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Gardens of the Hesperides: The Rural Archaeology of the Loukkos Valley. Interim Report on the 2016 Season

Aomar Akerraz – Stephen A. Collins-Elliott

Résumé

Ce rapport intérimaire explique la méthodologie et fait état des résultats préliminaires de la première saison du projet « Aux Jardins des Hespérides : l'archéologie rurale de la vallée du Loukkos » *(INSAP-UT), qui vise à reconsidérer le développement de l'économie agricole autour de Lixus, une des cités les plus anciennes d'Afrique du Nord (près de Larache, Maroc), et à mesurer la connectivité et l'intégration régionale de l'arrière-pays en vue de la formation urbaine de Lixus et de l'impact de l'annexion romaine. Par un programme de prospections systématiques et non-systématiques, quatorze sites archéologiques des époques préromaine et romaine ont été localisés, pour la majeure partie au nord de Lixus. En utilisant la modélisation informatique des données sur les caractéristiques présentes à chaque site ainsi que la quantification des céramiques, la région semble subir un procédé d'intensification de la circulation des biens transportés dans les amphores, ainsi que le peuplement stable dans la campagne plus éloignée, autour du deuxième siècle avant J.-C., bien que les plus fortes concentrations des amphores Dressel 1 ont été trouvées sur les sites à proximité des rivières. Enfin, l'utilisation de l'analyse des correspondences multiples est explorée comme une méthode multivariée pour le regrouppment des sites archéologiques en termes de leurs facteurs materiels, à établir la définition d'un site « de bas en haut », plutôt que prescriptivement.*

Introduction

Gardens of the Hesperides: The Rural Archaeology of the Loukkos Valley (henceforth "Project Hesperides") is a newly formed Moroccan-American archaeological project to survey and reconstruct the economic development of the Loukkos river valley around Lixus, the oldest city in northwestern Africa, over the longue durée. Named for the mythical gardens which classical authors located at Lixus, the aims of Project Hesperides involve four objectives: (1) to model rural settlement and economic patterns in the valley of the Oued Loukkos from the Atlantic coast near Larache (Lixus) to El Qsar el-Kebir (Oppidum Novum), through systematic survey, in order to evaluate landscape use and behavior over the long term from the Iron Age (Mauretanian I) onward; (2) to model the use of ancient plant and animal resources around the city, in particular, those related to economy of wine and olive oil; (3) determine the impact of the provincialization of the region by the emperor Claudius after ca. 40 CE on the hinterland around Lixus; (4) to compare the evolution of the regional economy of the Oued Loukkos broadly with that of the western Mediterranean, evaluating the level of integration and connectivity of Lixus in the Roman Empire.

Figure 1. Lixus in relation to other major ancient sites in the western Mediterranean.

The project is co-directed by Aomar Akerraz, *directeur géneral* of the Institut National des Sciences de l'Archéologie et du Patrimoine (INSAP), and Stephen A. Collins-Elliott, of the Department of Classics at the University of Tennessee, Knoxville (UT). The *convention scientifique* between INSAP and UT was signed on June 8, 2016, for a term of five years, subject to renewal for another three years, to accomplish the research objectives above. The first phase of the project, planned for 2016-2018, consists of a systematic survey of the Oued Loukkos, dedicated to the completion of the first research objective, while the second phase of the project, planned for 2019-2020, is devoted to targeted excavations of rural sites in order to achieve the second through fourth goals. The 2016 mission, which lasted from July 10 to August 5, 2016, was supported by INSAP and the UT Department of Classics, involving a pilot season in order to test the methodology of systematic and extensive fieldwalking and reconnaissance, artifact collection and processing, and photogrammetry as a means of documenting and mapping archaeological features. Project Hesperides is run in conjunction with the program of research carried out by INSAP under the initiative Protars (Programme Thématique d'Appui à la Recherche Scientifique), which has conducted surveys in the Oued Loukkos since 1997.

This interim report discusses the background and methodology of the small pilot season in 2016, and also seeks to provide some preliminary results. This project places emphasis on quantitative comparisons of archaeological materialin order to establish a comparative framework for understanding the scale of regional developments. As two more years of field survey are planned, the context and scope of the data obtained from the pilot season are destined to change with the addition of new information, and this this report seeks to place emphasis on the methodology used, especially using a composite z-score as a way to address the influence or effect of post-depositional factors on quantified archaeological assemblages. Multiple correspondence analysis, a method of categorical data analysis, is also put forward as a means to construct site definitions, rather than proceeding from *a priori* definitions based on scatter size of material.

Background

Located on the Atlantic coast at the mouth of the Loukkos river, Lixus was regarded by classical sources as one of the earliest foundations in northwestern Africa, associated with the Phoenicians, the cult of Herakles/Melqart, and the mythical Gardens of the Hesperides (Fig. 1)[1]. The site of Lixus was occupied from the

[1] Strabo 17.3.2-3, 8; Pliny, *NH* 5.2-5, 9; 19.53. See GRAS 1992, LIPIŃSKI 2004: 455-457.

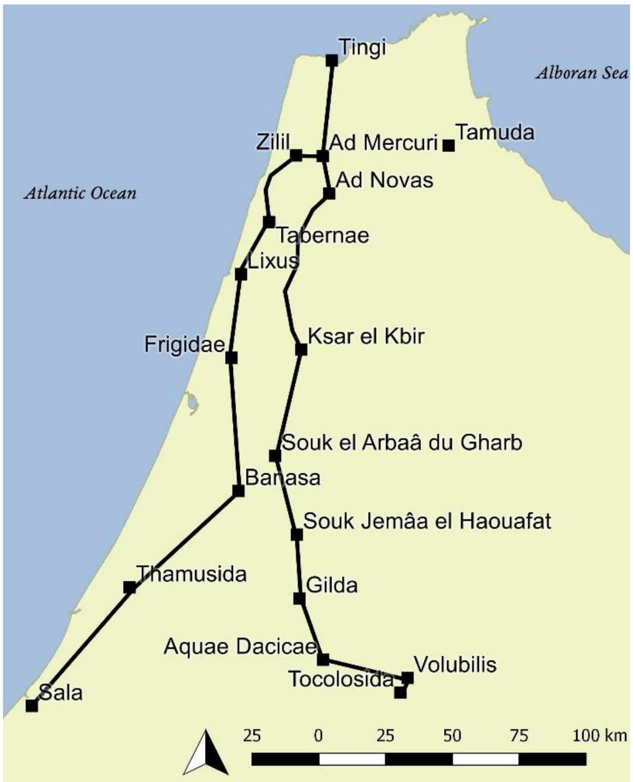

Figure 2. Routes of the Itinerarium Antoninum, with the location of Roman-period sites.

eighth century BCE up to the fifteenth CE, and its urbanization was one of the earliest in the western Mediterranean[2]. The earliest materials related to Lixus' occupation, Ramón T.10 amphorae and ceramics dating to the eighth and seventh century BCE whose types have close comparisons at other Iberian and Moroccan sites, have been viewed within the paradigm of a colonial, "Phoenician" trade diaspora[3]. The development of the city and its economic history throughout antiquity have therefore received much attention for its place in the broader context of the western Mediterranean, considered primarily in its capacity as an entrepôt, whose economic prosperity depended on commerce and maritime industries like the production of garum and sea-salt[4].

Yet, the hinterland of the Oued Loukkos offers the potential to assess the context of Lixus' urbanization as well as its regional connectivity. In contrast to the city center, the development of the ancient countryside has received relatively little attention[5]. One of the earliest substantial contributions was that of Charles Tissot, who relied in large part on the Itinerarium Antoninum, along with other classical authors, to chart the two parallel routes which passed through the basin of the Loukkos southward from Ad Mercuri, with one route heading toward Banasa and the other toward Volubilis (Fig. 2)[6]. The Loukkos river valley was further investigated by Michel Ponsich, who published a gazetteer of archaeological sites in 1966[7]. Ongoing surveys conducted by INSAP since 1997 have contributed greatly to our knowledge of the archaeology of the Loukkos[8]. These surveys, along with excavations, have shed important light on the material record of the Loukkos, including excavation of a necropolis at Raqqada to the west of Lixus that has yielded around fifty tombs dating from the end of the sixth to the fourth century BCE, containing grave goods of bronze, silver, and gold artifacts and amphorae[9]. The site of Azib Slaoui brought to light a settlement with multiple phases (Mauretanian (ca. 6th-5th c. BCE), Roman (1st-2nd c. CE), and Almohad-Merinid), as well as a necropolis of twelve tombs dating ca. 6th-4th century BCE[10]. Roman military camps have been located at Lemdenna Lahmira, El Mers, as well as Souier[11]. Finally, Oppidum Novum, mentioned in the *Itinerarium Antoninum*, is probably found at the site of the modern city of El Qsar el-Kebir, where Latin and Greek inscriptions have been located in the construction of the minaret of the Grand Mosque[12].

