasba data is somewhat questionable. A straightforward comparison

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[1] Columella, *R.R.*, 9.5.13 (*aequinoctium autumnale*) cited above; cf 11.2.79 (October: vines and olives); 4.8.1 (*post idus Octobris:* vines); 5.5.5 (*statim post aequinoctium autumnale:* vines).

[2] Cato, *R.R.*, 33.1-2; cf 36, quoted above.

[3] For *caput* meaning tree, or tree base, see *T.L.L.*, 3 (1906-12) s.v. 'caput', 408.44-409.2. Schmidt, *Eph. epigr.*, VII, p. 256 thought K could *not* be a tree *because* it designated the area to be irrigated. But, as we have seen, the two are not mutually exclusive. He also claimed that he could think of no arboreal species beginning with K; but the distinction between the generality 'K' and the specificity *oleae* shows that 'K' probably did *not* represent any one particular species of tree.

[4] The land sizes of the veterans' plots are: one of 650 K (no. 60), two of 600 K (nos. 53-54), and one of 350 K (no. 29). But it might be noted that 600 K is close to the mean, and that we have only four examples on which to generalize of which one, of 350 K, is quite different from the others. In addition the plots of 600 K, directly adjacent to one another, look suspiciously like other equally divided parts of an original whole, as often found in the system.

is made between the Lamasba figure of ca. 600 'K' and the average holdings possessed by veterans in the village of Philadelphia in Egypt of 15 *iugera*. By dividing the 'K' holding at Lamasba into the latter figure one arrives at an estimated area of ca. 0.025 *iugera* for the size of the Lamasba 'K' [1]. But such an estimate accepts that land acquisitions and hence values and prices in the rich fertile lands of the Nile river valley were subject to the same conditions as those found in the semi-arid zone of southwestern Numidia. If anything, the assumption should surely be precisely the reverse: that the arid zone land plots at Lamasba would *not* be subject to the same environmental conditions as those in Egypt, and no dependable conclusions could be drawn by a simple correlation between the two. There is, however, another more valid route to a solution.

In a least two cases *oleae* were irrigated according to precisely the same co-efficients that applied to 'K'. That alone assures us that 'K' represents the same irrigation units as the *oleae*, in all likelyhood the postulated units of *kapita*. Hence it is possible to gain a rough estimate of the land areas of the various irrigation plots without reference toland economies outside Africa. That is to say, one may estimate the spacing required for 'K' tree-units in a region of ca. 500-600 mm annual precipitation. In comparable regions in Tunisia, such as the High Plains south of Qairawân, trees are spaced in 4 × 4 m. or 6 × 6 m. squares [2]. Allowing the more liberal of these estimates to stand, in order to compensate for the slightly different soil conditions of the Lamasba region, we may take 5 × 5 m. and 6 × 6 m. spacing for our calculations. These figures would indicate the planting of ca. 400 to 278 trees per ha. respectively or, to be more precise, for the plots of 206 and 481 olive tree mentioned above it would mean a surface area of ca. 0.5 ha. and ca. 1.2 ha. respectively. Put in other terms, one 'K' would be 25 m.^{2} or ca. 0.01 *iugera* if the plantings were at 5 m. distances and 36 m.^{2} or ca. 0.015 *iugera* if the trees were set at 6 m. distances [3]. Accepting these two extremes, one may give a very rough estimate, on the conservative side, of the size of the plots at Lamasba.

TABLE 8

ESTIMATED PROPERTY SIZES AT LAMASBA

The estimates are based on 5-6 m spacings of the trees

		Size in :		
	Property Size in 'K'	*iugera*	*acres*	*hectares*
Small hold	150 K	1.5/2.3	0.9/1.4	0.4/0.5
Medium hold	600 K	6/9	3.8/5.6	1.5/2.2
Large hold	1 000 K	10/15	6.3/9.4	2.5/3.6
Largest hold	4 000 K	40/60	25.2/37.5	10/14.2

One must bear in mind that these are only the land areas *irrigated* in each case and not necessarily the total actual size of the plot owned by any individual. Nevertheless, the estimates accord well with the time of water allowed for irrigation and also match known conditions in the region [4].

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[1] DUNCAN-JONES (R.P.). *Some Configurations of Landholding in the Roman Empire*. chap. 2 (in) FINLEY (M.I.) ed., *Studies in Roman Property*. Cambridge, Cambridge University Press, 1976, p. 7-24, plus figs., at 18, nos. 46-47.

[2] Cf TOURNIÉROUX (J.A.), *L'oléiculture en Tunisie*. 2. ed., Tunis, 1929, p. 10-14.

[3] TOURNIÉROUX, *L'oléiculture*, 16 f.; DESPOIS (J.), *La Tunisie orientale : Sahel et Basse steppe, étude géographique*. 2. ed., Paris, 1955, p. 256-61. The spacings differ radically from the much greater distances between trees required by the dry-farming techniques of the southern Tunisian Sahel (*e.g.*, around Sfax) of c. 25 m apart, see TOURNIÉROUX, *L'oléiculture*, 24 f. and DESPOIS, *Sahel et Basse Steppe*, p. 261-65.

[4] DUNCAN-JONES (1976) p. 18-20; nearly half the owners with less than 11 *iugera* or 2.8 ha. For comparative figures from the region see DESPOIS (J.), *Le Djebel Amour (Algérie)*. Paris, 1957, p. 63-65.

b) The Social System: Property and Proprietors

Unfortunately all that can be known about the proprietors as persons depends on their names and a few other bits of information on the irrigation inscription. Nevertheless a study of nomenclature alone reveals much about the social fabric of the community. Most owners bear only two names, the *nomen* and the *cognomen*. The number of full *tria nomina* are only three of the fifty-four known names [1]. They are: P. Aemilius Rufus (no. 43), C. Publilius Valens (no. 50), and Q. Caecilius Saturninus (no. 56). Only four of the proprietors specify that they are *veterani;* of these, two might be locals since they specify no external *patria:* Flavius Fortis *veteranus* (no. 53) and Flavius Adiutor *veteranus* (no. 29). Both are Flavii whose parents may have served in auxiliary units and then settled around Lamasba after their discharge. Their sons bore 'army names' (Fortis, Adiutor) and, possessing Roman citizenship, enlisted in the legion and returned to Lamasba upon their discharge. The only two outsiders explicity attested at Lamasba are also veterans: Iulius Felix *veteranus q(ui) f(uit) Furni* (no. 54) and Iunius Saturninus *veteranus q(ui) f(uit) Nargu* (no. 60). They are prime examples of the pattern of army recruitment whereby men who had acquired Roman citizenship by the process of municipal growth in the older settled parts of Africa to the east used their citizenship as a means of entering the legion. After the completion of their service, principally in the Lambaesis region, they moved further west after their discharge to settle in communities like Lamasba. Furnos Maius and Nargu are merely two of the municipalities of the old province of Africa that provided recruits and settlers for the lands to the west [2]. There is indirect evidence of veteran settlement in the *cognomina* of two proprietors: Steminia Aemerita (no. 33) and Sextilius Aemeritus (no. 21), both of whom may have received the appellation based on *emeritus* from fathers who had served in auxiliary formations and had received honourable discharges.

