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A Medieval Boom in the North-west Sahara: Evolving Oasis Landscapes in the Wadi Draa, Morocco (c.700–1500 AD)

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Modern scholarship on the medieval Sahara has focused on a handful of famous entrepôt sites that have their origins in the 8th century or later, and as a result we still understand very poorly the nature and extent of Saharan oasis settlement and agriculture in the golden age of Saharan trade. This article presents the first securely dated chronology for oasis development in the north-west Sahara based on three seasons of archaeological survey and a comprehensive radiocarbon dating programme in the Wadi Draa, Morocco. The Draa Valley contains some of the largest, most populous and most productive oases in the Sahara, as well as serving as an important travel corridor for trading caravans coming from West Africa to access the Atlas passes and reach Marrakech. Focusing on evidence from a large zone of abandoned oases on the Kasr Bounou Plain, this article demonstrates that while oasis agriculture and settlement was taking place between the 4th–8th centuries—well before the Muslim conquest of Morocco—there was a significant increase in settlement and agricultural exploitation from the 9th century. This phenomenon is marked by the appearance of substantial mudbrick settlements, along with irrigation and field systems, and is coterminous with the development of the medieval trading entrepôt of Sijilmasa. A settlement boom and significant investment in irrigated oasis agriculture occurred between the 11th and 13th centuries, contemporary with Almoravid and Almohad rule of the Draa, followed by a retraction and abandonment of much of the oasis by the 16th century. The new evidence from the Draa challenges the long-held belief that sedentarization and irrigated oasis agriculture were unique to the medieval period in the north-west Sahara.

Introduction

The middle ages were a "Golden Age" for the north-west Sahara, evident in the rise of Sijilmasa in the 9th century as the most important trading entrepôt in the Sahara. The Almoravid and Almohad dynasties emerged from the Sahara and created vast new empires linking West

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Africa with Al-Andalus and Ifrīqiya in the 11th–13th centuries. Despite the focus on gold and slaves in the Arabic sources and modern scholarly literature, ancient and modern Saharan trading systems centred on bulk staple goods—grain, dates, salt, and pastoral products (dried meat, leather, textiles etc.)—produced or extracted within Saharan oases, traded by Saharan peoples, and consumed in the Sahara or on its fringes (Pascon 1984; Scheele 2010, 2017). Oasis agriculture requires considerable investment to irrigate the land and ongoing intensive labour to maintain plots and canal systems; however, even the most agriculturally productive oases are not self-sufficient and require trade to make life sustainable. The day-to-day exploitation, trade and consumption of staple agricultural goods therefore underpinned local economies and enabled the regional networks through which traders were able to move the gold, slaves and other high-value goods of Saharan trade. This article presents a new model for the development of oasis agriculture in the Middle Draa Valley which we suggest provides new insights into the rhythms of trading systems (and wider impacts on Saharan people) in oases in the north-west Sahara between 700–1500.

Very little is known about medieval oasis agriculture in the Sahara, and the first introduction of intensive irrigated agriculture and sedentarization of oases remains a particularly contentious topic. Iron Age and classical archaeologists have made significant advances in explaining the origins of oasis agriculture in the north-east and central Sahara (Sterry and Mattingly 2020), and it is now clear that intensive irrigated oasis agriculture was introduced to these areas long before the Muslim conquest of North Africa. Extensive fieldwork in the Libyan oases of Fazzan has been particularly transformative. Botanical assemblages from the 10th–6th centuries BC contain the earliest African evidence for date palm cultivation west of Egypt along with cereals and fruits, the classic tripartite system of irrigated oasis agriculture (van der Veen 1992). Sophisticated irrigation systems using underground channels (*foggara*) were introduced by the 4th century BC and laid the foundation for a boom in new mudbrick settlements and field systems within which the small urban centre of Jarma and the Garamantian state emerged (Sterry *et al.* 2021). There is increasing evidence for a westward movement and transfer of irrigation technologies and date palm cultivation in antiquity (Wilson *et al.* 2020). In Tunisia, Pliny (*Natural History*, 18.51) described fertile irrigated palmeries around the city of *Tacape* (modern Gabès) in the 1st century AD. Similar systems of foggaras and irrigation canals dating to the Roman period are also found in Algeria south of the Aurès (Mattingly *et al.* 2020) and an early 3rd-century AD customs tariff from Zarai, to the south-east of Sétif, includes dates among the many goods travelling to and from oases (Trousset 2002, 366).

In the north-west Sahara, however, the development of intensive irrigated oasis landscapes is commonly assumed to be of medieval date, linked to the establishment of urban entrepôts like Sijilmasa in the Moroccan Sahara and the growing importance of western Saharan trading routes from the late 8th century (e.g., Lightfoot and Miller 1996). Archaeological investigation has focused almost exclusively on those entrepôts described in the Arabic geographies. In recent years, important progress has been made in mapping the medieval irrigation systems in the hinterlands of Tamdult, Nul Lamta and Sijilmasa (González Villaescusa and Cressier 2011; Bokbot *et al.* 2013; Capel 2016), however, there is only limited dating evidence and as a result it is generally assumed that these irrigation systems were established at the same time, or just before the towns were founded in the late 8th and 9th centuries. Medievalists have also mined the Arabic texts for details on agriculture, irrigation, and rural settlement (Meouak and

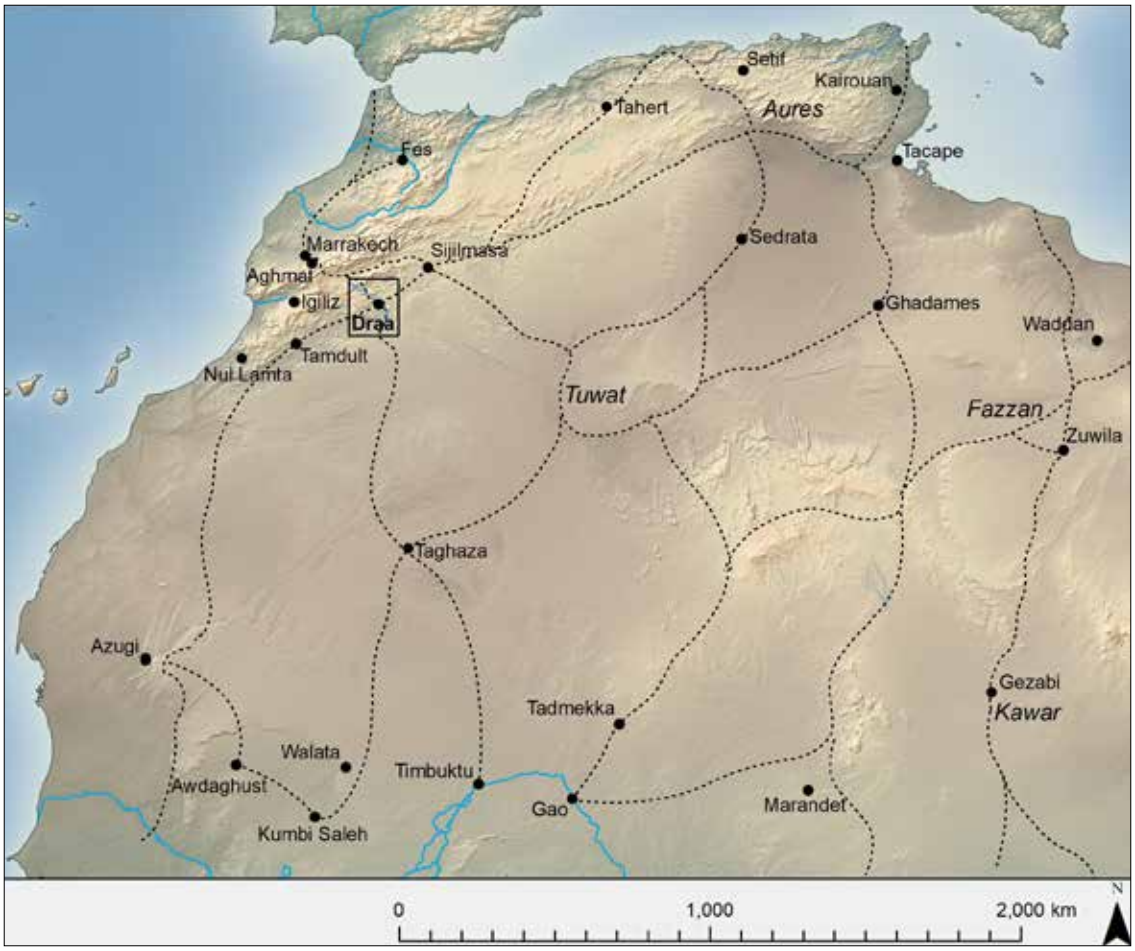

Figure 1 Map of key places and trade routes in the western Sahara during the medieval period.

Cressier 1998); however, there are few details on agriculture or oasis settlement outside these centres. In particular, archaeobotanical assemblages are known from only two sites south of the Atlas: Igiliz and Sijilmasa, with those of the latter being unpublished (Ruas 2018). Our previous work in the Draa has already challenged the model of medieval origins for oases and provided irrefutable evidence for sedentary settlement and cereal agriculture by the 4th century AD (Mattingly *et al.* 2019; Bokbot *et al.* forthcoming). We argue in this article that there are strong indicators of a medieval boom in the oases of the Draa contemporary with the attested Almoravid and Almohad peak in Saharan trade.