[2] For excavations at Lixus, see most recently ARANEGUI 2005 and ARANEGUI, HASSINI 2010, the collection of papers in *LIXUS* 1992, as well as AKERRAZ ET AL. 2009; BROUQUIER-REDDÉ, ICHKHAKH, EL KHAYARI 2006; BROUQUIER-REDDÉ, EL KHAYARI, ICHKHAKH 2008; BROUQUIER-REDDÉ ET AL. 2010; PAPI 2013: 800; and PONSICH 1981; PONSICH 1982: 820-821; TISSOT 1877: 67-85; PAPI 2014: 210-212.
[3] EL KHAYARI 2004: 149-150. See CAÑETE,VIVES-FERRÁNDIZ 2011 on wheel- and hand-made ceramics; cf. MAASS-LINDEMANN 1992. The earliest building phases date to the seventh century BCE; see ARANEGUI and HASSINI 2010: 99-102.
[4] PONSICH 1982: 836-840.
[5] A summary of the archaeology of the region can be found in VILLAVERDE VEGA 2001: 117-144.
[6] TISSOT 1877, 130-143, 160-164. Perip. Hanno (6-7) mentions the *Lixitai* but not Lixus. Pseudo-Scylax 112; Pomponius Mela 3.107; Ptol. *Geo.* 4.1; cf. sources in note 1. Tissot identified the site of Ad Mercuri with the site of Dchar Jdid (AKERRAZ ET AL. 1981, 171), which is today recognized as the site of the Augustan colony of Zilil. See EUZENNAT 1962: 601; AKERRAZ ET AL. 1987; SPAUL 1998.
[7] PONSICH 1966.
[8] AKERRAZ, EL KHAYARI 2000.
[9] EL KHAYARI 2007.
[10] AKERRAZ, EL KHAYARI 2000.
[11] Lemdenna Lahmir was discovered in 1997, situated in the district of Tlata Rissana, with ceramics dating to the 4th-5th c. CE. Souier, near Arba'a Ayacha on the left bank of the Oued Kebir, was originally a Roman fort, but later developed into a town.
[12] AKERRAZ AND REBUFFAT 1991.

Figure 3. The hill of Choumis, the loca-tion of the site of Lixus, rising above the plain from the southern bank of the Oued Loukkos (Photo: S.C.-E.).

In this context, then, Project Hesperides aims to assess land-use and the production, shipment, storage, and consumption of food, over the long term, focusing on the period of Roman occupation. The goal is to investigate the connectivity between Lixus and its hinterland in light of its agricultural economy, and the degree to which regional sufficiency or integration changed before and after the annexation of Morocco as *Mauretania Tingitana* under the Emperor Claudius, subsequent to the suppression of the revolt of Aedemon (after ca. 40 CE)[13]. The aim more broadly is to understand the development of the agricultural economy not in a teleological or evolutionary manner, but in light of behavioral, sociocultural factors that shaped the interests of the inhabitants of the Oued Loukkos, and how those trends related to the urbanism of Lixus, and, in turn, the maritime economy of the western Mediterranean.

The Environmental Landscape of the Oued Loukkos

The Oued Loukkos can be seen as a microregion, an ecological entity which has the river as its central feature (Fig. 3)[14]. In terms of coverage, the hydrological boundaries of the Loukkos river basin cover ca. 2,560 km^2, whose climate can be characterized as subhumid Mediterranean with Atlantic influences, with an average annual rainfall of the region of 700 mm[15]. Starting in the Rif Mountains, the river is supplied by the major affluents of the Oued Ouarour and the Oued El Makhazine, flowing west-northwest in a meandering course ca. 180 km to the Atlantic coast. The lower Loukkos consists of a coastal estuary characterized by clay marl and marshy lowlands, which experience a significant degree of both alluvial sedimentation and tidal processes from the Atlantic[16]. At the mouth of the Loukkos, the river is bordered on the north side by the plateau of the Sahel, and on the southern side by the sandstone plateau of R'mel, on which is located the modern city of Larache[17].

The Loukkos is a dynamic environment, and the changes that have signifantly altered appearance of the landscape are fairly recent[18]. The lower Loukkos around Lixus was formerly a lagoon, gradually becoming shallower from late Antiquity onward, until it rapidly diminished from the 17th to early 20th centuries[19]. Drainage of the lower Loukkos was undertaken during from the 1920s-1950s, with intensified agricultural development starting in the 1970s and 1980s, focused on the implementation of ecologically appropriate farming practices and

[13] *IAM* 2, 448, Suet. *Calig.* 35. BRIAND-PONSART, HUGONIOT 2006: 55-56; KABLY 2011: 113-117; VANACKER 2013.
[14] HORDEN, PURCELL 2000: 45-49.
[15] Information on the territorial extent of the Loukkos from ORMVAL (Office Régional de Mise en Valeur Agircole du Loukkos, at http://www.ormval.ma, as well as the Agence du Bassin Hydraulique du Loukkos at www.abhloukkos.ma. Other estimates range at ca. 3,750 km^2, e.g., CARMONA, RUIZ 2009, GEAWHARI ET AL. 2014; EL MORHIT, MOUHIR 2014. HUFTY (1988: 9) estimates it as 1,820 km^2.
[16] CARMONA AND RUIZ 2009 and GEAWHARI ET AL. 2014.
[17] CARMONA GONZÁLEZ 2003: 23-28; CARMONA AND RUIZ 2009: 826.
[18] Environmental analysis of the survey region will begin in 2017.
[19] CARMONA, RUIZ 2009: 839-841.

water management policies[20]. There are accordingly several geological, hydrological, biological studies available on the formation of the Loukkos over time[21], though these have largely been concentrated on the lower part of the Loukkos around Larache and Lixus, which continues to be the object of archaeological investigation[22].

Information about the plants and animals of the Loukkos valley in antiquity have been obtained primarily from the site of Lixus itself, which have produced a profile of the natural resources utilized by its inhabitants from its earliest occupations[23]. The earliest phase of occupation in the eighth and seventh centuries BCE attests to the presence of ash (*Fraxinus* sp.), olive (*Olea europea*), pine (*Pinus pinea*), poplars or willows (*Populus* sp. or *Salix* sp.), oak (*Quercus ilex*, *Quercus ilex-coccifera*, *Quercus suber*), elm (*Ulmus* sp.), as well as giant heather (*Erica arboraea*), *Leguminosae* sp., *Pistacia lentiscus*, hawthorne (*Rhamnus* sp.), and *Rosaceae* sp.[24]. In terms of cereals, the earliest phases attest to barley (*Hordeum vulgare*) and bread wheat (*Triticum durum-aestivum*), as well as the genus of grass *Phalaris*, which is found in fields under wheat cultivation[25]. Oats (*Avena* sp.) and figs (*Ficus carica*) appear in the sixth century BCE, but not in later contexts of the first centuries BCE and CE[26]. Noteworthy is the presence of the vine (*Vitis vinifera*) only in the first century CE[27].

The results from Lixus accord broadly with other palynological studies in the region, insofar as anthropogenic and geomorphological, rather than climatological, factors are considered to lie behind the shape of the plant record: the in-filling of the lagoon as well as the deforestation of local cork-oak woods, whether for cereal cultivation or for pasturage, is a trend in both antiquity and more recent times[28]. Yet, combining the results of palynological and other archaeobotanical data necessitates further research on local factors when considering the global picture of the Loukkos valley: cork oak around Lixus appears to diminish earlier during the mid-first millennium BCE[29], while coring from a bog at Krimda 14 km to the north indicates that the cork oak forest disappeared there during the 14th century CE[30]. Another more striking example can be found in the case of olive tree cultivation. While olive wood is present at Lixus from the earliest excavated phases, its frequency in cores from the Oued Sakh Sokh to the south is very low and only develops much later, from the 10th century CE onward, which could indicate either the disappearance of oleoculture at some point in antiquity, or rather its restriction to the area immediately around Lixus[31].

In terms of animal remains, the highest represented taxon from the earliest phases of Lixus is cattle (*Bos taurus*), followed by pig (*Sus domesticus*), present from the sixth century BCE, with ovicaprids (*Ovis aries*/*Capra hircus*) initially in lower frequency but increasing in the third century BCE. Horse (*Equus caballus*) appears in the fifth century BCE, dog (*Canis familiaris*) and donkey (*Equus asinus*) appear in the third; Taxa which appear starting in the first and second centuries CE include deer (*Cervus elaphus*), aoudad (*Ammotragus lervia*), and camel (*Camelus dromedarius*)[32].

