



# Supplying a medieval metropolis: water management and agriculture in the hinterland of early Islamic Basra

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## Abstract

Following its foundation in the 630s CE, medieval Basra rapidly expanded to become one of the most populous cities of southern Iraq and the wider Gulf region. At its foundation, the city's surrounding environment appears to have been poorly suited to sustaining a large urban population. This paper examines the different ways in which the early Islamic population of Basra transformed the immediate environs of the city to improve the urban water supply and the agricultural potential of the city's hinterland. In particular, this included the construction of substantial canals connecting Basra with sources of water such as the marshes to the north of the city and the Shaṭṭ al-ʿArab—the river which forms at the confluence of the Tigris and Euphrates and flows past Basra to the Gulf. The tidal influence of the Gulf causes the water level of the Shaṭṭ al-ʿArab to rise and fall daily and, by exploiting this characteristic, the medieval population of Basra could irrigate large swathes of land surrounding the city. Analysis of historic satellite imagery reveals possible evidence for the infrastructure that made this possible—including the remains of field systems bounded by, and interspersed with, canals as well as large raised linear ridge features which occur in tandem with relict canal systems. This paper critically assesses the evidence for the dating of these features, potential scenarios for how they functioned and their relationship to the medieval city of Basra.

**Keywords** Basra · Early Islamic · Water management · Canals · Zanj

## Introduction

Based on the ninth and tenth century accounts of historians such as al-Balādhurī (1924, pp. 60–66) and al-Ṭabarī (1992a, pp. 161–172), the city of Basra experienced rapid expansion from its foundation in the 630s CE to become one of the most populous and important cities, both politically and economically, in southern Iraq and the wider Gulf region. The city was located approximately 15 km southwest of the Shaṭṭ al-ʿArab—the river which forms at the confluence of the Tigris and Euphrates—and c80km northeast from

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its debouchure into the Gulf, occupying a natural terrace rising 2–12 m above the adjacent floodplain (Fig. 1).<sup>1</sup> Although precise figures are unavailable, the historical sources describe how, within a single generation of its foundation, the population of Basra had expanded to approximately 250,000 inhabitants which, in the context of the global early medieval period, would represent a major urban centre of international importance. As historians have frequently highlighted (Donner 1981, p. 230; Kennedy 2011, p. 182), sustaining a large, urbanised, population centre in the arid environment of the Basra region presents a significant challenge. Indeed, ensuring that a sufficient supply of water reached the city—for drinking water, hygiene, and industrial processes—as well as the surrounding landscape—for the irrigation of crops to feed the city’s inhabitants and produce an exportable surplus—required the construction of substantial hydraulic infrastructure in Basra’s surrounding hinterland. While most evidence suggests Basra’s demographic and commercial zenith occurred between the eighth and ninth centuries, it remained a noteworthy centre for several centuries. In the mid-fourteenth century, for example, Ibn Baṭṭāta (1962, p. 275) describes Basra as a city “renowned throughout the whole world” though he also explains that the extent of the city and its population had significantly declined since former times. By the early sixteenth century, the city had been abandoned in favour of a site closer to the Shaṭṭ al-ʿArab from where the modern city has developed to the present day. Through a variety of sources, including satellite imagery, historical maps, and the descriptions of travellers from various points in time, this paper explores the landscape impact of the early Islamic metropolis of Basra. Particular foci include the different routes through which water reached the city, how water was distributed in the surrounding hinterland, and the key role this played in sustaining and enriching the urban populace of medieval Basra.

## Historical background and previous work

Based on the later historical sources, the first Islamic settlement<sup>2</sup> at Basra was a military encampment established by ʿUtba b. Ghazwān<sup>3</sup> between 635 and 636, during the early phases of the Arab conquest of the Sasanian Empire. Initially, occupation was temporary—its reed buildings were disassembled and packed away when the soldiers left on military campaigns and reconstructed when they returned (al-Balādhurī 1924, p. 61). Though the precise motivations and timing remain unclear, settlement at the site was reportedly made permanent by 638–639. According to al-Ṭabarī (1992a, p. 168), the approximate site was selected by the caliph, ʿUmar b. al-Khaṭṭāb (r. 634–644), who instructed ʿUtba b. Ghazwān to halt when he reached “the most distant edge of the Arab desert ... at the nearest point of the cultivated Persian land”. The easy access to nearby resources—pasture for livestock, firewood, swamps full of reeds, and water—convinced ʿUtba b. Ghazwān that the site was a promising location for a more permanent settlement (al-Balādhurī 1924, p. 60). Basra also afforded ʿUtba b. Ghazwān’s forces a base within striking distance of the Sasanian town of al-Ubulla, which lay approximately 15 km distant on the Shaṭṭ al-ʿArab, while maintaining an escape route back into the desert<sup>4</sup> should the Sasanians have rallied their forces. After the rapid conclusion of the military campaign in favour of the Muslim conquerors, despite

<sup>1</sup> Measurements taken from AW3D and SRTM 30 m DTMs of the region.

<sup>2</sup> Though the site had seen light occupation before the arrival of the Islamic conquerors—who called it al-Khurybah “the small ruin” (al-Ṭabarī 1992a, pp. 163, 168).

<sup>3</sup> The commander of Islamic forces in the region who subsequently became Basra’s first governor.

<sup>4</sup> Note that ʿUtba b. Ghazwān’s army, which reportedly included Bedouin tribesman, were likely well accustomed and comfortable with travel across the desert.

the advantages offered by al-Ubulla's location on the banks of the Shaṭṭ al-<sup>c</sup>Arab, the new occupants of Basra did not relocate to the older town.

The settlement pattern favoured by the Islamic conquerors seems to have fundamentally differed from that which had prevailed throughout the Sasanian Empire. The establishment of new cities, rather than occupying existing centres, conforms to a wider pattern that characterised the nature of settlement in the aftermath of the Islamic conquests (Whitcomb 1994). In part, this may have related to a desire to remain separate from the existing civilian populations dwelling within the newly conquered territory (Christensen 1993, p. 86). On the other hand, the environment that the conquerors encountered when they reached southern Iraq was likely one in a state of flux. A flood disaster in c.629, which reportedly damaged many dikes irreparably, may have fundamentally altered the landscape surrounding Basra—especially the marshes to the north (Nutzel 1982). By the mid-630s, the landscape probably remained heavily disrupted, perhaps making the existing population centres unattractive, while a new city occupying a natural terrace above the floodplain, which was by and large safe from flooding, held obvious advantages. Comparably, the site chosen for al-Kūfa (al-Balādhurī 1916, p. 435), a near-contemporary Islamic foundation established in 638, was also selected for its elevation above the adjacent Euphrates floodplain.

