

# The Great Eastward Migration into the Late Neolithic Black Desert, Jordan

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## Abstract

The southern Levant underwent two massive episodes of population dislocation in the Neolithic period, both apparently caused to some extent by overexploitation of natural resources as well as some degree of climate instability. Palestine and the Jordan Valley were virtually abandoned in the mid-seventh millennium BC, and the movement of people to the highlands of Jordan resulted in the creation of enormous settlements, the “megasites” of the Late PPNB during the second half of the seventh millennium. The second “Great Eastward Migration” occurred at the end of the seventh millennium, at the onset of the PPNC/Final PPNB, when the LPPNB megasites collapsed, forcing outright abandonment in the southern half of Jordan and a major reduction of the size of megasites in the northern part of Jordan. The Jordan Valley and Palestine were re-populated as a consequence, but a substantial number of people forced out of their settlements were pulled into the basalt desert of eastern Jordan, southeastern Syria, and northern Saudi Arabia. The migrants used a new hunting method: the construction of large chains of overlapping traps (kites) to undertake mass slaughter of gazelles, as well as to develop a dairy base centered on yoghurt made from milking herds of domesticated sheep and goats.

**Keywords:** megasites, overexploitation, hunter-herder subsistence, kites, semi-permanent/permanent settlement.

## Introduction

In the long Neolithization process beginning 10,000 BC in the southern Levant, a persistent growth in population, population density, and an increase in the number of farming settlements was interrupted twice, and both had enormous consequences and subsequent developments. The pertinent chronological periods are provided below:

|                                        |                |
|----------------------------------------|----------------|
| Middle Pre-Pottery Neolithic B (MPPNB) | 8,300-7,500 BC |
| Late Pre-Pottery Neolithic B (LPPNB)   | 7,500-6,900 BC |
| Late Neolithic (LN)                    | 6,900-5,000 BC |
| Pre-Pottery Neolithic C (PPNC)         | 6,900-6,400 BC |
| Badia Late Neolithic (BLN)             | 6,400-5,000 BC |

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The first disruption happened around the middle of the 8th millennium BC when the *hiatus palestinienne* (Perrot 1968) was signaled by Kenyon's "missing millennium" at Jericho. Garfinkel claims that Kenyon indicated the end of PPNB Jericho occurred "at the beginning of the 8th millennium" (Garfinkel 1999: 5), but she did not offer a specific time when this happened beyond noting that Jericho was reinhabited "after an interval which is impossible to estimate" (Kenyon 1970: 60). In any event, the collapse of the local PPNB occupation appears on the basis of radiocarbon dates to have occurred in the middle of the 8th millennium (Kuijt and Bar-Yosef 1994: Table 3). The widespread abandonment throughout the Jordan Valley and in Palestine happened for unknown causes at the end of the MPPNB, although the dramatic drop in the level of the Dead Sea indicates it may have been a decrease in precipitation (**Figure 1**; note the black vertical line at the left of the graph). However, since storm tracks affecting agriculture in Palestine and the Jordan Valley continue into highland Jordan, farming villages here should also have been impacted, but that is not the case. While Palestine and the Jordan Valley were probably never completely vacated, many villagers migrated to the Jordanian highlands (**Figure 2**), either to establish large new settlements for the first time (e.g. Basta) or to join already established MPPNB settlements (e.g. 'Ain Ghazal and Wadi Shu'eib); in effect, this was the first "Great Eastward Migration", but it would be reversed half a millennium later.

### The Late PPNB

The mid-8th millennium population relocation took place at the start of the LPPNB and resulted in the first "megasites" in the Levant (cf. Rollefson 1989: 137). Ten LPPNB megasites in Jordan have been excavated thus far (**Table 1**), including Kharaysin, 25 hectares (ha) (Ibañez et al. 2015); 'Ain Ghazal, 15 ha (Rollefson and Kafafi 2013: 6); Wadi Shu'eib, 14 ha (Simmons et al. 2001: 2); Tell Abu Suwwan, 10.5 ha (al-Nahar 2008; 2010:3); al-Sayyeh 10 ha (Bartl and Kafafi 2015; 2016); al-Sifiya, 10.6 ha (Mahasneh 1997: 205); Khirbet Hammam, 8 ha (Peterson 2009; personal communication); Basta, 14 ha (Nissen et al. 2004: 22-23); al-Basit, 10 ha (Rollefson and Parker 2002: 21) and 'Ain Jammam, 8 ha (Waheeb and Fino 1997: 215).

The emergence of megasites represents a novel reaction to whatever forces drove the western villagers to resettle in Jordan; it also seems likely that populations from many of the small Jordanian MPPNB villages contributed to the sudden increase in Jordanian LPPNB megasites. One consequence of such shifts was unprecedented population sizes and all that entailed on local resources. **Table 2** reflects population growth at 'Ain Ghazal from its origin in the latter half of the 9th millennium. The average annual growth rate was 0.17% per year, a rate that was relatively constant for Neolithic populations (Bocquet-Appel 2008: 52). During the middle of the 8th millennium the site of 'Ain Ghazal doubled in area within a few generations, and the growth rate was momentarily 100%, although after the in-migration, population growth stabilized to earlier levels.

The subsistence economy was forced to compensate for an increased demand for food. Hunting wild animals dropped precipitously in the LPPNB (Köhler-Rollefson et al. 1993: 96 and Table 1). This is not surprising since it is likely the need for more farming acreage may have reduced earlier natural habitats. The wild meat portion of the diet was replaced with a much higher reliance on domesticated caprines. Along with the increase in the number of households in LPPNB 'Ain Ghazal, many more herds of sheep and goats were added, to the point that in order to keep caprines from the fields before harvest, they had to be taken farther and farther away until the harvest was finished. **Table 3** shows the results

of a growing human population, the growth in caprine herds, and the resulting increasing radius (**Figure 3**) that the herds had to be taken from the settlement<sup>2</sup>.

Note that by the end of the 8th millennium some herds were taken so far away from the settlement that even at the “low goat” level, the herds (and herders) were 20 km from the settlement. At the “high goat” take-off, some herds would have been taken on a 70 km one-way trek, implying that the animals and shepherds would have spent considerable time away from the settlement for months while the crops were ripening. Some evidence for this scenario comes from domesticated caprines at LPPNB Bawwabat al-Ghazal in the Azraq Wetland Reserve (Rollefson, Wilke and Quintero 2014; Emra 2011) and from Burqu’ sites 03000 and 35000, far into the Black Desert (Betts, Martin et al. 2013: 65-67, 76-80) (**Figure 4**).

Populations at the other northern megasites probably underwent roughly the same growth rates, although in southern Jordan al-Sifiya, Basta, al-Basit, and ‘Ain Jammam were megasites from the time of their founding. Population estimates for all the megasites are given at the lower right corner of **Figure 5** based on the ‘Ain Ghazal site size and population estimates<sup>3</sup>. Altogether, there may have been c. 21,500 people living in the megasites by the end of the eighth millennium. An estimate of the hunter-gatherer population in the *harra* (basalt fields, or, the Black Desert) is provided in the “panhandle” of the upper right of the figure. This estimate is derived from the average of population density of 10 hunter-gatherer groups in steppe-desert areas, including the Kung San of Botswana (Lee 1968: 35) and Native American hunters in the Great Basin of North America (Keeley 1988: Table 1). The area of the *harra* inside modern Jordan’s borders is c. 18,750 km<sup>2</sup>, and with a population density of 0.06 persons/km<sup>2</sup>, the estimated population for M/LPPNB hunter-gathers would be approximately 1,125 people.

The second interruption in Neolithization of the southern Levant took place at the transition to the seventh millennium, possibly as a result of a Rapid Climate Change episode called the 9.2ka event (Fleitmann et al. 2008; Flohr et al. 2016), when temperatures cooled and precipitation declined sharply (**Figure 1**; note the second vertical line from the left). Such a climatic deterioration would have severely impacted the megasites, whose local habitats were already under severe strain due to intensified exploitation on an unprecedented scale. In the south, all of the megasites were abandoned utterly, never to be reinhabited. In the north, ‘Ain Ghazal lost 90% of its population, as the impoverished PPNC cultural phase appeared; it is presumed that the other northern LPPNB settlements suffered a similar fate. Altogether, more than 19,000 people were uprooted, the households forced to move elsewhere.

Some people returned to the Jordan Valley (Garfinkel 1994; Shatil n.d.), the coastal region of Israel (Galili et al. 2002; Gopher 1993), in addition to founding the enormous PPNC/FPPNB site of Motza, not far from Jerusalem (Khalaily et al. 2020); others may have dispersed within Jordan, but they have been identified only at the ephemeral PPNC sites in the Wadi Jilat: J-13 and J-25 (Garrard et al. 1994: 87-88). The surveys in southern Syria have been too few to have identified PPNC sites, and the information from Saudi

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2 The “low goat” and “medium goat” categories refer to consuming two caprines per household per year in the first instance and six per household per year in the second. For more information see Rollefson and Köhler-Rollefson 1990: 7-9).

3 The estimate for Basta is based on personal communication from H.G.K. Gebel.

Arabia is too incomplete to detect any movement into that area. One logical place to investigate is the eastern steppe and desert of Jordan: the *hamad* (limestone plateau) and the harra. There could have been some opposition by indigenous LPPNB hunter-gatherer groups, but we cannot determine this in the absence of any evidence for conflict. Betts surveyed about 4,700 km<sup>2</sup> in the hamad just east of Burqu‘ (**Figure 4**), and she found just 68 sites, mostly ephemeral camps, animal enclosures, and burial cairns from the LN and later; only one site (88-4006) was datable to the LPPNB, and it was a small camp nestled alongside a kite wall (Betts, Cropper et al. 2013: 156-167).

