Offprint from

Water for Assyria

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2018
Harrassowitz Verlag · Wiesbaden

Contents

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Water for Arbail and Nimrud

The imperial and provincial capitals of the Neo-Assyrian empire held populations far beyond the limits of the Bronze Age cities that preceded them. This accomplishment came in part from intensifying agricultural production on the lands adjacent to the cities. The irrigation systems of Nimrud and Nineveh have over a century of exploration, but there are still many details to be revealed, especially through remote sensing and field exploration. This paper analyses the irrigation systems between Nimrud and Arbail (modern Erbil) using two sources. The first are remote sensing datasets from a variety of declassified American intelligence missions: aerial photographs from the U2 spy plane, and satellite photographs from the CORONA (1960–1972) and HEXAGON (1971–1984) programs, many of which have not been used for non-intelligence research before. The second source are field observations of the Erbil Plain Archaeological Survey (EPAS) in the regions of Gwer, Shemamok, Erbil, Kawr Gosk, and Qala Mortka, between the Upper Zab and the Chai Bastora. These observations have revealed a complex palimpsest of both massive irrigation systems and small scale *karez*/*qanat* systems that can be difficult to untangle. It is certain, however, that the river terraces and plains surrounding Nimrud and Arbail were abundantly irrigated. It is possible that some of these canal features were also being used for downstream shipment of bulky agricultural products, which would further extend the sustaining areas of these great cities.

Planning and the Assyrian Landscape

It is increasingly clear that the landscape of Assyria was heavily planned. The home provinces of what would become Assyria had seen heavily human-modified landscapes since at least the Early Bronze Age. Those early landscapes were largely self-organized, the result of motivations that could be placed at the level of individual households (Ur 2017, in press). By the early first millennium BC, however, massive interventions were made by kings and their planners, and with the labor of the empire itself. In many cases, the inhabitants of these landscapes found themselves just as manipulated as earth, stone, and water.

Nowhere is the imposed landscape better understood than at the final imperial capital of Nineveh. The monumentality of the capital city itself is well known from over a century and a half of excavation. Beyond it, the landscape was filled with ideologically-charged monuments that glorified its kings, and legitimized them by showing their divine approval (Bachmann 1927). These monuments were placed in close association to a series of massive canals that completely reworked the hydrology of Nineveh's extended hinterland (Reade 1978, Bagg 2000, Ur 2005). Their waters flowed in the direction of the capital, but also fed

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Studia Chaburensia 7 (2018), pp. 57–75.

fields, orchards and vineyards dozens of kilometers into the mountains. With the start of archaeological survey in the northern hinterland, it is apparent that the landscape was filled with people as well – most likely the deportees described by Sennacherib and others, who wrenched them from their homelands and marched them into the cities and countryside of Assyria (Oded 1979).

It is quite possible that the rest of core of the Assyrian state was just as planned, not only under Sennacherib in the 7th century, but in fact from at least the early ninth century (Wilkinson *et al*. 2005, Ur 2017). There are several lines of evidence, starting most emphatically with settlement. At the top of the hierarchy were the great capital cities. The city of Nimrud was founded in the early ninth century as a vast walled space encompassing 360 hectares. The final and largest capital was Nineveh, which at 750 hectares was the largest city in the Near East at the time.

Rural Assyria has been understudied until recently, but suggestive evidence comes from adjacent regions. To the west, the Assyrian landscape was remarkably full, not with cities, as had been the case in the Bronze Age, but with uniformly small villages, and dispersed at a remarkably even intervals (Morandi Bonacossi 1996, 2000, Wilkinson 1995, Wilkinson and Barbanes 2000, Kühne 2010). In the region of Tell al-Hawa and Hamoukar, surveyors have interpreted this pattern as the planned in-filling of a landscape with the goal of spreading agricultural labor evenly. This pattern, it has been argued, might be agricultural colonization, the result of deportation and forced resettlement (Wilkinson, Ur, and Casana 2004).

Another line of evidence is composed of monuments, mostly related to water. For over 150 years, archaeologists have documented these elements, largely in isolation. The Assyrians left behind dams and even aqueducts, and many of these features are found with ideologically charged reliefs. The canals themselves have only rarely been recognized (e.g., Jacobsen and Lloyd 1935), but with the wide availability of satellite imagery, it is now possible to connect these isolated monuments to a broad network of water features (Ur 2005, Altaweel 2008, Mühl 2013). Nearly the entire hydrology of the Nineveh region had been modified by its engineers, diverting water from the rivers and moving it to the capital cities but more importantly, making it accessible for irrigation throughout the hinterland.

It can therefore be hypothesized that the Assyrian state deliberately transformed its landscape by repositioning its hydrology and its people (perhaps better thought of as labor). Via forced migration and resettlement, the state populated its cities and its countryside. Via large engineering projects, it brought reliable water, and provided a low-friction means of transport. This hypothesis, based on anecdotal observations by early archaeologists, remote sensing studies without ground control, and the interpolation of settlement patterns from the periphery to the imperial core, needs to be tested properly, however. In the past five years, it is indeed getting a rigorous test, by the Udine Land of Nineveh Archaeological Project (LoNAP) in Dohuk governorate (Morandi Bonacossi 2014, 2016, Morandi Bonacossi and Iamoni 2015) and by the Erbil Plain Archaeological Survey (EPAS) in Erbil governorate.