A study of nomenclature also reveals something of the nature of landholding and the distribution of landed property within the system. Land tended to be familial in practical ownership; that is, members of the same family tended to hold units of land forming blocks contiguous to one another. Take, for example, the family of the *Apulei*. Five members of this family are attested: the immediate father of the surviving sons was Apuleus Faustinus (no. 7). The plot of land he held (Col. I.3) is the third on *scala 1* and is immediately succeeded by properties owned by his sons or close relatives: I.4 is owned by Apuleus Rogatianus (no. 6), I.5 by Apuleus Africanus (no. 5), and I.6 by Apuleus Processus (no. 19). Property I.3 once owned by Apuleus Faustinus is now held in common by his heirs. Only one of the known Apulei, Apuleus Rogatus (no. 11) owned a property far removed from this group of four plots (Col. IV.13). The size of all the plots is in the smaller range: the father's former plot is 117 K, and Rogatianus and Africanus who have the immediately succeeding properties hold 110 K each. The next property, that of Processus is precisely twice this size or 220 K, and Rogatus' plot is 150 K. It may be that Rogatianus and Africanus were joint heirs to a plot of 220 K which was then subdivided into two equal plots of 110 K each, of that Processus was the eldest son and received precisely twice their allotment. The three (or four) then held in common the remaining uneven sum of 117 K as joint heirs.

Other families also held plots in this same pattern. For example, the *Dentilii:* Dentilius Senex (no. 25) held the tenth plot in Col. II of 300 K; Dentilius Maximus (a younger brother?, no. 28) held the adjoining plot (Col. II.11) of 240 K. Again, the plots are similar to each other in size. So too, the two known *Caecilii,* Caecilius

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[1] See Chart II. There are perhaps up to c. 60 names on the stones that can be recovered (*i.e.*, at least one of the *tria nomina* in full), but six of the names are repeated so that only 54 individual names are known.

[2] Furni could be either Furnos Maius (more probably), modern 'Ain Fûrna (*Atl. arch. Tun.*, II, f. 25 (Jama) no. 187; cf Gascou, *Politique municipale*, p. 201, a *municipium* of Antonine date) or, less probably, Furnos Minus (modern Hr. al-M'sa'ardin, see Gsell, *Atl. arch.*, f. 19 (Tébourba) no. 235). Nargu may be an abbreviated form of Naraggara (?), cf Gascou, *op. cit.*, p. 203; modern Sidi-Yûssef; cf Gsell, *Atl. arch.*, f. 19 (El Kef) no. 73) which was *not* a *municipium*, although it did provide soldiers for *IIIa Augusta* (*C.*, 18085, e, line 8, cf line 15), see *C.*, XIV, 730; VI, 8771, and *C.*, p. 1780. The name is of Punic derivation, which clearly points to a location in the Old Province of Africa (cf *C.*, 7888, Sardinia). Compare the evidence of personal nomenclature: Nargeudud (*C.*, 11477 = 284, Hr. Sidi bû-Ghanem, nr. Sufetula-Theveste), Nargududs (*C.*, 1152, cf 14274, a woman from Carthage), and Nargeus (*C.*, 23867) in a work dedicated by *sufetes*. This does not mean, however, that I accept the contention of D'Escurac-Doisy (1967), p. 61 that *most* settlers in the region were veterans of *IIIa Augusta*.

Victor Maior (no. 23) and Q. Caecilius Saturninus (no. 56) were separated by only one property: they held properties no. 14 and 16 respectively as listed in Col. IV. The *Germanii* were yet another large landholding family. Six members of the family are known, those in the first group probably being sons of Germanius Petronianus (no. 58) who held plot 6 listed in Col. IV. A son of the same name (no. 42) held a plot on *scala II* (Col. II.13). So the family held two distinct groups of plots; yet although each group was separate, landholding was contiguous within each group. The first group on *scala II* included Germania Castula's plot (no. 67, Col. II.12) of 803 K, that of Germanius Petronianus (no. 42, II.13) of 440 K, and finally that of Germanius Valentinus (no. 39, II.16) of 430 K. The second group, recorded in Col. IV (probably on *scala* V or VI) followed in strict order one after the other (IV.5, 6, and 7) and consisted of plots held by Germanius Valens (no. 57) of 609 K, the heirs of Germanius Petronianus (no. 58) of 620 K, and of Germanius Valentinus (no. 62) of 664 K. Note that Germanius Valentinus held plots in both groups. Also, Germanius Dentilianus in group one was presumably the offspring of his father Germanius who married a daughter of the Dentilii (the family mentioned above); that is particularly significant since the Dentilii held plots 10 and 11 listed in Col. II, and the Germanii held the immediately succeeding properties (Col. II.12-16). Here then is an example of intermarriage between two families who wished to consolidate their adjacent property holdings.

The *Manilii* also conform to this pattern. Manilius Aufidianus (no. 24) owned the first property listed in Col. II (hence on *scala* II) of 260 K, whereas the heirs of his father (Manilius Rogatus, no. 65) owned the next plot (Col. II.2) of 790 K. The heirs (no. 52) also share the third plot downstream from this one (Col. II.5) of 600 K. Perhaps more impressive, however, are the contiguous holdings of the *Marii*. The name Marius itself ought to suggest an ultimate connection with the African 'Gaetulian' ethnic groups who seem to have been one of the backbone recruiting elements of the *IIIa Augusta* legion [1]. At least two families of Marii are attested: the descendants of Marius Saturninus and of Marius Catullinus were joint heirs of plots in *scala I*. But the two families were closely allied and undoubtedly intermarried, and held a continuous string of properties in the first terrace that was arranged as follows: the heirs of Marius Saturninus (no. 15) held a property of 200 K (Col. I-11), Maria Satura (no. 10) a property of 50 K immediately following (I.13), Maria Donatula (no. 3) held 100 K next along (I.14), and finally Marius Felix (no. 17) possessed 200 K, the last in this direct succession (I.15). Only one of the known Marii, Marius Honoratus (no. 4) held property that was not part of the group on *scala* I; he held a plot of 102 K at the very end of *scala* II (Col. II.17). Once again, all these plots are of approximately the same size, varying between 100-200 K. The *Iulii* may be a similar group of *veterani* or persons ultimately descended from army men. Iulius Fortunatus (no. 47) held a plot of 530 K (Col. IV.19), his father Iulius Petronianus (no. 48) left the adjacent plot of 530 K (Col. IV.20) to his other heirs to hold in common. The Iulia Victoria (no. 20) with 245 K (Col. IV.12) is probably a close relative. Here again the traces of an exact splitting of inheritance with (probably) the eldest son receiving twice the allotment of the rest can be traced. That alone suggests the continuity of an Hamitic-Semitic pattern of inheritance still strong in the local community [2]. And again evidence of intermarriage can be discerned. As noted above, the Germanii held plots in two blocks, one of which is listed in Col. IV of the inscription. The name itself of one of the Iulii, Iulius Petronianus, suggests a marriage between his father and a sister of Germanius Petronianus (II.13 and IV.6) and, as was noted above, the Germanii's holdings in this *scala* ran through Col. IV, 5, 6 and 7.