[20] Carmona, Ruiz 2009: 824-826; World Bank 1990.
[21] Geological, geomorphological and sedimentary research: Carmona González 2003, 23-28; Carmona González 2005; Carmona, Ruiz 2009; Carmona González, Ruiz 2010; and Mhammdi et al. 2015; cf. El Gharbaoui 1981; Ballouche et al. 1986. Erosion in the Rif: Moore et al. 1998, 359. Hydrology and water management: Tejera de León, Duplantier 1981; Snoussi 1984; Hufty 1988; El Kellouti 2005; Cheggour et al. 2005; El Morhit et al. 2008; Palma et al. 2012; El Hamidi et al. 2016; El Morhit et al. 2012; El Morhit et al. 2013; El Morhit and Mouhir 2014; and Geawhari et al. 2014. Botanical and biological studies: Bouhache, Boulet, Chougrani 1993 and Ballouche 2013. Maritime archaeology: Trakadas 2012.
[22] The Oued Loukkos Survey Project directed by Dr. Athena Trakadas (University of Southampton, UK/University of Southern Denmark, Denmark), Dr. Nadia Mhammdi (Université Mohamed V – Rabat, Morocco), and Dr. Lloyd Huff (Emeritus, University of New Hampshire, USA) is currently in progress, carrying out an archaeological, geological, and hydrographical survey to reconstruct the evolution of the Loukkos from the eighth century BCE to the eleventh century CE, to reconstruct the development of Lixus' harbor infrastructure and its maritime connections.
[23] Grau Almero 2005; Rodríguez Santana, Rodrigo García 2005; Carrasco Porras 2005; Iborra Eres 2005; Pérez Jordà 2005; Grau Almero, Iborra Eres, Pérez Jordà 2010a, 2010b, 2010c; and Grau Almero 2011.
[24] Grau Almero, Iborra Eres, Pérez Jordà 2010c: 61-62.
[25] Grau Almero, Iborra Eres, Pérez Jordà 2010c: 63.
[26] Grau Almero, Iborra Eres, Pérez Jordà 2010a.
[27] Grau Almero, Iborra Eres, Pérez Jordà 2010b: 129.
[28] Grau Almero 2011; Ballouche 2013: 74-75. In course of fieldwork during the 2016 season, several older residents commented on areas which had been forested in the mid-20th century.
[29] Grau Almero 2011: 107.
[30] Damblon 1991; Ballouche 2013: 75.
[31] Ballouche 2013: 76. Cf. Reille 1977.
[32] Grau Almero, Iborra Eres, Pérez Jordà 2010c: 65-66; Grau Almero, Iborra Eres, Pérez Jordà 2010a: 112.

Figure 3. North side of the Loukkos, looking north across the plateau of the Sahel, taken from TU0007 (Photo: S.C.-E.).

Figure 4. TU0030, on the south side of the Loukkos, looking east from the uplands over the alluvial basin of the river (Photo: S.C.-E.).

Methodology of the 2016 Season

Project Hesperides is diachronic, focusing on the development of the regional agricultural economy from the Early Iron Age (ca. 8th century BCE) to the period of the Roman occupation (up to the 5th century CE). The goals of the 2016 season included experimentation with siteless survey in the hinterland of Lixus and the evaluation of this methodology for future fieldwork seasons, as well as assessing the possibility of integrating the results of the earlier survey undertaken by Michel Ponsich. The survey thus focused initially on the north side of the Loukkos, on the series of hills that form the limestone plateau of the Sahel, which were divided by seasonal creek beds which feed into either the Loukkos or Atlantic (Fig. 4). Furthermore, the north side is comprised largely of open fields, which facilitated fieldwalking as a part of the systematic survey. The southern side of the Loukkos

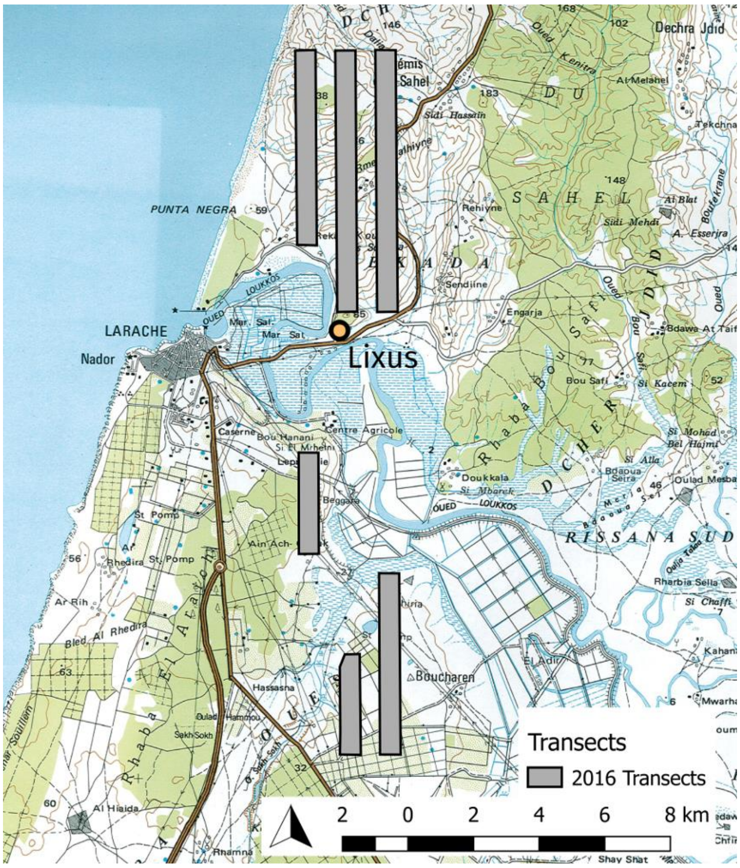

Figure 6. Sampling transects for the intensive field survey, 2016 pilot season.

was much more intensively cultivated and occupied, with private plots divided by large cactus hedges as well as irrigated farms which impeded fieldwalking. The program of intensive survey utilized a total collection of finds, including medieval material. Since the object was to assess changing patterns of connectivity in the Oued Loukkos over time, it was felt that potential comparisons with medieval occupation of the region should prove fruitful and should not be neglected out of hand.

Given the extent of the Loukkos basin, as noted above, a method of systematic sampling of transects across the river valley was used in order to select fields for a siteless, systematic survey. Extensive survey methods included the visitation of previous sites recorded by INSAP and Ponisch, to maximize the amount of information that could be collected during the survey. The aim was to achieve the most comprehensive results for the detection of archaeological sites in the Oued Loukkos in a way that entailed quantitative balance in the collection of finds. Additional reconnaissance and exploration of areas which were not amenable to systematic survey was undertaken, with the path of the team at all times recorded using handheld GPS (see below).

Approaching the Landscape

Project Hesperides is focused on the rural uplands of the Loukkos valley, above the marshy plain of the river itself (Fig. 5). The program of systematic survey was carried out on the model of a siteless survey, adapting the methodology used by extra-urban surveys around Leptiminus in Tunisia and Olynthos in Greece[33]. For the siteless survey, three survey transects were set up following a north-south orientation using the Merchich / Nord Maroc (Lambert) projection, along an arbitrary grid 500 m in width at 500 m intervals, west to east from 434,050 to 436,550, and north to south from 518,168 to 500,668, in which to conduct a systematic collection of materials (Fig. 6). While thin-strip transect sampling has been criticized for its failure to detect all sites, it was nevertheless desirable to outline a sampling zone prior to undertaking the pilot survey, given the limitations of the team size[34]. The sampling transects covered a total area of around 13.8 km^2. Maps used included those available at both 1:25,000 and 1:100,000 scale from the Agence Nationale de la Conservation Foncière, du Cadastre et de la Cartographie, as well as satellite images from Google Earth. A digital elevation model was also developed using topographic data collected from NASA's Shuttle Radar Topography Mission (SRTM), freely available online[35].

[33] Dunnell, Dancey 1983; Mattingly 1992; Stone, Mattingly, Dore 2011; as well as Stone 2014, provided by personal communication. See also Caraher, Nakassis, Pettegrew 2006.
[34] Bintliff (2000: 201-203) recommends *Siedlungskammer*, sampling areas which are considered to be large enough to support a settlement. Cf. Orton 2000: 67-87.
[35] https://www2.jpl.nasa.gov/srtm/.

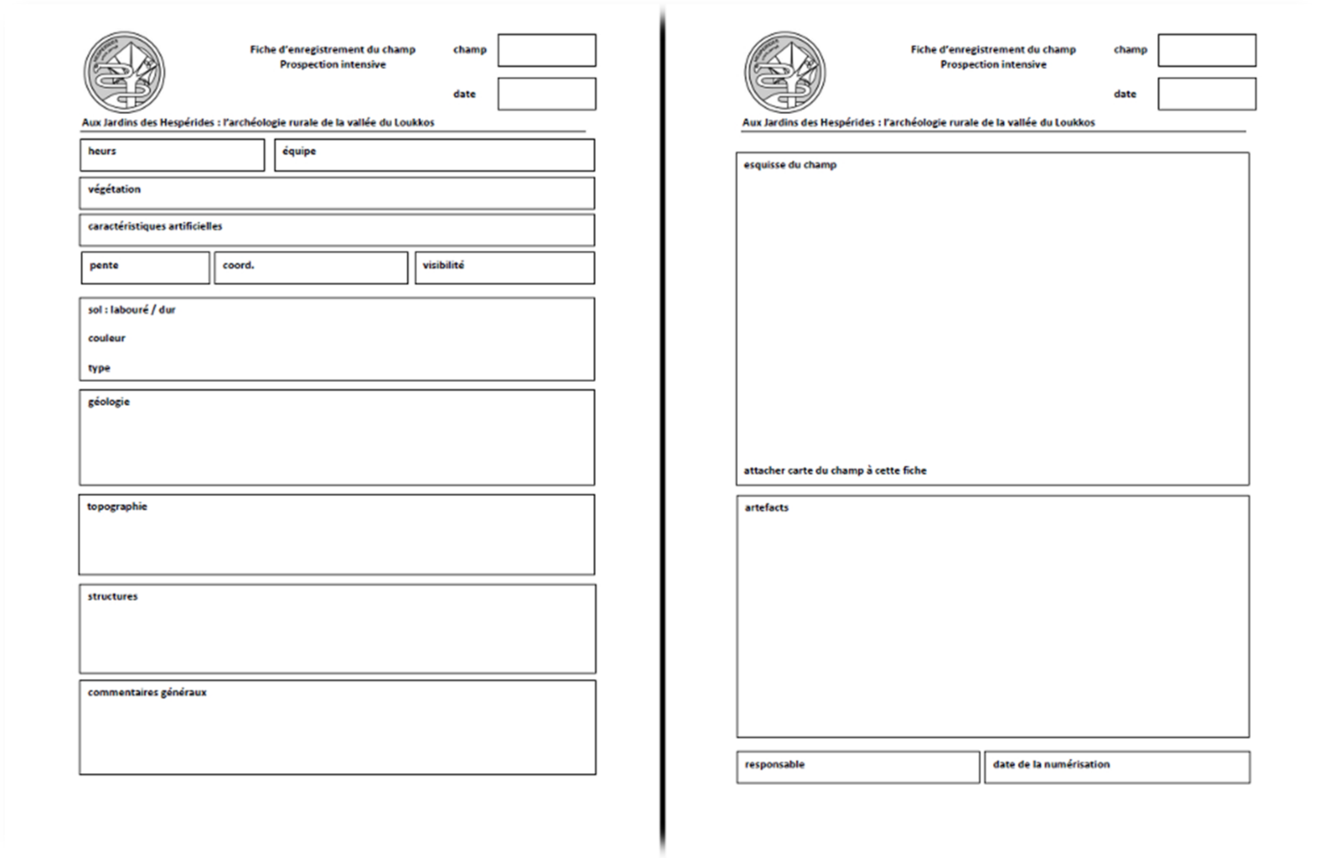
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Figure 7. Record sheet for the program of intensive survey.