This study considers top-down landscape planning from two directions. First, it reassesses the canal system behind Nimrud, primarily via remote sensing, but also taking advantage of data sources not available to earlier scholars. The second direction involves ground-based field survey, in the region of Erbil. This research, which is ongoing, was made possible by the resurgence of archaeological fieldwork in the Kurdistan Region of Iraq (Kopanias, MacGinnis, and Ur 2015, Kopanias and MacGinnis 2016). This study supports the thesis that the

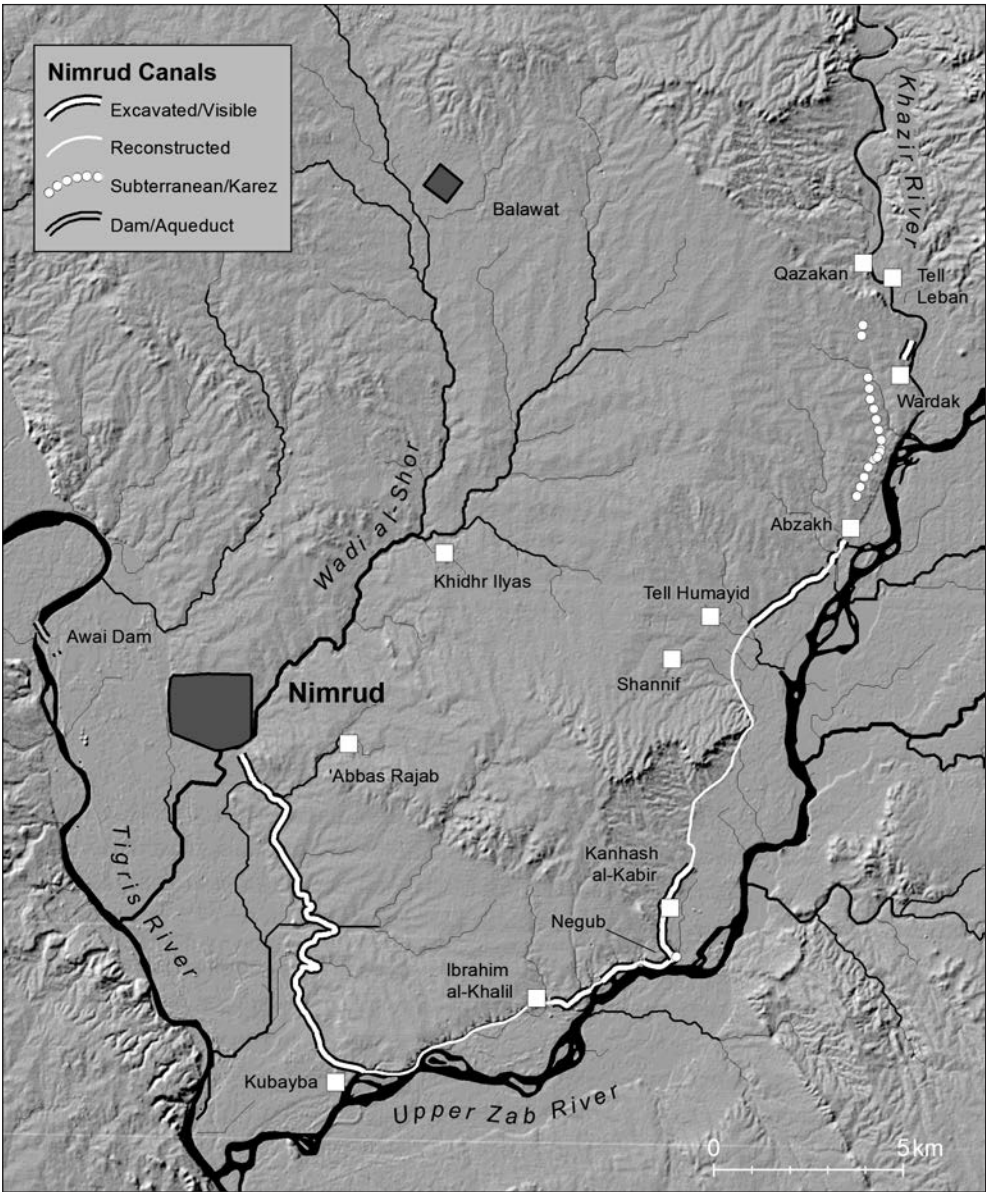


Fig. 1: The Khazir-Upper Zab canal to Nimrud.

central region of the Assyrian core, the hinterlands of Nimrud, Kilizu, and Arbail, was heavily engineered, both hydraulically and demographically. These hinterlands are conceived by modern scholars as adjacent but discrete, but the emerging landscape evidence suggests that these provinces were closely integrated, especially via artificial waterways.

In terms of methodology, both projects rely heavily on satellite and aerial remote sensing. Modern commercial imagery (ca. 2000 to the present) can see the full range of the visible spectrum, and even into the near-infrared, but it captures the twenty-first century landscape,

Fig. 2: The Qazakan-Abzakh subterranean canal near Warkdak village. Top: U2 mission 1554 (29 January 1960). Bottom: KH-9 HEXAGON mission 1213 (14 November 1977).

which includes a lot of damage to premodern elements. For this reason, these studies exploit declassified US intelligence imagery, from the CORONA, HEXAGON, and U2 programs. These images often predate heavy damage to early features, and allow extensive reconstructions. Almost all sites and canals in the Erbil area were first identified from CORONA. In the last year, U2 aerial photographs have begun to be used for landscape research. In the Middle East, these photographs date from 1958 to 1960, and are of extraordinary high resolution. The Erbil case study also draws on aerial and terrain data derived from drone-based photography, collected by the Erbil Plain Archaeological Survey since 2016.

Water for Nimrud

The question of how to feed the immense population of the Assyrian capital at Nimrud inspired David Oates (1968, 42–49) to look closely at its canal (Figure 1). The canal itself had been well documented since the 1850s, especially by Felix Jones (1855), who published the most accurate map of its course. Since then, elements of it have been restudied (Davey 1985, Altaweel 2008), but no full description of its features has been made, nor has it been analyzed using modern geospatial tools until very recently (Ur and Reade 2015).[1]

1 An interactive map of the Nimrud canal is available on Harvard's WorldMap platform at http://worldmap.harvard.edu/maps/nimrudlandscape .

Fig. 3: Canals, tunnels, and hypothesized features at Negub (background image U2 mission 8648, 30 October 1959). Dashed lines show the extension of the tunnel angle into the Upper Zab floodplain.