Joint ownership of plots was not unknown. Two *Fuficii*, Felix and Priscianus (no. 30) held a plot jointly in scala II (listed in Col. II.9) of 360 K. The same pair (no. 55) held yet another plot listed at Col. IV.15 of 600 K where their names are followed by the phrase *inibi (partem) Messi(i)*. The full meaning of the phrase becomes clearer when we see that a brother or close relative of the pair, Fuficius Messianus (no. 13), held a plot 165 K that was contiguous with theirs on *scala* II (listed in Col. II.8). It seems that Felix and Priscianus held a property

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[1] See Gascou (J.), *Inscriptions de Tébessa. 4 : Marius et les Gétules*. M.E.F.R., t. 81, 1969, p. 537-99, and *Le cognonem Gaetulus, Gaetulicus en Afrique romaine*. M.E.F.R., t. 82, 1970, p. 723-36.

[2] See, *e.g.*, Vaux (R. de), *Ancient Israel*. Vol. I: *Social Institutions*. New York-Toronto, McGraw-Hill, 1965, 53 ff. with references.

listed in Col. IV in which Fuficius Messianus also had an interest, to judge from the same phraseology used elsewhere in the decree a shared interest in the water flowing through the properties [1]. The only other case of joint ownership explicitly attested is that of Aelius Victor and Valeria Fortunata (no. 68) of 826 K; the man was a member of the Aelii (nos. 16, 46) with property on *scala* I whereas she was a member of the Valerii (cf no. 81).

Without pursuing the study of nomenclature further, the following can be noted:

1. that, as might be expected in a society and economy of this type, ownership is closely tied to kinship links; families and members of families tend to hold irrigation plots in contiguous units,

2. that neighbours consolidate their interests in land and water by intermarriage,

3. that considerable property is held in common by heirs, thus dispersing proprietory rights throughout the system, and that there are some possible hints of a local system of inheritance paralleling the 'Semitic' system of double preference of eldest sons; this system has been modified markedly, however, by the right of women to own and inherit land,

4. and that in these units, even though there is multiple ownership (that is, the same proprietor holding many different plots scattered throughout the system) both individual plots and the collective units are comparatively small.

The last observation does not mean to suggest that the fragmentation of property into small units (probably dictated to some degree by the irrigation technology itself) necessarily excludes large total holdings. Take the case of the Aemilii. P. Aemilius Rufinus (no. 43) held a plot of 481 *oleae* at the end of *scala* V or VI; a relative Aemilius Secundus (nos. 41, 84) held two plots: one in *scala* I of 450 K and a very large property at the beginning of *scala* III of 2300 K, for a total *attested* ownership of 2750 K, making him the second largest known proprietor in the system.

The distribution of property on the whole is very uneven. The owner whose name is lost at the top of Col. III (no. 85) possessed as much property in one unit as the first twenty-five proprietors combined (see Chart I)... 4000 K. The ten largest landholders, between themselves, owned as much land as the first *fifty* proprietors combined. Put in other terms, twenty proprietors (that is, a little more than a quarter of the known sample) collectively possessed *less than 5 %* of the known land in the system. There were three very large landowners in the scheme: 1) the heirs of Rogatus (?, no. 83) held 2065 K, and if these are the same as the heirs of Manilius Rogatus, the total is boosted to 3455 K; 2) Aemilius Secundus whose known holdings total 2750 K, and 3) the unknown proprietor holding 4000 K. The latter person and Aemilius Secundus alone (presuming them to be different) held 6750 K or 12.7% of all known land. In other words, property tended to pyramid in a rather steep fashion with land being distributed very unevenly, with a large number of average and small-sized plots at one end and a small number of very large units at the other. Multiple ownership, not only within a plots, but of lands and other property outside the scheme may have ameliorated the position of the smallholders somewhat but as can be seen from the irrigation inscription itself these options are followed as often and on a greater scale by the large landowners themselves. Multiple landownership within the irrigation scheme does not seem to be directed towards equalizing land holdings, but rather as a primitive form of insurance to spread the risk of irrigation of plots far from the source in dry years [2] (see table 9).

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[1] Rather than Schmidt's hypothesis, *Eph. epigr.*, VII, p. 260, not noting our correlation, that he was a *possessorem pristinum, ut qui haud raro adiciantur ad fundum quendam accuratius significandum,* and *ibidem quondam fuit Messi fundus* another improbable and far-fetched explanation.

[2] So KRAEMER, *Nessana*, 45 F. (for Near Eastern antiquity); GEERTZ (1972) for modern Morocco; cf MAYERSON (P.), *The Ancient Agricultural Regime of Nessana and the Central Negeb*. London, The British School of Archaeology in Jerusalem, 1964, p. 225-27 on the former, and HILL (R.W.), *Some Problem of Economic Geography in Northern Tripolitania: A Study of Agriculture and Irrigation on the Jefara Plain*. PhD Thesis, University of Durham, 1960, p. 44 on the latter comparison.

TABLE 9

PROPERTY DISTRIBUTION IN THE IRRIGATION SCHEME

Size Range in K Units of Hundreds	*(No. of Owners)*	*Units of Thousands*	*(No. of Owners)*
000-99	2	(000-999)	(66)
100-199	11	1 000-1 999	12
200-299	11	2 000-2 999	2
300-399	8	3 000-3 999	0
400-499	9	4 000-4 999	1
500-599	6		
600-699	9		
700-799	2		
800-899	5		
900-999	3		
	Total 66		Total 15

The totals include joint ownership as follows :

1. Fuficius Felix and Fuficius Priscianus (360 K + 600 K) = 960 K
2. Germanius Valentinus (430 K + 664 K) = 1 094 K
3. Heirs of Manilius Rogatus (790 K + 600 K) = 1 390 K
4. Aemilius Secundus (450 K + 2 300 K) = 2 750 K.

Large amounts of land were held in common by heirs (13.7% of the known total) and by women (8.5% of the known total). As we have seen the former situation seems to reflect, in some cases at least, the distribution of 'remnant' property after the primary distribution to the heirs in equal sized allotments. The case of female heirs is probably even more significant. Property passing into the hands of women can illustrate divergent attitudes to property ownership itself in different regional contexts. For example, in the contemporary Jabal Amûr region in western Algeria, in conditions analogous to those at Lamasba, daughters do not ordinarily inherit because of the fear that land in the hands of women could pass into the hands of strangers by way of marriage outside the community [1]. But this propensity to keep irrigation plots within the community, as reflected in the documents from Niṣṣanah and in the *Tablettes Albertini*, is not the only option. Studies on the modern indigenous property régimes in the Hodna Basin, the major geographical region closest to Lamasba to the south, reveals the opposite attitude: the land is not subject to the same social control... it may be willed or sold to women, and alienated outside the community [2]. At Lamasba, presuming no apparent rules on endogamy, the latter situation would appear to be our closest analogy. Although women within known family groups hold property in their own right and when outsiders such as the *veterani* came to the community, there is clear evidence of intermarriage. Both the Hostilii from Lamsorti and the case of Iulius Castus from Qsar Bellezma illustrate this theme in local development. The *impression*, therefore, is of a more fluid and flexible property régime, due in part, to the openness of Lamasba to external (*i.e.*, Roman) influences. The economy of the region was one of frontier expansion and direct outside communication, including the regular addition of outside members, all factors that would favour a more dynamic property system. There is no reason to believe, however, that

[1] DESPOIS, *Djebel Amour*, p. 58; cf *Le Hodna*, p. 178-81.