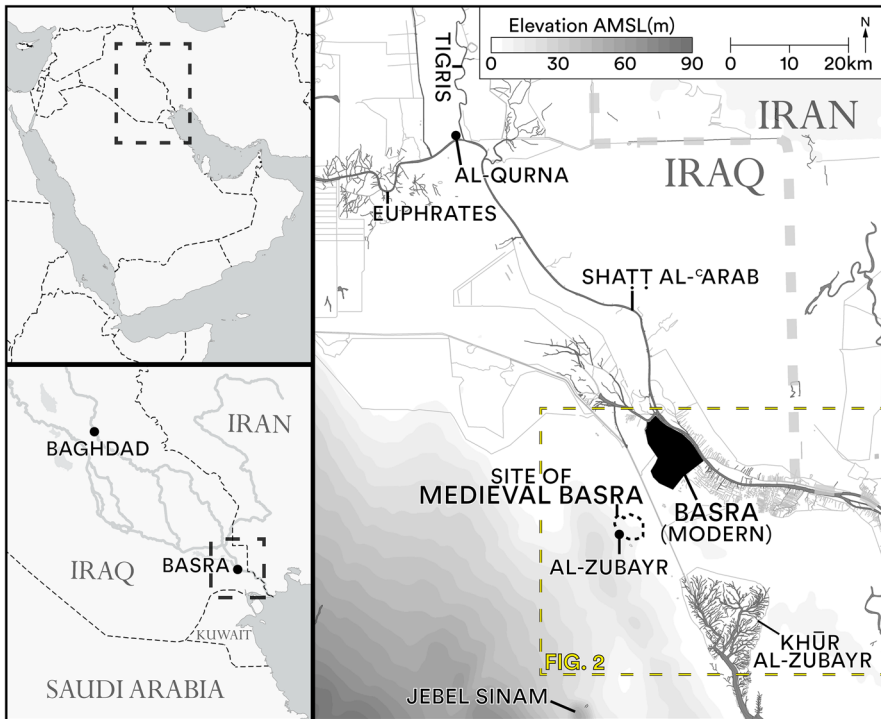
What was only a small-scale and temporary military camp of perhaps 1000 people initially (Donner 1981, p. 230), quickly grew to become a permanent *miṣr* or garrison town. In the two decades that followed the conquest of Iraq, the soldiers and their families who had initially settled in Basra were joined by a significant influx of migrants—many of whom belonged to the same tribes as those who had fought against the Sasanians—rapidly inflating the new city's population (Donner 1981, pp. 231–233). The veterans of the conquest—as well as, at a lesser rate, these later migrants—were paid a regular salary by the state known as the <sup>c</sup>*atā* (Kennedy 2011, p. 181)—an incentive which played a key role in drawing Muslim migrants to Basra. Reportedly, during the governorship of Ziyād (665–670), the soldiers of Basra numbered 80,000 while their households made up an additional 120,000 (al-Balādhurī 1924, p. 66). Historians have extrapolated these figures to suggest a population of at least 250,000 (Kennedy 2011, p. 177), though figures as high as 400,000 have been suggested (Kennedy 2002, p. 156). Compared to contemporary urban centres such as Byzantine Constantinople<sup>5</sup> and Tang Chang'an,<sup>6</sup> such a large population would place Basra among the largest cities in the world.

For Basra, this estimate can be checked to some degree through the archaeological evidence. Although the medieval city was abandoned in favour of a site closer to the Shaṭṭ al-<sup>c</sup>Arab by the early sixteenth century, remains have survived into the modern period. Only ephemeral standing structural remains have been documented,<sup>7</sup> with the notable exception

<sup>5</sup> At its fifth century peak, estimates place the population of Constantinople at approximately 400,000 though note that the Justinianic plague between 541 and 750 is thought to have significantly thinned population numbers throughout the Byzantine Empire and the population of Constantinople is likely to have seen a substantial decline (Stathakopoulos 2008, pp. 310–312).

<sup>6</sup> Estimates for the first half of the eighth century suggest that the population of Tang Chang'an was in the region of 700,000 (Kiang 2014, p. 106).

<sup>7</sup> Lorimer (1908, p. 1951) describes remains covering several square miles “consist[ing] of mounds of earth intermingled with fragments of yellow burnt brick” the latter of which were “excavated in great quantities” by the residents of the nearby town of al-Zubayr for use in the construction of their houses. The mounded remains of the city appear in a 1915 British military sketch map of the area (IOR/L/MIL/17/15/95, p. 14) and were later described by Lees and Falcon (1952, p. 36) and Solecki (1955, p. 123), the latter of whom noted remnants of “former earthen walls” along with ubiquitous pottery and glassware—some of which he dated to the seventh and tenth centuries CE.



**Fig. 1** Location of the modern city of Basra and the site of the medieval city in relation to modern water features and locations discussed in the text. Created by the author in ArcGIS 10.7.1 and Adobe Illustrator using data from Natural Earth, GADM, OCHA and OpenStreetMap under Open Database Licence <https://opendatacommons.org/licenses/odbl/1-0/>

of the ruins of the city's Great Mosque<sup>8</sup> and several shrines and tombs associated with important figures in Islam.<sup>9</sup> In the few instances they have occurred, excavations have revealed "large, well-built residences" (Postgate 1979, pp. 147–148), an oil press and a kiln (Simpson 2019, p. 40). These remains, however, are insufficient to allow any population estimation based on the numbers of residences, as has been attempted for Sāmarrā' (Kennet 2001, pp. 175–180). The survival of the city wall, however, which has recently been mapped (Peterson 2018), provides a figure for the area of the city. With estimates

<sup>8</sup> For a description of the standing remains of the mosque see: Sarre and Herzfeld (1911a, pp. 249–251, 1911b: Tafel XXXVII). For details of limited excavations made on the site of the mosque see Postgate (1973, pp. 191–192).

<sup>9</sup> Notably the shrine of al-Ḥassan al-Baṣrī and the tomb of Ṭalḥā b. °Ubayd Allāh (the latter of which was destroyed in 2007).

of population density,<sup>10</sup> this can be used to check whether a population in the region of 250,000 could have feasibly dwelt within Basra's walls. The wall only bounds the city on the south-western side while, to the north-east, the limit of seasonal inundation provides another boundary—as it is unlikely that significant permanent settlement existed outside this line. The area within these two boundaries is approximately 22 km<sup>2</sup>. Dijandjgava (1992, p. 67) gives 150–160 people per hectare for 'dense' population in medieval Muslim cities—described as more than 30% of the site being occupied by two-storey houses with small yards. When applied to the area calculated for medieval Basra, this suggests a population of between 330,000 and 352,000. Clearly, the figures derived from the historical sources are not entirely fanciful, and indeed an even larger population could have resided at Basra, though some areas may have been relatively sparsely occupied—it is unknown, for example, whether settlement continued right up to the wall line. The more conservative figure of 250,000, corresponding to an average population density of c.114 people per hectare, remains a possible estimate though its veracity remains open to doubt. Later indicators for the city's population suggest a declining population of c.100,000 by the ninth century, casting doubt on the larger figures for the earlier period (Chandler 1987, p. 313). While precise population numbers and their chronological development over time cannot be accurately resolved for the early Islamic period, Basra was evidently a large and important city for several centuries after its foundation.