The basic contextual unit for artifact collection was defined as the topographic unit, abbreviated as TU (*l'unité topographique*, UT), a geospatial entity in the physical terrain which contained an archaeological feature or element (e.g., standing architecture or debris, rock cutting; archaeological finds, namely ceramics, or other material). The TUs from 2016 were numbered consecutively from TU0001, TU0002, etc, with the information about each TU registered on a context sheet (*fiche d'enregistrement*, Fig. 7). Sheets were scanned at the end of their completion and linked to the project database in MS Access. The most frequent definition of a TU was an individual field which was surveyed through systematic collection of finds. Other TUs included walls, fragments of architecture, and cairns. TUs were mapped using a handheld Garmin GPSMap 64 Worldwide with high-sensitivity GPS and GLONASS receiver, and all photos tagged using a Solmeta Geotagger N3-c. The spatial data of each TU was uploaded to the project GIS, managed in QGIS, at the end of each day of fieldwalking. The boundaries of each TU were compared against satellite imagery to ensure correct placement, with reference to the sketch of the field on the context sheet filled out in the field. Context sheets were digitized at the end of the season, ensuring a complete digital record of fieldwork with the paper sheets kept archivally.

With the low accuracy of the handheld GPS device and the exigencies of a small survey team with limited time, photogrammetry with rudimentary trilateration was used to map any architectural features. For example, TU0076 at the site of HESP-7 comprised a thermal building complex that was visible on the southern bank of the Oued Rayhane, composed of large blocks of masonry with mortar, with walls ca. 0.5 m in width along a northwest-southeast orientation (Fig. 8 and 9). This site may be the one recorded by Ponisch as no. 47, called Graza, near Sidi Abderahim, but this cannot be confirmed on the basis of the coordinates or the description contained in his report[36]. If this is the site of Graza, Ponsich recorded fragments of Roman amphora and ARS at the site, but grab sampling during the 2016 season around the immediate area around the structure recovered only two datable

[36] PONSICH 1966: 412.

Figure 8. Standing architecture of a thermal complex (TU0076), so-called "Graza." Taken from the bed of the Oued Rayhane (Photo: S.C.-E.).

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Figure 9. Standing architecture (TU0076, "Graza"). From above, looking NE. (Photo: S.C.-E.).

sherds, one of Spanish *terra sigillata* and another of an African amphora (type uncertain)[37]. Processing of photos for photogrammetric econstruction had to take place post-season rather than in-field, to produce an orthophoto and map of surface architecture at the site (Fig. 10 and 11).

The procedure for the collection of finds within a TU was carried out following both a systematic method to collect a representative assemblage of material on the surface, as well as a non-systematic grab sampling to collect any finds which might have qualitative significance (e.g., diagnostic sherds for dating). First, the TU was mapped following existing field boundaries in the terrain, and the visibility of the field was evaluated: only fields with a visibility of 30% and over were surveyed in the pilot, since fields passed over could be revisited in subsequent seasons. The systematic collection involved lining up walkers along one field limit, spaced at a distance of 10 m from one to the other, with a window of 1 m on either side, in order to obtain a coverage of 20% of the terrain, 2 m for each 10 m (Fig. 12). If the field dimension was larger than the extent that could be covered by the number of available walkers, sweeps of the remaining terrain were conducted. After a systematic pass had been made, a non-systematic grab sampling was made. For certain TUs in which a systematic collection of finds was impossible (such as standing architecture, debris found in ravines), only a grab sample was collected. More intensive gridded collection at sites is planned for future seasons.

[37] Sherd scatters were more substantial across the riverbed of the Oyed Rayhane ot the north, which were mapped as TU0077, TU0078, and TU0079. Further comments on the detection of sites mentioned by PONSICH 1966 can be found below, in the section on preliminary results.

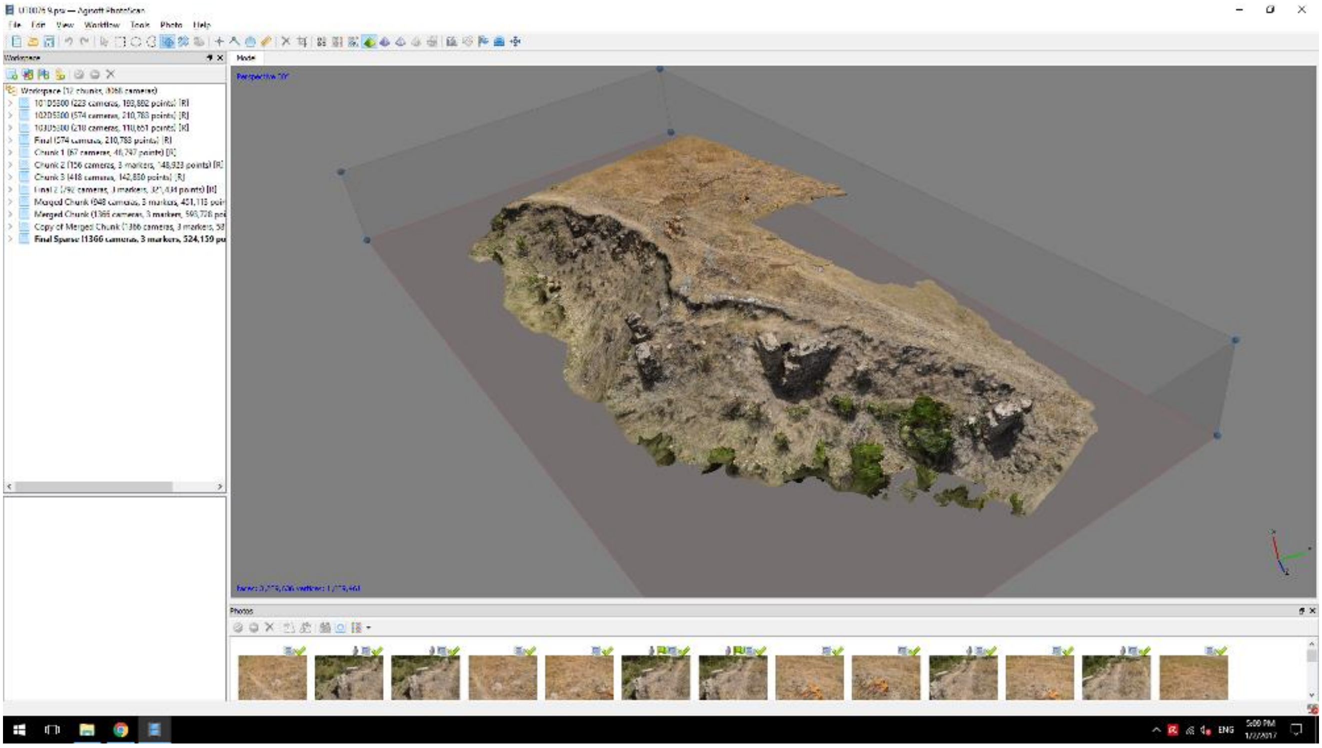

Figure 10. Photogrammetry: post-season processing of a 3d model of the surface features of the site of "Graza" in Agisoft Photoscan.