Most modern discussions of the canal place its origins from either the Upper Zab near the confluence with the Khazir, or from the Khazir itself, near this confluence (e.g., Oates 1968, 46). Felix Jones, however, had already noticed a line of shafts that led from further up the Khazir to the right bank of the Tigris, near the village of Qazakan (see Ur and Reade 2015, Fig. 2). These shafts mark the course of a subterranean canal, probably similar or identical to the feature leading to Erbil and built by Sennacherib. Although this feature (Figure 2) looks superficially like a Medieval *qanat* or *karez*, it behaves like a canal, as does the Erbil feature. The canal brings the water to the village of Abzakh, below which the canal can be traced for three kilometers along the left river terrace, before its traces have been removed by the Upper Zab.

The canal reappears a few kilometers above the tunnel complex at Negub (Figure 3). It flows in a clear open channel until reaching the Negub bluff. At this point, the Assyrian engineers cut deeply through it, to a point where the open channel turns sharply to the southwest. Also at this point, two subterranean channels, both leading in from the Zab valley, come in from the northeast and the east. In one of these shafts was found an inscription of Esarhaddon. The Negub feature is complicated and difficult to understand; it may represent as many as three different versions of the canal, functional at three different times (see discussions in Davey 1985, Ur and Reade 2015, 38–39, 43–4). It seems probable, however, that at one point the Upper Zab was a source of water for the tunnel, and probably at Negub itself.

Fig. 4: The terminus of the Nimrud canal near Fort Shalmaneser
(CORONA Mission 1039, 28 February 1967).

Beyond Negub, the canal continues in a channel cut sharply into the terrace edge. It cuts through another bluff before again being removed by the Upper Zab. It can next be found where it departed from the Upper Zab terrace to move north toward Nineveh, near the village of Kubayba. Near this point is evidence of a secondary canal, which would have allowed irrigation of the Tigris terrace from the main channel. From this point, the canal flowed northward, following the contours in and out of wadis and small drainages, until it reached the Wadi al-Shor near Fort Shalmaneser (Figure 4).

A few conclusions can be drawn about the canal for Nimrud. It was an impressive engineering feat that functioned for almost three centuries, although perhaps intermittently. It had a complex history that involved responding to environmental changes. Certainly these involved destructive high flood levels, but the system may have witnessed the slow down-cutting of the bed of the Upper Zab, which may have forced changes in the canal head. In his study, David Oates was concerned with modeling the land that could have been irrigated by the canal, and he concluded that it was inadequate for his population estimation (1968, 47–49). Remote sensing-based close mapping confirms Oates' conclusions, and indeed the estimated irrigable area resulting from this mapping is even smaller than Oates' (Ur and Reade 2015, 45).

To put it simply, a tremendous amount of effort was expended, over several centuries, to create and maintain a canal that did not irrigate much land, especially when compared to the Nineveh systems. Why would this be? The new discoveries by the Land of Nineveh Archaeological Project may point at an answer to this question. Daniele Morandi's team is revolutionizing our understanding of Sennacherib's Khinis-Jerwan system (Morandi Bonacossi 2016, Morandi Bonacossi and Iamoni 2015), but it has also discovered the remains of quays on the Navkur plain (Morandi Bonacossi 2014). The best-preserved is at Zinawa Ghazi, and while it has no inscriptional evidence, its materials and construction are identical to known Assyrian constructions at Jerwan and elsewhere. This quay would have served as a loading space for water transport. Zinawa Ghazi is close, on the horizontal plane, to the Khinis-Jerwan canal, but these features were not connected directly. The quay is at roughly 370 meters above sea level, but the Jerwan-Khinis canal flows at about 410 meters – in other words, forty meters above it, on the vertical plane. Water transport must have gone downstream, in other words, south down the Gomel River. Such a trajectory would have ultimately brought water traffic to the head of the Nimrud canal. It is possible, therefore, that agricultural products of the Navkur plain, possibly ancient Kurbail Province (Radner 2006, 47), could have been moved via water to the gates of Nimrud. The primary function of the Nimrud canal may therefore have been transportation, rather than irrigation.

Water for Arbail

Starting in 2011, archaeological research projects have flooded into the Kurdistan Region of Iraq, a stable and secure autonomous region in the country's north. The major Assyrian capitals fall just outside of it, but the Kurdistan Region encompasses a large part of the triangular Assyrian core (Radner 2011), including its most important non-capital city, Erbil. At its core is a great artificial mound, built up over six thousand years. At the time of the empire, it included this citadel, plus a vast area below it, encompassing about 360 hectares. Most of the Assyrian city has long since been subsumed under the modern city.

The Erbil Plain Archaeological Survey is investigating a 3200 square kilometer region with Erbil at its center (Ur *et al*. 2013, Ur and Osborne 2016). Although it is fringed with hills, most of the survey region is a broad alluvial plain, with settlement beginning at least eight thousand years ago. In three field seasons, the survey has concentrated on this plain, directly between Erbil and the imperial capital at Nimrud, and with the important provincial city of Kilizu (Qasr Shemamok) at center (Figure 5). It has recovered 329 habitation sites in the zone south and west of Erbil, with some non-systematic observations along the Upper Zab River and the Bastora Chai. In the systematically surveyed region of Qwer and Shamamok nahiya, 301 sites have been recovered in 400 square kilometers, a ratio of 0.75 sites/square