[2] DESPOIS, *Le Hodna*, p. 166-67, 188-96, and *Djebel Amour*, *locc. cit.*

Lamasba was typical of all African irrigation systems in this particular respect; it only reflected its own environment. The more isolated Tripolitanian wadi settlements, like the village attested in the *Tablettes Albertini*, would have been closer to the parallel of the Jabal Amūr: a more restricted physical environment, scarcer resources, greater isolation and lesser external influence, and hence a tendency to a closed property régime.

The relationships between the large and small proprietors in the system are not, of course, specified on our inscription. But we can make some probable deductions about their social and labour relations. Most of the plots were rather small and were probably worked by peasant family units. Columella does give an estimate of the labour requirements for the process of *ablaqueatio* described above; he remarks that one man could easily cope with 50-80 trees, depending on their size [1]. Given family units of production, there is no reason why plots in the median range of 500-600 K could not be worked without recourse to external sources of labour. But proprietors holding up to 4000 K could not have provided all the labour they needed even for this one operation alone, and must have acquired it by means of relations of dependence within the community itself. As stated above, some of the potential for dependence was inherent in the extreme polarization of land itself. But this polarization reflects two different trends. On the one hand, properties are fragmented and dispersed through the irrigation system as a form of insurance. Economic protection is afforded for families by owning some properties on *scalae* close to the source and others located further away. This would tend to minimize 'upstream' - 'downstream' irrigation conflict. The trend towards decentralization of holdings, however, is counteracted by the grouping of properties into familial blocks, a process of consolidation of property by intermarriage. In fact, at Lamasba a dozen families controlled nearly three-quarters (72%) of all the land in the system as recorded.

TABLE 10

FAMILIAL GROUPINGS OF PROPERTY AT LAMASBA

No.	*Family*	*Amount of Property*	*Order (1 = the largest)*
1.	Aelii	1 113 K*	7
2.	Aemilii	3 231 K	2
3.	Apulei	707 K	11
4.	Caecilii	854 K	9
5.	Dentilii	640 K	12
6.	Fuficii	1 125 K	6
7.	Germanii	4 015 K	1
8.	Iulii	1 905 K	4
9.	Manilii	1 650 K	5
10.	Marii	902 K	8
11.	Sextilii	850 K	10
12.	Valerii	1 913 K	3
		Total = 19 005 K	

*Assuming a half interest of Aelius Victor and Valeria Fortunata in Col. IV. 17.

[1] Cf Columella, *R.R.*, 11.2.40, *Arbores quoque tempus est ablaqueatas circumfodere, et operire: una opera novellas circumfodiet arbores octuaginta, mediocres LXV, magnas quinquaginta.* Cf 11.2182, *Duo iugera tres operae commode occabunt, arboresque quae intererunt ablaqueabunt...*

Since the actual modes of property ownership at Lamasba remain obscure, the problem of the land-water relationship is difficult to solve. There does exist Despois' general theorem of a distinction between a *tellian* principal where water and land tend to be separable... that is, the water can be sold, rented, inherited, or mortgaged independently of the land to which it was allotted, and a *saharan* principle where the opposite is true, where water is property attached to the land it irrigates [1]. This principal, however, seems to be tied to another, namely that *tellian* waters are ordinarily divided into volume units whereas division of water in the semi-arid or arid regions tends to be in time units. But, as we have seen, the latter form was compatible with Roman legal forms and farming practices in Italy itself. If a different distinction is made, that between relative abundance and scarcity, it might be possible to hypothesize that the tendency at Lamasba and in other arid zone settlements would be to separate water from land as property so that the former could be dispersed to those who required supluses available from other proprietors. Clues are available in the residual rights which Fuficius Messianus retained in a plot owned by his relatives (no. 30) but his rights would seem to pertain to the land rather than the water [2]. The maintenance of property in familial blocks would also make sense if a social exchange or sharing of water was envisaged. None of this is incompatible with the conception of water as property in itself, finitely divisible into time units. In Italy, both urban and rural water was viewed as real property, even subject to the vectigal or property tax [3]. We might also note that separation of water as property in theory seems to be true of the property arrangements of the *Tablettes Albertini* where water rights are always specified as an additional and separate part of the sale of each parcel of land.

To conclude. The irrigation system detailed at Lamasba was based on an indigenous social system that failed to function for very specific, though unknown, reasons. The system itself, however, was a preliterate one that employed a very 'low-level' technology. That the system and most of its material components are demonstrably African at base remains true in spite of the prevailing tendency to identify most archaeological ruins of waterworks in the region as 'Roman'. These systems are in fact the same spring, captage, barrier, canal, and terrace schemes that are casually labelled 'Roman' throughout the entire ancient Maghrib because of the apparent indebtedness of their construction techniques to a foreign culture. But the case of the Lamasba system shows how much more complex that interchange must have been, and also places in high relief the distinction that must be drawn between material remains, techniques of construction, and any deductions that can be made legitimately about the mental world the material objects served. The Africans at Lamasba undeniably were part of a Roman technological world, but the questions must remain open as to how conscious they were of subsuming part of that technology in the building and upkeep of their irrigation system, and as to how much the external technology merely fit into pre-existent economic forms. The expression of the system is in Latin and its terms are perfectly compatible with the models provided by the Latin civilization of which the Africans were part. But the economic forms underlying the agricultural development of the Bellezma Plain clearly appear to be local in nature. The attempt to regulate and resolve conflicts within the system also seem to have been encapsulated within the local social system. In this sense there is a nice match between the boundaries of the social system and the economic system to which it is attached. The two formed one package: each irrigation system functioning in its own valley, wadi, set of terraces, basin, or, as Geertz expresses it more generally, in its own 'micro-environment'. The upshot of this whole analysis, then, is to question many facile hypotheses that have been advanced about the process of 'development' in the peripheral regions of the Roman Empire. This is no place to enter into a prolonged debate over the much disputed question of technological invention and innovation,

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[1] Despois (J.), *Development of Land Use in Northern Africa with references to Spain*, (in) Stamp (L.D.) ed., *The History of Land Use in Arid Regions*. (UNESCO: Arid Zone Research, XVII) Paris, 1961, p. 219-37, at 223. See especially Rosen's description of the property régimes and water-types in the system of the Sidi Lahcen near Sefrou in a system that in every way bears a most striking resemblence to the Lamasba scheme as we have described it Geertz and Rosen, *op. cit.*, 31-32.

[2] Glick, *Irrigation and Society*, 230 f., cf the typology of Brunhes (J), *L'irrigation, ses conditions géographiques, ses modes et son organisation dans la péninsule iberique et dans l'Afrique du Nord*. Paris, 1902, p. 59-93.

[3] Cf Mommsen (1850) p. 309-12 = (1907) p. 88-90; Cic., *de Agr.*, 3.2.9; *D.*, 7.1.27.3 and 1.30.39.5, and the text from Venafrum to which the whole of Mommsen's article is devoted (*C.*, 4842 = *I.L.S.*, 5743).