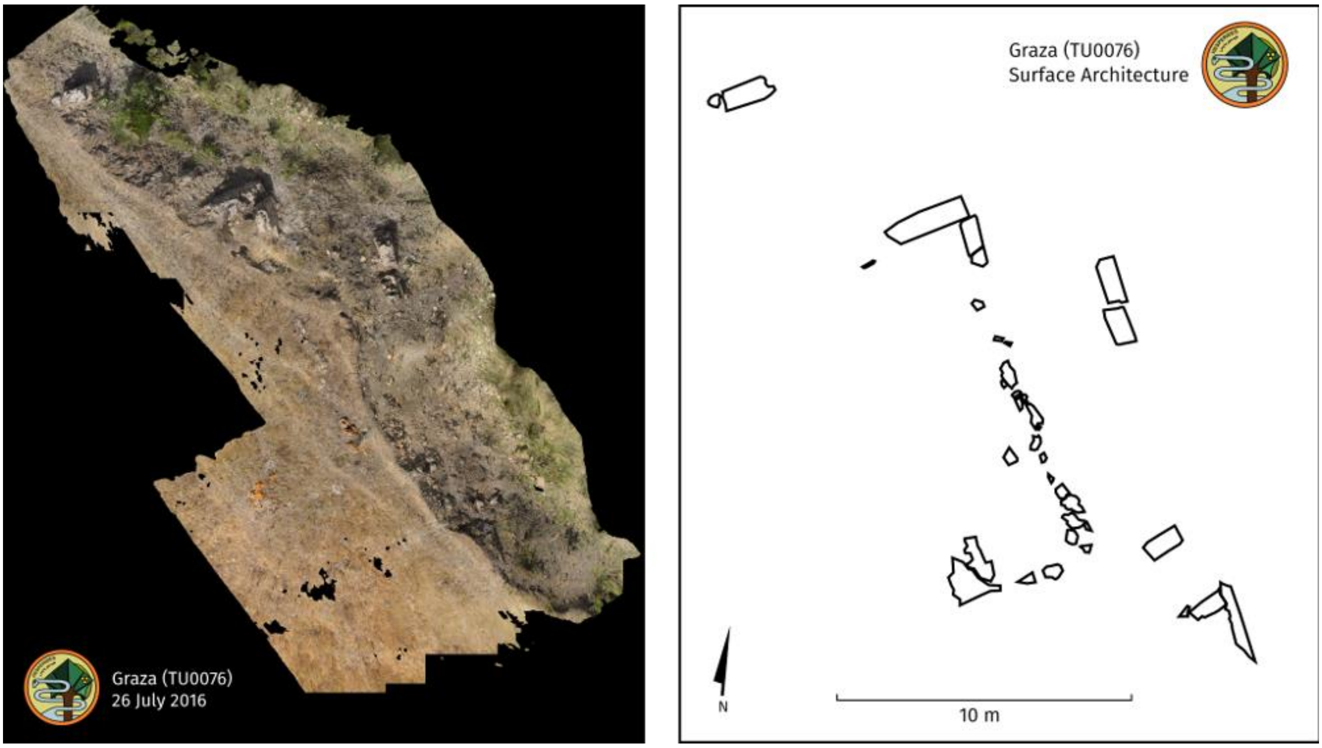

Figure 11. Resulting orthophoto and plan of the site of TU0076 "Graza".

Figure 12. First day of the field survey, with INSAP and University of Tennessee students walking TU0003, to the north of Lixus and the Oued Loukkos (Photo: S.C.-E.).

Finds Analysis

Finds from the program of systematic survey were lab eled in bags with a label recording a bag number, date, and collection method (systematic or grab), and were entered into a relational database. The database in MS Access was designed primarily for accession, with the analysis of results achieved through scripts in python that could query and return results for quantitative analysis using methods available in either R or numpy (Fig. 13).[38] The structure of the ceramics database was such that each record comprised a uniquely identifiable set of sherds, which are defined by the list of attributes presented in Table 1.

Field	Description
id	unique key of the batch of sherds processed
bag	inventory - bag number
frpart	whether fragment(s) is/are rim, handle, base, body (lamps only: spout, shoulder)
sherdcount	number of fragments
weight	weight in grams
eve	estimated vessel equivalent (percentange of rim/base)
class	class - ware (text string description)
form	type - form (text string description)
bibl	comparanda, citation, or reference
comment	additional text comments
date1	earliest possible date
date2	latest possible date
drawing	true/false if drawn

Table 1. List of fields in the ceramics quantification table of the project database.

The classification and typology of ceramics was treated as a multi-stage process, the first treated as a broad preliminary classification to organize the material into batches, the second a more detailed analysis regarding the ware and morphology of the vessel. The goal was to have in place an expedient method to organize the flow of research. With respect to data entry and inventory using the initial step of a preliminary classification, accession for these fields were made using two text-string fields of ware and form. A. El Khayari and S. Collins-Elliott undertook the preliminary classification.

The set of preliminary classifications in the ware or form field is linked to a relational table of analytical classifi cations for the purpose of studying the material, breaking the process of identifying and describing finds study into a process of immediate accession and analysis. Thus, classification and typology of finds was maintained in the database in two text fields, “class” and “form,” with an additional field for discursive notes. Information in the class and form fields was entered in as a text-string description of unique, basic attributes, for example, “amphora Dressel_1 Dressel_1_Tyrrhenian,” or “amphora Haltern_70_type.” Where ceramic fabrics could not be exactly or clearly classified, the field description could still be expressed by a string of potential categories, like

[38] Hunter 2007; Lê, Josse, Husson 2008; van der Walt, Colbert, Varoquaux 2011; R Core Team 2016.

"amphora amphora-like common_ware", to express any potential categorization of finds. These database descriptions were then subjected to a data-cleaning and taxonomic algorithm, *synthkat*, which generates a set of synthetic categories for the purpose of querying finds from the database[39]. Subsequent restudy of finds is tracked through the addition of tables, keeping study and research separate from the process of inventory and accession. This "double-entry" method of data-keeping thus serves the needs of a project as it evolves throughout the duration of fieldwork, allowing for the generation of new queries and tables alongside pre-existing data structures. Mapping artifacts was accomplished by importing finds data into the project GIS, managed in QGIS, where densities were calculated and plotted.

Table 2 provides an overview of the quantitative distribution of the different ceramic classes that were recovered in the 2016 pilot season. It should be emphasized, however, that this classification is preliminary and more detailed research remains to be conducted, above all toward establishing a catalogue of fabrics related to the production of course wares in the Oued Loukkos. The most frequent classes of finds by far were unslipped ceramics and amphorae. Transport amphorae comprised the bulk of datable ceramics, most of which consisted were dated to the late second century BCE or first century BCE (as evidenced by Dressel 1 amphorae) and after. Even in the areas which were close to the sites published by Ponsich that had yielded African Red Slip or *terra sigillata*, easily identifiable finewares were scant. Lithics were likewise scarce, with only two worked flints collected. Islamic ceramics were identified on the basis of fabric, and divided into common (unslipped), painted, and glazed classes.

Ceramics were quantified by sherd count, weight, and estimated vessel equivalents (eve), the last of which used the percentage surviving of the rim and/or base of the vessel[40]. These measures were further normalized using z-scores, which were then averaged to compute a composite z-score that mitigated the effects of fragmentation, material density of the fabric[41]. Issues of fragmentation with respect to archaeological assemblages are well known, especially those related to surface contexts[42]. Thus, the use of a composite z-score aided in minimizing the effects of post-depositional factors on the quantification of the assemblage. Given that this approach is not common or standard practice in survey archaeology, a few words on the prodecure are or in order, and using by way of illustration the case of the assemblage of Dressel 1 and Dressel 1-type amphorae, dating ca. 150 – 10 BCE, recovered from the survey.

	Systematic			All Finds		
Class	n_{fr}	n_w	n_e	n_{fr}	n_w	n_e
African cookware	13	76	0.314	24	156	0.844
Amphora	572	35946	1.933	614	39339	3.425
ARS	8	38	0.458	16	73	0.703
Black gloss	1	10	0.083	2	19	0.083
Common	63	801	1.553	102	1374	3.717
Dolium	4	520		8	1268	
Handmade	7	350		7	350	
Islamic common	132	3673	3.492	162	4766	4.639
Islamic glazed	3	55		12	170	
Islamic painted				1	17	
Terra sigillata	2	16	0.264	7	48	0.514
Thin-walled ware				1	2	0.103
Non id	203	4597	0.097	246	6420	0.097
Total	1008	46082	8.194	1202	54002	14.125

Table 2. Preliminary quantification of ceramic finds collected at the end of the 2016 pilot season, in both the systematic inventory and the total inventory (systematic + grab). Finds are quantified by sherd count (n_{fr}), weight in grams (n_w), and eve (n_e).

[39] COLLINS-ELLIOTT 2016. See also MEYER 2003; MOORE 2008.
[40] See ORTON 1975; ORTON, TYERS 1990; and ORTON 1993; 2009.
[41] In practical terms that the smaller the fragment, the greater the potential error in calculating the estimated diameter, and hence surviving percentage, of the ceramic vessel. While estimated vessel equivalents using rim or base fragments circumvents both the effects of vessel breakability and density of material, the paucity of diagnostic fragments in comparison to the rest of the assemblage means that a significant source of information would be lost if only eve was used.
[42] See HASELGROVE 1985; FRANCOVICH, PATTERSON 2000; and WINITHER-JACOBSEN 2010.