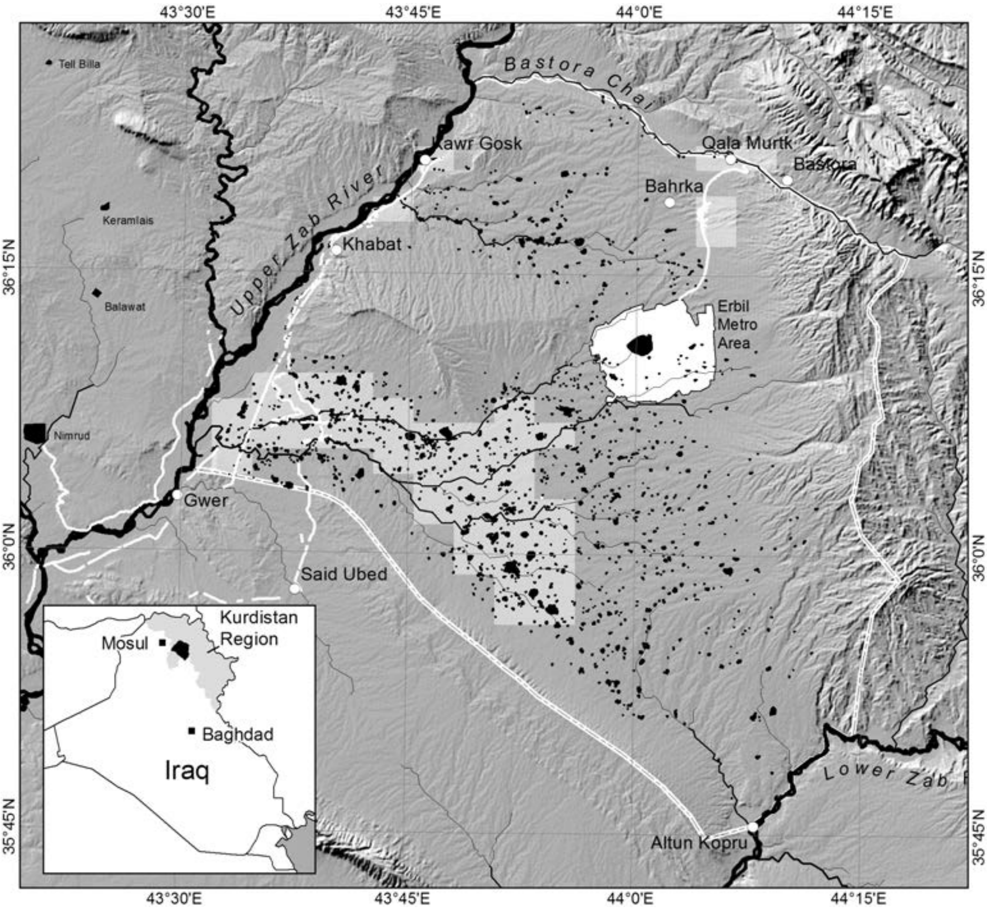


Fig. 5: Erbil Plain Archaeological Survey map, with surveyed regions, confirmed sites, and potential sites indicated.

kilometer.[2] The Erbil Plain is one of the densest archaeological landscapes yet recorded in Mesopotamia, and it validates the project's remote-sensing based site identification method (see Ur *et al*. 2013, 94–97).

With the rise of the Neo-Assyrian empire in the Iron Age, the plain saw a radical transformation in settlement (Figure 6). In the systematically surveyed zone, settlement numbers expanded from to 52 in the Late Bronze Age to 83 in the Iron Age. Kilizu remained an important provincial capital, but other LBA towns declined. Especially in the western area of the survey, settlement location was disconnected from water proximity. More than ever previously in the history of the plain, sedentary occupation moved into the areas between the major watercourses.

2 This figure includes only confirmed sites. As of December 2016, there are 226 unconfirmed sites (i.e., potential sites identified from satellite imagery but not yet visited by the survey team) within this 400 square kilometer zone. If all prove to be sites, that ratio rises to 1.31 sites/square kilometer. The project's current rate of correct imagery interpretation is approximately 77 %; if that rate continues, 174 of those 226 unconfirmed sites will prove to be ancient settlements, and the total ratio will be 1.18 sites/square kilometer.