Although the 'Fertile Crescent' is one of the birthplaces of urban civilisation, the environmental realities of southern Iraq present substantial challenges in reliably sustaining dense population centres of this magnitude. Exactly how such a substantial population could be supplied with the food and water they required is discussed below, but the impetus for these developments was the market created by a heavily concentrated population, many of whom received a guaranteed salary from the state. This purchasing power attracted trade and commerce to the city, allowing Basra to quickly become an important commercial centre—as various strands of evidence demonstrate. For example, the number and wide variety of *sūqs* named in the documentary sources, each specialising in different products and trades,<sup>11</sup> indicates the existence of an extremely active commercial market. This may have been facilitated by a banking system that used credit notes to make payments—as it was when Nāṣir Khusraw (2010, pp. 115–119) visited in the eleventh century: "The procedure at the market is as follows: you turn over whatever you have to a moneychanger and get a draft in return; then you buy whatever you need, deducting the price from the moneychanger's draft. No matter how long you stayed in the city, you would never need more than a moneychanger's draft". Basra, therefore, became established as a centre of business and trade and the city's inhabitants garnered a reputation for their commercial mindedness (Ibn al-Faḳīh 1885, p. 51).

A key component of this economic vitality was Basra's location which enmeshed the city in a complex web of international exchange. The Shaṭṭ al-<sup>c</sup>Arab provided a connection to the major Iraqi cities to the north, to the west caravans across the desert could reach the important Islamic centres of the Arabian Peninsula, and its proximity to the Gulf granted easy access to Indian Ocean trade networks. As early as the seventh century, sailors from

<sup>10</sup> As has been carried out for al-Fuṣṭāṭ, another of the early Islamic *amṣar*, or garrison towns (Dijandjgava 1992).

<sup>11</sup> Including foodstuffs, livestock, fodder, textiles, clothing, drugs, perfumes, spices, books, stationery, wine, jewellery, glass products, metalwork, carpentry, ceramics and slaves (Nāji and Ali 1981, pp. 301–309).

the Gulf were sailing as far as China and, in addition to further contact through middlemen, Chinese sailors likely travelled in the opposite direction (Beaujard 2019, pp. 38–40). Soon after, products from southern Iraq were reaching as far as Japan (Priestman 2016, pp. 21–26). Dates were one of the main exports produced in Basra’s hinterland—for which the city grew internationally renowned. Later writers such as the thirteenth century Chinese scholar Zhao Rukuo (Hirth and Rockhill 1911, p. 137), as well as travellers such as Marco Polo (Murray 1845, p. 210) and Ibn Baṭṭāta (1962, p. 276), remark on Basra as a supplier of dates. Widespread evidence for the long-distance trade in dates during the early Islamic period may come from the large turquoise glazed jars produced in southern Iraq, found throughout the Indian Ocean and East Asia, which Priestman (2016, p. 24) argues originally contained dibbs (date syrup) from the plantations of the Shaṭṭ al-ʿArab. Other crops such as wheat, sugar cane and citrus fruits were also grown—and later evidence suggests these were also exported (Beaujard 2019, p. 520). Additionally, the city appears to have become a notable centre for the production of fine pottery—several classes of which seem to have been produced either within the city itself or its immediate environs.<sup>12</sup> In turn, slaves reached Basra in high numbers. In the textual sources these slaves are referred to as ‘the Zanj’ and are traditionally thought to have been predominantly East African in origin. Debate continues, however, over the extent to which East Africans made up the slave population in and around Basra as slaves were also sourced from North Africa, Europe and Central Asia (Campbell 2016, pp. 286–297).

This booming domestic market, as well as international trade opportunities, incentivised the improvement and development of Basra’s immediate hinterland. As we shall see, this took the form of the transformation, through canalisation, of almost the entire floodplain surrounding the city into an agricultural zone. According to the traditional narrative, however, this transformation also played a role in arresting the growth of Basra and eventually initiating its decline. The Zanji slaves, who are thought to have provided much of the manpower for the construction of infrastructure and agricultural cultivation in Basra’s hinterland, revolted in 869—presumably largely in protest at the harsh conditions under which they were forced to work—plunging southern Iraq into chaos (Popovic 1999; Campbell 2016). In 871 the rebels sacked Basra itself, destroying parts of the city and massacring many of its inhabitants (Popovic 1999, pp. 61–63). After the revolt was put down in 883, although it remained a notable city, Basra never again regained the important position in terms of size or commercial importance that it had enjoyed for almost two and a half centuries from its foundation.<sup>13</sup>

<sup>12</sup> These were distinctive turquoise glazed wares, opaque-white glazed wares—often decorated with cobalt blue or ‘lustre’ overglaze painting—and, less conclusively, ceramics with a splashed lead-glaze (Mason and Keall 1991, pp. 57–64). The identification of Basra as the site of production is based on a group of ceramics in the collection of the Metropolitan Museum of New York though their provenance is problematic (Mason and Keall 1991, p. 53). If not produced at the city itself they were almost certainly produced in the wider region (Priestman 2011, p. 104).

<sup>13</sup> For example, in the mid-eleventh century, when Nāṣir Khusraw (2010, pp. 115–119) visited the city, Basra “lay in ruins, the inhabited parts being greatly dispersed, with up to half a league from one quarter of the city to another.”

## Water in the Hinterland

Between 1937 and 1956, mean annual precipitation at Basra was just 167.4 mm with high seasonal variability—almost no rainfall fell between June and October (Meteorological Department 1960, p. 9). For a large urban population to inhabit this environment, therefore, a reliable source of water had to be provided. Shortly after the city's foundation, during the reign of ʿUmar b. al-Khaṭṭāb (634–644), the inhabitants of Basra had to travel two parasangs<sup>14</sup> to reach potable water (al-Balādhurī 1924, p. 77). This might have come from a source called Dayr Qāwūs, which reportedly brought drinking water to Basra via the Shaṭṭ al-ʿArab. It was located four parasangs upstream of al-Ubulla, and traversed uncultivated lagoons, but the wind—and presumably sedimentation—gradually reduced the water it brought to the city (al-Balādhurī 1924, p. 79). Wells likely also sustained the early settlers—and probably remained an important source of water throughout the occupation of the city. In 1604, the Portuguese traveller Pedro Teixeira (1902, p. 35) describes wells “amid the ruins” of medieval Basra at a place called ‘Drahemya’. By 1908, the wells at Dirhamīyah provided drinking water for the c.6000 inhabitants of the town of al-Zubayr, c.2 km to the northwest, as well as irrigating melon and alfalfa crops (Lorimer 1908, p. 1951).<sup>15</sup> Though sufficient to sustain the relatively small population of twentieth century al-Zubayr, the capacity of these wells appears to have been unable to support the swelling medieval population as a variety of other measures were undertaken. At least one rainwater cistern is mentioned by al-Balādhurī (1924, p. 98), and the tenth century geographer al-Muqaddasī (1994, p. 113) implies that many other storage cisterns existed,<sup>16</sup> though when these were constructed is unknown. Although such structures would have provided a useful additional supply of water, it is doubtful that their capacity could have sustained the city's population for long periods, especially during the dry summer months.<sup>17</sup>

The need for a more reliable and higher-volume water supply must have been evident from an early date. The potential of bringing water inland from the Shaṭṭ al-ʿArab was demonstrated by the presence of at least three pre-Islamic canals which flowed from the river between Basra and al-Qurna (Verkinderen 2015, p. 108). According to the textual sources, the first canal constructed to bring water to the medieval city was the Nahr al-Ubulla which linked Basra with the pre-existing town of al-Ubulla, the Shaṭṭ al-ʿArab and, eventually, the sea. This canal was constructed following a request from the residents of Basra to ʿUmar b. al-Khaṭṭāb and may have been an extension of a natural inlet (al-Balādhurī 1924, p. 78). Its construction may be recalled by a tradition related by al-Ṭabarī (1992a, p. 165) that the inhabitants of Basra originally settled on the banks of the Shaṭṭ al-ʿArab and gradually relocated themselves inland, digging a canal as they went, before reaching the final site. Although this disagrees with all other accounts of the city's foundation, it does highlight the importance attached to bringing water to the city shortly after its foundation.