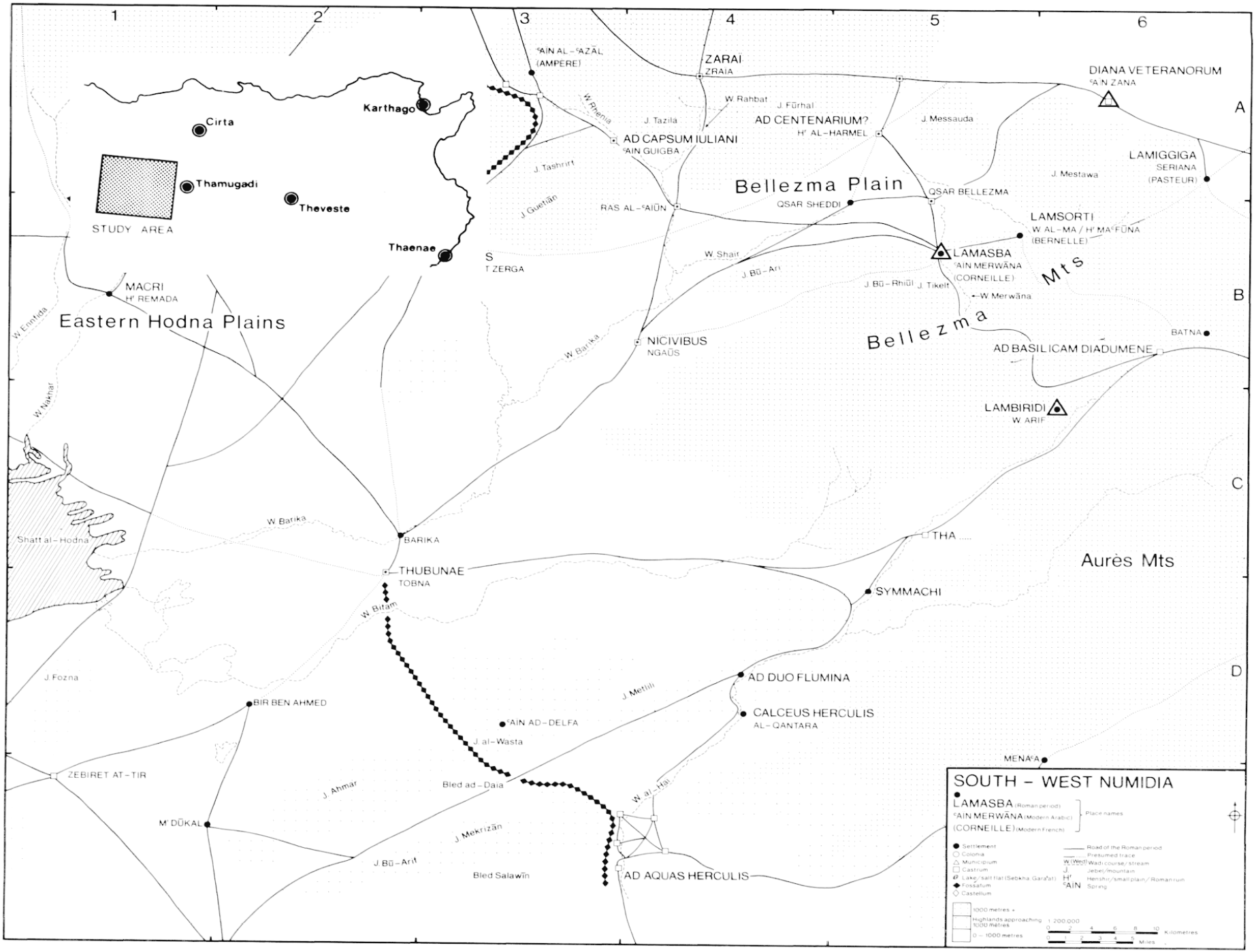

FIG. 4. — South-West Numidia.

but one can note two indisputable facts. Whatever new material techniques might have filtered into the Lamasba region were put to the service of a quite traditional type of African agriculture not found north of the Mediterranean. Nor do the new techniques themselves seem to have altered fundamentally the social circumstances in any process of economic change of which they were part. Secondly, the entire process of change in the Lamasba region, insofar as it is directly specifiable, is a profound cultural and social revolution that brought this particular region of North Africa within the orb of *Romanitas*. But how that cultural change relates to the extension of technologies is not at all clear, and must remain a question open to further investigation. Again, one can only note that the traditional tendency to lean on crutches, such as the introduction and settlement of Roman veteran soldiers, must be firmly rejected. The case of Lamasba clearly shows that, in spite of their undeniable presence in not insignificant numbers, *veterani* too fit very nicely into the African social system of the irrigation community. Too nicely, in fact, to offer us any easy explanation for the social metamorphosis that produced this hybrid of Roman and African economy and society in the ancient Maghrib.

APPENDIX:
THE ORIGINAL SIZE OF THE LAMASBA IRRIGATION INSCRIPTION

For the purpose of our argument it is necessary to establish what portion of the original stone remains in the four existing fragments, and therefore what part of the original land and number of proprietors may be analyzed legitimately. From the numbers of proprietors and the precise dates recorded on the remaining parts of each of the four columns, it is possible to calculate how much time and therefore how much property was covered in the missing portions of each column.

TABLE 11

MISSING PORTIONS OF THE EXISTING COLUMNS

COL. I	
Remaining :	20 properties irrigated from 25 Sept. (vii kal. oct.) until the morning of 28 Sept. (iiii kal. oct.) = c. 3.5 days
Missing :	unknown number of properties irrigated from the afternoon of 28 Sept. (iiii kal. oct.) until the afternoon of 19 Oct. (xiv kal. nov.) = c. 21 days
Total for Col. I = c. 24.5 days.	
COL. II	
Remaining :	22 properties irrigated from the afternoon of 19 Oct. (xiv kal. nov.) until 28 Oct. (v kal. nov.) = c. 9.5 days
Missing :	unknown number of properties irrigated from 29 Oct. (iiii kal. nov.) until the early morning of 17 Nov. (xv kal. nov.) = c. 19.5 days
Total for Col. II = c. 29 days	

In this manner it is possible to establish that the total time period covered in Col. I was c. 24.5 days and in Col. II, c. 29 days, and also to determine the time period covered in the lost portions of Cols. I and II. From the latter figures one can proceed to calculate the amount of property irrigated on the lost parts of the stone. This can be done by calculating the precise periodicity of *AqA* and *AqD* (see above, pp. 77 f.), and by dividing the time by the co-efficients fixed for these two water régimes. Thus in Col. I the water is *descendens* from the early morning of 25 September until midnight 4 October, *ascendens* from 5 to 9 October, and then *descendens* again

from 10 October until midnight on the 19th. This schema matches perfectly with the data given in Col. I, and on Col. II where *AqD* becomes *AqA* again on the morning of 20th October (xiii kal. nov.). By employing the coefficients established for each water régime (see p. 78 f. above) the number of property units (K) that were irrigated in the missing portions of Cols. I and II can be calculated.