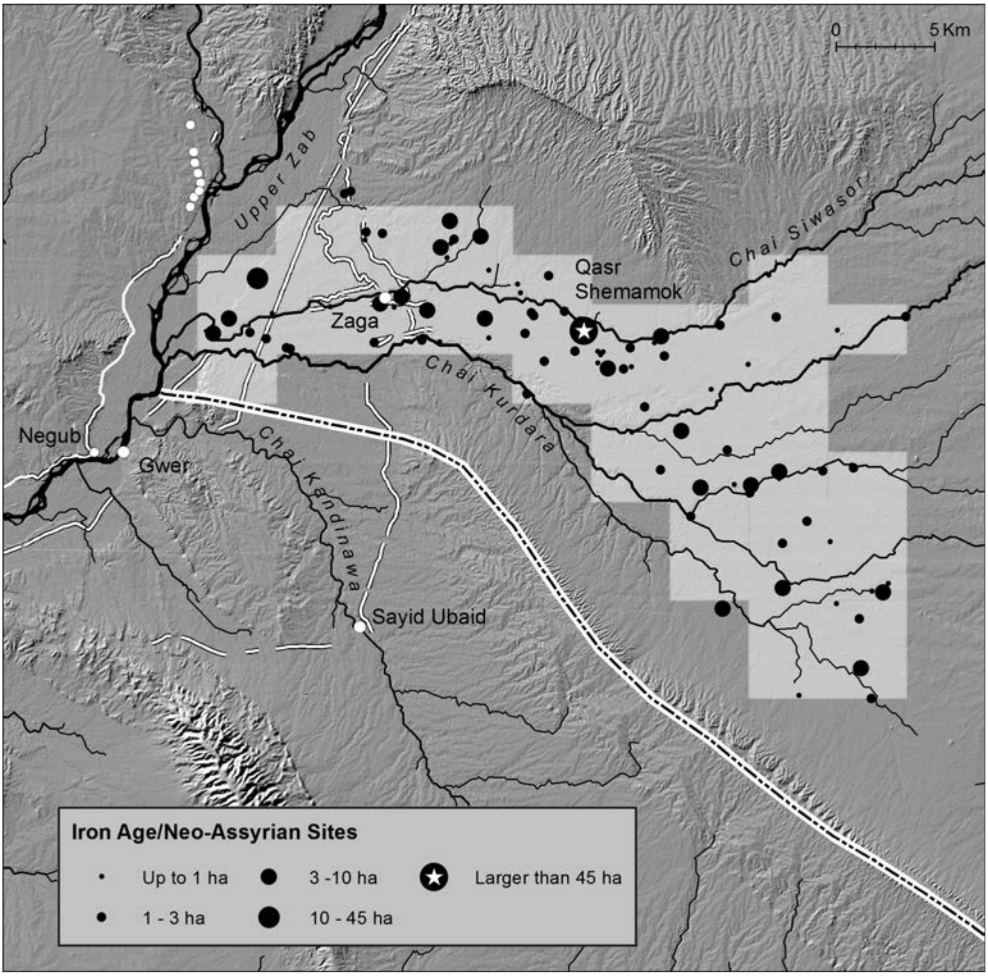


Fig. 6: Iron Age/Neo-Assyrian settlement (EPAS Period 11, ca. 900–600 BC) and associated canal remains on the lower Chai Siwasor and Chai Kurdara. Gray area surveyed in 2012–2016, other areas remain unsurveyed.

Erbil's rural settlement at the height of the empire was incredibly dense, when compared to regions adjacent to the Assyrian core. In these adjacent regions, sites have been recovered at densities between 0.11 and 0.18 sites per square kilometer (Ur and Osborne 2016, Table 16.1). In all cases, these densities were very high compared to other periods of settlement. On the Erbil Plain, Neo-Assyrian site density overall is 0.20 sites per square kilometer. In the irrigated western subregion of the Erbil plain (see below), that figure rises to 0.34 sites per square kilometer. In terms of the size of Assyrian sites, adjacent surveys recovered average sizes between one and a half to just over three hectares. On the Erbil Plain, sites average about 2.24 hectares, if we exclude 50-hectare Qasr Shemamok. In other words, Erbil settlements were not appreciably smaller than those on the fringes of the Assyrian core, but they *were* substantially more numerous. Previous surveys have shown that dramatic rural extensification occurred in areas adjacent to the core; we now see that in the heartland, this pattern of rural settlement was intensified.

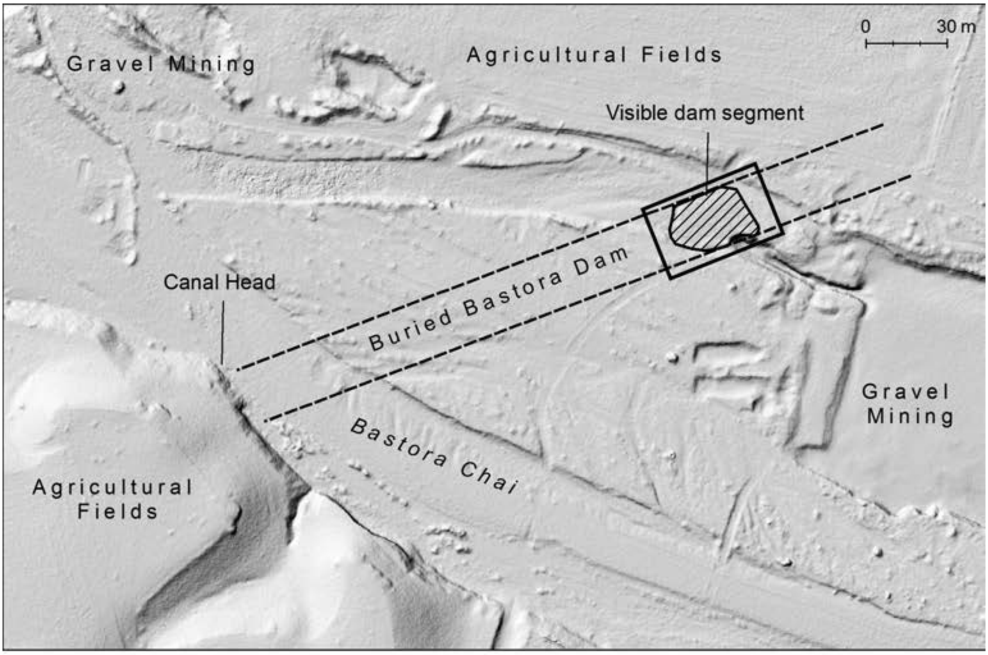
The Neo-Assyrian settlement expansion happened in the direction of some of the most marginal agricultural land on the plain, if one defines marginal in an agricultural sense, and via proximity to natural surface water. These watershed zones were, however, redesigned by Assyrian engineers. Satellite imagery reveals not only habitation sites, but abundant ancient canals as well. EPAS has documented three integrated water systems in the project area.

Fig. 7: The entrance to the Bastora canal (drone-based image acquired 28 September 2016).

The first is a previously known feature north of Erbil: a long subterranean canal that led from the Bastora River to Erbil itself. The entrance to the subterranean canal, which consists of an ashlar-fronted opening in the side of the left bank terrace (Figure 7), was documented by Fuad Safar (1946, 1947). An inscribed block over the entrance, now lost, names Sennacherib as its builder. It can now be demonstrated that this opening was fed by a broad stone diversionary feature across the river. A combination of gravel mining and channel avulsion resulted in the uncovering of a 20 m wide stone structure, which had been previously hidden beneath floodplain silts. In September 2016, the EPAS team identified this feature via drone photography, documented it via photogrammetry (Structure from Motion), and reconstructed its course in with GIS software (Figure 8).[3] Similar features are assumed to have fed the canal head at Khinis, and probably also diverted the Upper Zab river near Negub (see above); an undated but potentially similar feature was recognized by Felix Jones and later Julian Reade on the Tigris above Nimrud (see Ur and Reade 2015, 33 and Fig. 4). The Bastora dam is therefore probably not unique, but it is the best-preserved unambiguously Assyrian dam currently known.