<sup>14</sup> A unit of measure usually interpreted as approximately 6 km (Hinz 1955, pp. 62–63).

<sup>15</sup> Though note that early twentieth century maps indicate that visible remains of the medieval city did not extend as far as these wells—instead fading out some 2 km to the north.

<sup>16</sup> Al-Muqaddasī is not specific about the source of the water these cisterns contained. As well as a rainwater cistern, Al-Balādhurī (1924, p. 98) mentions cisterns which seem to have stored water transported by canals.

<sup>17</sup> Calculations based on excavated reservoirs from the city of Merv, Turkmenistan, demonstrate how rapidly water held by these structures would be exhausted. Cisterns holding 29 million litres of water, for example, would only have provided water for a population of 65,000 people for between 12 and 24 days (Williams 2018, pp. 168–169).

Apparently, after only a few years, during the reign of °Uthmān b. °Affān (644–656), a blockage affected the Nahr al-Ubulla (al-Balādhurī 1924, p. 78). Though this blockage was later cleared, these kinds of problems may have instigated the construction of a second canal—the Nahr Ma°qil (Verkinderen 2015, p. 85). This canal joined the Shaṭṭ al-°Arab north of the mouth of the Nahr al-Ubulla, from where it flowed southwest, meeting the latter canal close to medieval Basra at a point which became known as ‘the port’ (Abū al-Fidā’ 1848, p. 72). As this name suggests, this became an important harbour which benefited from the tidal effects of the Shaṭṭ al-°Arab as, at high tide, ships were able to travel upstream from the mouth of the Gulf to al-Ubulla—from where the reversed flow of water through the Nahr al-Ubulla into the Nahr Ma°qil allowed ships to reach Basra<sup>18</sup>—and later return to the Shaṭṭ al-°Arab (Abū al-Fidā’ 1848, p. 72).

The approximate course of these two canals can be identified with some certainty. The Nahr Ma°qil likely met the Shaṭṭ al-°Arab in the northern area of modern Basra known as Ma°qil while Verkinderen (2015, p. 79) equates the Nahr al-Ubulla with one of the main canals running through the modern city of Basra. Though it no longer reaches the site of the medieval city, its modern name, Nahr al-°Ashshār, references a famous mosque in the town of al-Ubulla. The remains of substantial canals running from the site of medieval Basra into both these areas are visible on 1960s satellite photographs of the area captured by the United States’ CORONA programme—providing strong evidence for the course of these canals (Fig. 2). Islamic writers frequently describe the area between the Nahr al-Ubulla and Nahr Ma°qil as an island<sup>19</sup> divided up by many smaller channels flowing between the larger canals. When travelling through this zone on a journey from Basra to al-Ubulla<sup>20</sup> in the mid-fourteenth century, for instance, Ibn Baṭṭāṭa (1962, pp. 280–281) observed: “an uninterrupted succession of fruit gardens and overshadowing palmgroves both to right and left, with traders sitting in the shade of the trees, selling bread, fish, dates, milk, and fruit”. Nāṣir Khusraw (2010, pp. 115–119) describes similar scenes in the mid-eleventh century and the situation was probably comparable from shortly after the completion of the Nahr al-Ubulla and Nahr Ma°qil canals. An intricate network of regularly spaced canals dividing up the land in this area is visible in the CORONA imagery,<sup>21</sup> in many cases preserving the layout of individual parcels of land (Fig. 3). This closely matches Ibn Baṭṭāṭa’s description while the possibility that these are the remains of more recent fields is excluded by the early seventeenth century description of Pedro Teixeira (1902, p. 34) who noted that: “much of [the floodplain around the medieval city of Basra], once fertile, has been desolated”.<sup>22</sup> Although the precise chronology of this complex pattern of canalisation is difficult to un-pick, al-Balādhurī’s account suggests that the intensive irrigation works carried out in the aftermath of the city’s foundation were mostly completed by 674 (Kennedy 2011, p. 187). After this date progress appears to have become more gradual, encompassing a few

<sup>18</sup> Due to the difficulties of travelling further upstream, ocean-going ships would have unloaded their cargoes at Basra to be transported further by barges or over land by camel (Agius 2008, p. 298).

<sup>19</sup> Nāṣir Khusraw (2010, pp. 115–119), in the mid-eleventh century, describes the land between the Nahr al-Ubulla and Nahr Ma°qil as an island as does Abū al-Fidā’ (1848, pp. 72–73) in the fourteenth century.

<sup>20</sup> Presumably travelling down the Nahr al-Ubulla at low-tide.

<sup>21</sup> DS1045-1040DA041, captured on 27/01/1968, offers a particularly clear view of this area.

<sup>22</sup> Further evidence for the abandonment of this zone in the early modern period comes from European maps of the city after its relocation closer to the Shaṭṭ al-°Arab. Both Isaak de Graaf’s 1677 map of Basra and Carsten Niebuhr’s (1778) map depict the area inland of the city, lying between the new city and the site of medieval Basra, as desert or waste. See: National Archives of the Netherlands, The Hague, Collection of Foreign Maps, Leupe, number access 4.VEL, inventory number 863; Niebuhr (1778: Tafel 39).

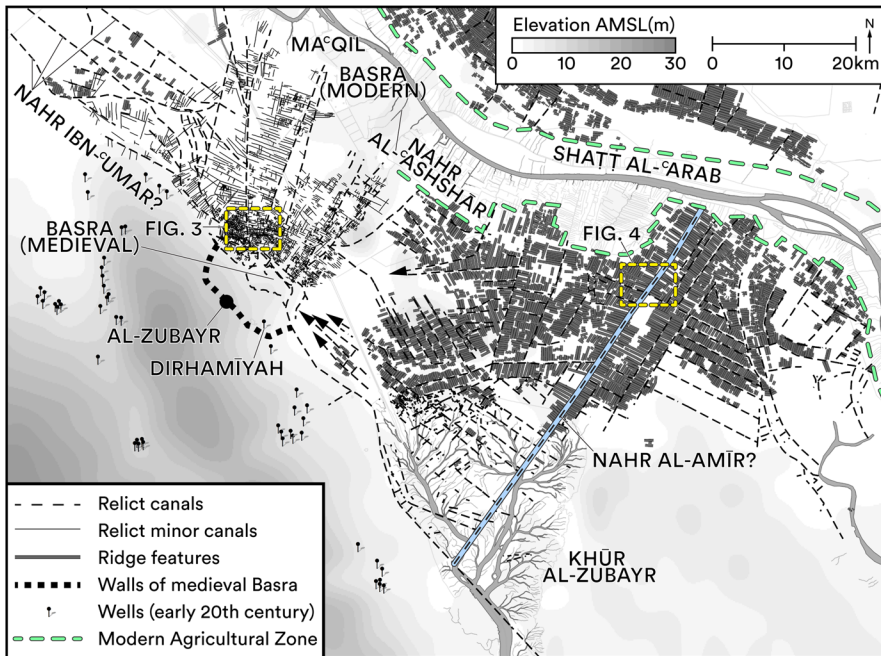


major projects. Certainly, by the early fourteenth century, the numerous canals of Basra had achieved such fame that the Mamluk official and scholar Abū al-Fidā' (1848, p. 71) had heard that there were more than 100,000.