The M/LPPNB sites that have been found in the harra (Betts 1998: 37-58; Betts 2013; Wasse and Rollefson 2005) are almost always small and ephemeral camps, and little in these surveys has been found to indicate any relatively long-term occupation. One other possibility is a thick and relatively dense accumulation of LPPNB artifacts on the west bank of Wadi Wisad in the eastern harra (cf. Rollefson et al. 2011: 272). Despite the problems of insufficient local survey, it is likely that the population density of the LPPNB harra was near 0.06 persons/km<sup>2</sup>, and conflict with arriving migrants from the megasites would not have been a major problem.

### **The Late Neolithic Megasites in the Harra**

The Great Eastern Migration into the basalt fields involved a relatively large number of people. Large concentrations of solid architecture have been researched by the Eastern Badia Archaeological Project since 2008 at two enormous site areas: the basalt-covered mesas in the Wadi al-Qattafi at the southwestern corner of the harra and at Wisad Pools, 50 km farther east in the southeastern corner of the Black Desert (**Figure 4**). There are more than 20 mesas at Qattafi, spread 7.35 km along the length of the wadi and 3 km on either side of it. On the slopes and at the base of the mesas, a count of structures (excluding animal enclosures) on aerial photographs exceeds 800 (**Figure 6a**). The distribution of the buildings is not random but appears to be dispersed as clusters of four to eleven structures (**Figure 6b** and Rollefson et al. 2016: Figure 12; Rollefson et al. 2017:27-28). How many of the 800+ buildings are Late Neolithic is impossible to ascertain concretely, but architectural similarities suggest that many (if not most) were occupied sometime between 6,600-5,500 cal BC, **Table 3**. How many any of them were inhabited simultaneously at any of the mesas cannot be determined.

The second megasite is at Wisad Pools and extends over 10.5 km<sup>2</sup>, although the densest concentration of structures is in a core area of 1.5 x 1 km (**Figure 7a**). A survey of the site concluded that there were more than 300 buildings (excluding animal enclosures), although perhaps 30 or more were large tombs or ritual structures (Rollefson, Wasse and Rowan 2014). In contrast to the situation at the Qattafi mesas, clusters of buildings are not as apparent at Wisad, although as was the case for the “New Village” in **Figure 6b**, there are concentrations of huts-and-enclosures (probably around 5,500-5,000 BC) in the far north of the core of the settlement, which suggests related herding families (cf. Wasse et al. n.d., Figure 19); excavation of one of these (W-400) has produced abundant radiocarbon samples, but the Covid-19 crisis has prevented their processing.

Excavations of two other buildings at Wisad (W-66 and W-80) have produced radiocarbon dates that begin prior to the end of the PPNC (Table 4) and may represent a

later phase of the original eastward migration from the arable parts of Jordan<sup>4</sup>. Both W-66 and W-80 were constructed atop a reddish gritty permeable soil about 35 cm thick that would have absorbed rainfall, unlike the case today where rain washes immediately into drainages that lead to playas, where water tends to evaporate rapidly and leads to a brackish quality before drying up completely. The moisture in the soil would have supported a lush vegetation cover lasting much longer than is the case today. That sediment no longer exists on the unprotected surface of Wisad, having eroded away, especially by northwesterly winds that blows daily with appreciable strength. The same red sediment has been found in a playa downstream from Wisad (**Figure 7b**), and the pollen profile (OSL dated to a range from 6650-5250 BC [Ikram 2016: Table 4]) includes species including *Quercus* sp. *Ulmus*, *Typha latifolia* and *Lemna* sp. (Ikram 2016: Figure 5). Charcoal from hearths in W-80 includes *Quercus ithaburensis* as well as *Tamarix*, *Prunus*, sedges, and *Salix* sp. (Wasse et al. n.d.). Clearly, the landscape in the Late Neolithic was more inviting than now.

Other Late Neolithic megasites have been identified on Google Earth (**Figure 8** and **Table 4**<sup>5</sup>), and a smaller version of multiple residential structures in a single location is at al-Ghirqa. The situation for al-Ghirqa is unclear, for Betts and Helms note that while Site 2329 “Ghirqa” has c. 10 possible residential structures, “there are ... many undisturbed sites in the vicinity of el-Ghira” (Betts and Helms 1987: 335). It is possible that this an example of residential clustering similar to the situation among the mesas in the Wadi al-Qattafi.

### **A New Subsistence Economy and New Population Density in the Harra**

The Great Eastward Migration introduced new people into the harra as well as a new subsistence economy: hunter-herder subsistence. Preliminary faunal assessments from Mesa 7 and W-80 indicate that domestic caprines accounts for 10% or less of the faunal inventory, and that the overwhelming importance of gazelle is slightly changed from PPNB times. The appearance of caprines in the harra is taken as evidence for their adoption by local indigenous PPNB hunter-gatherers (e.g. Byrd 1992), and this may indeed be the case. However, in view of the minor position in the menu, adopting sheep and goats cannot explain the eruptive population growth represented by the semi-permanent settlements after the end of the eighth millennium. That surge can only be explained by a large influx of people, bringing a practiced familiarity with caprines. If only half of the LPPNB megasite populations moved into the harra, that would increase the local population to around 10,000 people (**Figure 9**), an enormous nine-fold jump in population density from 0.06/km<sup>2</sup> to 0.53/km<sup>2</sup>, an unprecedented pressure not present in the era prior to the early to middle part of the 7th millennium BC<sup>6</sup>.

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4 Additional radiocarbon samples from the lowest layers at W-80 are being assayed and may be considerably older than 6,600 cal BC. It should be recalled that initial migration of caprine herders was in the LPPNB at Bawwabat al-Ghazal and Burqu’.

5 The current resolution of Google Earth in the area of Cairn Field 1 is very poor.

6 Note the catastrophic decline in population in highland Jordan in the aftermath of the collapse of the LPPNB megasites; notably, the area south of the Wadi Mujib became virtually empty, at least compared to the end of the eighth millennium. The northern Jordanian region recovered to early eighth millennium population levels during the

The reliance on gazelle in the Levant, including the harra, was already well established by 11,000 cal BC (Legge and Rowley-Conwy 1987: 88), but despite the large population of gazelle in the region, hunter-gatherers were held to a low population density (0.06) in the basalt country by a strategy that focused on individual take-downs of gazelle. But a new “technology” emerged quickly at the end of the LPPNB that enabled the “mass slaughter” of gazelle using a method of trapping herds that were stampeded by the dogs of the hunter-herders into large stone traps called “kites” (**Figure 10**). The oldest kites were constructed at the end of the LPPNB period (Betts 1998: 42; Khasawneh et al. 2018; Abu-Azizeh et al. n.d.; Crassard et al. n.d.). More than 1,500 kites have been counted in the harra of Jordan (Kennedy 2011: Table 1). Kites consisted of two or more long, low (c. 1 m high) guiding walls of basalt, sometimes reaching 10 km in length, that converged towards an enclosed “trap” of variable diameter, but reaching 200 m in some cases. “Chains” of kites with overlapping guiding walls ran in a general N-S direction with the opening of the traps oriented towards the southeast, opposite to the direction of the prevailing wind in the harra. The labor needed to create even one average-sized kite would require 562 person-days (Kempe and Malabeh 2010: 213). The amount and duration of labor probably involved some degree of hierarchical management: 1,500 kites would amount to 843,000 person-days using Kempe and Malabeh’s figures (although the construction of the kites may have taken place over 3,000 years or more), but once finished, a kite would last almost forever. Building kites made it possible for higher population densities, but they also required higher populations to build.

### Concluding Remarks

The Great Eastward Migration was a major option for the inhabitants of collapsing LPPNB megasites at the end of the seventh and the beginning of the sixth millennium. There had been an increasing familiarity with the badia (including the harra) since the beginning of the LPPNB, due to the replacement of malachite and other copper oxides from southern Jordan by Dabba marble from the eastern territories for bead and pendant manufacture (Rollefson et al. 1989: 15 and Table 7)<sup>7</sup>. The reason for the growing awareness of the potentials of the harra was due to the expanding caprine pasturage needed for the huge populations at the megasites, which withdrew a large section of the residents farther and farther away from fields of ripening cereals and other crops. By the PPNC, there was at least one sector of ‘Ain Ghazal that had been set aside for storage of property and foodstuffs of the herding population (Rollefson et al. 1993: 111-113).

The Stygian landscape of today’s harra was very different during the Late Neolithic. A thick and absorbent soil cover retained moisture to provide a dense and widespread grassland that provided not only rich fodder for caprines but also for large herds of ungulates, especially gazelle. A burned *Ficus carica* (fig) was recovered from building SS-1 at Mesa 7 (Rollefson et al. 2016: 6). The oaks near Wisad Pools produced abundant and nutritious acorns, and *Prunus* sp. trees possibly were the source of almonds; charcoal from sedges and *Salix* sp. as well as pollen from *Typha latifolia* (cattail) and *Lemna* sp. (duckweed) show permanent fresh water as well as marshland at Wisad, at least (Ikram

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Yarmoukian Pottery Neolithic, although the southern region remained relatively sparsely populated during the seventh and sixth millennia.

<sup>7</sup> Dabba marble outcrops occur in the Wadi al-Qattafi and in the limestone ridges east of Wisad Pools.

2016; Rowan et al. 2015; Wasse et al. n.d.). Gazelle and larger hoofed mammals provided abundant meat and hides, and caprine dairy products added to the protein base. Despite the absence of hard evidence, opportunistic agriculture cannot be ruled out of the scenario during the heightened precipitation in the steppe during the Late Neolithic period.