The current paper presents new evidence from relict landscapes for the development of oases and agriculture in medieval Morocco. The Middle Draa Valley, in southern Morocco, (Figure 1) contains some of the largest, most populous, and most agriculturally productive oases in the Sahara. The fecundity of the oases of the Draa and their ability to support a large population today as well as in the past is explained by the presence of the Draa River, the longest river in Morocco. Fed by snowmelt from the mountains of the High Atlas, the river provides a reliable water supply for agriculture that can be exploited via irrigation. The valley also

serves as an important travel corridor for Saharan caravans coming from the south to access the Atlas passes and reach Marrakech, as well as a crucial east-west corridor to the fertile Sous and the Atlantic coast (Jacques-Meunié 1982, 122–137). For much of the medieval period, it was secondary to other trade routes, particularly that of Sijilmasa to the north-east, but Sijilmasa's dominance was displaced when the Arab Maʿqil cut the eastern route from Fes to Timbuktu in the 13th century. By the 16th century, when the Saadian dynasty emerged as a powerful new force, the Draa Valley had already become the main terminus for Saharan trade from West Africa and served as the departure point for the famous Moroccan invasion of Timbuktu in 1591 and the subsequent downfall of the Songhay Empire (Jacques-Meunié 1982, 570–578).

The Middle Draa Project (MDP) was established in 2015 to explore the long-term history of settlement and agriculture in the valley in the Iron Age, medieval, and early modern periods. Only limited prior archaeological research has taken place in the region, largely focused on a handful of well-known prehistoric and Iron Age rock art sites with horse and rider/hunting scenes (Glory *et al.* 1952; Reine 1969; Simoneau 1972; Bokbot *et al.* 2021) and the significant cairn cemeteries of the North African Iron Age (Jacques-Meunié 1958). Several architectural projects have also surveyed many of the several hundred pisé *qsur* or *igherm* that are generally agreed to be of post-1600 date (Kölbl *et al.* 2007; Arena and Raffa 2018). In contrast, the rich medieval archaeology of the valley has been almost completely overlooked with the exception of small-scale explorations of the medieval walled town at Zagora in the 1950s by Charles Allain and Jacques Meunié (1956). Between 2015–2018, our survey identified two further walled towns and 20 additional major medieval settlements of 2 ha+ (Figure 2). Of special importance has been the discovery of several areas of substantial abandoned medieval oasis landscapes with well-preserved mudbrick buildings, gardens, and irrigation systems. Most oases in the Draa—and the north-west Sahara more generally—are currently intensively cultivated,

Figure 2 Major medieval sites and palmeries in the Middle Draa region and the location of the Kasr Bounou Plain.

obscuring earlier settlement, and making it difficult to study their diachronic evolution. The abandoned oasis areas are therefore a rare opportunity to study this type of environment in detail. Through a combination of field survey, remote sensing and an extensive radiocarbon dating programme, we offer a new model for oasis development in medieval Morocco.

Geography and history

The source of the Draa lies in the High Atlas above the Ouarzazate Basin, fed by snowmelt and rainfall run-off, its tributaries run through a series of canyons whose confluence lies just south of Ouarzazate and is now controlled by Al Mansour Ad-Dhabi Barrage. From here it cuts through the Jebel Saghro range of the Anti-Atlas in a narrow winding gorge until it widens out just north of Agdz. This is the start of the c.200 km long Middle Draa Valley, which runs as far south as Mhamid. Today, the valley is characterized by a strip of palm groves on either side of the river. A few kilometres beyond this is an area of gently rising hamada known locally as *feija*, which is in turn bordered by mountains and steep escarpments (*jebel*) (Jacques-Meunie 1982, 145). The north-east to south-west ranges of the Anti-Atlas create several "pinch-points" where access to the next stretch of the valley can be controlled and which effectively divide the oasis into a series of six distinct palmeries: Mezguita, Tinzouline, Ternata, Fezwata, Ktawa and Mhamid (Figure 2) (Rohlfs 2001, 53–59; Zainabi 2004, 17–24). Beyond Mhamid, the river disappears underground for much of the valley's long passage westwards to the Atlantic.

The region has an arid climate with the average daytime temperature reaching 33°C during summer and 12°C in the winter and extremely low average annual rainfall, varying from 108 mm at Adgz to 54 mm at Mhamid (Ait Lamqadem *et al.* 2018). Water supplied by the river therefore conditions the possibility of oasis agriculture both now and in the past, though annual discharge is highly variable. Irrigation in the Draa depends primarily on traditional flood diversion systems, supplemented to a limited degree by artesian springs, wells and (rarely) foggaras. The upper half of the valley closer to Agdz receives the highest and most reliable water supply, but is substantially narrower, affording less space for palmeries, agriculture and settlement. Conversely, the broader palmeries of the south-east, in the so-called Coude du Draa are significantly more exposed to Saharan winds and sand dune encroachment. Today the region is under severe environmental pressure from climatic change, dropping groundwater and a rapidly growing population. These have contributed to soil depletion, loss of vegetation and sand dune encroachment, particularly in the Ktawa and Mhamid oases where the oasis area has reduced significantly since the 17th century (Gutelius 2002, 29), and particularly in the past 40 years (Ait Lamqadem *et al.* 2018). These areas of abandoned oasis provide a crucial archaeological window into how the oasis was exploited in the past.

Historical developments in the Draa Valley remain obscure. Djinn Jacques-Meunié's (1982) magisterial history of the Moroccan Sahara provides the fullest account of the Draa in the medieval and early modern period from the perspective of written and oral sources. The river Draa was known to Greco-Roman geographers of the 1st and 2nd centuries AD, some of whom suggest that a sub-group of the Gaetuli people inhabited the region (Vitrivius *On Architecture* 8.2.6; Ptolemy *Geography* 4.6.6; 9; 14; Pliny, *Natural History* 5.9–10; Orosius 1, 2, 31). Local Jewish oral traditions written down in the 17th century maintain that Jewish groups settled in the Draa (called the Oued Zitoun) and established a kingdom there after a great struggle with the Christian Kushites (Gattefossé 1935; Jacques-Meunié 1982, 180–185). The Arabic conquest

narratives are brief and confused for southern Morocco, but the Jewish traditions suggest that Muslim groups started to enter the valley from the 8th century, though the Jewish "kingdom" remained independent until about the 11th century (Jacques-Meunié 1982, 186).

From the 11th century, Arabic accounts provide more details on southern Morocco, and the Draa Valley (Ar. *Dar'a*) begins to be mentioned more frequently, though seldom in much detail. In this period, the Draa seems to have been loosely under the sovereignty of the Midrarid emir of Sijilmasa, who apparently grazed his substantial camel herds in the region. The valley was captured in 1053 by the Almoravid movement of the Sanhaja Berbers and a garrison was established—probably at Zagora, which was fortified in this period (Allain and Meunié 1956). This may be the centre described by al-Bakrī (d. 1094) as Tioumetin, the capital of the province: it had a large population, a large Friday Mosque, and several busy markets (al-Bakrī, *Description*, trans. de Slane, 295). A century later, under Almohad rule, al-Idrīsī (in 1154) wrote that Dar'a was a union of unfortified villages and gardens. Merchants from the Draa also become more visible in Arabic accounts of Saharan trade and are described as trading with Ghana alongside rivals from Sijilmasa, Aghmat and Nul (al-Idrīsī, *Description*, 29, trans. Dozy and Goeje, 116). Subsequently, the region was occasionally the target of Marinid and Wattasid expeditions, before becoming the powerbase for the Saadian sharifian dynasty who controlled Morocco in the 16th century. By this point, the Draa Valley had decisively displaced Sijilmasa as the main route for Saharan caravans from Gao and Timbuktu to Fez and Marrakech; control and access to Saharan goods underscored its wealth. Contemporary accounts by Leo Africanus (d. 1554, *History* trans. Pory, 778–780) and Luis del Mármol Carvajal (d.1600, *L'Afrique* 7.9-22 trans. Perrot, 9–17) who travelled through the Draa provide the first detailed descriptions of the valley, its inhabitants, agriculture, and the towns, kasbahs and villages that lined the banks of the river.

Survey methodology

Between 2015–2018, the MDP identified more than 250 sites that are of certain or likely medieval date as well as more than 50 sites of Iron Age date through a combination of remote sensing and in-field visits (for first reports, see Mattingly *et al.* 2017; Mattingly *et al.* 2019; Bokbot *et al.* forthcoming). The wadi was divided into subzones, designated by three-letter codes abbreviated from local toponyms and sites located were numbered in separate sequences within each sector. Sites and field-systems were identified and mapped from satellite imagery; selected sites were then visited by our survey teams for further survey, systematic surface collection and test-pitting to collect dating evidence (ceramics, AMS samples).

The greatest challenge in understanding medieval oasis settlement and agriculture stems from the invisibility of earlier activity in the intensively cultivated zones of Saharan palmeries. In the Draa, as elsewhere in the Sahara, hundreds of minor villages and date-palm gardens from the last few hundred years cover medieval and earlier occupation on the oasis floor. However, in those areas where the oasis has been abandoned, traces of gardens, irrigation canals and settlements are visible, allowing us to chart the medieval expansion of the oasis. Dating poses additional problems. Medieval ceramic chronologies are still poorly understood in North Africa, particularly regional productions of handmade and wheelmade wares (Cressier and Fentress 2011; Fenwick 2020). For the Moroccan Sahara and Atlas, only a handful of preliminary reports on medieval ceramics exist for Sijilmasa (Taouchikht 1995; Messier and Fili 2011; Capel 2020), Nul Lamta (De Juan Ares *et al.* 2011) and Igiliz (Fili *et al.* 2020). Our dat-

ing strategy was designed to address this gap in our knowledge: we combined the study of ceramics from surface collection with test-pitting to gain stratified sequences of ceramics and organic samples for radiocarbon dating; we also collected organic samples for radiocarbon dating from pisé, mudbrick and mortared walls. Wherever possible, annual seeds of plant species (e.g. wheat, barley, fig, date) were preferred for radiocarbon dating. Seeds also have the potential to give a *terminus post quem* for their first attested cultivation in the region, especially important for understanding the dates of the earliest oasis cultivation and the introductions of new crop species. In conjunction with morphological studies of sites and masonry typologies, this strategy gives a high level of confidence for phasing sites and offers great potential for reconstructing the settlement history of the medieval Sahara.