The water supply at Basra was a recurrent problem—likely a combined result of the fact that (1) the waters of the Shaṭṭ al-ʿArab were high in salinity and unpalatable as drinking water, (2) they carried a significant sediment load, which quickly clogged up the canals (Buringh 1960, p. 51), and (3) the high population of the city demanded a huge volume and regular supply of water. That the water supply borne by the canals dug in the decades immediately after Basra's foundation was unsatisfactory is illustrated by an anecdote given by al-Balādhurī (1924, p. 97) that, in c.744, two glass bottles, one containing water from the Shaṭṭ al-ʿArab—from which Basra's water supply was drawn—and one from the marshes of al-Baṭīḥa to the north, were presented to the governor ʿAbd Allāh b. ʿUmar b. ʿAbd al-ʿAzīz. The obvious superiority of the water from the al-Baṭīḥa marshes reportedly motivated the construction of a new canal—the Nahr Ibn ʿUmar—connecting Basra with these northern marshes (Verkinderen 2015, pp. 86–88). Although major human modifications within the Shaṭṭ al-ʿArab basin since the 1960s, primarily dam building and marsh drainage, appear to have caused increased salt intrusion from the Gulf (Brandimarte et al. 2015), salinity levels in the Shaṭṭ al-ʿArab prior to these developments were primarily influenced by freshwater inflows from the saline lakes within the marshes north of Basra (Najarian et al. 1961). While the marsh water in the vial may have looked clearer than the water of the Shaṭṭ al-ʿArab, therefore, it was likely at least as saline. The Nahr Ibn ʿUmar, which brought water to Basra from the marshes, experienced problems soon after its construction which required a dam to be built to prevent most of the water diverting along another canal into the Shaṭṭ al-ʿArab before reaching Basra (al-Balādhurī 1924, pp. 98–99). Perhaps indicative of the efforts to transport the al-Baṭīḥa marsh water to the city, the remains of at least three linear features connecting the site of medieval Basra with the marshes to the north are discernible in the 1960s CORONA imagery (Fig. 2). That the construction of these canals failed to entirely alleviate the problems of the water supply at Basra, however, is reflected by Abū Ishāq al-Ṣābi's tenth century poem which unfavourably contrasts the “sickly, yellowish” water of Basra with the pure meltwater that reached Baghdad (Snir 2013, p. 127).

Another major canal, the Nahr al-Amīr, was excavated during the reign of the caliph Al-Mansur (754–775). This feature is probably to be identified with a substantial linear canal visible in satellite imagery 20–25 km east of the site of medieval Basra,<sup>23</sup> connecting the Shaṭṭ al-ʿArab with other canals flowing to and from the city (Verkinderen 2015, pp. 92–93). Since this canal did not flow directly to Basra, it probably did not contribute to the city's water supply—instead providing a source of irrigation for the surrounding landscape and a conduit for transport. Within the main canals mentioned by the historical sources, therefore, there appear to have been two major phases of canal construction. The first took place in the mid-seventh century, in the decades following Basra's foundation, and saw the construction of the Nahr al-Ubulla and the Nahr Maʿqil, while during the second, in the mid-eighth century, improvements were made to the water supply via the Nahr Ibn ʿUmar and irrigation in the hinterland was intensified through the Nahr al-Amīr. The information provided by the documentary sources, however, is limited to the largest and most important

<sup>23</sup> See Lees and Falcon (1952, p. 34; Plate I) for an aerial photograph of this canal taken from a 1946 flight over the area.



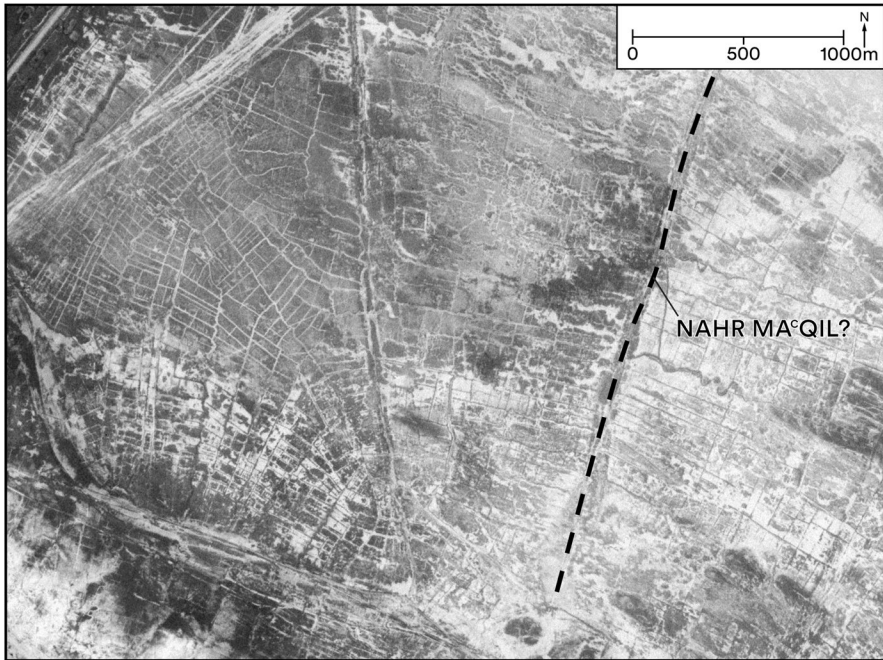
**Fig. 2** Features in the hinterland of the medieval city of Basra relating to agriculture and irrigation. Relict canals identified through remote sensing. Minor canals are smaller in scale and bisect the larger canals. Arrows indicate relict canals that appear to orient toward the site of the medieval city, though their route in between has not been preserved making it impossible to confirm whether this is the case. Created by the author in ArcGIS 10.7.1 and Adobe Illustrator using data from Natural Earth, GADM, OCHA and OpenStreetMap under Open Database Licence <https://opendatacommons.org/licenses/odbl/1-0/>

canals which, as the satellite imagery reveals, were bisected by many smaller channels which brought water to individual parcels of land.

This network of canals in the hinterland of medieval Basra operated primarily as a system of tidal irrigation. As noted above, the tidal effects of the Shatt al-<sup>c</sup>Arab produce daily variations in water level—at high tide, the river level rises and water is forced upstream and down the canals that join the Shatt al-<sup>c</sup>Arab (Buringh 1960, p. 121). In some instances—such as during spring tides—this caused flooding across large areas of the plain surrounding the city. The canalisation of the floodplain bounding medieval Basra on its eastern side, therefore, allowed large areas to be irrigated for agricultural production with relative ease by harnessing these regular tidal effects. Moreover, al-Muqaddasī (1994, p. 113) describes how the ebbing of the tide drove mills positioned at the mouths of these canals—allowing the agricultural produce to be processed. All of this infrastructure, however, would have required continual maintenance, including dredging and the re-excavation of canals, to ensure that the waters kept flowing.