Although the harra was fruitful during the Neolithic and during the Early Bronze Age, there were also occasional periods of drought, sustained at times, reflected by occasional periods of abandonment of the structures at Wisad and among the mesas in the Wadi al-Qattafi. Nevertheless, the harra regained its abundance again, buildings were renovated, and habitation resumed. This pattern repeated itself until sometime at the end of the Early Bronze Age (c. 3,500-2,800 BC), when desertification set in permanently (Müller-Neuhof 2017: 130), losing all the red soil that had made the harra so attractive earlier.

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**Tables****Table 1. Estimated populations in LPPNB megasites.**

| <b>Megasite</b> | <b>Area (ha)</b> | <b>Population</b> |
|-----------------|------------------|-------------------|
| Tell Abu Suwwan | 10               | 2,000             |
| Kharaysin       | 25               | 3,000             |
| As-Sayyeh       | 10               | 1,500             |
| ‘Ain Ghazal     | 17               | 3,000             |
| Wadi Shu‘eib    | 14               | 3,000             |
| As-Sifiya       | 10               | 2,000             |
| Khirbet Hammam  | 8                | 1,000             |
| Al-Basit        | 10               | 1,500             |
| Basta           | 14               | 3,000             |
| ‘Ain Jammam     | 8                | 1,500             |
| <b>Total</b>    | <b>126</b>       | <b>21,500</b>     |

**Table 2. Population growth at ‘Ain Ghazal during the late 9th through the 8<sup>th</sup> millennia BC.**

| <b>Century Ending, BC</b> | <b>Families</b> | <b>Population</b> | <b>Growth rate/ century</b> |
|---------------------------|-----------------|-------------------|-----------------------------|
| 8,250                     | 60              | 300               |                             |
| 8,150                     | 70              | 350               | 16.7%                       |
| 8,050                     | 82              | 410               | 17.1%                       |
| 7,950                     | 96              | 480               | 17.1%                       |
| 7,850                     | 113             | 565               | 17.7%                       |
| 7,750                     | 132             | 660               | 16.8%                       |
| 7,650                     | 154             | 770               | 16.7%                       |
| 7,550                     | 180             | 900               | 16.9%                       |
| 7,450                     | 360             | 1,800             | 100.0%                      |
| 7,350                     | 421             | 2,105             | 16.9%                       |
| 7,250                     | 493             | 2,465             | 17.1%                       |
| 7,150                     | 577             | 2,885             | 17.0%                       |
| 7,050                     | 675             | 3,375             | 17.0%                       |
| 6,950                     | 790             | 3,950             | 17.0%                       |

**Table 3. Growth in human population, goat herd size, browse area at different rates of goat consumption, and browse radius at different rates of goat consumption.**

| Date BC | n Households | Goat population |             | Goat browse (ha) |             | Browse radius (km) |             |
|---------|--------------|-----------------|-------------|------------------|-------------|--------------------|-------------|
|         |              | Low Goat        | Medium Goat | Low Goat         | Medium Goat | Low Goat           | Medium Goat |
| 8,250   | 60           | 360             | 1,080       | 540              | 1,620       | 1.72               | 5.16        |
| 8,150   | 70           | 420             | 1,260       | 630              | 1,890       | 2.00               | 6.02        |
| 8,050   | 82           | 492             | 1,476       | 738              | 2,214       | 2.35               | 7.05        |
| 7,950   | 96           | 576             | 1,728       | 864              | 2,592       | 2.75               | 8.25        |
| 7,850   | 113          | 678             | 2,034       | 1,017            | 3,051       | 3.24               | 9.71        |
| 7,750   | 132          | 792             | 2,376       | 1,188            | 3,564       | 3.78               | 11.34       |
| 7,650   | 154          | 924             | 2,772       | 1,386            | 4,158       | 4.41               | 13.24       |
| 7,550   | 180          | 1,080           | 3,240       | 1,620            | 4,860       | 5.16               | 15.47       |
| 7,450   | 360          | 2,160           | 4,320       | 3,240            | 6,480       | 10.31              | 20.63       |
| 7,350   | 421          | 2,526           | 7,578       | 3,789            | 11,367      | 12.06              | 36.18       |
| 7,250   | 493          | 2,958           | 8,874       | 4,437            | 13,311      | 14.12              | 42.37       |
| 7,150   | 577          | 3,462           | 10,386      | 5,193            | 15,579      | 16.53              | 49.59       |
| 7,050   | 675          | 4,050           | 12,150      | 6,075            | 18,225      | 19.34              | 58.01       |
| 6,950   | 790          | 4,740           | 14,220      | 7,110            | 21,330      | 22.63              | 67.90       |

**Table 4. Radiocarbon dates from M7 SS-1, M4 SS-11, W-66 and W-80.**

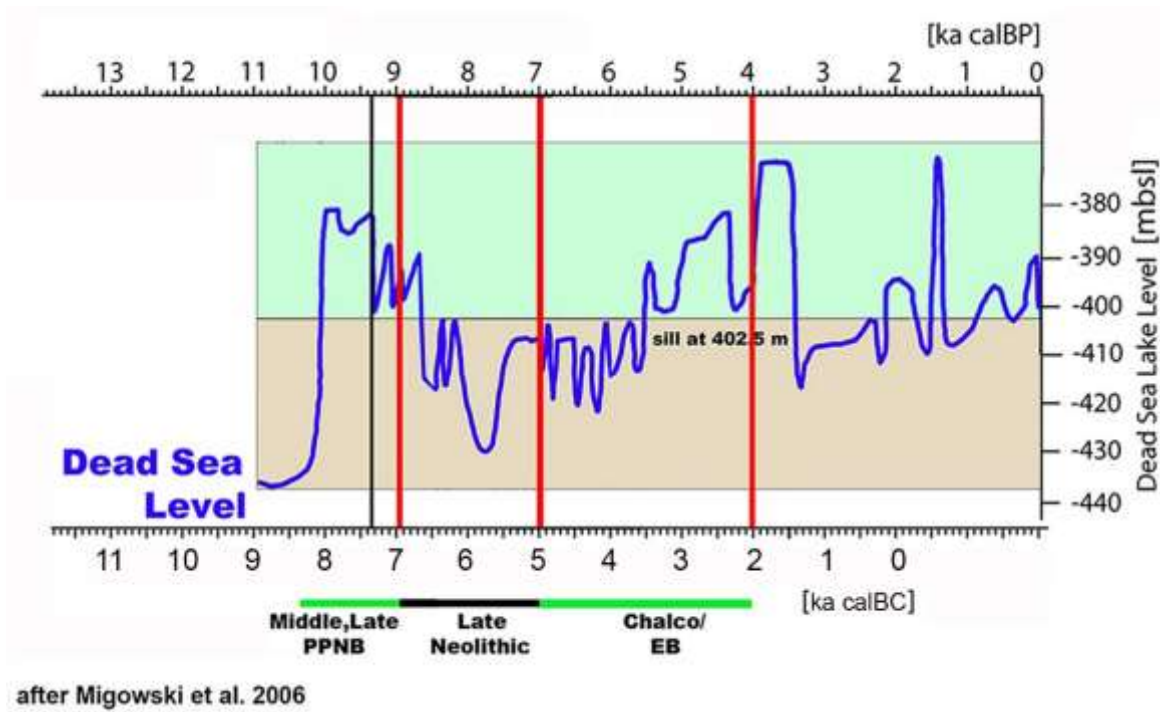
| Site   | Structure | Sample      | Locus | Cal BC                    | Comments                          |
|--------|-----------|-------------|-------|---------------------------|-----------------------------------|
| Mesa 4 | SS-11     | Beta 346614 | 015   | 5480 to 5320              | Main occupation                   |
| Mesa 7 | SS-1      | Beta 431871 | 026   | 6455 to 6390              | Fill of fire pit 029              |
| Mesa 7 | SS-1      | Beta 431872 | 029   | 6490 to 6430              | Near bedrock                      |
| Mesa 7 | SS-1      | Beta 464324 | 063   | 6383 to 6236              |                                   |
| Mesa 7 | SS-1      | Beta 464325 | 073   | 6432 to 6336/6315 to 6255 |                                   |
| Wisad  | W-66      | Beta 346621 | 6     | 6600 to 6460              | Anabasis in floor plaster         |
| Wisad  | W-80      | Beta 395440 | 073   | 5765 to 5670              | Late locus <i>Quercus</i> twiglet |
| Wisad  | W-80      | Beta 366675 | 011   | 5710 to 5610/5590 to 5570 | Mid-sequence                      |
| Wisad  | W-80      | Beta 395441 | 078   | 5890 to 5740              | Middle locus <i>Tamarix</i> twig  |
| Wisad  | W-80      | Beta 366677 | 033   | 6000 to 5840              | Mid-fill of alcove                |
| Wisad  | W-80      | Beta 366676 | 022   | 6590 to 6336/6315 to 6255 | Near floor                        |

**Table 5. Other megasites in the harra of Jordan and distance (D) from Wisad Pools.**

| <b>Name</b>          | <b>Latitude</b> | <b>Longitude</b> | <b>D from Wisad</b> |
|----------------------|-----------------|------------------|---------------------|
| Bakhita Cairn Field  | 32.169359°      | 37.918930°       | c. 30 km N          |
| Ghussayn Cairn Field | 32.236010°      | 37.955501°       | c. 45 km NNE        |
| Cairn Field 1*       | 32.189299°      | 37.815151°       | c. 32 km NNW        |
| Cairn Field 2        | 32.316818°      | 37.834228°       | c. 47 km N          |

\* Google Earth resolution is currently very poor in this area.