The Kasr Bounou Plain: An oasis landscape in transition at the Coude du Draa

Our clearest picture of the transformation and development of the medieval oasis comes from a substantial area of relict oasis at the Coude du Draa, the famous "elbow" of the Draa where the river makes its sharp turn to the west (Figure 3a). Here a large area of abandoned oasis on the Kasr Bounou plain (BOU) lies on the left (southern) bank of the river with remains of mudbrick structures, field systems and canals covering around 670 ha in two distinct zones (eastern and western) and partly covered by encroaching sand dunes. On the north bank is the area of Foum Larjam (LAR) which encompasses the south-eastern hills of the Jebel Beni Selmane and is famous for what is arguably the largest concentration of Iron Age burial cairns in Morocco (Jacques-Meunié 1958); it also contains a series of well-preserved protohistoric and medieval hill-top settlements. The area is also known as Tidri or Foum Tidri, and it is associated in local oral traditions with the earliest Jewish settlement and fortress in the valley (Jacques-Meunié 1982, 181). In the 16th century, Mármol Carvajal described in this general area a ruined town called Tesuf, which once had a centre of Saharan trade built by "Numidians" and destroyed by "schismatic Arabs" (Mármol Carvajal, *L'Afrique*, trans. Perrot, 12). Examining the two sides of the river together provides a sequence of settlement which covers both the hilltops and the oasis floor and serves as a proxy for understanding the development of oasis settlement and agriculture in the late 1st and 2nd millennium in other parts of the valley. An initial visit took place in January 2015, and detailed survey, ceramic collection and test-pitting was conducted in November 2015 with an additional campaign in November 2016 involving further ground survey, test-pitting, and drone survey. Furthermore, samples collected in the field have provided radiocarbon dates for 30 sites in this sector (Table 1, p. 147).

Late Iron Age

The timing of sedentarization in the oases of Moroccan Sahara is a controversial topic, as outlined above. Our work has identified substantial numbers of settlements throughout the Middle Draa Valley in the early 1st millennium AD, demonstrating that sedentary communities engaged in oasis cultivation by the 3rd–6th centuries AD, significantly earlier than the medieval date usually postulated (Mattingly *et al.* 2017). Foum Larjam and the river terraces to the south was one of these areas (Figure 3b). Thousands of Iron Age funerary monuments have been identified on the slopes of the jebel and surrounding hamada (themselves built over an earlier prehistoric burial landscape) and a number of enclosures and offering structures not attested elsewhere in the Draa (Jacques-Meunié 1958; Souville 1959). Four hilltop sites, LAR002 and

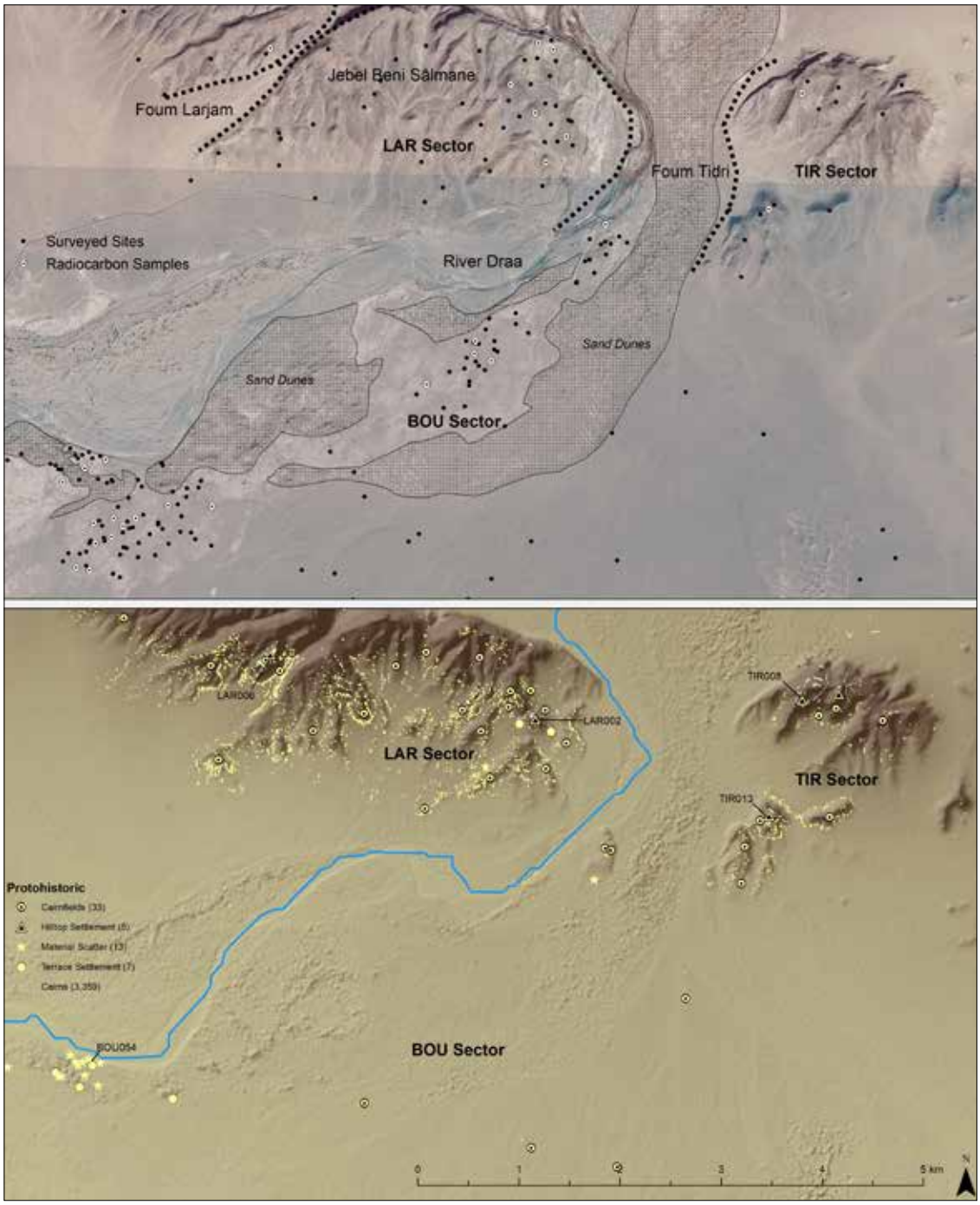

Figure 3 Top) Overview of the Kasr Bounou Plain showing surveyed sites (GeoEye-1 imagery 13 January 2013 (c) Maxar Technologies); Bottom) Late Iron Age Settlement in the Kasr Bounou Plain.

Table 1 Radiocarbon dates from the Coude du Draa. All dates calibrated using OxCal 4.4 (Bronk Ramsey 2009) to the IntCal20 calibration curve (Reimer *et al.* 2020)

	Site	Context	Material	Lab Code		Calibrated (2σ)
Late Iron Age	BOU054	From clay-lined pit. Trench 3 (3111)	Barley grain (*Hordeum vulgare*)	OxA-35367	1338±28 BP	cal AD 647–774
	BOU054	From clay-lined pit. Trench 1 (3104)	Charcoal (cf. *Tamarix sp.*)	OxA-35366	1318±27 BP	cal AD 655–775
	LAR002	Occupation layer Trench 1 (1015)	Charcoal	OxA-32373	1504±28 BP	cal AD 484–641
	LAR002	Occupation layer Trench 1 (1015)	Charcoal (cf. *Tamarix sp.*)	OxA-33825	1616±27 BP	cal AD 411–540
	LAR002	Occupation layer Trench 1 (1015)	(same sample as above)	OxA-33826	1676±28 BP	cal AD 257–431
	LAR002	Occupation layer Trench 1 (1019)	Charcoal	OxA-33827	1638±27 BP	cal AD 375–539
	LAR002	Occupation layer Trench 2 (1021)	Charcoal (cf. *Tamarix sp.*)	OxA-33828	1121±28 BP	cal AD 774–995
	LAR002	Occupation layer Trench 2 (1021)	Barley grain (*Hordeum vulgare*)	OxA-33829	1377±27 BP	cal AD 605–757
	LAR005*	Trench 1 (1014)	Charcoal (cf. *Tamarix sp.*)	OxA-33720	1589±30 BP	cal AD 419–549
	TIR008	Occupation layer Trench 1 (3116)	Charcoal (cf. *Tamarix sp.*)	OxA-35649	1500±24 BP	cal AD 542–638
	TIR013	Occupation layer Trench 1 (3119)	Wheat grain (*Triticum sp.* free-threshing species)	OxA-35194	1604±28 BP	cal AD 416–542
	TIR013	Occupation layer Trench 1 (3118)	Wheat grain (*Triticum sp.* free-threshing species)	OxA-35193	1588±29 BP	cal AD 420–548
Medieval	BOU001	From mudbrick wall of fortified building	Plant remains (grass)	OxA-33783	933±31 BP	cal AD 1031–1201
	BOU002	From SE wall of fortified building	Charcoal (cf. *Tamarix sp.*)	OxA-33784	1196±32 BP	cal AD 706–950
	BOU003	From SE wall of fortified building	Charcoal (cf. *Tamarix sp.*)	OxA-33823	870±26 BP	cal AD 1050–1256
	BOU009	From mudbrick wall of building	Plant remains	OxA-33824	810±27 BP	cal AD 1179–1275
	BOU022	From mudbrick wall of building	Plant remains (grass)	OxA-33718	969±37 BP	cal AD 995–1164
	BOU033	Outer wall of fortified building	Charcoal (cf. *Tamarix sp.*)	OxA-35336	1050±25 BP	cal AD 899–1032
	BOU036	From mudbrick wall of building	Charcoal (cf. *Tamarix sp.*)	OxA-35361	899±28 BP	cal AD 1043–1219
	BOU038	From mudbrick wall of building	Charcoal (cf. *Tamarix sp.*)	OxA-35362	894±26 BP	cal AD 1045–1220
	BOU064	Burnt clay feature	Charcoal	OxA-35368	890±40 BP	cal AD 1036–1226
	BOU071	From mudbrick wall of building	Charcoal	OxA-35369	802±27 BP	cal AD 1212–1278
	BOU073	From mudbrick wall of building	Charcoal (cf. *Tamarix sp.*)	OxA-35370	874±26 BP	cal AD 1047–1255
	BOU076	From mudbrick wall of building	Charcoal	OxA-35371	874±26 BP	cal AD 1047–1255
	BOU092	Burnt clay feature	Wood	OxA-35603	833±26 BP	cal AD 1171–1266
	BOU105	From mudbrick wall of building	Charcoal (cf. *Tamarix sp.*)	OxA-35372	957±26 BP	cal AD 1029–1158
	BOU110	From mudbrick wall of building	Charcoal (cf. *Tamarix sp.*)	OxA-35373	971±27 BP	cal AD 1022–1158
	LAR003	Occupation Layer Trench 1 (2006)	Charcoal	OxA-33719	823±28 BP	cal AD 1175–1271
	LAR004	From S pisé wall	Charcoal	OxA-32374	878±25 BP	cal AD 1047–1225
	TIR006	From wall of qasr	Plant remains	OxA-32432	919±25 BP	cal AD 1037–1206
Late Medieval to Early Modern	BOU051	From mudbrick wall of building	Wood	OxA-35447	331±25 BP	cal AD 1484–1639
	BOU051	From mudbrick wall of possible mosque	Charcoal	OxA-35363	287±29 BP	cal AD 1500–1793
	BOU051	From mudbrick wall of building	Plant remains (grass)	OxA-35647	174±23 BP	cal AD 1661–1950
	BOU053	From mudbrick wall of fortified building	Date stone (*Phoenix dactylifera*)	OxA-35364	535±27 BP	cal AD 1326–1436
	BOU053	From mud bonding of stone wall	Charcoal (cf. *Tamarix sp.*)	OxA-35365	450±26 BP	cal AD 1421–1473