An important question is how these substantial canals, which stretch over considerable distances,<sup>24</sup> were constructed. There is some evidence of segregation by tribal or ethnic

<sup>24</sup> The canal identified as the Nahr al-Amīr is 31 km in length.



**Fig. 3** Satellite photograph of relict canals demarcating abandoned fields immediately north of the site of medieval Basra. The route of a major canal (dashed line), which runs into the area of modern Basra known as Ma<sup>q</sup>il, may be the remains of the Nahr Ma<sup>q</sup>il—one of the canals frequently described by the documentary sources. Processed and annotated by the author in ArcGIS 10.7.1 and Adobe Illustrator. Photograph number DS1045-1040DA041, captured 27/01/1968 by the United States of America's CORONA program. Reproduced courtesy of the U.S. Geological Survey

communities in the organisation of urban space within Basra<sup>25</sup> and this may have had an impact on the construction, layout and maintenance of the canals within and immediately surrounding the city. When the Asāwira, a Sasanian military unit, settled at the city after converting to Islam, their residential quarter was marked out for them (Akbar 1989, p. 26). Presumably as an immediate priority to bring water to their new homes, however, they had to dig their own canal—which became known as the Nahr al-Asāwira—the ‘canal of the Asāwira’ (al-Balādhurī 1924, p. 106). Although the marking out suggests the involvement of a city-wide authority, it is possible that, just like the Asāwira, each tribal or ethnic group had their own water canal, the original construction of which had been the responsibility of the group. By extension, the maintenance of these canals was likely also organised internally within these tribal/ethnic groupings. Similar arrangements for the maintenance of irrigation systems were common in other parts of the Islamic World including the Egyptian Fayyum region (Rapoport and Shahar 2012, pp. 25–28) and Al-Andalus (Glick 1995, pp. 69–76). At least in the immediate aftermath of Basra's foundation, therefore,

<sup>25</sup> Ibn Battāta describes three distinct quarters divided by tribal or ethnic identity in mid-fourteenth century Basra (Ibn Battāta 1962, p. 276). For a discussion of how this system might have operated see Akbar (1989).

it was probably the residents of Basra, and particularly the large military garrison, who excavated the canals in the city's hinterland. By the mid eighth century, however, during the second major phase of canal construction, the Zanj slaves may have provided the primary source of labour.<sup>26</sup>

## A system of intensive agriculture?

Perhaps the most interesting landscape feature in Basra's hinterland is a system of substantial linear ridge features, the remains of which are widely distributed in the flood plain of the Shaṭṭ al-<sup>c</sup>Arab. These long ridges rise above the ground surface by 1–3 m—typically measuring 0.8–1 km in length and 25–50 m in width. The distance between individual ridges varies but is typically 150–300 m. Notably, however, discrete groups of ridges, sharing the same orientation, are usually spaced at regular intervals suggesting that they were laid out contemporaneously. This implies that the ridge system was not constructed in a single episode, but laid out sequentially in groups, perhaps with the involvement of different landowners working independently. Remains survive of more than 5000 of these ridges, in varying states of preservation, distributed in groups on either side of the Shaṭṭ al-<sup>c</sup>Arab, at times stretching 20 km inland. The southernmost group visible today are a few ridges on the east bank of the Shaṭṭ al-<sup>c</sup>Arab near Abbādān, present-day Iran, while the northernmost lie just 15 km southeast of al-Qurna. By far the densest concentration, for which visible evidence survives, begins some 8 km east of medieval Basra and stretches for a further 30 km eastward, encompassing the entirety of the floodplain between the Shaṭṭ al-<sup>c</sup>Arab and the natural terrace to the southwest. Invariably, the orientation of the ridges respects relict irrigation canals—some of which are obvious features, even merging into canals close to the Shaṭṭ al-<sup>c</sup>Arab that are still in use today, while the routes of others may be inferred based on the distribution of ridges along their length (Fig. 4). In most cases, the ridges abut canals at approximately 90°, though, in some instances, ridges also run in parallel with relict canals.

When exactly these ridge features were created is at present unconfirmed.<sup>27</sup> The ground surface immediately between the site of medieval Basra and the system of ridges is heavily disrupted making it difficult to discern their relationship to the site of the city. The strongest evidence comes from the alignment of the canals abutted by the ridges—many of which orient toward the early Islamic city of Basra, either directly or via secondary canals (Fig. 2). Notably, the substantial canal that Verkinderen (2015, pp. 92–93) equates with the mid-eighth century Nahr al-Amīr is abutted by ridges at 90° along almost its entire length (Fig. 4). As this canal must have existed before the construction of the adjacent ridges, this provide a *terminus post quem* for the ridges orientated along its length—and neighbouring ridges, which form one cohesive system, are likely to have been constructed within the same broad period. Further evidence that the ridges are early Islamic in date comes from al-Ṭabarī (1987, pp. 106, 112, 132) who refers to *jibāl* (mountains or hills) around Basra—a description which likely describes the ridges simply because there are no other raised

<sup>26</sup> For a discussion of the development of the medieval Islamic slave trade and likely sources of slaves reaching Basra see Campbell (2016, pp. 286–288). Historians such as Belyaev (1969, p. 240) ascribe tasks such as ditch digging to the Zanj though the primary evidence for this, discussed below, is not definitive.

<sup>27</sup> The dating of the ridge features is the subject of an ongoing research collaboration between Radboud University and the universities of Newcastle, al-Qadisiyah and Basra funded by the Gerda Henkel Stiftung.

features for a considerable distance<sup>28</sup> while further reference to ‘mountains’ around Basra is made by an anonymous chronicle thought to date to the eleventh century.<sup>29</sup>

That the ridges and canals are not modern is confirmed by the fact that, 10–25 km southeast of medieval Basra, they disappear into, and are overlain, by the channels of the tidal inlet known as the Khūr al-Zubayr. In forming along existing depressions, the creeks of this tidal inlet preserve elements of the landscape that existed prior to its formation.<sup>30</sup> In this case, the creeks form long linear channels on alignments parallel with ridges and relict canals immediately outside the Khūr al-Zubayr. Evidently, therefore, the area which now forms the Khūr al-Zubayr was formerly bisected by canals and ridges just like the surrounding landscape and, accordingly, the construction and use of this system must predate the formation of the tidal inlet. When exactly this occurred is unknown, but the channels of the Khūr al-Zubayr are depicted, in approximately their present-day configuration, on a British Admiralty chart issued in 1902.<sup>31</sup> Although some uncertainty remains, which is unlikely to be resolved without scientific dating, the available evidence supports the interpretation that the network of ridge features and associated relict canals date to the same period as the occupation of medieval Basra.