Context	Area (m^2)	n_{fr}	n_w	n_e	n_{fr} / m^2	n_w / m^2	n_e / m^2	z_{fr} (log)	z_w (log)	z_{comp}
TU0061	3833	7	755	0.40	1.83E-03	1.97E-01	1.05E-04	2.01	1.93	1.97
TU0060	3036	2	313	0.00	6.59E-04	1.03E-01	0.00E+00	1.14	1.49	1.32
TU0034	6311	9	285	0.00	1.43E-03	4.52E-02	0.00E+00	1.80	0.93	1.36
TU0077	5700	2	116	0.18	3.51E-04	2.04E-02	3.17E-05	0.60	0.39	0.49
TU0059	7423	2	424	0.00	2.69E-04	5.71E-02	0.00E+00	0.38	1.09	0.73
TU0058	5861	2	247	0.00	3.41E-04	4.21E-02	0.00E+00	0.58	0.88	0.73
TU0056	5050	2	122	0.00	3.96E-04	2.42E-02	0.00E+00	0.71	0.50	0.60
TU0011	3533	1	50	0.00	2.83E-04	1.42E-02	0.00E+00	0.42	0.14	0.28
TU0088	38909	5	634	0.00	1.29E-04	1.63E-02	0.00E+00	-0.25	0.23	-0.01
TU0017	3334	1	22	0.00	3.00E-04	6.60E-03	0.00E+00	0.47	-0.38	0.04
TU0084	15513	1	350	0.00	6.45E-05	2.26E-02	0.00E+00	-0.84	0.46	-0.19
TU0082	12392	1	158	0.00	8.07E-05	1.28E-02	0.00E+00	-0.65	0.07	-0.29
TU0089	20926	2	134	0.00	9.56E-05	6.40E-03	0.00E+00	-0.51	-0.40	-0.46
TU0083	10576	1	37	0.00	9.46E-05	3.50E-03	0.00E+00	-0.52	-0.82	-0.67
TU0019	10411	1	22	0.00	9.60E-05	2.11E-03	0.00E+00	-0.50	-1.16	-0.83
TU0040	10800	1	23	0.00	9.26E-05	2.13E-03	0.00E+00	-0.53	-1.15	-0.84
TU0085	19702	1	26	0.00	5.08E-05	1.32E-03	0.00E+00	-1.05	-1.48	-1.26
TU0035	62576	2	113	0.00	3.20E-05	1.81E-03	0.00E+00	-1.44	-1.27	-1.35
TU0063	95469	2	133	0.00	2.09E-05	1.39E-03	0.00E+00	-1.80	-1.45	-1.62

Table 3. Quantities of Dressel 1 amphorae (systematic collection only). The composite z-score (z_{comp}), is used to assess the distribution of finds by topographic unit (measured per square meter), quantified by sherd count (n_{fr}), weight (n_w), and estimated vessel equivalent (n_e). The measures were divided by the total area of each topographic unit, and were then standardized using a lognormal z-score. The composite z-core was calculated using only sherd count and weight.

Some consideration of fragmentation is warranted given the observation that there were diferent fragmentation rates even within the same TU for different classes of material (e.g, the ratio of sherd count/weight in TU0061 was 0.0093 for Dressel 1, and 0.0036 for Dressel 7/11). The post-depositional or taphonomic processes which resulted in variable fragmentation patterns on the surface are likely impossible to explain fully over the course of several centuries, even if they are able to be categorized broadly under the headings of erosion or plowing. Nevertheless, the impact of these processes on the quantification of archaeological material cannot be ignored when considering estimating the amount of vessels that were discared in any one place, and must be accounted for. Moveover, it is desireable that the exercise of quantification should not merely be grounded in the attempt to address the way in which fragmentation or other factors might influence estimated frequencies of finds, but it should also better contextualize those estimates within an intuitive framework of understanding.

Examining the distribution of Dressel 1 amphorae per TU reveals that their distribution follows a lognormal distribution, a pattern which is regularly found in examining quantities of fragmentary finds material (Fig. 13). This distribution holds whether the material is quantified by sherd count or by weight, but, as Table 3 shows, the quantities of material per TU will vary owing to the different metrics used (sherd count, weight, and eve). The use of a z-score, also called the standard score, appeared to be the most effective way to address these different metrics, in order to render their frequencies per TU comparable with one another.

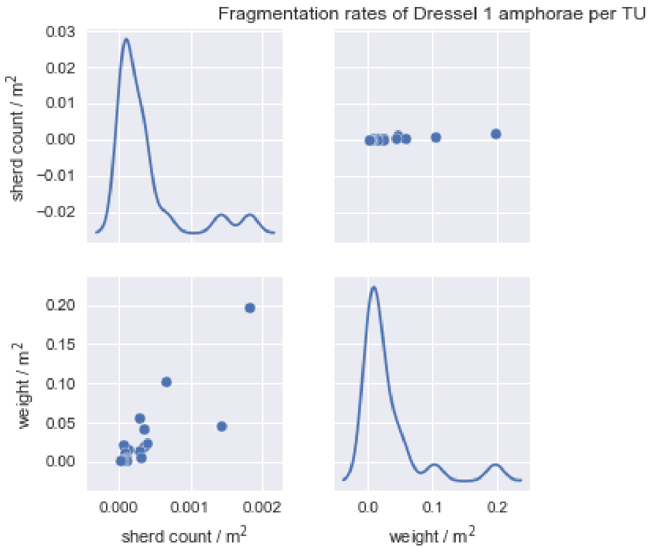

Figure 13. Scatterplot of sherd count and weight of Dressel 1 amphorae, with each point representing a TU, showing they approximate a lognormal distribution.

Z-scores express a quantity as an absolute measure in relation to the mean of its sample. The

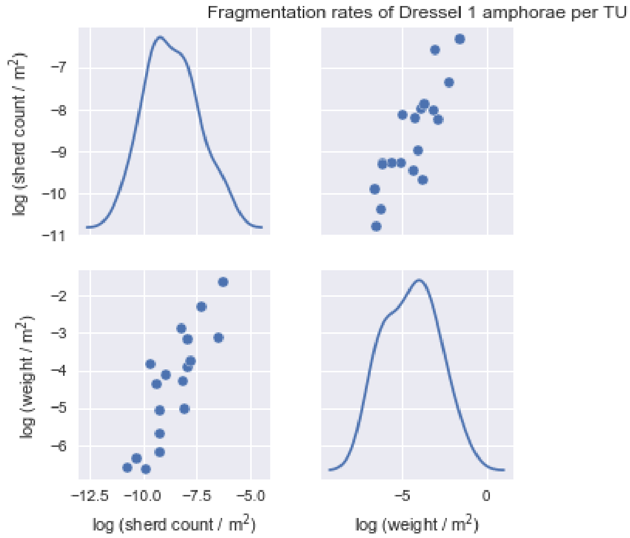

Figure 14. Scatterplot of the sherd count and weight of Dressel 1 amphorae, with each point representing a TU, after their transformation to follow a normal distribution.

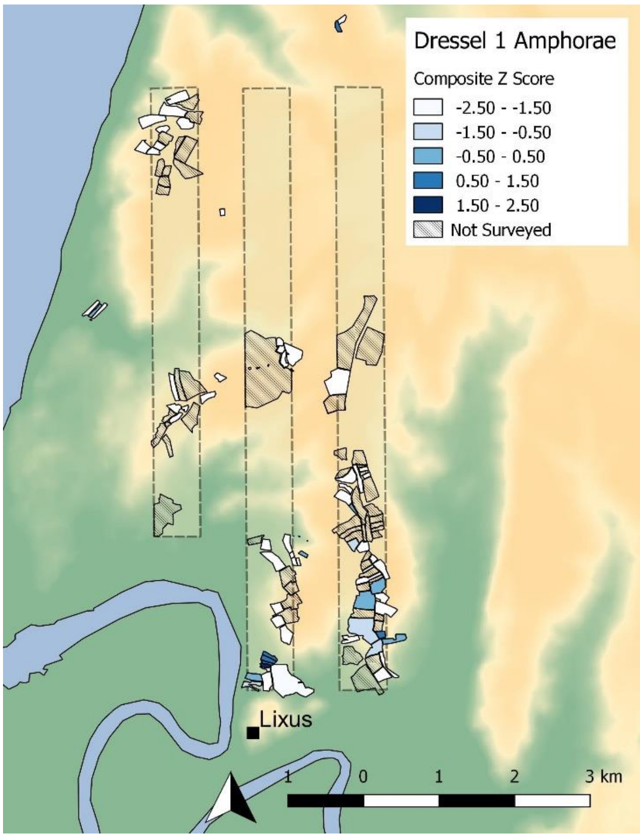

Figure 15. Map of densities of Dressel 1 or Dressel 1 type amphorae in the Oued Loukkos recovered by the 2016 pilot season. Darker shading indicates above average frequencies within the class of Dressel 1 amphorae.

value z is defined as z = (x - μ) / σ, where x is an observed measurement, μ is the mean, and σ is the standard deviation. A result of z = 0 thus indicates that a given observation is at the mean of all observations. A score of z = 1 means that the value is one standard deviation above average and a score of z = -1 that the score is one standard deviation below. This method of standardizing the observed quantities of finds thus relates them to the shape of the entire regional assemblage, rather than basing observations on *ad hoc* impressions of absolute counts of finds.