* tombs overlying LAR006

Figure 4 Plan of Late Iron Age hilltop site LAR002.

LAR006 to the north and TIR008 and TIR013 to the north-east were established in the early-mid 1st millennium and represent the earliest permanent settlement (Figure 4). At three of these (LAR006, TIR008 and TIR013), an outer wall encloses a group of small enclosures each with a few round huts. They are similar in morphology to Late Iron Age hillforts elsewhere in the valley and test-pitting recovered charcoal and charred wheat grain (*Triticum sp.*) from TIR008 and TIR013 that date them to the 4th–6th centuries (Sterry *et al.* 2020). At LAR006 and TIR013, the settlements were given over to funerary use by the 6th or 7th century when a series of distinctive high conical corbel tombs were constructed across the site reusing the stone from earlier enclosures and buildings.

The fortified hilltop site of LAR002 (Figure 5) is the best preserved and a range of AMS dates suggest that the site was in use from the late 4th until at least the 8th century, possibly serving as a cereal processing and storage site. The walled site was entered via a switchback gateway at the north-west corner: inside were 50–60 rectilinear structures, probably a mix of habitation and storage units, typically constructed directly against the enceinte. Further loosely organized buildings and terraces were on the lower slopes of the hill. Barley (Cal AD 605–757) was found in a drainage channel. There is limited space for livestock and many rotary querns and grinding stones were also found at the site and on its slopes; the grain processed here was surely farmed on the banks of the Draa some 1–2 km to the south. Indeed, there is at least one contemporary 7th–8th-century site (BOU054) in the western zone of the abandoned gardens on the southern bank of the Draa (Figure 3b). Its plan is obscured by a later field-system, but building foundations, pottery scatters and many clay-lined silos for storage were visible over a wide area as well as some evidence of copper-working (metal-working debris, slag, and artefacts). Excavation of one of the silos recovered charred barley grain (Cal AD 647–774) further confirming the agricultural nature of this site. By the 8th century at the latest, therefore, there is strong evidence for both oasis agriculture and settlement on the low terraces beside the main river channel.

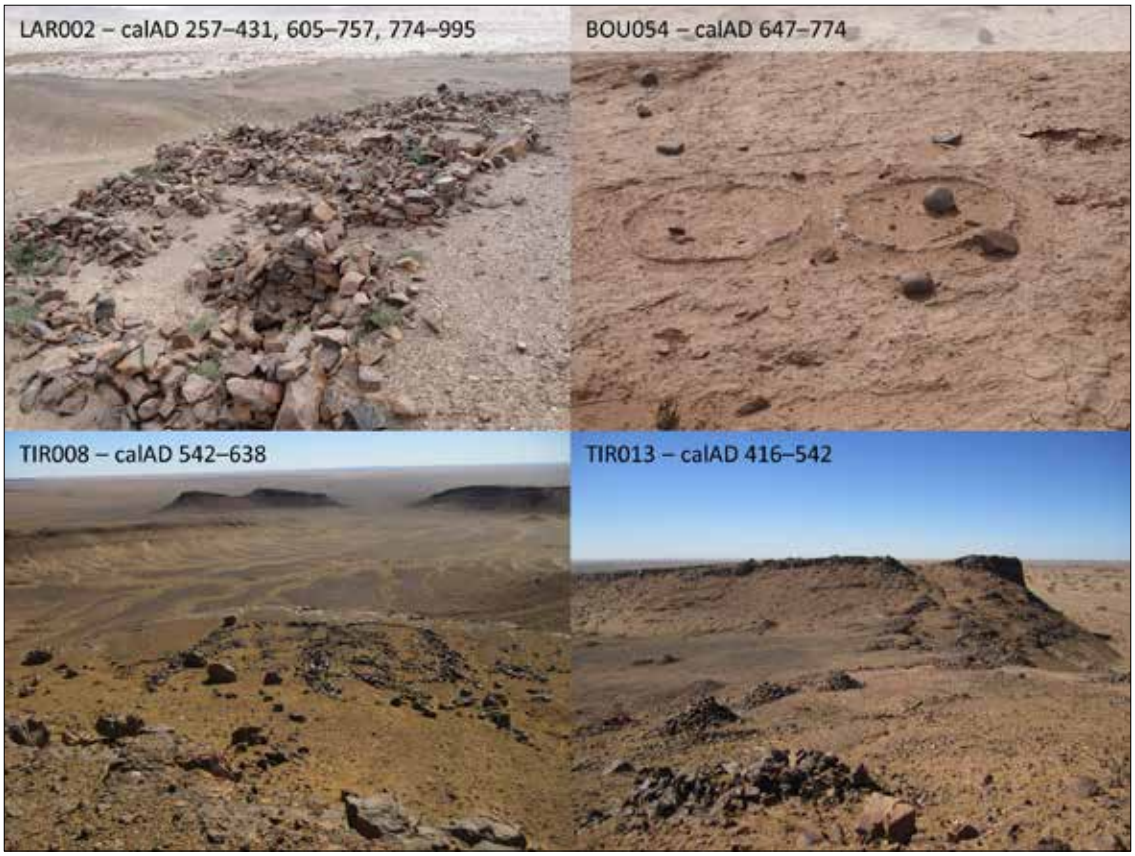

Figure 5 Iron Age settlements (with radiocarbon dates), LAR002, BOU054, TIR008 and TIR013.

Medieval

The Kasr Bounou Plain was completely transformed in the medieval period (9th–14th century) when a system of canals irrigating walled fields was established on the southern terrace of the Draa where 670 ha is still visible today (Figure 6). The first elements seem to have been created between the 8th and 10th centuries in two zones around mudbrick fortified oasis buildings with outlying structures (BOU002 and BOU033). In this early phase the irrigation system consisted of a main channel, probably fed via a diversion dam close to the river bend and then running parallel to the Draa, with branching canals flowing off into the fields. The main canals were on a north-east to south-west alignment, flowing at a slightly steeper gradient (0.2–0.5%) than the Draa and therefore attaining a more elevated head to supply the network of lateral canals in a first area of gardens by gravity flow. They then branched out into a complex network of channels and fields. Although the irrigation system must have abstracted in the Tidri pass, an intake point for the main canals has not been identified and may well have been destroyed by flooding (a nearby dam and canal that was in use as recently as 1975 to supply the Mhamid oasis is now entirely eroded). An early medieval date for the initial phases of the canal system in the eastern zone is supported by the dating of BOU002 to Cal AD 706–950. It is a substantial square mudbrick structure (31 x 30 m) with its entrance on the north-west side, an external

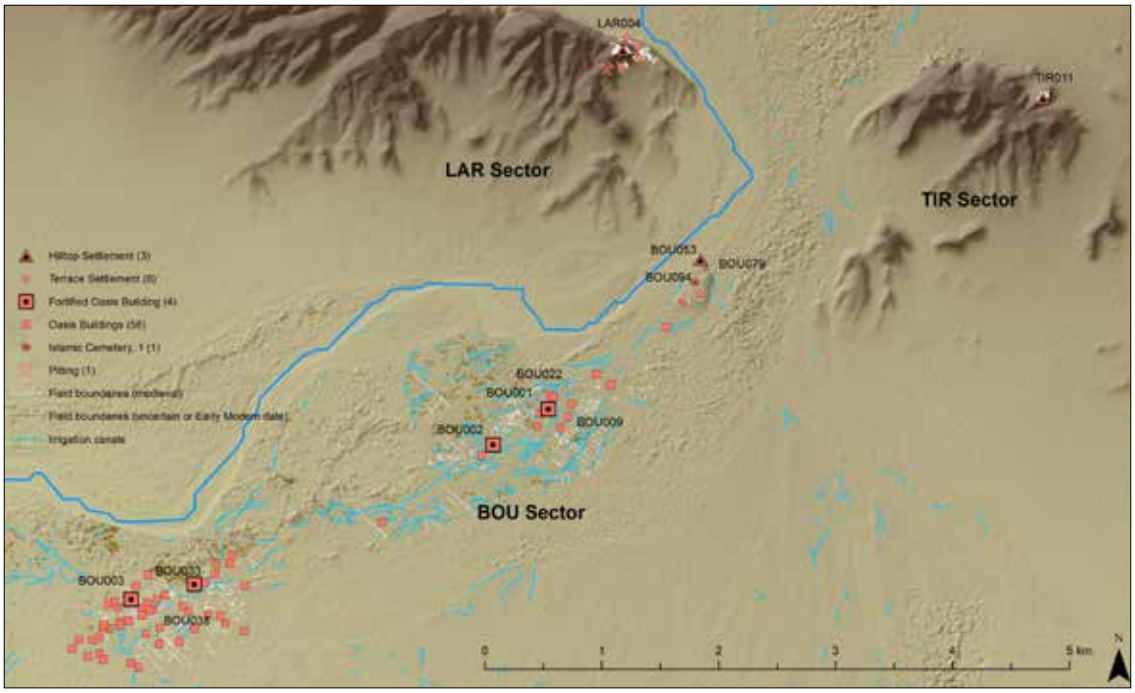

Figure 6 Medieval settlement in the Kasr Bounou Plain.

tower built against the south-west side and a well immediately to the east (Figure 7b). In the western zone, the fortified oasis building (30 x 18 m) and compound (42 x 30 m) of BOU033 has provided a similar date of Cal AD 899–1032. Grinding stones were found at the latter. Both are close to major branches of the canal system.