While presumably agricultural in nature, exactly how these ridge and canal features may have functioned is unclear. As with the canals described above, the potential for tidal irrigation must have been key in their creation. This suggestion finds support in the observation that the distribution of ridge features fades out just south of al-Qurna, which is approximately the point at which the tidal effects of the Shaṭṭ al-ʿArab cease to be noticeable (Buringh 1960, p. 189). There are, therefore, several possible scenarios which explain the form and function of these ridge features. (1) The ridges might be a response to the accumulation of salts in the ground surface through repeated inundation by the saline water of the Shaṭṭ al-ʿArab. To remedy this, at regular intervals, the worst affected topsoil was cleared and heaped into linear rows—over time creating large ridges—leaving fertile soil in between that could be profitably cultivated. This is the scenario advanced by Nelson (1962) who documented higher salinity levels in the ridges compared to the interspersing flat areas.<sup>32</sup> Importantly, however, these salinity levels could have naturally accumulated over the last millennium so high measurements do not necessarily represent the condition of the ridges during the medieval period. Furthermore, it is unclear that such a strategy would have been an effective solution to the problem. Iraq’s distinctive dark saline soils, known as *sabakh*, do lose their colouration through ploughing—so clearing these soils into ridges may have superficially appeared to alleviate the problem—but the most important

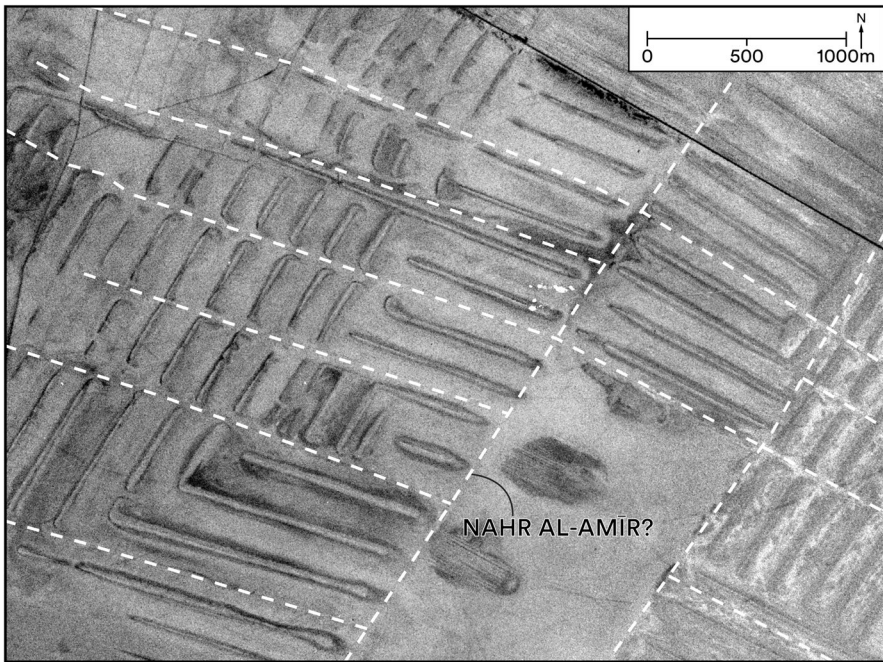
<sup>28</sup> See Verkinderen (2015, p. 92). The closest feature which might be regarded as a mountain is Jebel Sinam, located c30km south of Basra—but far removed from the locations discussed by al-Ṭabarī.

<sup>29</sup> Anon (1972, p. 16). The description in this source suggests the ‘mountains’ were created by the Zanj slaves. This is discussed in more detail below.

<sup>30</sup> For a discussion of the comparable preservation of medieval features as a result of saltmarsh formation in England see Gardiner (2005).

<sup>31</sup> British Library IOR/L/PS/20/130, f 43. This chart depicts “low sand hills” in the approximate position of a group of the ridges, further indicating that they were present at this time. These also appear on a 1916 British military map of the area, British Library IOR/L/PS/12/3737, f 15, which shows “Numerous Low Mounds” on the east bank of the Shaṭṭ al-ʿArab in another area in which many of the ridge features are located.

<sup>32</sup> Though note that Nelson does not give the precise number of samples taken nor the locations from which they were acquired.



**Fig. 4** Satellite photograph of an area covered by ridge features to the east of the site of medieval Basra. The routes of relict canals are indicated by dashed lines. A large canal running northeast-southwest may be the remains of the Nahr al-Amir. Processed and annotated by the author in ArcGIS 10.7.1 and Adobe Illustrator. Photograph number DS1035-1040DF019 captured 23/09/1966 by the United States of America's CORONA program. Reproduced courtesy of the U.S. Geological Survey

consideration in restoring the fertility of saline soils is drainage and a sufficient water supply to wash out the salts (Buringh 1960, pp. 96, 105).

(2) Popovic (1999, p. 13) proposes a variation of the former scenario in which the ridges were created during the initial clearance of already salt-encrusted topsoil—undertaken to make these areas cultivable. Carrying out this work would have allowed these parcels of land to be brought into private ownership through the Islamic *qatf'a* system of landholding by which 'dead' land became the property of the individual who made it productive (Kennedy 2011, pp. 181–182). This was usually achieved by irrigating the land through the construction of canals or the clearance of undergrowth that prevented cultivation. In this model, therefore, land ownership would have been transferred to those who organised and paid for the clearance of the unproductive topsoil. In support of this model is the layout of the ridges—separate blocks of ridges appear to have been spaced at different intervals—which might indicate the involvement of independent entities such as individual landowners. As in the previous scenario, though, these newly cleared areas would probably have remained relatively infertile without proper drainage and the removal of salts with water.

(3) The ridges could be an irrigation solution—to bring water to certain areas, the ground level had to sit below the source of water. The ridges could, therefore, be spoil heaps containing earth excavated from the areas in between to lower the ground level in these areas. Sedimentation from regular irrigation would have required these areas to be frequently 're-excavated' to ensure water continued to reach them. Both Lees and Falcon

(1952, p. 34, note 1) and Buringh (1960, p. 189) describe essentially this practice in relation to date farming in the Basra region in the mid-twentieth century though the scale and extent of the ridge systems discussed here are far more substantial than any modern areas of cultivation. Something similar may be seen in *falaj* systems where, for water to reach a larger area than would be naturally possible, ‘sunken fields’ are dug into the ground surface—with the excavated soil heaped into large spoil mounds which can reach a comparable scale (Wilkinson 2003, p. 156, Fig. 8.4). A slight variation of this scenario is that the ridges could form a so called ‘plot-and-berm’ agricultural system—variants of which are found widely around the coasts of the Mediterranean. These traditional agricultural systems are usually found in coastal areas where shallow ground water aquifers allow crops to be grown through capillary action or well irrigation. Cultivation generally takes place in man-made rectangular depressions, excavated to minimise the distance between the ground surface and the aquifer, surrounded by 1–5 m high berms, which are in some cases stabilised with crops—such as vines (Roskin and Taxel 2021). Pottery, and soils dated through Optically Stimulated Luminescence (OSL) methods, demonstrate that examples of these systems from the coasts of Israel were in use between the ninth–eleventh centuries (Roskin and Taxel 2021, pp. 474–475). These differ from those around Basra, however, in that the ridges at Basra do not entirely enclose the ‘plots’ in-between, always leaving gaps through which water could have flowed. The *navazo*, a variant of this type of system which has been practiced in Andalusia for at least several hundred years, relies on the interface between salt- and fresh-water being pushed further inland through tidal action as well as a network of drainage channels to remove excess water during the wet season (Sánchez and Cuellar 2016, pp. 902–904)—both of which are factors which may explain aspects of the ridge and canal systems in the Shaṭṭ al-ʿArab floodplain.