The dam fed a subterranean canal that led water over 20 kilometers to Erbil, but it has proven to be very difficult to find it on the ground since its initial discovery in the 1940s. In the process of seeking it, however, the EPAS survey team discovered a series of smaller, local surface canals, both on imagery and on the ground, in the region east of the town of Bahrka (Ur *et al*. 2013, 104–106). On the imagery, the canals appear to start from the tops of narrow drainages, and then led water along their slopes. On the ground, they survive as in-filled cuts into the slope, generally four to six meters wide, which follow the contours closely (Figure 9). Ultimately nine such canals were documented over a three kilometer stretch of stony hills. The survey's non-systematic mapping identified *no* associated material culture, nor did it recognize any associated settlements. The only evidence for dating these features comes again for their morphology. The Bahrka canals are remarkably similar in structure and morphology to the Faida canal systems near Nineveh, which can firmly be connected to the Assyrians via the iconography of its associated rock reliefs (Reade 1978, 159–163, Boehmer 1997).

3 This feature was documented by the EPAS drone team (directed by Dr. Bjoern Menze, piloted by Mr. Khalil Barzinji). Photogrammetry of the dam feature was undertaken by Dr. Rob Homsher. A full report on this feature is in preparation.



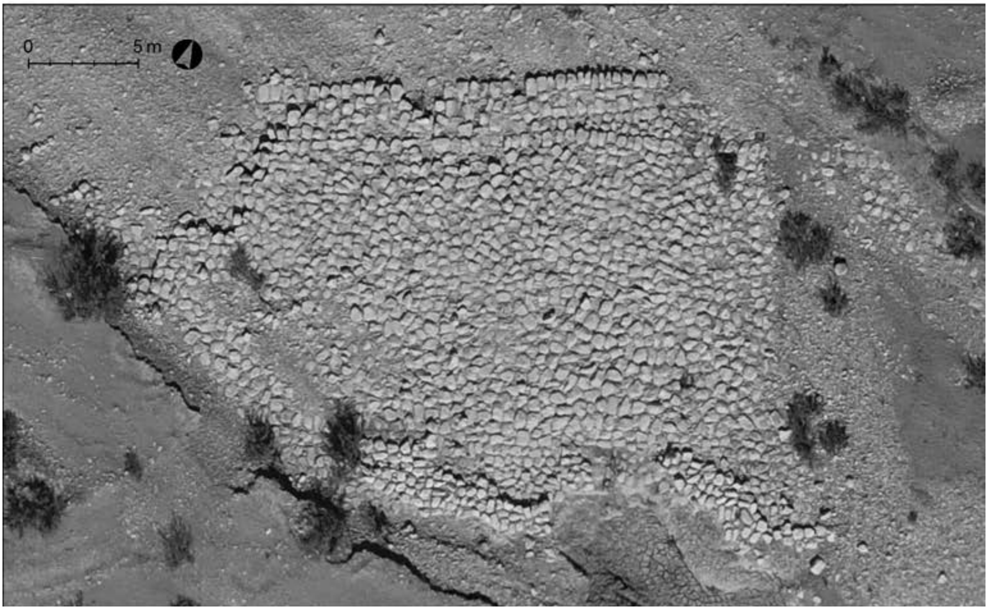


Fig. 8: The Bastora Chai dam and canal head near Qala Mortka. Top: hillshaded terrain with interpreted elements (derived from drone photogrammetry). Bottom: drone orthophoto of the visible dam segment (photo acquired 30 September 2016).