Between the 11th and 13th centuries, there was a significant expansion of the irrigated area and a corresponding boom in the number and density of settlements. Settlement sites of this date were typically square mudbrick two-storey structures and range in size from small 5 x 5 m structures to much larger structures of 40 x 40m with outlying buildings (Figure 7a–h). The similarities between the mudbrick buildings in terms of plan and orientation and their close spacing suggests a relatively rapid period of planned development. In the eastern zone (Figure 8a), a second large, fortified oasis building, BOU001 (Cal AD 1031-1201; Figure 7a) was constructed and many additional small buildings line a network of minor canals. Several other smaller rectangular mudbrick buildings (including two radiocarbon dated examples: BOU009 Cal AD 1179–1275 and BOU022 Cal AD 995–1164) clustered about BOU001 and followed the same alignment of the earlier field system. In this zone, settlement sites are more distant from the major canals and seem less regularly aligned in terms of the orientation of buildings, gardens, and secondary canals.

In the western zone (Figure 8b) a second phase of oasis expansion of circa 80 ha occurred around the large, fortified building BOU003 dated to Cal AD 1050–1256 (Figure 7c). The field-systems are on a north-west to south-east alignment and are relatively large and regularly spaced enclosures. BOU003 is surrounded by more than 20 smaller mudbrick buildings (usually 5 x 5 m with two storeys) that are also dated to this period by ceramics (several more have also

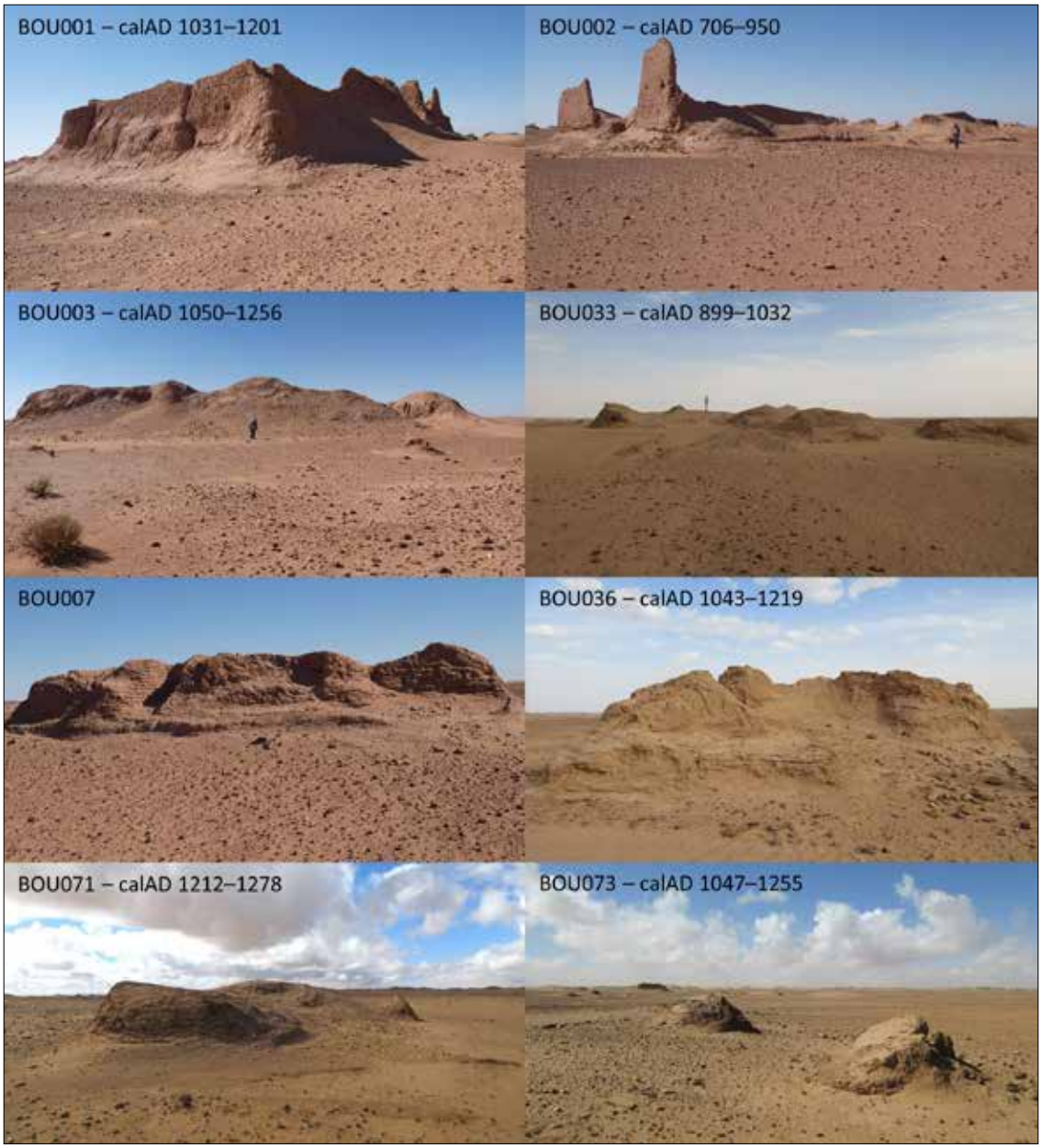

Figure 7 Mudbrick buildings on the Kasr Bounou Plain (with radiocarbon dates where applicable).

yielded dates from radiocarbon samples). Many yielded evidence of metalworking waste and a furnace was found at BOU038, just outside the main structure, with slag adhering to fragments of furnace wall (Cal AD 1045-1220). Almost all the sites recorded lie close to one of the canal lines, suggesting an integral connection between the layout of the oasis irrigation system, settlements, and gardens.

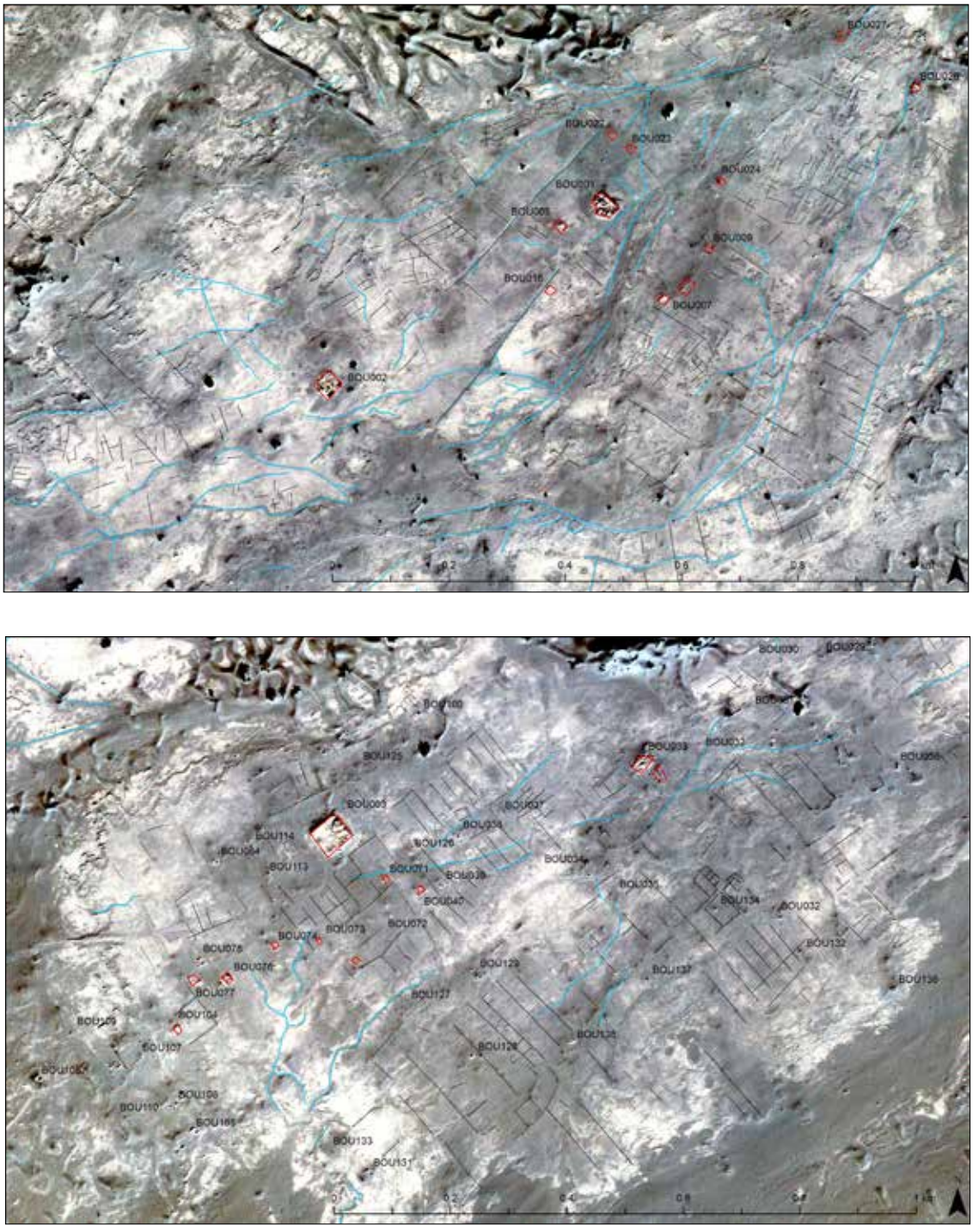

Figure 8 Top) Map of the eastern section of the Kasr Bounou Plain (BOU001); Bottom) Map of the western section of the Kasr Bounou Plain (BOU003).