(4) The ridges could, themselves, be elongated fields raised above the level of the floodplain. In the modern period, river levees in the Shaṭṭ al-ʿArab region, which are typically 2 m higher than the surrounding ground surface, have often been farmed in a similar way—planted with date palms, sometimes with vegetables growing at ground level—while the adjacent lower-level areas become waste ground (Buringh 1960, p. 189). Higher ground would protect crops from floodwaters while crops could still be watered—either through water lifting mechanisms or, more likely, capillary action within the soils when the surrounding areas were inundated. In support of this model is the fact that, although some erosion has occurred making it difficult to be certain, the ridges are roughly uniform in their scale and seem to have originally reached a consistent height. This might indicate that this height was important—perhaps because it was the level required to protect from tidal inundation.<sup>33</sup> One problem with this scenario is the significant gaps between the ridges, typically between 150 and 300 m. Unless other crops were grown in these lower areas, it is unclear why such large spaces would have been left between the ridges.

Not all of these scenarios are mutually exclusive though each would have required substantial manpower. The Zanj slaves are the most obvious source and, indeed, several textual sources make reference to the tasks they carried out in the surroundings of the city, apparently reflecting work associated with the ridges. According to al-Ṭabarī (1992b, p.

<sup>33</sup> In describing the area in December 1906, the British Lieutenant-Colonel Wilfrid Malleon (1907, p. 14) states that “the rise and fall [of the tide] is from 8 to 12 feet but is dependent on the strength of the wind and the amount of water in the river. The difference between spring and neap tides is about 3 feet”. Today, many of the ridges are 4 m higher than the surrounding ground surface so a tidal rise of 12 feet (3.6 m) would have left approximately 40 cm of the ridges exposed above the floodwaters.

30), the Zanj “labored in removing the nitrous topsoil (*sibākh*) of the marshland districts” and used mules to transport this material (al-Ṭabarī 1992b, p. 40). Meanwhile, a description in an anonymous chronicle (Anon 1972, p. 16), often mis-attributed to al-Ṭabarī himself,<sup>34</sup> specifies that the ‘mountains’ created by the Zanj, to make the *sibākh* cultivable, are well known in Basra. Nelson (1962) interpreted these descriptions as evidence for the first scenario, in which saline soil was repeatedly cleared and deposited to form the ridges. However, the scant descriptions given in the sources do not entirely exclude any of the scenarios outlined above. Furthermore, the exact meaning of the term *sibākh*<sup>35</sup> in the historical sources is unclear. While Nelson (1962), and others, interpreted this as a reference to the accumulation of salt in the topsoil because of repeated irrigation, an alternate possibility is that *sibākh* was a product spread on areas of cultivation as a manuring strategy to enhance fertility. As in the *navazo* systems discussed above, soil nutrients are one of the limiting factors in sandy soil agrosystems and highly decomposed organic matter, such as household and animal waste, are key for restoring and maintaining soil fertility (Sánchez and Cuellar 2016, pp. 905–906). Al-Ṭabarī (1992b, p. 37) describes “boats laden with compost of dung and ashes” around Basra while the 12th-century geographer al-Idrīsī (1836, p. 157) tells how the droppings of sea birds, collected on small islands in the Gulf, were shipped to Basra, where they fetched a high price, to be used as a fertilizer for vines, date palms, and general garden cultivation. Some of al-Ṭabarī’s other comments regarding *sibākh* lend weight to this view—for example, “the sale of *sibākh*” is discussed (al-Ṭabarī 1992b, p. 34)—which fits well with the purchase of fertilizer but can only be reconciled with Nelson’s scenario if, as Verkinderen (2015, p. 300, note 67) suggests, the intended meaning is the sale of the salt encrusted parcels of land themselves rather than soils per se. Based on the available evidence, therefore, exactly what the Zanj were tasked to do in Basra’s hinterland remains uncertain. Though they likely played significant roles in all parts of the agricultural system—maintaining canals, weeding, manuring, harvesting—their role in the creation of the ridges, and the reasons for doing so, may not be as clear cut as has frequently been alleged.

## Conclusions

The foundation of the medieval city of Basra, and its rapid growth into a city of perhaps as many as 250,000 people, set off a chain of events which led to the transformation of the landscape surrounding the city—especially the floodplain between the medieval city and the Shaṭṭ al-ʿArab. The need to provide water for this significant population seems to have been a perennial problem that caliphs and governors repeatedly made attempts to solve through a variety of different canal-building initiatives. Although complaints about the water supply at Basra are ubiquitous throughout the historical sources, the water these canals brought to the city—as a result of the tidal effects of the Shaṭṭ al-ʿArab—also allowed the surrounding landscape to be irrigated for agricultural purposes. The zone immediately adjacent to the city, particularly the area between the two major canals that connected the city to the Shaṭṭ al-ʿArab, became an intensively farmed area of garden cultivation that can be reconstructed both through the descriptions of travellers at various points in time as well as the surviving pattern of fields visible in twentieth-century satellite

<sup>34</sup> See, for example, Nelson (1962, p. 68).

<sup>35</sup> This term is still used to describe soils with a high salt content in modern day Iraq (Buringh 1960, p. 91).



imagery. The system of ridges to the southeast of medieval Basra, on the other hand, is more difficult to understand. Although the dating of these features remains imprecise, the available evidence suggests their construction and period of use occurred during the early Islamic period. Less clear is the function the ridges played in the agricultural exploitation of the landscape. While in the past, historians have readily interpreted the ridges as the work of the Zanj, the models that have been proposed do not fully account for the practical considerations associated with agricultural practices, tidal irrigation, and the formation of saline soils in the region. If the Zanj were the creators of these features, the ridges represent a monument of significant historical importance—the construction of which played a role in sparking the Zanj revolt that curtailed Basra's growth and prosperity. Ideally, to confirm the dating of these features and their *raison d'être* as well as to more fully understand their relationship to medieval Basra, field investigations and scientific dating should be undertaken in accompaniment with more detailed modelling of the behaviour of tidal irrigation and the accumulation of salts in relation to the system of ridges.

While much of the evidence, both historical and archaeological, for the development of the hinterland of early Islamic Basra is difficult to interpret, it is clear that substantial remains exist relating to pre-modern agricultural production in the landscape surrounding the medieval city. While today, agriculture barely extends 5 km inland from the banks of the Shaṭṭ al-<sup>c</sup>Arab, the evidence from satellite imagery demonstrates that a much wider swathe of land has been cultivated in the past, stretching up to 30 km inland, which covered almost the entire floodplain in a network of canals and fields. Evidently, therefore, just as the city itself grew to be an important population centre, which achieved significant prosperity through trade and commerce, the surrounding landscape also experienced significant transformations as the requirement to bring water to the city, irrigate the surrounding landscape and produce an agricultural surplus for domestic and international markets shaped and re-shaped the city's hinterland.

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## Declarations

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