**Figures**



**Figure 1. Changes in Dead Sea levels due to changes in precipitation patterns.  
(After Migowski et al. 2006).**

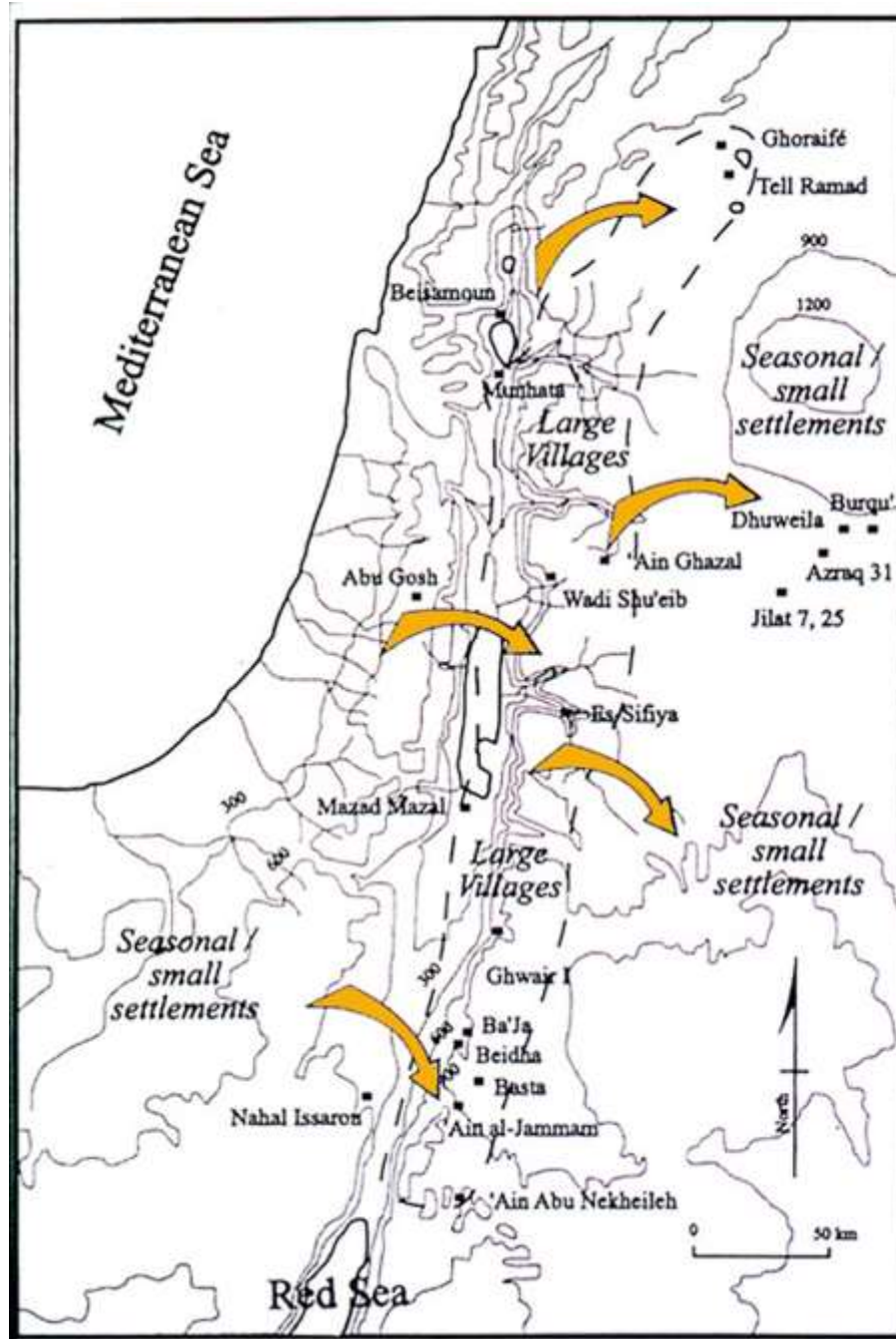
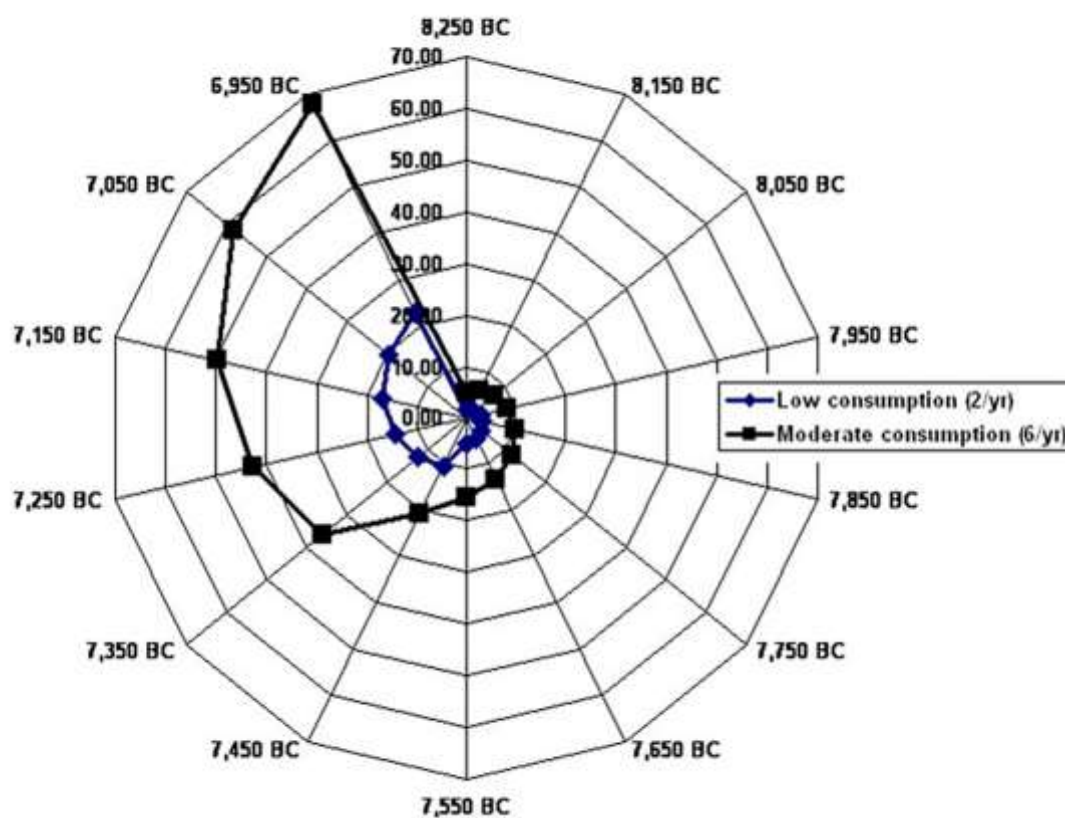
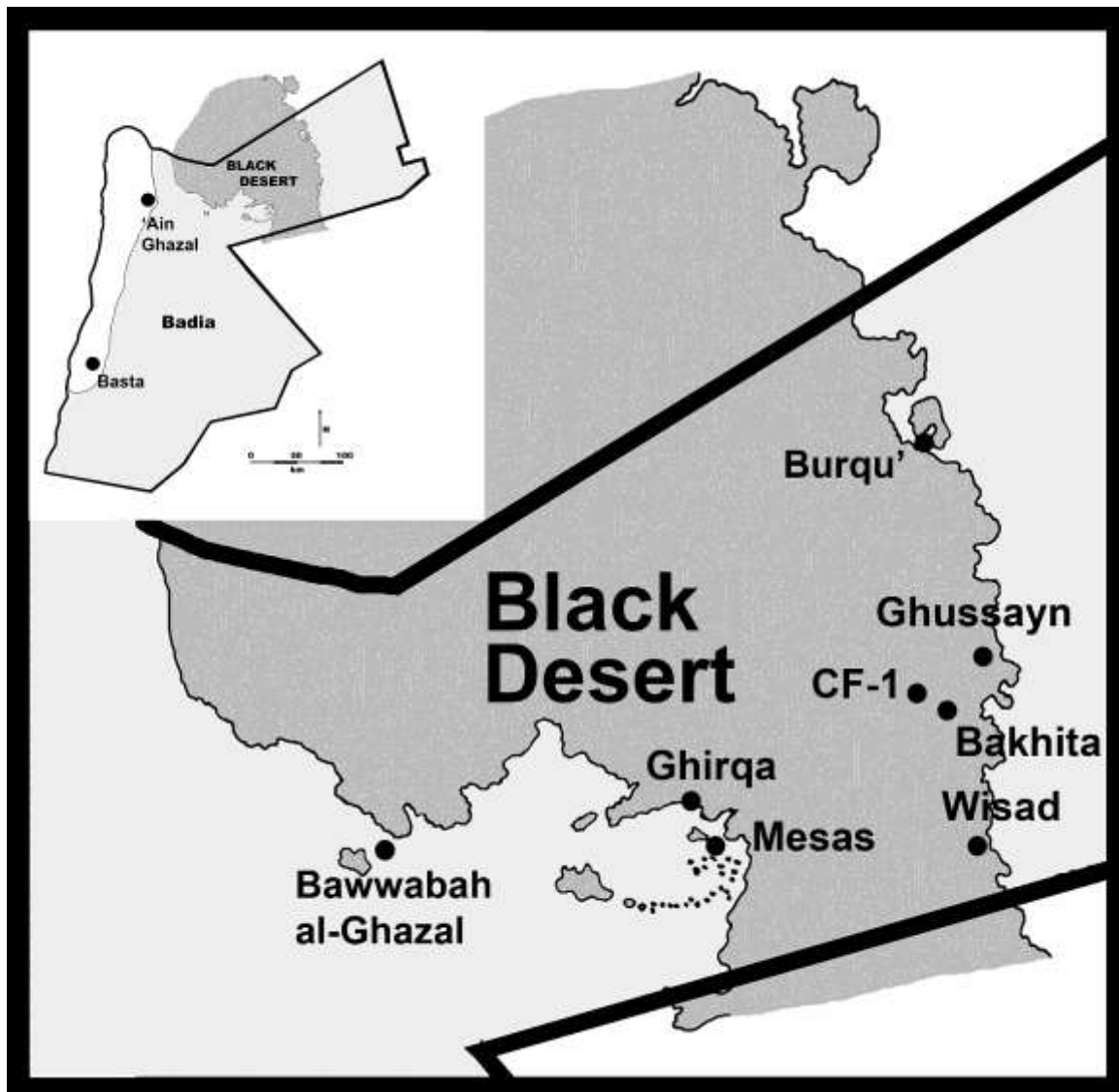