The use of a z-score presupposes that the observed values follows a normal distribution, and since the finds follow a lognormal distribution it is necessary to transform the data, thus obtaining z = (ln x – ln μ) / σ. The resulting transformation can be seen in Fig. 14. These values are also given in Table 3, which lists the z-score for each TU that had Dressel 1 amphorae. The topographic units which had no evidence of these classes were omitted in this exercise, as it would unnecessarily skew the distribution, greatly altering the mean and resulting in far higher z-scores without any change in the understanding of their occurrence. The z-scores obtained from sherd count and weight were then averaged, to produce a composite z-score which would rank each TU for how far above or below average Dressel 1 amphorae were present.[43]

The map of the composite z-score values can be found in Figure 15, showing the degree to which TUs fell above or below the average for those contexts which had Dressel 1 amphorae. The picture illustrates that Dressel 1 amphorae were present in TU0060 and TU0061, located just north of Lixus, and TU0034, to the north-east, at a frequency far higher than other TUs with respect to others; similarly TU0058 and TU0059 (determined to be part of the same site as TU0060 and TU0061, see below) had above average representation of Dressel 1 amphorae in the survey area. In sum, the impression is that Dressel 1 amphorae, while diffuse in the area north of Lixus, find a greater presence at two sites closely adjacent to the city of Lixus, HESP-1 and HESP-2, above the other areas surveyed. As a method, then, the use of a composite z-score gives more clarity to the object of quantification, by utilizing different independent metrics and by treating finds in relation to the total assemblage, toward constructing spatial comparisons.

[43] Adding a third z-score based on eve was also desireable, but not feasible given that rim and base fragments were only recovered from TU0061 and TU0077.

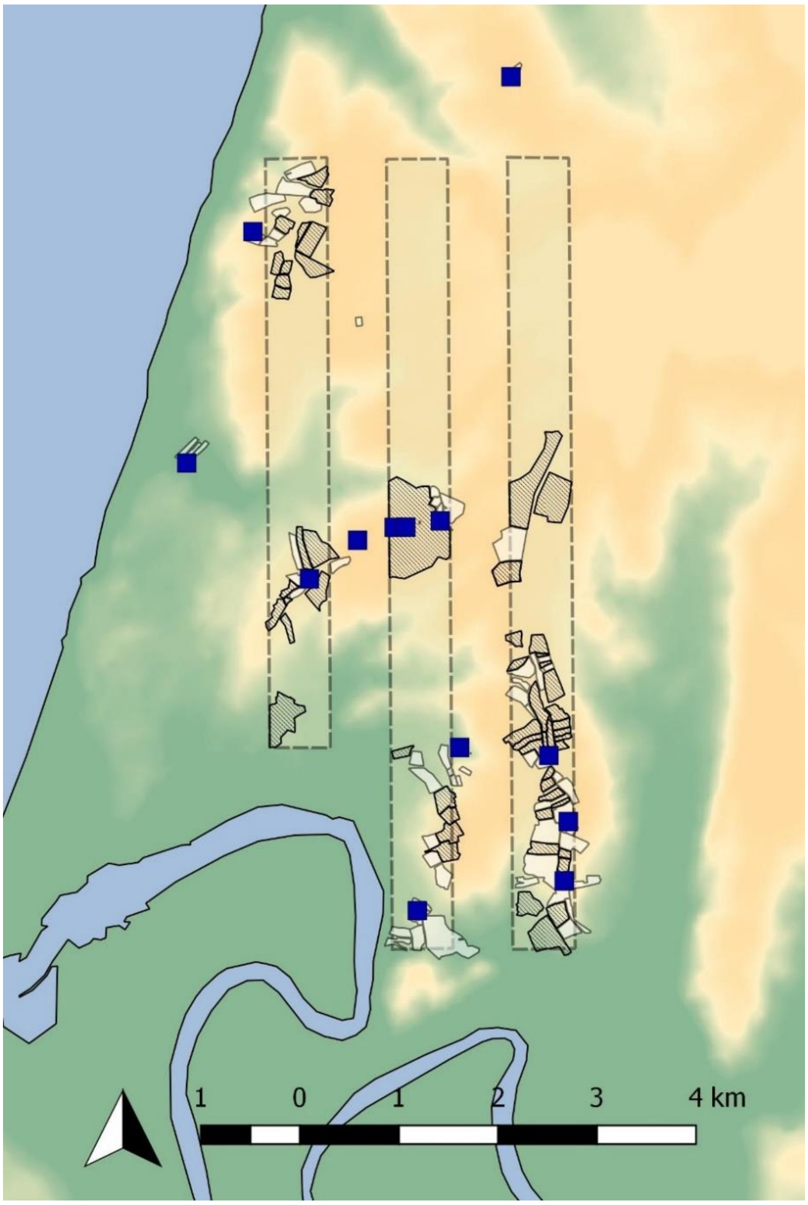

Figure 16. Northern sampling transects of the 2016 pilot survey, showing sites identified by Project Hesperides. Fields that were systematically surveyed are in white, while those which were not surveyed due to occupation, vegetation, or low visibility in black.

It can be emphasized that quantification depends on the context and the scale of comparisons that are being made, and, accordingly, quantification is a non-trivial matter. As such, the comparisons and estimations of the relative importance of finds will over time change with the acquisition of new data. This does not weaken the case for using quantitative data as a useful approach to regional analysis, but it does make it essential to frame and qualify the central intuition behind assessing the quantitative distribution of finds[44]. The example above used Dressel 1 amphora independent of the rest of the ceramic classes of their respective topographic units, whereas weighting their frequency out of the total assemblage (that which was contemporary to their use) can also be viewed as providing relevant information, that contextualizes the frequency of amphorae relative to the rest of the ceramic profile at the TU. The scale of context, too, is determinative for the issue of quantification, insofar as grouping artifact-quantities by multiple TUs (as a site) could result in a different set of estimates. As this brief interim report cannot undertake a deeper exploration of these issues, time and the acquisition of additional data will allow for more informative comparisons to be made, as well as more exploration of these issues in depth.

Preliminary Results

In the 2016 season we were able to systematically fieldwalk around 1.10 km^2 of terrain, mostly in the northern sampling transects (Fig. 16). In evaluating the use of systematic fieldwalking in the Oued Loukkos, it can be noted that a systematic collection proved useful as a method to ensure an assemblage of finds from the surface that was as representative as possible of the material present, while keeping grab finds separate from the systematic assemblage. This method ensured that comparisons within the survey data could be profitably subjected to future quantitative analysis as discussed above. That said, current landholding patterns, vegetation, and natural topography rendered some areas unsuited to the methods of systematic siteless survey; the southern banks of the Oued Loukkos, which were far more intensively cultivated than the northern side, were largely

[44] See FENTRESS 2000.

Figure 17. Sites published by Ponsich (1966), plotted according to the coordinates given in his report, most of which could not be located or verified on the basis of material noted in 2016.

inaccessible for these reasons. Moreover, the decision to use a siteless model in the Oued Loukkos was experimental, and was ultimately combined with a site-based approach, which consisted of relating TUs in the project databse to a specific site, which was added as a separate layer in the project GIS.

The 2016 season located fourteen archaeological sites, many of which had been mapped by previous INSAP surveys[45]. In certain cases, some of these were probably already noted by Ponsich, but it was frequently not possible to identify with precision the sites from his survey (Fig. 17). The inability to indentify Ponsich's sites was owed in part to the imprecision of the published coordinates. For example, the sites listed along the Plateau de Sidi Bou Jari (nos. 24-28) were located in the Ghabet Lolige, a densely forested area where systematic fieldwalking was not possible[46]. Locating the features mentioned by Ponsich was difficult, as no features were present at the given coordinates, and was thus attempted by walking a series of paths, which ultimately identified several areas (the sites TU0101, TU0102, and TU0021, which was not classified as a site), that had apparently been subjected to excavation at some point. The finds around these TUs were poor – only TU0102 returned datable Roman material – and on the basis of Ponsich's descriptions it was not possible to ascertain which of these sites were which, and whether the sites of TU0103 and TU0023 also located in the Ghabet Lolige, were also ones mentioned in his report. In other cases, however, site destruction could not be ruled out: the site of Sidi Khayri (TU0046), identified by Ponsich as a large tumulus, was largely devoid of datable finds, save for one fragment of ARS[47].

A second pass of the sites to conduct a gridded collection of materials will be undertaken in the course of future fieldwork, and in light of on going fieldwork this interim report a preliminary sketch can be offered regarding periods of occupation, hierarchy, and function, as well as an overall characterization of the landscape. The tentative results on the distribution of artifacts in the countryside so far hints at a less well-connected rural economy prior to the second century BCE, given that the only site to produce datable finds from the early Iron

[45] Originally, the total count was fifteen sites, but one site, consisting of rock cuttings, was later determined to have been a natural formation.
[46] PONSICH 1966: 402, nos. 24-28.
[47] PONSICH 1966: 402, no. 22, "Sidi Jari."

Figure 18. Select diagnostic finds from TU0061 (Duira). From top left: Dressel 1 Tyrrhenian amphora, Mañá C2b amphora, Black gloss Morel 2320-2350 bowl, nonid cookware; from bottom left: 3 rim fr. of unidentified Dressel 1 amphoras.

Age is HESP-1, on the hill of Ben Ali just north of Lixus, labeled Duira on the topographic maps. HESP-1 possesses a broader chronological range of finds than any other site encountered (Fig. 18). Other early sites were likewise found close to the Loukkos, at Raqqada and Azib Slaoui[48], and it remains to be seen whether these early maritime connections reached beyond the immediate context of the river valley as well as to what degree. So far, then, the second and first centuries BCE seem to inaugurate a period of increased economic activity in the more removed countryside to the north, evidenced by the presence of Dressel 1 and/or black gloss present at the sites of HESP-2, HESP-3, and HESP-11. Certain of these sites appear have had occupation into the first few centuries CE, again, to judge from the datable amphora and fineware (Table 4). Some of their occupation perhaps lasted into late Antiquity, but it would be premature to assert whether this occupation was continuous throughout this entire period. As concerns the research questions of Project Hesperides, these results would tend to highlight that the Roman annexation of the area took place already within a well-developed and interconnected countryside, one which might have more of an immediate relationship with changes in Lixus and its urban society.