TABLE 12

IRRIGATED PROPERTY IN THE MISSING SECTION OF COL. I

Water Regime	*Time Period*	*Units of Property*
AqD	v noct. v kal. oct. to iv. non. oct. = 7 days, 7 hours = 175 h (/k^d)	= 11 667 K
AqA	iii non. oct. to vi idus oct. = 5 days = 120 h (/k^a)	= 5 000 K
AqD	v idus oct. to iii noct. xiv kal. nov. = 9 days, 15 hours = 231 h (/k^d)	= 15 400 K
		Total = 32 067 K

Given the average property size in the remaining portion of Col. I (228 K) this would mean approximately 120 more properties for that column, but it is more proper and accurate to consider the mean size (close to the mode) of c. 630 K, which would give about 40-45 more properties in that column.

In the missing portion of Col. II the water is *AqD* from 25 October until 3 November; *AqA* from 4 November until 8 November, and *AqD* from 9 to 18 November. And, as predicted by this form, in the third column the water begins to be *ascendens* again on 19 November (xiii kal. dec.). Therefore, the total property irrigated in the mission portion of Col. II can be calculated (Table 13). At the average size of properties in the existing portion of Col. II (582 K) there would be about 50 more properties in the missing portion of the column, and at c. 630 K (the overall mean) about 45 more properties. Given the range of error inherent in these estimates, the calculations only represent rough guesses. But even at the lowest, most conservative estimate, there are more than twice as many properties at the bottom of each column as there are preserved on the remaining upper portions (see Table 13). Thus, probably about *the upper third of the columns has survived.*

But the problem must be pressed further. How many additional columns once existed to the right of the part of Col. IV that still remains? Again, only the most approximate of guesses can be made since the dates on which the properties listed in Col. IV were irrigated are not even known. This deprives us not only of a terminal date for the surviving part of the inscription, but also of the possibility of calculating the time span covered by Col. III. Even with the much larger average property sizes in Col. II, however, the whole column still covered much the same time period as Col. I where the average property sizes are notably smaller (29 days in Col. I as opposed to 24 days in Col. II). In spite of the increased average property sizes in the existing portions of Cols. III and IV (1006 and 560 K respectively) an average total time per column of not more than c. 30 days seems probable. But what was the total time period covered by the whole irrigation inscription? Nowhere, not even in the preamble, is this stated explicitly. Comparative data would limit the rationale of any irrigation system in the ancient Maghrib to the winter months, that is, the growing season between late September and early March. The terms of the irrigation decree indicate that the scheme began to operate each year on the early morning of 25 September (vii

TABLE 13

IRRIGATED PROPERTY IN THE MISSING SECTION OF COL II

Water Régime	*Time Period*	*Units of Property*
AqD	xi noct. v kal. nov. to xii noct. iii non.nov. = 6 days, 1 hour = 145 h (/k^d)	= 9 667 K
AqA	prid. non. nov. to vi id. nov. = 5 days = 120 h (/k^a)	= 5 000 K
AqD	v id. nov. to viis d. xv kal. dec. = 8 days, 7.5 hours = 199.5 h (/k^d)	= 13 300 K
		Total = 27 967 K

kal. oct.). This is no mere coincidence since that date (24/25 September) was regarded as the first day of the winter season by both the ancient agricultural writers and by official texts (*e.g.*, the law codes):

Scala I: ex vii kal(endas) octob(res) primo mane/
quo Claudiana descendit ad matrice(m) riganda(m)

The winter season spanned the time between the autumn and spring equinoxes, that is, approximately from 24 September to 24 March inclusive [1]. A further argument in favour of a winter irrigation system is found in a fragment of an inscription that Gsell discovered at 'Aïn Merwâna at the same time as the discovery of the new fragment of the irrigation decree itself. Gsell did not believe it to be part of the decree, but context alone connects the two and the inscription clearly mentions the winter season (*hiemis tempore*) [2]. Given an irrigation scheme covering the six winter months and the average number of days accounted for by each column, it would seem that the stone originally had a total of six or seven columns to cover the time span. To attempt to check this estimate by restoring the imperial title at the head of the stone and thereby estimate the total width in letters is virtually impossible. In addition to the emperor's name there must be some formulaic expression (such as *quaesita per re* as suggested by Mommsen) *and* the *nomen-cognomen* of at least one commissioner plus the *nomen* of Valentinus who appears at the beginning of line two. These variables are too vague, and the method even more hazardous than the one attempted above [3]. The upshot of this argument is that in the four fragments of the inscription that remain we have approximately half the lateral width of the original, and of this remaining width about one-third of the original height of the monument. Hence, we are left with about one-fifth to one-sixth of the original and hardly, as is often stated, 'the greater part' of the inscription [4].

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[1] Both dates were approximate. See Pliny, *N H.*, 2.97-99.215 and Varro, *L.L.*, 6.8, with *D.*, 43.13.1.8: *...aestatem incipere (sic petitiores tradiderunt) ab aequinoctio verno et finiri aequinoctio autumnali; ita senis mensibus aestas et hiems dividitur.*

Cf Columella, *R R.*, 9.14.1: *Ab aequinoctio primo quod mense Martio circa viii calendas Aprilis in octava parte Arietis conficitur.*

And 9.14.10-11: *...autumni aequinoctio, quod est ante calend. Octobris cum octavam partem Librae sol attigit... Ab aequinoctio deinde quod conficitur circa viii calend. Octobris.*

[2] GSELL, *R.A.A.*, p. 84 (Lamasba) with lettering the same size as the main text of the irrigation decree (0.09 cm).

[--]G[---/---]GENT CE[---/---]QVE COMMOD [---/---] HIEMIS TEMP[ore ---/---]VR HANC AVTE[m? ---/--- per] SCRIB[ere? ---]

Gsell wrote, « ...(elle) ne semble pas avoir appartenu à une liste semblable à celles des deux tables connues », though de PACHTHERE (1908) p. 375-76 thought it possible, as does BIREBENT, *Aquae Romanae*, p. 394.

[3] A procedure followed by Pachtère (1908) who estimated c. 110-15 letter spaces in all and hence 8-9 columns beneath the preamble (matching the estimate of the editors of the *Corpus* of nine columns, p. 1780). He then arbitrarily reduced this to a minimum of six and a maximum of seven columns.

[4] *E.g.*, WHITE, *Roman Farming*, p. 158, and HEITLAND, *Agricola*, p. 293.