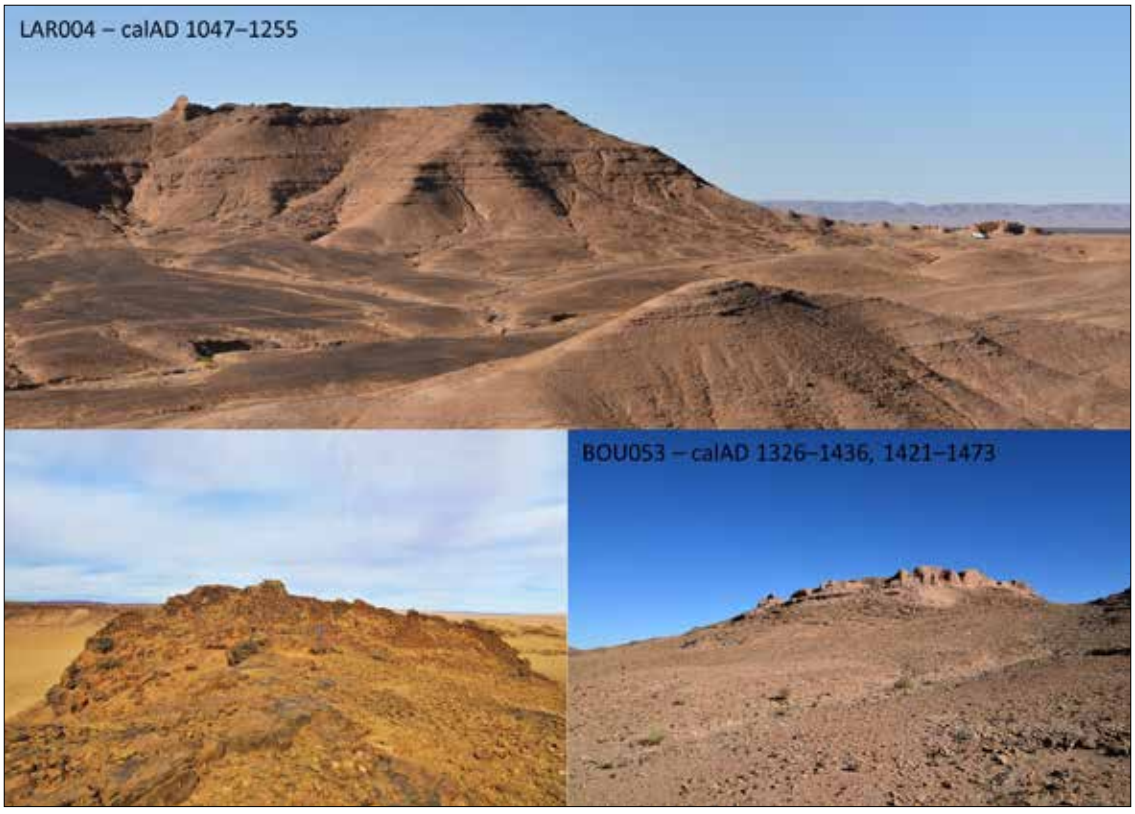

Figure 9 Medieval hilltop sites overlooking the Kasr Bounou Plain: LAR004, TIR011 and BOU053 (with radiocarbon dates).

Contemporary with these developments in the oasis, a large, pisé-walled settlement (LAR004) was built to guard the narrow passage of the Draa through Jebel Bani where the river starts its turn west (Figure 9a). It overlooks the Ktawa plain and guards the Foum Larjam and Foum Tidri passes to the north and the south. On the other side of the river, the fortification BOU053 is in line-of sight with LAR004 and is likely to have been built at the same time to guard the river-bend and southern approaches (see below for its late medieval/early modern phases) (Figure 9c). A third, smaller, stone-walled settlement TIR011, also of medieval date, guards another pass via Jebel Megag to the east (Figure 9b). These sites seem to have played a critical part in protecting access between the Ktawa palmeries and the Bounou Plain.

The site of LAR004 is divided into a hill-top citadel (LAR004) and a lower settlement (LAR025) on the sloping terraces overlooking the Draa (Figure 10). Rock shelters (LAR026) in the cliffs of the Draa may have been used for storage. Outside the lower defensive wall, is a small settlement (LAR003) comprising of around 45 scattered single-room and multi-room drystone structures; charcoal from the floor of one of these structures produced an AMS date of Cal AD 1175–1271). There is a second area of small structures (LAR013) on the steep slope directly south of the upper citadel. In total the complex covers 6.5 ha.

The upper citadel (LAR004) of 0.8 ha is typical of medieval hilltop settlements throughout the Draa region and this example clearly had a residential function. Protected by a thick, stone-faced,

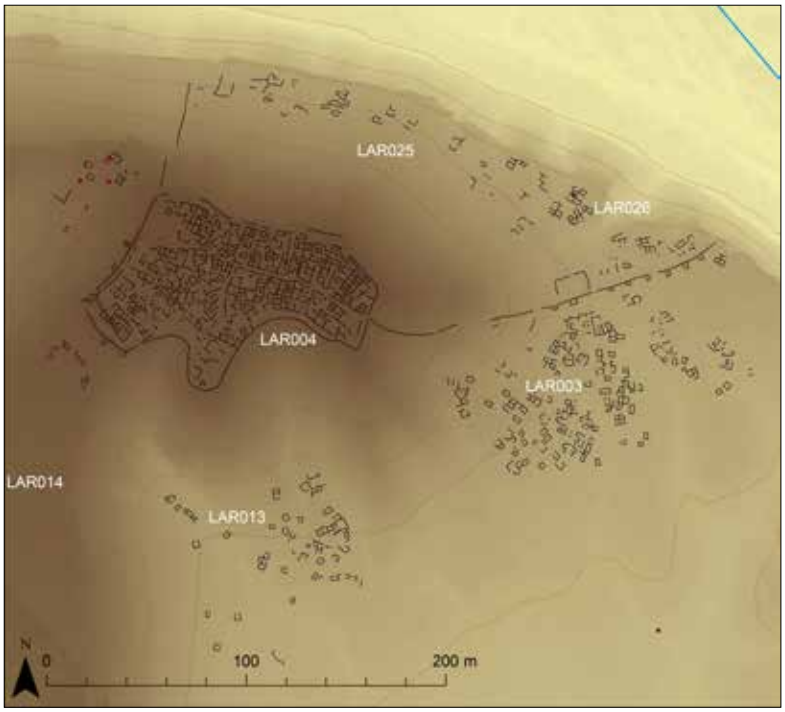

Figure 10 Plan of medieval settlement LAR004.

pisé wall with at least six square towers with a very hard pisé core (4 m thick), access was gained via a monumental dogleg, stone gateway on the south-west corner marked by two large square towers. In the south-west this stands 5–6 m tall (10 courses of pisé), but on the north side it survives only as buttressing and foundations. A large area of pitting (LAR014) on the plateau immediately to the south probably provided the material for the walls. A second access was located to the east via a narrow gateway that led down a steep slope to LAR025 and eventually to the wadi floor. This path was protected by a further linear stone-faced-pisé wall (dated to Cal AD 1047–1225) with at least eight towers on the southern side facing inland, away from the wadi. The settlement is divided into a series of streets leading off a central street, each lined with compounds made up of rectangular rooms of different sizes. The largest compounds are in the western sector of the site where there is a central building with a very large courtyard, possibly a public building, though it is tempting to interpret as a mosque or, if this is indeed the Jewish settlement of Tidri, as a synagogue. There are at least two phases of occupation, the second visible in repairs and later huts on the southern side of the site.

The lower enclosed settlement (LAR025) of 1.5 ha is protected by thick pisé walls to the west and to the south-east that, along with cliffs above and below, enclose the site. The south-east wall stands up to 4 m high in places and has eight square towers with a gap towards the eastern end, where a gateway was presumably located. Inside were rectilinear buildings concentrated on the outer edge of the terrace. These are drystone constructions in a very poor state of preservation, having been disturbed by hill wash from above. There is also a large and distinctive rectangular structure (19 x 12.5 m) abutting the south-east wall. The settlement is clearly contemporary with LAR004, but was significantly less densely occupied, perhaps due to the less favourable terrain.