The fourteen sites located by Project Hesperides accordingly range from scatters of off-site material to building debris, and in-situ architecture. In terms of site definition, a long-standing problem in regional archaeology[49], the use of the siteless model based on the topographic unit allowed for the flexible definition of sites contingent upon the selection of TUs that pertained to location[50]. In order to mitigate the effects of post-depositional factors like plowing (which would affect the dispersal of material), scatter size was eschewed in favor of using categorical factors of attributes or characteristics at each identified site[51]. Multiple correspondence analysis (MCA) was used to construct site definitions from these characteristics, taking a bottom-up approach to definition[52]. Thus, categorical attributes formed the basis of site interpretation, to produce a biplot showing clusters of sites which had the same material factors in evidence: for example, the presence of stone, tile/brick, and different functional classes of ceramics (quantities of ceramics related to transport, storage, and preparation-consumption). In order to combine qualititative variables, like the presence or absence of tile/brick and cut stone, with quantitative variables, like the presence of ceramics, a series of categorical “bins” that groupped together scalar values of each functional class of ceramic were used as the factors. The results illustrate which factors are correleated with other factors, indentifying the underlying relationships in the material record of each site.

[48] AKERRAZ, EL KHAYARI 2000.
[49] WITCHER 2012.
[50] STONE 2004: 136.
[51] An approximate measurement of scatter size was given in the comments section on the context sheet, but since post-depositional processes are considered to have been a major factor in the dispersal of material it was not used as a factor in site definition.
[52] On multiple correspondence analysis, see GREENACRE, BLASIUS 2006 and GREENACRE 2007.

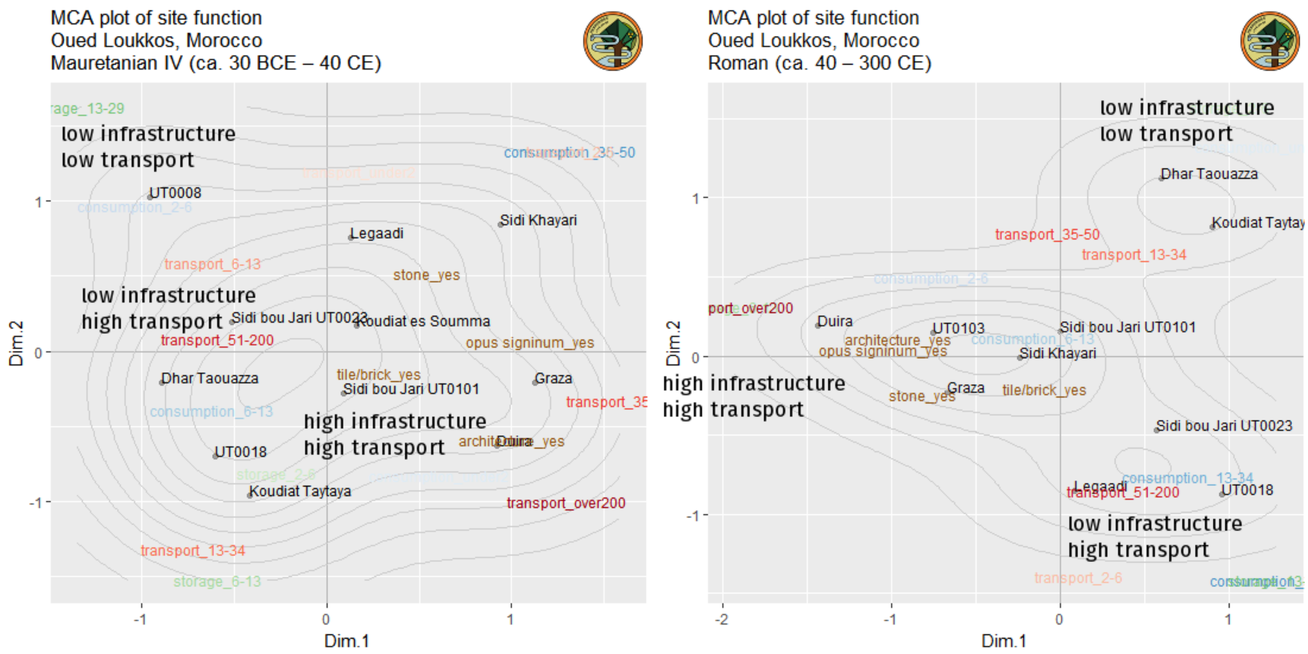

Figure 19. Diagram of multiple correpsondence analysis of material factors present at each site during the Mauretanian IV and Roman periods, showing which sites are associated with higher degrees of mobility and architectural investiment.

HESP	Name	Date	Characteristics
1	Duira	ca. 7/6 c. BCE - 3 c. CE?	Construction; Ramón T-10, Ramón T-12, Dressel 1, Dressel 7/11, Beltrán IIB, Haltern 70, Mañá C2b, Black gloss, Dolium, Islamic, Tile/brick
2	Dhar Taouazza	ca. 2 c. BCE - 1 c. CE?	Dressel 1, Dressel 7/11, Haltern 70, Dolium, Islamic
3	TU 0018-0019	ca. 2 c. BCE - 3 c. CE	Dressel 1, Dressel 7-11 / Beltrán IIB, Terra sigillata, ARS (Hayes 196, 197), Tile/brick
4	TU 0008-0010	ca. 2 - 1 c. BCE	Dressel 1, Dolium, Cut stone
5	Sidi Khayri	ca. 4 - 5 c. CE?	Amphora (non id), ARS Hayes 61, Islamic, Tile/brick. Potential mid-1st mill. BCE material?
6	Koudiat es Soumma	ca. 2 - 1 c. BCE	Dressel 1, Tile/brick
7	TU 0076-0079	ca. 1 c. BCE – 1 c. CE	Construction; Dressel 1, Dressel 7-11 / Beltrán IIB, Haltern 70, African, Terra sigillata, African cookware
8	TU 0103	ca. 2 - 4 c. CE	Amphora (non id), African cookware
9	TU 0101	ca. 1 c. BCE - 3 c. CE	Amphora (non id), terra sigillata, African cookware (Hayes 196), Tile/brick
10	TU 0102	?	Possible construction; Non id ceramics
11	TU 0023	ca. 2 c. BCE - 3 c. CE?	Black gloss, Beltrán IIA, Beltrán IIB, Dressel 7/11, Haltern 70, Thin-walled ware, African cookware (Hayes 196), ARS, Islamic, Tile/brick
12	Legaadi	?	Amphora (non id), Islamic
13	Koudiat Taytaya	ca. 2 c. BCE - 1 c. CE	Dressel 1, Dressel 7/11, Dolium, Tile/brick
14	Douar Dhayriya	ca. 2 - 1 c. BCE?	Dressel 1, Islamic

Table 4. Table of sites identified during the 2016 pilot season of fieldwork, dates, and a list of characteristic features attested at each site.

Creating multiple biplots to account for changes in the patterns of ceramics over can even show the way in which site functions might change over time. Taking the evidence at each site separately during the the Mauretanian IV period (the reigns of Juba II and Ptolemy, considered archaeologically as ca. 30 BCE - 40 CE) and during the subsequent Roman imperial occupation suggest that site functions changed into the Roman period, becoming more distinct and clustering together, whereas in the previous period much more gradation was present in terms of site use (Fig. 19). Sites can be ranked on the basis of their associations, for example, with a high degree of investment in construction as well as in the presence of transport amphora, like HESP-1 (Duira), in either the Mauretanian IV or Roman period. Similiarly, sites like Dhar Tauouazza and Koudiat Taytaya can be identified as ranking fairly low in terms of the degree of architectural investment and the presence of transport amphora. Further work needs to be done, however, to refine the categories of evidence taken into consideration toward performing this type of analysis, ideally toward associating readily comprehensible definitions of sites (like ‘farmstead,’ ‘road station,’ or ‘fort’) with a spectrum of attested material evidence. Furthermore, additional data needs to be collected in order to better contextualize the groupings obtained here, which must be considered tentative on the basis of the initial season of fieldwork. The results of the 2017 and 2018 season of field survey will provide more information in service to these questions, as well as to traditional demographic questions about the density and extent of occupation in the countryside.

In conclusion, quantitative approaches to the comparison of archaeological finds and the relationships between them at a regional level offers a viable avenue towards understanding changes in the rural economy of the Oued Loukkos, and comparing the distribution of artifacts as through composite z-scores and the use of categorical data analysis, like MCA, will aid in establishing a picture of general trends in these distributions over time, showing where and when shifts in the intensity of the circulation of goods occurs. Quantitative analysis and comparison of ceramic finds thus provides essential information on the scale and degree of economic relationships in the Oued Loukkos. From addressing post-depositional factors like fragmentation to more advanced sensitivity tests and resampling of the data, quantified data is essential for assessing the scale of developments within the rural economy. Future work devoted to extending the survey in 2018 and 2019 as well as well as excavation will provide a higher resolution of the economic fortunes of the inhabitants of the Oued Loukkos. The data obtained from this pilot season are a first step in that direction.

Acknowledgments

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