CHART 1. PROPERTY AND WATER REGIMES

No.	*Proprietor*	*Sequence**	*K***	*Horae****	*Aqua*****	*% +*
1.	X	1.17	(c.30-50)	.5	D	.1
2.	Cornelius Expectatus	4.3	70	X	X	.1
3.	[Mar?]ia Dona[t]ula	1.14	100	1.5	D	.2
4.	Marius Honoratus	2.17	102	(1.5)	D	.2
5.	Apuleus Africanus	1.5	110	1.5	D	.2
6.	Apuleus Rogatianus	1.4	110	1.5	D	.2
7.	(Heirs of) Apuleus Faustinus	1.3	117	1.5	D	.2
8.	X	1.16	120	1.5	D	.2
9.	(Heirs of) Marius Ca[t]ullinus	1.13	150	2	D	.3
10.	Maria Satura	1.12	150	2	D	.3
11.	Apuleus Rogatus	4.13	150	X	X	.3
12.	Lollia Mustia	4.11	155	X	X	.3
13.	Fuficius Messianus	2.8	165	4	A	.3
14.	X	3.8	200	3	D	.4
15.	(Heirs of) Marius Saturninus	1.11	200	3	D	.4
16.	Aelius Felix	1.10	200	3	D	.4
17.	[Mar?]ius Felix	1.15	200	3	D	.4
18.	Trebius Barbarus	4.9	206 (oleae)	X	X	.4
19.	Apuleus Processus	1.6	220	3	D	.4
20.	Iulia Victoria	4.12	245	X	X	.5
21.	Sextilius Aemeritus	2.15	250	(3.5)	D	.5
22.	X	2.21	(c 250)	(3.5)	D	.5
23.	Caecilius Victor (Maior)	4.14	254	X	X	.5
24.	Manilius Aufidianus	2.1	260	(4)	D	.5
25.	Dentilius Senex	2.10	300	(7)	A	.6
26.	Mattius Fortis	1.1	308	4.5	D	.6
27.	X	1.18	(c 300-320)	4.5	D	.6
28.	Dentil(ius) Maximus	2.11	340	8	A	.6
29.	Flavius Adiutor vet(eranus)	1.2	350	5	D	.7
30.	Fuficius Felix (and) Priscianus	2.9	360	(8.5)	A	.7
31.	[...] Ianua[ri]us	3.15	360	5.5	D	.7
32.	[... Qu]adra[tus?]	3.14	385	5.5	D	.7
33.	Steminia Aemerita	1.9	400	6	D	.8
34.	Laelius M[...]	2.20	400	(6)	D	.8
35.	[---]ntis	3.13	400	6	D	.8
36.	Octavia Donata	2.3	406	(9.5)	A	.8
37.	X	1.19	(c 400)	(6)	D	.8
38.	[---]vena	3.12	420	6	D	.8
39.	Germanius Valentinus	2.16	430	(6.5)	D	.8

No.	*Proprietor*	*Sequence**	*K***	*Horae****	*Aqua*****	*% +*
40.	Germanius Dentilianus	2.14	440	(6.5)	D	.8
41.	Aemilius Secundus	1.8	450	6.5	D	.8
42.	Germanius Petronianus	2.13	450	(6.5)	D	.8
43.	P. Aemilius Rufinus	4.10	481 (oleae)	X	X	.9
44.	[... Lu]ppu[s?]	3.6	490	11.5	A	.9
45.	X	3.18	(c 500)	7.5	D	.9
46.	(Heirs of) Aelius Chrysa	1.7	500	7.5	D	.9
47.	Iulius Fortunatus	4.19	530	X	X	1
48.	(Heirs of) Iulius Petronianus	4.20	530	X	X	1
49.	X	3.5	540	13	A	1
50.	Caius) Publil(ius) Valens	2.7	550	(13)	A	1
51.	Sextilia Macrina	2.6	600	(14.5)	A	1.1
52.	(Heirs of) Manilius Rogatus	2.5	600	(14.5)	A	1.1
53.	Fl(avius) Fortis vet(eranus)	2.4	600	(14.5)	A	1.1
54.	Iulius Felix vet(eranus)	4.1	600	X	X	1.1
55.	Fufici(us) Felix (and) Priscianus	4.15	600	X	X	1.1
56.	Q(uintus) Caelius Saturninus	4.16	600	X	X	1.1
57.	Germanius Valens	4.5	609	X	X	1.2
58.	(Heirs of) Germanius Petronianus	4.6	620	X	X	1.2
59.	(Heirs of) Septimius Felicio	4.18	631	X	X	1.2
60.	Iunius Saturninus vet(eranus)	4.4	650	X	X	1.2
61.	X	3.7	660	10.5	A + D	1.3
62.	Germanius Valentinus	4.7	664	X	X	1.3
63.	X	3.4	700	16.5	A	1.3
64.	[---]kastus	3.17	730	11	D	1.4
65.	(Heirs of) Manilius Rogatus	2.2	790	(16.5)	A + D	1.5
66.	X	3.21	800	12	D	1.5
67.	Germania Castula	2.12	803	17	A + D	1.5
68.	Aelius Victor (and) Val(eria) Fortunata	4.17	826	X	X	1.6
69.	X	3.11	848	12.5	D	1.6
70.	Claudius Euticianus	4.21	891	X	X	1.7
71.	Licinia Domitia	4.8	900	X	X	1.7
72.	X	3.3	918	22	A	1.7
73.	X	3.2	1 000	24	A	1.9
74.	[---]nius Se[---]	4.22	1[000 +]	X	X	1.9 +

No.	*Proprietor*	*Sequence**	*K***	*Horae****	*Aqua*****	*% +*
75.	(Heirs of) Rutilius Luppus	4.2	1 100	X	X	2.3
76.	X	3.20	1 150	17	D	2.3
77.	X	3.23	(c 1 160-1 200)	17.5	D	2.3
78.	[---]s Gallo[nius?]	3.10	1 210	18	D	2.3
79.	[---]s Satur[nin]us	3.9	1 300	19.5	D	2.5
80.	X	3.19	1 350	20	D	2.7
81.	Valerius Crassus	2.19	1 500	(22.5)	D	2.8
82.	X	3.22	[19]55	29.5	D	3.7
83.	(Heirs of) Rogatus	3.16	2 065	31	D	3.9
84.	Aemilius Secundus	2.18	[2]300	34.5	D	4.3
85.	X	3.1	4 000	71.5	A + D	7.6

*Séquence : the order in which the property appears on the existing fragments of the stone. The first number indicates the column number, the second the order within the column counting from the top. E.g. : 2. Cornelius Expectatus 4.3 means that he is the third proprietor in the fourth column.

**K : the units of property possessed by each proprietor : a measure of his land area.

***Horae : the number of hours of water to which each proprietor is entitled measured in half-hour units.

****Aqua : the water regime according to which the property is watered, either *aqua ascendens* (A), or *aqua descendens* (D).

+ % : the percentage of the total *known* holdings on the existing fragments of the stone represented by each property.

( ) : figures in brackets have been restored.