The site of TIR011 is similar in size to the upper citadel of LAR004 at 0.75 ha but lacks any evidence of outlying suburbs (Figure 9b). It is located at the end of a spur on a hill facing the Jebel Megag at one of the more easterly approaches to the Ktawa palmeries. A large roughly-coursed defensive wall standing 6 m high in places guards the approach along the spur from the south and augments the steep cliffs on all other sides. In the centre of the site is a rectangular build-

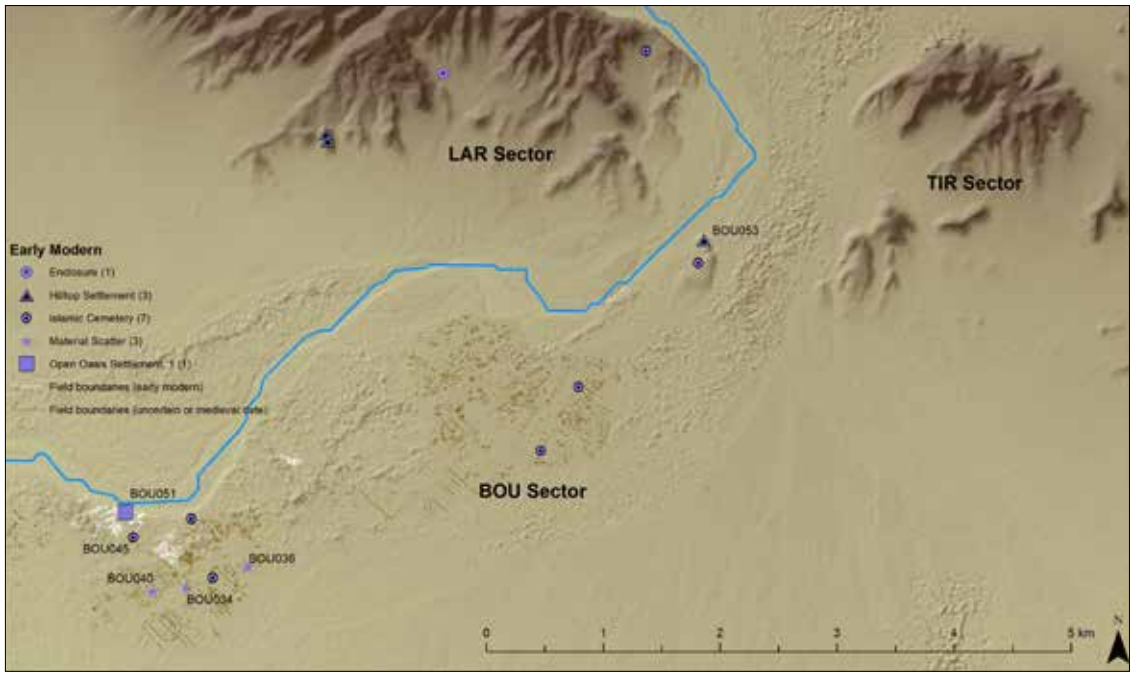

Figure 11 Early modern settlement in the Kasr Bounou Plain.

ing with three square column bases that is likely a mosque. There are several blocks of rectilinear housing occupying the rest of the plateau along the western edge of the site. Several small, plaster-lined rooms (perhaps cisterns) were observed; most rooms are small, rectangular cells that were presumably used for storage.

Late Medieval to Early Modern

After the great expansion of the 11th–13th century, the oasis dramatically contracted before being abandoned at some point in the early modern period (Figure 11). In the 14th–17th centuries, parts of this oasis may already have become desertified due to the drying up of the main channel of the Draa. Certainly, Mármol Carvajal described the area as uninhabited in the 16th century and implied that the ruined former capital of Tesuf lay in this area (Mármol Carvajal, *L'Afrique* 7.10, trans. Perrot, 12). The changing dynamics of the river through the Coude du Draa could easily have led to the destruction of the canal abstraction or left the field terraces higher than the level at which water from the river could be easily diverted into a canal system. The abstraction point of the head of the system is not visible, either because it had been removed by flooding/erosion or obscured by sand dunes. In either case, irrigation of parts or all the gardens could rapidly have become unviable.

The fortification BOU053 at the eastern end of Foum Tidri continued in this period to guard the river-bend, mirroring LAR004 across the river just to the north, which may also have continued to be occupied (Figure 9c). Radiocarbon dates place the construction of the mudbrick and drystone walls in the late medieval period (Cal AD 1326–1436, 1421–1473), but there is evidence of multiple rebuilds and the presence of medieval and early modern ceramics suggest it was occupied for a long period. The site has an associated Muslim cemetery (BOU094) of

Figure 12 a) The early modern village of BOU051 facing south with BOU003 in the background; b) Detail of BOU051 and the surrounding field systems.

around 35 oval graves outlined with stone, some of which have headstones and footstones. It is also adjacent to a canal (BOU079), which probably took water from the Draa, within a few hundred metres of the site.

Only a handful of other sites date to this period. The longest-lived occupation was at BOU051 (Cal AD 1484–1639, 1500–1793), a settlement on a terrace overlooking the Draa that in recent years has been partially washed away (Figure 12a). This is very likely the ruined village that Caillié passed by (1830, 162) in 1828 on his return from Timbuktu, which would act as a *terminus ante quem* for the occupation of the site. The site consists of at least 20 mudbrick multi-roomed complexes in neat rectilinear layouts over an area of at least 2.5 ha that is partially obscured by sand dunes (Figure 12b). Unusually, there is no evidence of a defensive wall or of a central or fortified building and the settlement is dissimilar in form to the pisé kasbahs or tighremt that are common in southern Morocco. At the south end of the site there is a small tower that may be the minaret of a mosque (Cal AD 1661-1950) with a stone basin or well-located 9 m to the south-west. The marabout tomb (BOU045) of Ibrahim al-Habashi, a follower of Sidi Uqba, is surrounded by a Muslim cemetery (BOU046).[1] This is probably the same mausoleum that was visited by Caillié (1830, 126) in 1828 and where his companions worshipped.

The settlement produced a large amount of pottery of early modern date and metalworking debris as well as numerous clay tobacco pipes. Several Alaouite coins (17th–19th century) and around 20 musket balls have reportedly been found (Professor Bakkhas Salah, pers. comm). Judging by the wide range of pottery found here and the fact that many forms and wares are not seen at other sites in the region, one could say that this was a nodal centre of trade and exchange, marking an important stopping point for Saharan caravans. Traces of a distinctive

1. When the site was revisited in 2021, the marabout had been destroyed to its foundations.

system of small square gardens on a range of new alignments continue up to the steep bank of the current course of the Draa, where they have been partly eroded away by the river. They were most likely fed by a canal running close to the south bank of the river, but similar field systems are also visible to the north of the eastern zone (BOU001 and BOU002). The presence of early-modern ceramics at the nearby sites of BOU034, BOU036 and BOU040 suggests that some of the medieval buildings and gardens of the western zone may still have been in use, but most had been abandoned, perhaps due to increasing desertification or problems with the medieval canal system.

Discussion

This detailed study of a well-preserved abandoned oasis landscape shows the potential of conducting systematic large-scale field-survey and radiocarbon dating programmes in Saharan settings. Our work on the Kasr Bounou Plain presents the first securely dated chronology for oasis development in Saharan Morocco: from the origins of cereal agriculture and sedentarization between the 4th–8th centuries, the introduction of large-scale canal irrigation systems in the 8th–10th centuries, a significant planned expansion of the irrigation system and population boom in the 11th–13th centuries, contemporary with Almoravid and Almohad rule, to the retraction and abandonment of much of the oasis by the 16th century. We suggest here that this chronological framework can help refine our understanding of medieval developments elsewhere in the Draa and north-west Sahara, especially in areas where the physical structures of this phase are obscured by modern oasis cultivation.

The introduction of irrigated agriculture and sedentarization in the oases of the north-west Sahara is frequently seen as a medieval phenomenon. This has been the standard model of development because it has proven challenging for archaeologists to identify and securely date earlier occupation. However, the evidence presented here of sedentary communities engaged in cereal agriculture, grain processing and defensive storage during the 4th-8th centuries indicates the need to revisit these assumptions. As demonstrated, dozens of Late Iron Age hilltop settlements are found throughout the Draa Valley presenting evidence for sedentary settlement, cereal agriculture and metallurgy by the 4th century at the latest, though probably earlier in the northern palmeries, where there was a more reliable water supply and nearby copper resources (Mattingly *et al.* 2019; Bokbot *et al.* forthcoming). A similar pattern is clear on the Tafilalt plain, where many large protohistoric cemeteries and hillforts as well as fire-pits dated by radiocarbon analysis to the 6th-8th centuries suggest the possibility of earlier sedentary life and agriculture before the foundation of Sijilmasa in the 8th century (Bokbot 2019; Capel and Fili 2018; Messier and Miller 2015, 69–71). There is also evidence for the exploitation and mining of copper and silver south of the Atlas by the mid-1st millennium (Rosenberger 1970). Environmental studies in southern Morocco and the High Atlas also suggest an increase in anthropogenic pressures and an expanding pastoral and agricultural base in the medieval period beginning slightly before the Arab conquest of Morocco and accelerating thereafter (McGregor *et al.* 2009).

Nonetheless, it is only in the 9th and 10th centuries that we see the first evidence for the construction of large-scale canal irrigation systems with gardens and mudbrick oasis settlement on the Kasr Bounou Plain. This follows a well-attested pattern of medieval expansion in irrigated oasis agriculture in the 8th and 9th centuries across the north-west Sahara in association

with the foundation of new urban centres in Morocco and Algeria and the growing importance of the western Saharan trading routes. At Sijilmasa, a palmery of c.100 km^2 was created in the 8th-9th centuries, at the same time or just before the establishment of the town of Sijilmasa by the Midrarid dynasty (Lightfoot and Miller 1996). Capel (2016; 2017, 540–541) has argued that the construction of a canal cutting of the Wadi Ziz and an irrigation system in c.800—at the point of or soon after the foundation of the city—was a social event that required the coming together of multiple rival factions and is therefore linked to wider trans-Saharan networks and the emergence of the Midrarid state. The medieval entrepôt of Tamdult, 275 km to the west of the Coude du Draa, has a similar system that seems to have its origins in the 9th century, or just before the establishment of the town and silver mines described in the Arabic texts. Here there is a cultivated area of at least 5 km^2 centred around an urban settlement with numerous small buildings and fortifications amongst gardens were fed by 4–6 parallel irrigation canals (González Villaescusa and Cressier 2011). The introduction of large-scale irrigated agriculture in the north-west Sahara is thus markedly later than in the central and eastern Sahara and must be linked to the growth in Saharan trade.