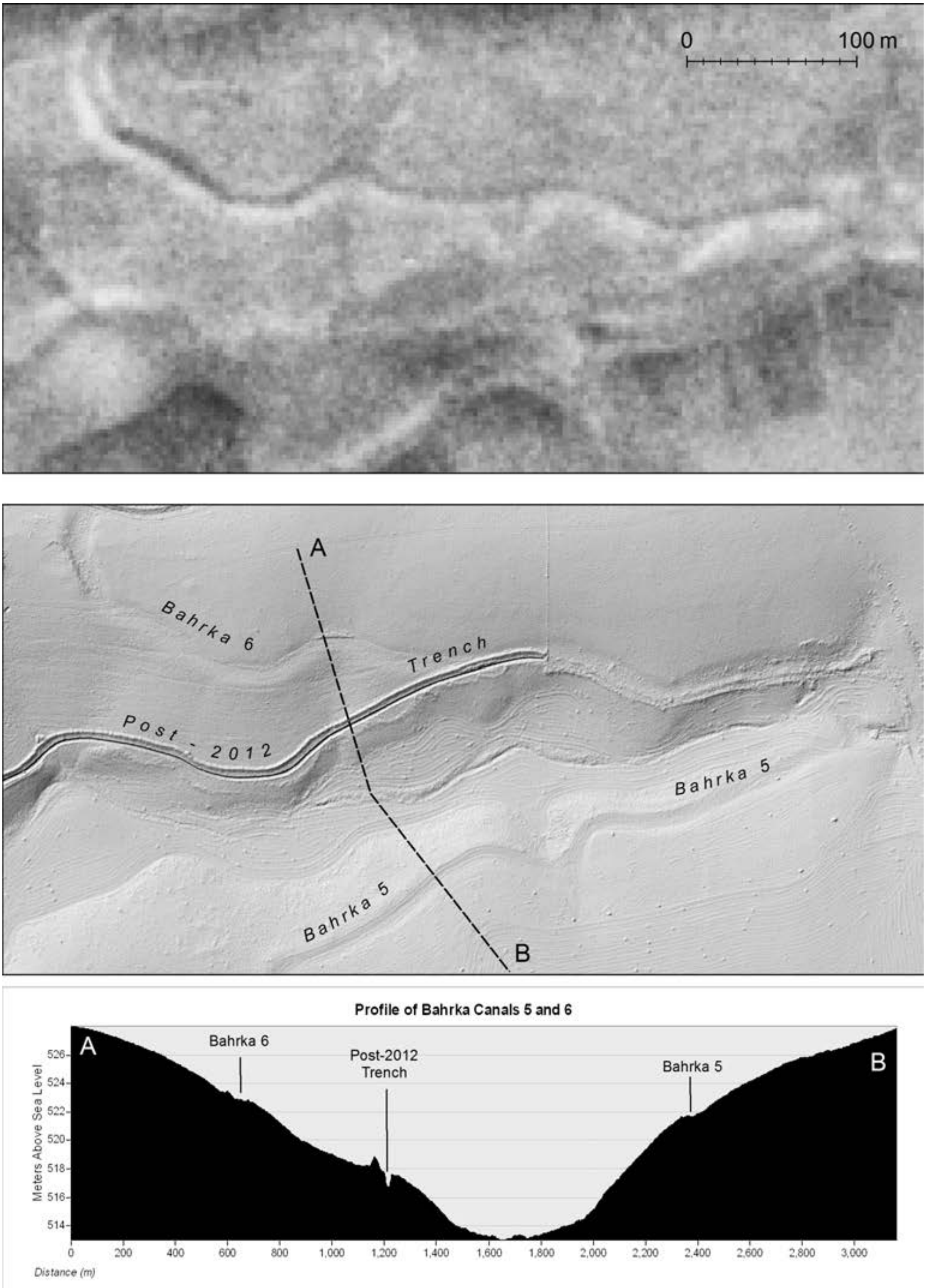


Fig. 9: Bahrka canals 5 and 6, north of Erbil. Top: CORONA image (Mission 1039, 28 February 1967). Middle: Drone-derived hillshaded terrain with elevation profile. Bottom: vertically-exaggerated elevation profile.

The small systems east of Bahrka probably watered orchards or vineyards in the hinterland of Erbil. It is tempting to propose that they were fed by the subterranean Bastora canal of Sennacherib, on the basis of its probable proximity, but without better documentation of the trajectory of the main canal, such a proposal is highly speculative.

Assyrian canal features are also abundant on the plain southwest of Erbil. Two large systems brought water to the plain between Qasr Shemamok and Nimrud. Both canals are massive interventions in the landscape. The first started on the left bank of the Zab, near the village of Kawr Gosk (Ur *et al*. 2013, 106–108). A second, more linear canal also began at this point, which is probably to be dated to the Sasanian or early Islamic period. Both canals continued down the right bank terrace, with the probable Assyrian canal removed in many places. Upon reaching the lower Erbil Plain, the likely Assyrian canal follows the contours to the southeast, into the plain, to maximize the irrigation zone; the probable Sasanian canal, on the other hand, maintains its rigid linearity and flows directly over it (see Figure 6).

On the plain itself, another canal originated from the Chai Siwasor, near the village of Zaga. The Siwasor is one of the major drainages of the plain, and was likely a perennial river in the past. The Zaga canal cut through right bank watershed of the Siwasor and flowed to the north (Figure 10). This massive feature is eight meters deep and 100 meters wide between its upper edges. It ends in an enormous basin, also about 8 meters deep and 300 meters across, before flowing into another drainage. In close association are found smaller channels and abundant Assyrian settlements. This feature is similar in scale and morphology to the massive feature at Bandwai, above Nineveh (Oates 1968, 51 and Pl. IV, Ur 2005, 330–331).

Yet a third canal appears to bring water to the plain from the south. This canal taps the Chai Kandinawa, which flows northwest into the Upper Zab (Figure 11). A diversion must have existed at or near the village of Sayid Ubaid, where traces of a right bank canal and a left bank canal are visible on CORONA satellite imagery. The right bank canal follows the river for just over a kilometer before moving northward toward the plain. This Kandinawa canal traveled about fourteen kilometers before it merged with (or crossed) the Chai Kurdara on the Erbil Plain. Especially at its northern end, it could have brought a large area of the southern Erbil Plain under irrigation.

It is not possible to date these large canals directly. However, in their physical characteristics, they are strikingly similar to known Assyrian canals to the north, above the city of Nineveh. The Zaga canal, for example, is similar in scale and morphology to the likely Assyrian canal near Bandwai, and to other features close to Maltai.

The Kawr Gosk, Zaga, and Kandinawa canals fed into a large irrigated zone on the lower plain west of Kilizu, and directly between Nimrud and Arbail, two of the most important cities in the imperial core. It includes almost all of the lower plains of the Chai Siwasor and Chai Kurdara. These are the deepest and richest soils on the Erbil plain. However, it is possible that the lower Erbil plain was actually a sustaining area not just for Kilizu or Arbail, but for the capital at Nimrud. It has already been proposed that the production of the Navkur Plain could have reached the canal head at Qazakan by floating down the Gomel and Khazir rivers. This massive investment in canal construction, and at a location only 20 kilometers east of an imperial capital city, raises the possibility that the agricultural production of the lower Erbil plain was actually intended to support Nimrud. Is it possible that produce-laden barges could have been floated down to Negub? The multiple tunnels at Negub are difficult to explain. One of them might have been intended to bring watercraft from the Upper Zab into the system. From that point, goods could have been shipped directly to Nimrud.

Fig. 10: The Zaga canal from the Chai Siwasor (KH-9 HEXAGON Mission 1202, 1 February 1972). Inset: drone-derived hillshaded terrain of the north end of the canal with large basin.