CHART II. NAMED PROPRIETORS AT LAMASBA

Proprietor's Name	*Inscription Sequence*
1. Aelius Chrysa +	1.7
2. Aelius Felix	1.10
3. Aelius Victor°	4.17
4. Publius Aemilius Rufinus	4.10
5. Aemilius Secundus	1.8 ; 2.18
6. Apuleus Africanus	1.5
7. Apuleus Faustinus	1.3
8. Apuleus Processus	1.6
9. Apuleus Rogatus	4.13
10. Apuleus Rogatianus	1.4
11. Quintus Caecilius Saturninus	4.16
12. Caecilius Victor (maior)	4.14
13. Claudius Euticianus	4.21
14. Cornelius Expectatus	4.3
15. Dentilius Maximus	2.11
16. Dentilius Senex	2.10
17. Flavius Adiutor	1.2
18. Flavius Fortis	2.4
19. Fuficius Felix°	2.9 ; 4.15
20. Fuficius Messianus	2.8 ; 4.15
21. Fuficius Priscianus°	2.9 ; 4.15
22. Germania Castula	2.12
23. Germanius Dentilianus	2.14
24. Germanius Petronianus +	4.6
*25. Germanius Petronianus	2.13
26. Germanius Valens	4.5
27. Germanius Valentinus	2.16 ; 4.7
28. Iulia Victoria	4.12
29. Iulius Felix	4.1

Proprietor's Name	*Inscriptions Sequence*
30. Iulius Fortunatus	4.19
31. Iulius Petronianus +	4.20
32. Iunius Saturninus	4.4
33. Laelius	2.20
34. Licinia Domitia	4.8
35. Lollia Mustia	5.11
36. Manilius Aufidianus	2.1
37. Manilius Rogatus +	2.2 ; 2.5
38. Maria Satura	1.12
39. Maria Donatula	1.14
40. Marius Catullinus	1.13
41. Marius Felix	1.15
42. Marius Honoratus	2.17
43. Marius Saturninus +	1.11
44. Mattius Fortis	1.1
45. Octavia Donata	2.3
46. Caius Publilius Valens	2.7
47. Rutilius Luppus	4.2
48. Septimius Felicio +	4.18
49. Sextilia Macrina	2.6
50. Sextilius Aemeritus	2.15
51. Steminia Aemerita	1.9
52. Trebius Barbarus	4.9
53. Valeria Fortunata°	4.17
54. Valerius Crassus	2.19
55. Saturninus?	3.9
56. Gallonius?	3.10
57. Quadratus?	3.14
58. Ianuarius?	3.15
59. Rogatus + ?	3.16

This list includes only those proprietors at least *one* of whose *tria nomina* is fully preserved.

\+ signifies a person who is not a current proprietor, but a named ancestor of one of the heirs

° signifies a co-owner

* Assuming him to be a different person from no. 24.

CHART III. RATIOS OF AQUA DESCENDENS TO K

Kapita (K)	*Horae* (h)	*Water time (h) : K*
100	1.5	.015
150	2	.013
200-220	3	.015-.014
250	3.5	.014
260	4	.015
308	4.5	.015
350	5	.014
360-385	5.5	.015-.014
400-420	6	.015-.014
430-450	6.5	.015-.014
500	7.5	.015
800	12	.015
848	12.5	.015
1 050-1 150	17	.016-.015
1 210	18	.015
1 300	19.5	.015
1 450	20	.014
1 500	22.5	.015
1 955	29.5	.015
2 065	31	.015
2 300	34.5	.015

Includes all cases that are clearly testable and for which full data are preserved on the extant portions of the inscription.

CHART IV. RATIOS OF AQUA ASCENDENS TO K

Kapita (K)	*Horae* (h)	*Water time (h) : K*
165	4	.024
300	7	.023
340	8	.024
360	8.5	.023
406	9.5	.023
490	11.5	.023
540-550	13	.024
700	16.5	.024
916	22	.024
1 000	24	.024

Includes all cases that are clearly testable and for which full data are preserved on the extant portions of the inscription.

CHART V. LAND IN THE COMMON OWNERSHIP OF HEIRS

No.	*Heirs*	*Sequence*	*K*
7.	of Apuleus Faustinus	1.3	117
9.	of Marius Catullinus	1.13	150
15.	of Marius Saturninus	1.11	200
46.	of Aelius Chrysa	1.7	500
48.	of Iulius Petronianus	4.20	530
52.	of Manilius Rogatus	2.5	600
58.	of Germanius Petronianus	4.6	620
59.	of Septimius Felicio	4.18	631
65.	of Manilius Rogatus	2.2	790
75.	of Rutiloius Luppus	4.2	1 100
83.	of (---) Rogatus	3.16	2 065
		Total	7 703

(Approximately 14 % of the known total K).

RÉSUMÉ

Bien que l'inscription de Lamasba, découverte en 1877 par Masqueray, soit l'un des plus importants documents de l'épigraphie romano-africaine et qu'à ce titre, elle ait déjà fait l'objet de travaux anciens comme ceux de F.G. de Pachtère, cette importance est néanmoins telle pour la connaissance de l'organisation économique et sociale de l'Afrique romaine, les problèmes qu'elle soulève sont si multiples et si complexes, qu'il est souhaitable d'en reprendre l'étude à la base.

Paradoxalement c'est la spécificité même du document en question qui en fait l'intérêt principal. En effet, si l'organisation hydraulique qu'elle révèle devait être d'un type courant dans la zone présaharienne, les circonstances qui l'ont fait transcrire sont, en revanche, bien particulières puisqu'il s'agit du règlement par une commission d'arbitrage d'un conflit d'irrigation survenu au sein d'une petite communauté urbaine. Celle-ci était implantée au sud-ouest des Hautes-Plaines constantinoises, dans une région ouverte aux influences extérieures en raison de la proximité de la frontière : on remarque la présence dans l'élite municipale des propriétaires de Lamasba de vétérans venus de l'Afrique romanisée. La procédure, exposée dans le préambule de l'inscription, de règlement du conflit laisse deviner par une action conjointe entre les décurions et les *coloni*, la recherche d'un consensus concernant la répartition des temps d'eau en fonction de celle — très inégale — de la propriété des terres irrigables.

Ce qui reste du libellé du décret proprement dit (1/5 environ du texte primitif) fait apparaître en effet qu'à chaque propriétaire était accordé au prorata de l'importance de sa parcelle, pour une date précise de la saison d'hiver, un certain temps d'eau exprimé en heures ou en demi-heures. Ce système fondé sur une unité de temps et non de volume suppose l'existence d'une source pérenne (*Aqua Claudiana*) dont le débit devait être à peu près constant. L'eau devait être distribuée aux parcelles par un canal principal branché sur la source et qui traversait lui-même plusieurs terrasses successives. Mais outre ce réseau d'arrosage par gravité (*aqua descendens*) existait un autre dispositif (*aqua ascendens*) fonctionnant en alternance avec le précédent mais avec un débit moindre, ce qui introduisait dans le schéma de distribution un élément de complexité supplémentaire, au sujet duquel on ne peut faire que des suppositions.

Quant à l'unité de base du système qui sous l'abréviation *k* est appliquée à la propriété parcellaire, il ne s'agit pas d'une unité de valeur mais de superficie. Divers indices permettent de penser que la surface d'un casier correspondant à l'arrosage normal d'un arbre servirait de référence implicite (soit 25 à 36 m²). Ce qui ressort de l'analyse sociale du système est une grande inégalité dans la répartition de la propriété, une douzaine de familles s'attribuant les 3/4 de la surface, tandis qu'au bas de l'échelle une vingtaine d'autres n'en avaient que 5 %. En revanche, on note une grande fragmentation des parcelles dictée peut-être par des raisons de sécurité en cas d'assèchement de la source. Cette tendance est corrigée toutefois par un regroupement des lots en blocs familiaux, facilité par l'apparentement de la plupart des propriétaires.

La conclusion d'ensemble est qu'on a affaire à un système fondamentalement autochtone, perfectionné grâce à la technologie romaine, mais en cela même la société de Lamasba est très représentative des situations hybrides, tant il est difficile de distinguer le greffon du sujet greffé.