Capel (2021) has recently suggested that climate change may have also played a factor in the early medieval expansion of irrigated agriculture in the north-west Sahara. She suggests that a dry phase of the "Medieval Warm Period" forced the inhabitants of the Tafilalt Plain to change their subsistence strategies from pastoralism and (perhaps) seasonal flood recession farming, to the more reliable irrigated agriculture. This brought together rival groups and provided the political authority for the construction of the irrigation canals of the Tafilalt and thus the foundation of Sijilmasa and the Midrarid state. While we lack firm data on how changes in temperature and rainfall during the Medieval Warm Period affected the volume and consistency of water flow in the Draa, it is evident both that the river course was highly dynamic and that there is insufficient flow today to irrigate many of the zones of medieval field systems. The development of canalized irrigation systems in the medieval period could have been a response to changing river levels, but whether this was to cope with unpredictable flow, increased flow (and floods), or decreased flow (necessitating stricter management) remains elusive based on current evidence.

This early medieval investment in irrigation systems is not simply a Saharan phenomenon but reflects broader changes in Moroccan political and settlement dynamics between the 8th-14th centuries (Cressier, 1998). The establishment of new urban centres by the Maghrebian dynasties seems to go together with the construction of expansive hydraulic systems in their hinterlands, as at Aghmat in the 9th century (Cressier and González Villaescusa 2019), Marrakech in the 11th century (Goblot 1979, 152–154) or at Tagsa, where significant expansion seems to date to the Almohad period (Carbonero *et al.* 1997). While in these cases, urbanization (and the state) seems to be the prime driver of irrigation—essentially a variation on Wittfogel's (1957) hydraulic hypothesis—another model is presented in the Tuwat oases, where hundreds of foggaras were constructed, each supporting small, fortified settlements and a modest area of palm gardens. The dating is unclear but can be broadly placed in the medieval period, though written sources suggest earlier settlement (Échallier 1972). Here it was the pastoralist Tuareg that were the most powerful actors, receiving a tithe of the agricultural produce (Scheele 2017).

The onset of Almoravid rule marked an agricultural boom in the Draa Valley. Exploitation intensified significantly on the Kasr Bounou Plain, with a major expansion of the total irrigated area in the 11th century. This boom was mirrored in other areas of abandoned oasis in the Coude du Draa (the Fezwata, Ktawa and Mhamid palmeries) (Figure 2). Securely dated evidence for investment in the Almoravid and Almohad periods comes from the southernmost tip of the Ktawa palmeries, where two fortified buildings featuring gardens has an area of approximately 2 km^2. The construction of one (TIR006) is dated to Cal AD 1030–1169, contemporary with the oasis expansion in the Kasr Bounou Plain. Another large zone of abandoned oasis (10–15 km^2) at the southern end of the Fezwata palmeries contains around 200 square buildings, some of which are fortified. A brief sample of five of these structures confirmed a medieval date based on collected ceramics.

By far the largest zone of abandoned field systems is in the most exposed southerly Mhamid palmeries. While we have not conducted ground-survey in this region, field-systems and rectangular buildings similar in plan and form to those on the Kasr Bounou Plain can be identified over a 30 x 5 km strip to the south of the Draa, and it is reasonable to assume that these are also medieval in date. The Coude du Draa is extremely exposed to environmental and climatic risks: irregular annual water-supply, salinization, wind-blow and the movement of sand dunes. Such factors have impacted the palmeries in the north-west of the Middle Draa to a lesser degree. The Coude du Draa palmeries seem to have reached their maximum extent in the 11th–13th centuries, retracting significantly in the following centuries. Smaller, abandoned areas (under 1 km^2) exist in the better watered and narrower palmeries of Ternata and Tinzouline, although they are far less common. Based on this evidence we would argue that by the 11th century, the majority of the valley-floor of the Draa was cultivated in a similar fashion by canalized irrigation supporting a high density of small buildings on the oasis floor, some of which were fortified.

Descriptions by later medieval Arabic geographers support the picture of a highly fertile and exploited oasis landscape in the 11th to 14th centuries linked into wide Saharan and Moroccan trading networks. In the 11th century, al-Bakrī claimed that the cultivated area extended for a length of seven days' walking and described the riverbanks as filled with "prodigious quantities" of groves and fruit trees, including a species of tamarisk whose galls—known as *takout*–were used to prepare leather from Ghadames in Libya (al-Bakrī, *Description*, trans. de Slane, 290–291). The Kitāb al-Istibṣār (587/1191) adds that fruit trees, date palms and olive trees were cultivated, and that high-quality henna was produced in the valley and exported from there "to all the lands" (*Kitāb*, trans. Fagnan, 175–177). According to the Jewish manuscript tradition, the wadi was originally called the "Oued Zitoun" due to the olive trees cultivated there (Gattefossé 1935, 41–44). Other spices including cumin and caraway were produced, as well as indigo, which, according to al-Idrīsī, was of low quality but exported widely in the Maghreb due to its cheap price (al-Idrīsī, *Description*, 62, trans. Dozy and Goeje 70–71). In the 14th century, Ibn Baṭṭūṭa noted that slaves in the salt mines of Taghaza in northern Mali lived off dates from the Draa in a compelling example of the inter-reliance of Saharan regional economies and the importance of staple goods in Saharan trade (Ibn Baṭṭūṭa, *Travels,* trans. Gibb and Beckingham, 947). When Mármol Carvajal travelled through the region in the 16th century, exported dates provided the main source of income for the Draa and were widely celebrated for their taste and size (Mármol Carvajal, *L'Afrique* 7.9, trans. Perrot, 10–12).

The significant increase in agricultural production for both local consumption and export as well as the continued investment and labour required to irrigate the palmeries, implies a substantial rise in population in the valley. This is further attested by the expansion and foundation of urban sites at Zagora, Taghzout and Imi n'Takat, which had Iron Age and early medieval origins but reached their maximum size in the 11th–12th centuries, when they were fortified with stone-built or pisé enceintes. Zagora—the largest and best known of these—was probably the base of the Almoravid (and subsequently Almohad) governor and his garrison and was fortified with imposing walls similar to those built by the Almoravids at Tasghimut (Meunié and Allain 1956). This large town consists of two densely settled walled compounds of 17 ha with streets, large courtyard houses and a hammam. We have also identified a further 20 fortified hilltop settlements ranging in size from 2–10 ha, some of which have visible mosques (Mattingly *et al.* 2017). These settlements are confined to defendable hills and upper slopes beyond the cultivable area with a significant number "hidden" in deep side wadis away from the Draa. The medieval period thus represents the greatest extent of settlement and cultivation in the valley prior to the late 20th century, with good evidence for a population boom between the 11th–14th centuries, at the time of Almoravid and Almohad rule.

By the 16th century, when the valley was the main conduit for Saharan trade from West Africa, there were two fundamental changes. First, the settlement system moved to one of modest size, but densely built, walled villages (variously known as *qsur*, *qasab* or *igherm*) located in the field systems with no urban component. Second, many outlying palmeries were either fully or partially abandoned. On the Kasr Bounou Plain, these changes appear to have been gradual, with a reduction in the farmed area and the construction of the open village of BOU051 as a sort of transitional site in which the oasis buildings were agglomerated but not fortified. Although this village is larger than any other site on the plain, it cannot have supported the population of a few centuries earlier, and the related field systems cover only 25 ha. Desertification was evidently already a problem in the Coude du Draa by the 16th century (Gutelius 2002) and it is notable that neither Leo Africanus nor Mármol Carvajal, who visited the region in 16th century, mention any oasis settlement beyond Beni Sabih in the Ktawa. Famines and plagues too were frequent disasters in southern Morocco which resulted in depopulation of the Draa region, particularly in 1628–1631 and 1639 (Hammoudi 1980, 619). While desertification and depopulation were certainly factors in the retraction of oasis settlement in marginal areas such as the Kasr Bounou plain, political, and social changes also played a part in the reconfiguration of the organization of the palmeries.

In the aftermath of the collapse of Almohad authority in the 14th century, control of the valley was contested between the Moroccan dynasties, nomadic groups of various factions, and *zawiya*. From the 16th century onwards, the valley became the powerbase of the Saadian dynasty and the main corridor for Morocco's trans-Saharan trade. The development of villages in the Draa has been interpreted as a reflection of the social system of *raʾya*, or pacts of protection in which "nomad" communities provide protection to "sedentary" villagers in exchange for a quarter share or *rba* of the houses, fields and water rights of the village (Casciarri 2008). Similar shifts in settlement patterns occur in the Tafilalt: Sijilmasa was replaced by 80 small villages (Lightfoot and Miller 1996) and at Tamdult the town and field system were abandoned in favour of the smaller compact settlement of Akka (Rosenberger 1970; González Villaescusa and Cressier 2011). In the Tuwat Oases, the settlement pattern and social dynamics were seem-

ingly already close to this early modern model (Échallier 1972). In this system, defence, collective rights, and above all, a mobile elite dictated settlement choices.

Conclusion

In this article we have outlined new evidence from the rich medieval oasis landscapes preserved in the Draa and presented a new and robust chronological framework for the development of irrigated oasis agriculture in the Draa Valley based on systematic large-scale field-survey and radiocarbon dating programmes. Our findings challenge still widely held scholarly assumptions that sedentarization and oasis agriculture did not originate before the medieval period in the north-west Sahara. In the Draa, oasis agriculture first developed in the late Iron Age, significantly before the Muslim conquest of Morocco. Large-scale irrigation programmes were implemented in the 8th–10th centuries in the same period as new Saharan trading entrepôts were established in the north-west Sahara. An agricultural boom and significant expansion of oasis area under cultivation took place in the 11–13th centuries, coinciding with Almoravid and Almohad rule and the intensification of Saharan trade between Morocco and West Africa. However, this boom built upon an oasis landscape and networks that had existed for centuries. Our work therefore presents new insight into the role that oases played as sites of agricultural production and investment, as a first step to understanding the agricultural landscapes and cultivation of staples that underpinned Saharan trading systems.

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