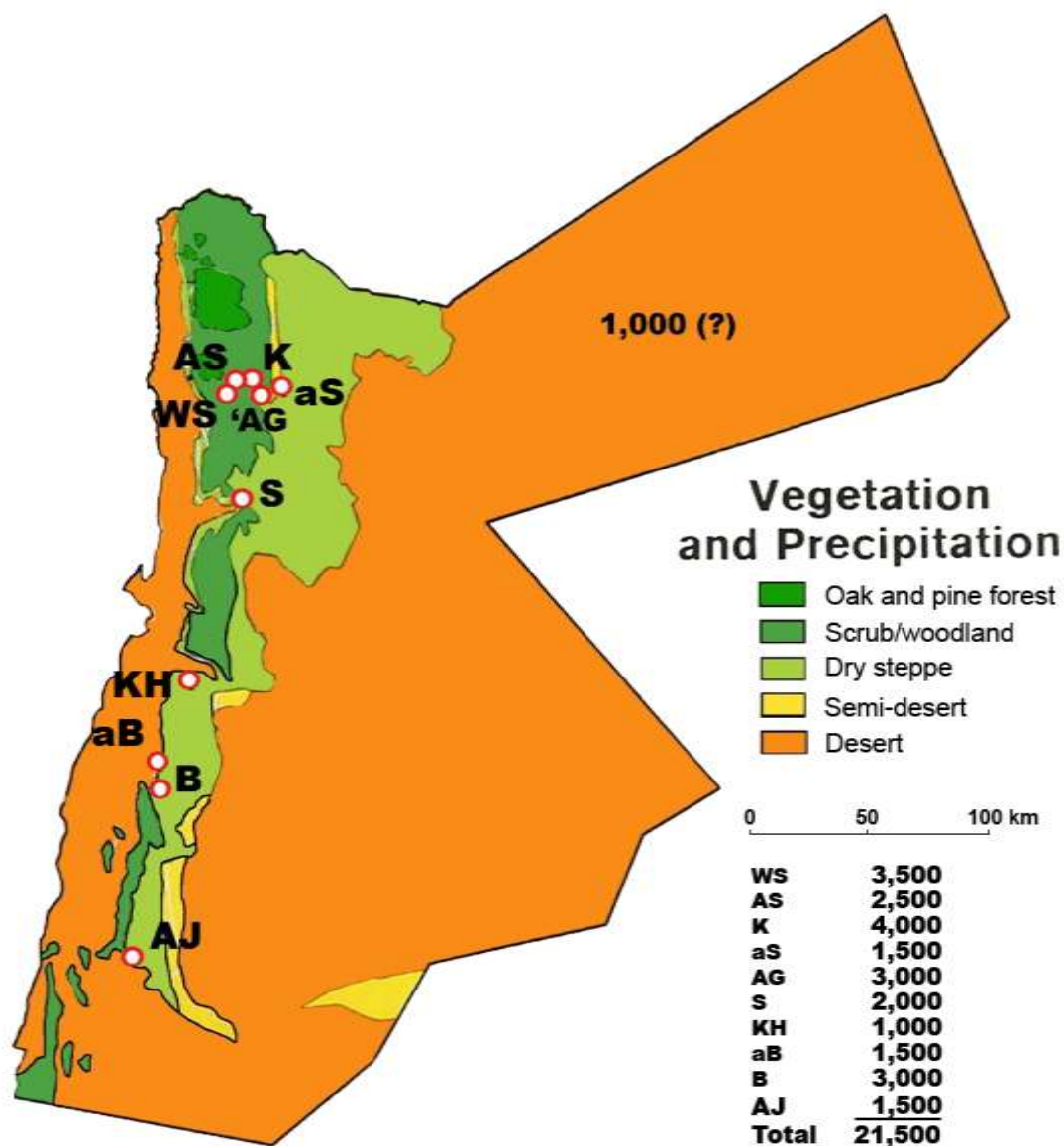
Figure 2. Population movement from the Jordan Valley and Israel at the end of the Middle Pre-Pottery Neolithic B period at c. 7500 BC. (After Gebel 2004: Figure 1).



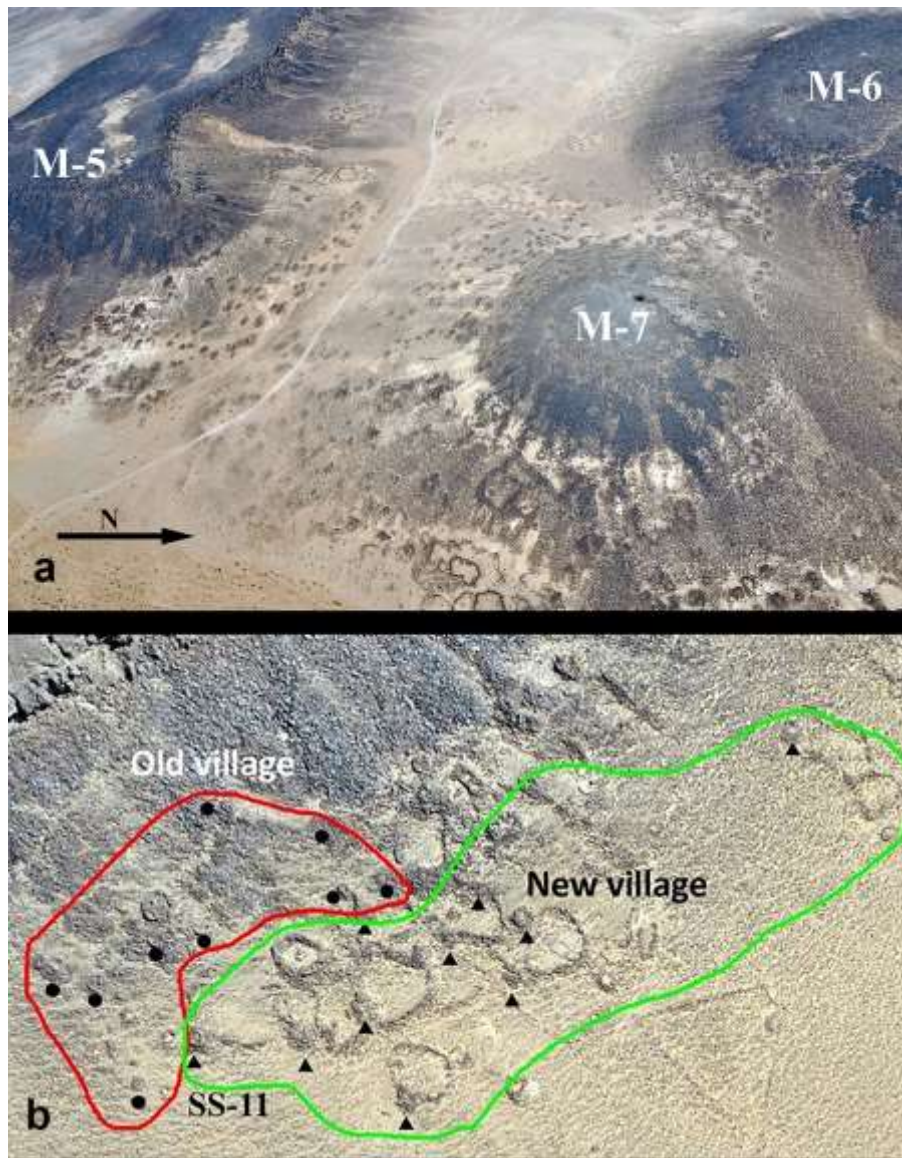
**Figure 3. Radius in km of distance to caprine forage based on herd size during the Pre-Pottery Neolithic B period, based on a low consumption rate of goats per family (2/year, inner arc) and moderate consumption rate (6/year, outer arc); cf. Rollefson and Köhler-Rollefson 1990: 8-9 and Table 6).**