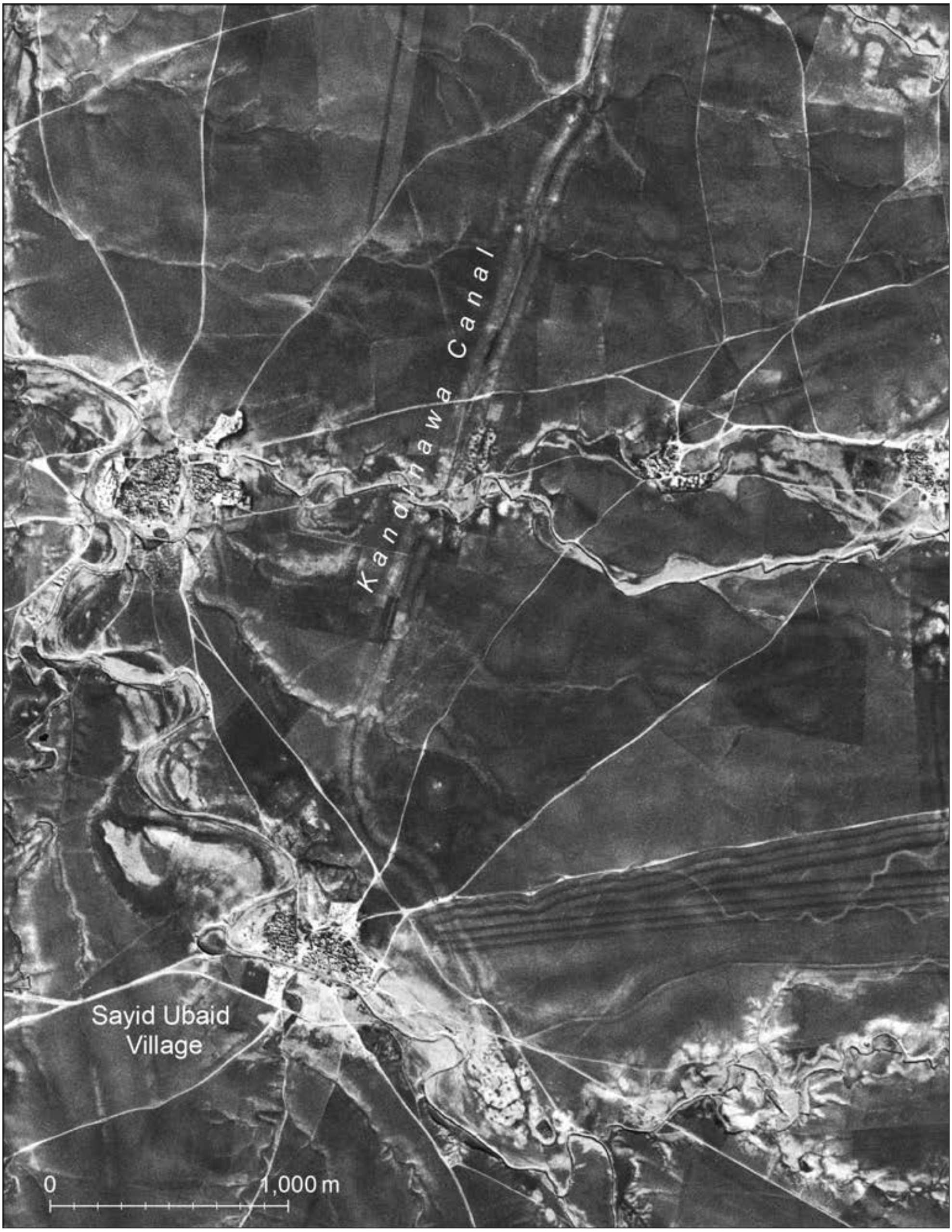


Fig. 11: The head of the Kandinawa canal near Sayid Ubaid village (CORONA Mission 1039, 28 February 1967). For location, see Figure 6.

Conclusions: Water for Assyria

It is inadvisable, at this early stage of research, to end with any firm conclusions. On the one hand, the emerging settlement pattern data for the Neo-Assyrian period is reliable: the landscape of the core of the empire was one of the most densely settled in the ancient Near East, and in its density and patterning, it was likely planned that way.

The canal data, however, is more suggestive than conclusive at present. This situation is especially true for the Erbil canal systems, which require much more study.[4] The data presented in this study, however, do suggest that scholars need to consider the possibility of a far more extensive and integrated planned landscape, particularly with regard to water management. The Navkur plain, which has been associated with Nineveh, may have also been originally integrated with the subsistence economy of Nimrud. The lower Erbil Plain, spatially connected to its eponymous city and to the provincial capital at Kilizu, may also have been connected via water directly to Nimrud. It has been noted that the great innovation of Assyrian urbanism was the dramatic expansion of cities' hinterlands, via friction-free movement on the Tigris (Wilkinson 2003). Now it seems likely that the Assyrians did not rely solely on natural watercourses for these transportation arteries; they may have created them themselves.

Once this landscape palimpsest is better understood, it is likely that the landscape of the central Assyrian core will be shown to have been dramatically altered at the height of the empire, in terms of the spatial organization of settlement, and most probably in terms of its hydrology as well. It is difficult not to connect these two features into an extraordinarily centralized and long-term plan to re-engineer the Assyrian landscape.

Acknowledgements

Many of these thoughts about the Nimrud canals emerged in collaboration with Julian Reade, and from productive discussions with Daniele Morandi. The Erbil Plain Archaeological Survey is grateful for the support of the General Directorate of Antiquities (Mala Awat, General Director), our colleagues in the Erbil Governorate Directorate of Antiquities (Nader Babakir, Director), and our friends in the Kurdistan Regional Government's Washington DC Representative's Office (Bayan Sami Abdulrahman and Qubad Talabani, current and former Representatives, and Najat Abdullah, Director of Culture and Community).

CORONA imagery is used courtesy of the US Geological Survey. HEXAGON and U2 imagery was made available with the assistance of the National Archives and Records Administration (NARA) in College Park, Maryland. The Nimrud canals research was enabled by a grant of imagery from the GeoEye Foundation. Drone-based imagery was acquired and created by EPAS team members Bjoern Menze and Khalil Barzinji with processing by Rob Homsher. Funding for the Erbil Plain Archaeological Survey comes from the US National Science Foundation (NSF), the National Geographic Society, Dumbarton Oaks, the American School of Prehistoric Research, and Harvard University.

4 EPAS team member Dr. Maurits Ertsen, a hydraulic engineer and water historian from Delft University, is in the process of modeling the flows of the Erbil canals.

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