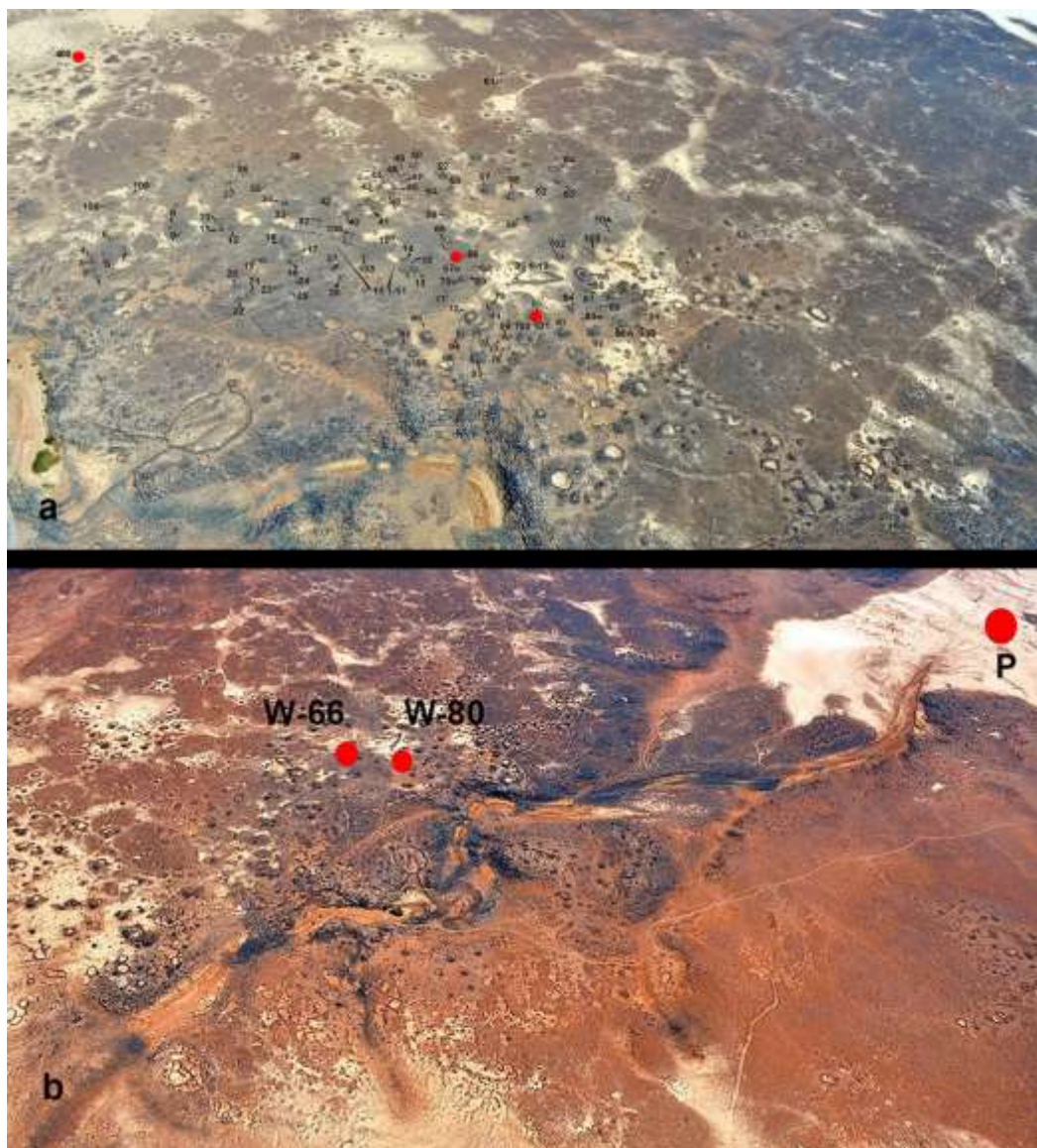
**Figure 4. Map showing the Black Desert. Bawwabat al-Ghazal and Burqu' have Late PPNB domesticated caprines. The other sites are all Late Neolithic concentrated hunter-herder settlements.**



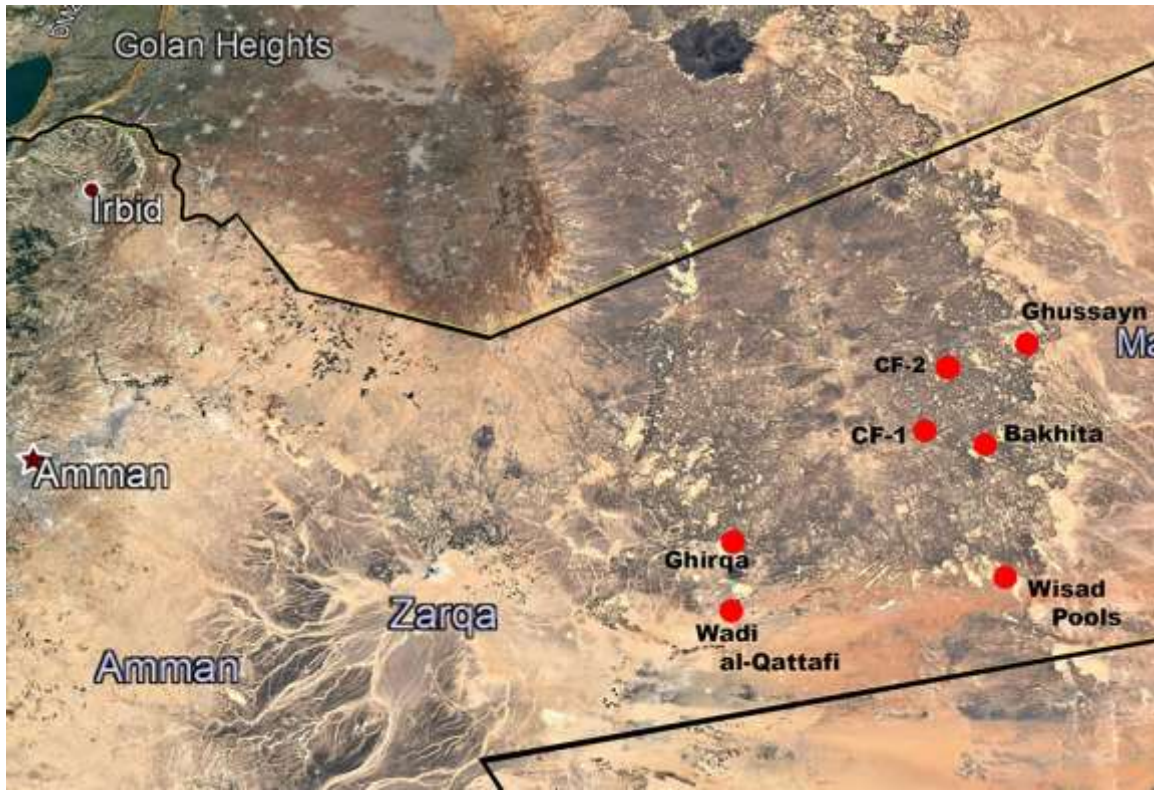
**Figure 5. Vegetation map and location and estimated population of Late PPNB megasites at c. 7,000 BC. WS – Wadi Shu‘eib; AS – Tell Abu Suwwan; K – Kharaysin; AG – ‘Ain Ghazal; aS – al-Sayyeh; S – as-Sifiya; KH – Khirbet Hammam; aB – al-Basît; B – Basta; AJ – ‘Ain Jammam. The eastern badia population estimate of 1,000 is based on a population density of 0.06/km<sup>2</sup>.**



**Figure 6. a: Distribution of structures at the feet of Mesa 5 and Mesa 7. b: The “Old Village” (circles) and “New Village” (triangles) at the base of Mesa 4. The New Village is associated with an occupation at the end of the 6th millennium BC. Photos by David Kennedy, a: APA\_08\_DLK-285; b: APAAME\_20100601\_DLK-241.**



**Figure 7. a: The center of the Wisad Pools concentration of Late Neolithic structures. Red dots indicate the locations of the excavated W-66, W-80 and W-400 structures. b: W-66, W-80, the Wadi Wisad (at bottom), and the playa where a probe (P) recovered soil samples with a preserved pollen profile. Photos by David Kennedy, a: APA\_08\_DLK-363; b: APA\_08\_DLK-370.**



**Figure 8. Google Earth map of the locations of large and dense concentrations of Late Neolithic hunter-herder settlements at al-Ghirqa, the mesas in the Wadi al-Qattafi, Wisad Pools, Cairn Field 1, Cairn Field 2, Bakhita, and Ghussayn.**

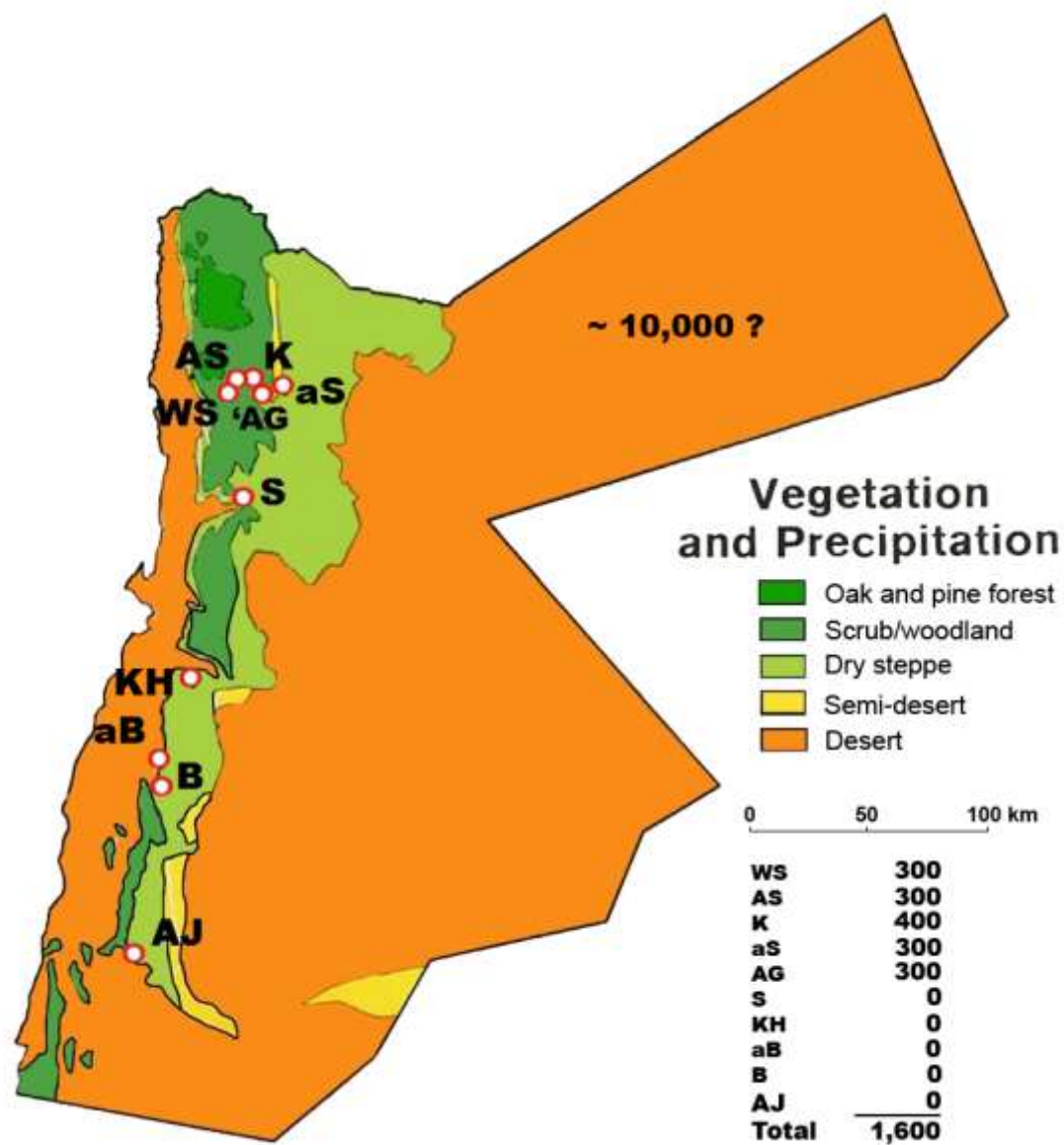


Figure 9. Population figures of post-7,000 BC. The badia population estimate of c. 10,000 people results in a population density of 0.16/km<sup>2</sup>.



**Figure 10. Two of the more than 1,500 “kite” hunting traps in Jordan’s harra. The diameter of both trap enclosures is approximately 200 meters. The upper image is a Google Earth image; the original photo in the lower part is by David Kennedy et al. 2015.**

## الهجرة الكبرى باتجاه الشرق في أواخر العصر الحجري الحديث إلى الصحراء السوداء؛ الأردن

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### ملخص

شهد جنوب بلاد الشام فترتين هائلتين من النزوح السكاني في العصر الحجري الحديث، يبدو أن كليهما كان ناجماً إلى حد ما عن الإفراط في استغلال الموارد الطبيعية، إضافة إلى عدم الاستقرار المناخي. وقد جرى التخلي عن مناطق فلسطين ووادي الأردن فعلياً في منتصف الألفية السابعة قبل الميلاد؛ مما أدى إلى انتقال الناس إلى مرتفعات الأردن وإنشاء مستوطنات كبيرة جداً، "المواقع الكبرى" (megasites) في فترة العصر الحجري الحديث (ب) المتأخر، خلال النصف الثاني من الألفية السابعة. وفي نهاية الألفية السابعة؛ أي في بداية الفترة (ج) من العصر الحجري الحديث، حدثت "الهجرة الكبرى الثانية نحو الشرق عندما انهارت مواقع فترة العصر الحجري الحديث (ب) المتأخر الضخمة؛ مما أدى -في النهاية- إلى التخلي التام عن النصف الجنوبي من الأردن وتقلص حجم المواقع الضخمة إلى حد كبير في شمال الأردن. ونتيجة لذلك، أعيد السكن في مناطق وادي الأردن وفلسطين، لكن عدداً كبيراً من الأشخاص الذين أُجبروا على الخروج من مستوطناتهم هاجروا إلى المناطق الصحراوية في شرق الأردن وجنوب شرق سوريا وشمال المملكة العربية السعودية، واستخدموا وسائل جديدة للصيد، مثل بناء سلاسل كبيرة من الفخاخ المتداخلة لذبح الغزلان بشكل جماعي، كما طوّروا مراكز للرعي قائمة على حلب قطعان الأغنام والماعز المستأنسة وصناعة الألبان.

**الكلمات الدالة:** المواقع الضخمة، الاستغلال المفرط، الكفاف عند الصيادين والرعاة، المستوطنات شبه الدائمة، المستوطنات الدائمة.

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## REFERENCES

- Abu-Azizeh, W., Tarawneh, M., Crassard, R. and Sanchez, J.A., (n.d.), Discovery and Excavation of Desert Kites in the Southeastern Badia of Jordan. In: A. Betts and P. van Pelt (eds.), *The Gazelle's Dream. Game Drives of the Old and New Worlds*. University of Sydney Press, Sydney (in press).
- Bartl, K. and Kafafi, Z. (2015), Eh-Sayyeh, Jordanien. Die Arbeiten des Jahres 2014. *e-Forschungsberichte* 2015/2, Pp. 31–35.
- Bartl, K. and Kafafi, Z. (2016), Eh-Sayyeh, Jordanien. Die Arbeiten des Jahres 2015. *e-Forschungsberichte* 2016/2, Pp. 74–77.
- Betts, A. (1998), Dhuweila: Stratigraphy and Construction. In A. Betts (ed.), *The Harra and Hamad. Excavations and Surveys in Eastern Jordan, Volume 1*, Pp. 59-120. Sheffield: Sheffield Academic Press.
- Betts, A. (ed.) (2013), *The Later Prehistory of the Badia*, Pp. 156-178. Oxford: Oxbow Books.
- Betts, A., Cropper, D., Lancaster, W. and Lancaster, F. (2013), Area Survey in the *Hamad*. In A. Betts (ed.), *The Later Prehistory of the Badia*, Pp. 156-178. Oxford: Oxbow Books.
- Betts, A. and Helms, S., (1987), A Preliminary Survey of Late Neolithic Settlements at el-Ghira, Eastern Jordan. *Proceedings of the Prehistoric Society* 53, Pp. 327-336.
- Betts, A., Martin, L., Matsaert, F. and McCartney, C. (2013), Prehistoric Sites at Burqu'. In A. Betts (ed.), *The Later Prehistory of the Badia*: 52-133. Oxford: Oxbow Books.
- Bocquet-Appel, J.P. (2008), Explaining the Neolithic Demographic Transition. In J.P. Bocquet-Appel and O. Bar-Yosef (eds.), *The Neolithic Demographic Transition and Its Consequences*, Pp. 35-55. New York: Springer.
- Byrd, B. (1992), The Dispersal of Food Production across the Levant. In A. Gebauer and T.D. Price (eds.), *Transitions to Agriculture in Prehistory*, Pp. 49-59. Madison: Prehistory Press.
- Crassard, R., Sanchez Priego, J.A., Pichon, F., Abu-Azizeh, W. and Tarawneh, M. (n.d.), The Ghassanian Techno-complex: Late/Final PPNB Lithic Assemblages from Desert Kite-Associated Occupation Sites in Jibal al-Khashabiyeh, South-eastern Jordan. *Proceedings of the 9th International Conference on the PPN Chipped and Ground Stone Industries of the Near East* (in press).
- Emra, S. (2011), *In Hunt of Herders: What Can We Tell About Subsistence Strategies in Eastern Jordan during the PPNB from Zooarchaeological Records?* BSc dissertation, University College London Institute of Archaeology.
- Fleitmann, D., Mudelsee, M., Burns, S., Bradley, R., Kramers, J. and Matter, A. (2008), Evidence for a Widespread Climatic Anomaly at around 9.2 ka before Present. *Paleoceanography* 23, DOI : <https://doi.org/10.1029/2007PA001519>
- Flohr, P., Fleitmann, D., Matthews, R., Matthews, W. and Black, S. (2016), Evidence of Resilience to Past Climate Change in Southwest Asia: Early Farming Communities and the 9.2 and 8.2 ka Events. *Quaternary Science Reviews* 136, Pp. 23-39. DOI: <https://doi.org/10.1016/j.quascirev.2015.06.022>
- Galili, E., Rosen, B., Gopher, A., and Kolska-Horwitz, L. (2002), The Emergence and Dispersion of the Eastern Mediterranean Fishing Village: Evidence from Submerged Neolithic Settlements off the Carmel Coast, Israel. *Journal of Mediterranean Archaeology* 15.2, Pp. 167-198. DOI: <https://doi.org/10.1558/jmea.v15i2.167>

- Garfinkel, Y. (1994), The PPNC Flint Assemblage from Tel 'Ali. In H.G. Gebel and S. Kozlowski (eds.), *Neolithic Chipped Stone Industries of the Fertile Crescent*, Pp. 543-562. Berlin: ex oriente.
- Garfinkel, Y. (1999), Radiometric Dates from 8th Millennium B.P. Israel. *Bulletin of the American Schools of Oriental Research* 315, Pp. 1-13. DOI: <https://www.journals.uchicago.edu/doi/10.2307/1357529>
- Garrard, A., Baird, D., Colledge, S., Martin, L. and Wright, K. (1994), Prehistoric Environment and Settlement in the Azraq Basin: an Interim Report on the 1987 and 1988 Excavation Seasons. *Levant* 26, Pp. 73-108.
- Gebel, H.G.K. (2004), Central to What? The Centrality Issue of the Mega-Site Phenomenon in Jordan. In H. Bienert, H.G.K. Gebel and R. Neef (eds.), *Central Settlements in Neolithic Jordan*, Pp. 1-19. Berlin: ex oriente.
- Gopher, A. (1993), Sixth-Fifth Millennia BC Settlements in the Coastal Plain, Israel. *Paléorient* 19/1: 55-63.
- Ikram, Haroun (2016), *The Paleoenvironments of Wisad, Southeast Jordan*. Honors dissertation of BSc, School of Geography, University of Nottingham.
- Ibañez, J., Muñiz, J., Iriarte, E., Monik, M., Santana, J., Teira, L. Corrada, M., Lagüera, M., Lendakoca, Z., Regalado, E. and Rosillo, R. (2015), Kharaysin: A PPNA and PPNB Site by the Zarqa River. 2014 and 2015 Field Season. *Neo-Lithics* 2/15, Pp. 11-19.
- Keeley, L. (1988), Hunter-Gatherer Economic Complexity and "Population Pressure": A Cross-Cultural Analysis. *Journal of Anthropological Archaeology* 7, Pp. 373-411. [https://doi.org/10.1016/0278-4165\(88\)90003-7](https://doi.org/10.1016/0278-4165(88)90003-7)
- Kempe, S. and Malabeh, A. (2010), Kites and other Archaeological Structures along the Eastern Rim of the Harrat (Lava Plain) of Jordan, Signs of Intensive Usage in Prehistoric Time, a Google Earth Images Study. *Proceedings of the 14th International Symposium on Vulcanospeleology*, Pp. 199-215.
- Kennedy, David (2011), The "Works of the Old Men" in Arabia: Remote Sensing in Interior Arabia. *Journal of Archaeological Science* 38, Pp. 3185-3203. DOI: <https://doi.org/10.1016/j.jas.2011.05.027>
- Kennedy, D., Banks, R. and Dalton, M. (2015), 'Kites in Arabia', *Arabian Archaeology and Epigraphy* 26(2):177-195. DOI:<https://doi.org/10.1111/aae.12053>
- Kenyon, K. (1970), *Archaeology in the Holy Land* (4th edition). New York: Praeger.
- Khalaily, H., Re'em, A., Vardi, J. and Milevski, I. (2020), *(Moza): The Neolithic and Later Occupations up to the 20th Century*. Jerusalem: Israel Antiquities Authority.
- Khasawneh, S., Murray, A., Thomsen, K. Abu-Azizeh, W. and Tarawneh, M. (2018), Dating a Near Eastern Desert Hunting Trap (Kite) Using Rock Surface Luminescence Dating. *Archaeological and Anthropological Sciences*: DOI: <https://doi.org/10.1007/s12520-018-0661-3>.
- Köhler-Rollefson, I., Quintero, L. and Rollefson, G. (1993), A Brief Note on the Fauna from Neolithic 'Ain Ghazal. *Paléorient* 19/2, Pp. 95-97.
- Kuijt, I. and Bar-Yosef, O. (1994), Radiocarbon Chronology for the Levantine Neolithic: Observations and Data. In O. Bar-Yosef and R. Kra (eds.), *Late Quaternary Chronology and Paleoclimates of the Eastern Mediterranean*, Pp. 227-245. Tucson: Radiocarbon.
- Lee, R. (1968), What Hunters Do for a Living, or, How to Make out on Scarce Resources. In R. Lee and I. Devore (eds.), *Man the Hunter*, Pp. 30-48. Chicago: Aldine.

- Legge, A. and Rowley-Conwy, P. (1987), Gazelle Killing in Stone Age Syria. *Scientific American* 255, Pp. 88-95.
- Mahasneh, H. (1997), The 1995 Season at the Neolithic Site of Es-Sifiya, Wadi Mujib, Jordan. In H.G.K. Gebel, Z. Kafafi and G. Rollefson (eds.), *The Prehistory of Jordan, II. Perspectives from 1997*, Pp. 203-209. Berlin: ex oriente.
- Migowski, C., Stein, M., Prasad, S., Negendank, J. and Agnon, A. (2006), Holocene Climate Variability and Cultural Evolution in the Near East from the Dead Sea Sedimentary Record. *Quaternary Research* 66, Pp. 421-431. DOI: <https://doi.org/10.1016/j.yqres.2006.06.010>
- Müller-Neuhof, B. (2017), The Chalcolithic/Early Bronze Age Hillfort Phenomenon in the Northern Badia. *Near Eastern Archaeology* 80(2), Pp. 124-131. <https://doi.org/10.5615/neareastarch.80.2.0124>
- al Nahar, Maysoon (2008), "Tell Abu Suwwan Neolithic site in Jordan, The first Three Seasons Results". *Jordan Journal for History and Archaeology* 2(3), Pp.172-190.
- al Nahar M. (2010), Tell Abu Suwwan, A Neolithic Site in Jordan: Preliminary Report on the 2005 and 2006 Field Seasons. *Bulletin of the American School of Oriental Research* 357, Pp. 1-18. <https://www.jstor.org/stable/27805157>
- Nissen, H., Muheisen, M. and Gebel, H.G.K. (2004), Editor's Introduction. In H. Nissen, M. Muheisen and H.G.K. Gebel (eds.), *Basta I. The Human Ecology*, Pp. 7-34. Berlin: ex oriente.
- Perrot, J. (1968), La préhistoire palestinienne. *Supplément au dictionnaire de la Bible VIII*. Pp. 286-446. Paris: Letouzey et Ané,.
- Peterson, J. (2009), The View from Khirbat al-Hammam: Neolithic at a Crossroads. *Studies in the History and Archaeology of Jordan* 10, Pp. 311-324.
- Rollefson, G. (1989), The Aceramic Neolithic of the Southern Levant: The View from 'Ain Ghazal. *Paléorient* 15/1, Pp. 135-140.
- Rollefson, G. and Kafafi, Z. (2013), The Town of 'Ain Ghazal. In D. Schmandt-Besserat (ed.), *Symbols at 'Ain Ghazal. 'Ain Ghazal Final Reports, Vol. 3*, Pp. 3-29. bibliotheca neolithica Asiae meridionalis et occidentalis. Berlin: ex oriente.
- Rollefson, G., Kafafi, Z. and Simmons, A. (1989), The 1988 Season at 'Ain Ghazal: Preliminary Report. *Annual of the Department of Antiquities of Jordan* 33, Pp. 9-26.
- Rollefson, G., Kafafi, Z. and Simmons, A. (1993), The Neolithic Village of 'Ain Ghazal, Jordan: Preliminary Report on the 1989 Season. *Annual of the American Schools of Oriental Research* 51, Pp. 107-126.
- Rollefson, G. and Köhler-Rollefson, I. (1990), The Impact of Neolithic Subsistence Strategies on the Environment: The Case of 'Ain Ghazal. In S. Bottema, G. Entjes-Nieborg and W. Van Zeist (eds.), *Man's Role in the Shaping of the Eastern Mediterranean Landscape*, Pp. 3-14. Rotterdam: A.A. Balkema.
- Rollefson, G. and Parker, M. (2002), Bead-Making Tools from LPPNB al-Basît, Jordan. *Neo-Lithics* 2/02, Pp. 21-23.
- Rollefson, G. and Pine, K. (2009), Measuring the Impact of LPPNB Immigration into Highland Jordan. *Studies in the History and Archaeology of Jordan* 10, Pp. 473-481.
- Rollefson, G., Rowan, Y. and Wasse, A. (2011), The Deep-Time Necropolis at Wisad Pools, Eastern Badiya, Jordan. *Annual of the Department of Antiquities of Jordan* 55: 267-286.

- Rollefson, G., Rowan, Y., Wasse, A., Hill, A.C., Kersel, M., Lorentzen, B., al-Bashaireh, K. and Ramsay, J. (2016), Investigations of a Late Neolithic Structure at Mesa 7, Wadi al-Qattafi, Black Desert. *Neo-Lithics* 1/16, Pp. 2-16.
- Rollefson, G., Wasse, A. and Rowan, Y. (2014), In Loving Memory: A Preliminary Assessment of the Architecture at the Late Prehistoric Necropolis at Wisad Pools, Eastern Badia, Jordan. In G. Rollefson and B. Finlayson (eds.), *Jordan's Prehistory: Past and Future Research*, Pp. 285-295. Amman: Department of Antiquities.
- Rollefson, G., Wasse, A., Rowan, Y., Kersel, M., Jones, M., Lorentzen, B. Hill, A.C. and Ramsay, J. (2017), The 2016 Excavation Season at the Late Neolithic Structure SS-1 on Mesa 7, Black Desert. *Neo-Lithics* 2/17, Pp. 19-29.
- Rollefson, G., Wilke, P. and Quintero, L. (2014), Report on the 1998 Test Excavations at Bawwabit al-Ghazal, Azraq Oasis, Eastern Jordan. In G. Rollefson and B. Finlayson (eds.), *Jordan's Prehistory in Past and Future Research*, Pp. 169-181. Amman: Department of Antiquities of Jordan.
- Rowan, Y., Wasse, A., Rollefson, G., Kersel, M., Jones, M. and Lorentzen, B. (2015), Late Neolithic Architectural Complexity at Wisad Pools, Black Desert. *Neo-Lithics* 1/15, Pp. 3-10.
- Shatil, A. (n.d.), *The PPNC Flint Assemblage from Sha'ar Hagolan. A Typo-Technological Examination of the Assemblage*. BA dissertation, Hebrew University, Institute of Archaeology.
- Simmons, A., Rollefson, G., Kafafi, Z., Mandel, R., An-Nahar, M., Cooper, J., Köhler-Rollefson, I. and Duran, K. (2001), Wadi Shu'eib: A Large Neolithic Community in Central Jordan – Final Report of Test Investigations. *Bulletin of the American Schools of Oriental Research* 321, Pp. 1-39. <https://doi.org/10.2307/1357655>
- Waheeb, M. and Fino, N. (1997), 'Ayn Jammam: a Neolithic Site near Ras en-Naqb, Southern Jordan. In H.G.K. Gebel, Z. Kafafi and G. Rollefson (eds.), *The Prehistory of Jordan, II. Perspectives from 1997*, Pp. 215-219. Berlin: ex oriente.
- Wasse, A. and Rollefson, G. (2005), The Wadi Sirhan Project: Report on the 2002 Archaeological Reconnaissance of Wadi Hudruj and Jabal Tharwa, Jordan. *Levant* 37/1, Pp.1-20.
- Wasse, A., Rollefson, G., Rowan, Y., Braun, G., Heidkamp, B., Kersel, M., Lorentzen, B. and Ramsay, J. (n.d.), Eastern Badia Archaeological Project: Preliminary Report on the 2018 Season at Late Neolithic Structure W-80, Wisad Pools. *Annual of the Department of Antiquities of Jordan* 50 (in press).