

The Waters of el-Hesi and a Suggestion about Climate Change in the EB IIIA

Jeffrey A. Blakely

University of Wisconsin—Madison and Cobb Institute of Archaeology,
Mississippi State University, U.S.A. jblakely@wisc.edu

Abstract

For centuries, the Bedouin of the Hesi region have known that the only good potable water in the area was to be found at a spring below Tell el-Hesi, Ayun Hesi. What was the source of this spring? Could it have met the water needs of the more than 10-hectare EB IIIA walled settlement of Tell el-Hesi? If the spring was so plentiful in the EB IIIA, why did subsequent occupations of Hesi never reach a similar magnitude? Why is there virtually no evidence of this spring today? These are questions asked by the Joint Archaeological Expedition to Tell el-Hesi, which excavated the site in the 1970s. Unknown to them, already in the 1960s, the source of Ayun Hesi had been identified as an aquifer underlying Tell Kuneitirah. The drilling of a well adjacent to Tell Kuneitirah before the Great War exhausted the aquifer upstream and dried the springs downstream, leading to a subsequent loss of memory of the prior nature of Ayun Hesi. Today's seasonal trickle is just a shadow of what was once a flowing seasonal stream and, in the EB IIIA, even a permanent stream that flowed past Tell el-Hesi.

Keywords: Tell el-Hesi; Ayun Hesi; Wadi el-Hesi; Nahal Shiqma; Wadi Kuneitirah; Nahal Adorayim; aquifer

1. Introduction

Tell el-Hesi is a relatively well-known archaeological site in southwestern Israel (Fig. 1). Its notoriety, however, is not due to its biblical identification, for being the site of a major ancient battle, or for its association with a famous biblical character. Rather, it is known because it is where the modern archaeological discipline first took shape in the Palestine Exploration Fund (PEF) excavations under the direction of William Matthew Flinders Petrie in 1890 (1891) and Frederick J. Bliss in 1891 and 1892 (1894). It is also known for issues regarding biblical toponymy (e.g., Albright 1924; 1929; Blakely and Horton 2000), as well as being one of the “big digs” of the 1970s and 1980s (e.g., Dahlberg and O’Connell 1989). Still, the site’s archaeology is rarely discussed.

Count Volney introduced the site to western scholars (1787: 337), but it was the work of Edward Robinson in 1838 that described and highlighted Tell el-Hesi and its environs. The name of a neighboring site, Um Lakis, led many scholars to suggest that biblical Lachish had been located in this region (Robinson 1841: 388–92; von Raumer 1843: 23; Ritter 1866: 247). Following several surveys (Guérin 1869: 296–303; Conder and Kitchener 1880: Sheet XX, 1883: 261, 278, 290–91, 293), the PEF sponsored Petrie’s excavations, first at Um Lakis and then at Tell el-Hesi, mistakenly assuming it was Lachish. Seventy-five years later, the Joint Archaeological Expedition to Tell el-Hesi (henceforth, the Joint Expedition) chose to re-excavate the site to clarify and refine the results of an earlier generation of archaeologists.

Based on the Joint Expedition’s work, we now understand that Hesi was briefly a large walled settlement in the EB IIIA but was soon abandoned. It remained unoccupied until the dawn of the Late Bronze Age, when the site appears to have become a small Egyptian outpost, which lasted until about 1130 BCE. After a brief abandonment, it was rebuilt at the end of the Iron Age I (ca. 1000 BCE) as a small border outpost, which continued to operate throughout most of the Iron Age II. In the Persian period, it was a small administrative center and likely a grain storage depot. Subsequently, it was abandoned and lastly served as a Bedouin cemetery (Toombs 1985; Bennett and Blakely 1989; Eakins 1993; Blakely, Hardin, and Master 2014; Blakely 2018; Toombs, Anderson, and Blakely 2020; Blakely et al. 2023). Notably, a new settlement, Ajlan, was founded, possibly in the Roman period, a kilometer downstream from Tell el-Hesi in the floodplain of Wadi el-Hesi; this site remained occupied until the Ottoman period (Lecker 1989; Blakely 2010).

Thus, it was only briefly, in the EB IIIA, that Hesi ever was a proper settlement. All other times, it was some kind of small governmental outpost.

Why was this particular spot chosen for a series of governmental outposts, yet, aside from the EB IIIA, was never a settlement of any size? In part, the answer derives from the region's soils. While Robinson and generations of succeeding scholars viewed this region as agriculturally productive, it was not. As Blakely and Hardin (2018) noted, the area is dominated by *kurkar* ridges and Ruhama loess with many gullies and *wadis* dissecting the plains (Sneh and Buchbinder 1984; Sneh 2008). Both *kurkar* and loess were unsuitable for farming in pre-modern times. *Kurkar* is a calcareous sandstone, and a significant characteristic of the Ruhama loess is that it saturates very quickly, causing most of the rainfall to simply run off in the form of highly erosive and localized flash floods. Thus, although the region gets around 350 mm of annual precipitation, the soil absorbs only a fraction of that amount. Claude Conder and H. H. Kitchener noted that sedentary agriculture using traditional methods mostly stopped north of the Hesi region (1883: 256), and it was only in the floodplain to the west, where sandier soil had been reworked, that grains were grown (Robinson 1841: 389).

The Hesi region is truly transitional. It is positioned between the Hebron Hills to the east and the Coastal Plain to the west, and between the Shephelah to the north and the Negev to the south, comprising a semi-tropical-arid-bordering-on-arid environment. The site is at the interface of the Mediterranean and Irano-Turanian regions. The land snails comprise species characteristic of both Mediterranean and desert environments (Blakely and Ktalav 2017), reinforcing this impression. In such circumstances, fluctuations in the amounts and timing of rainfall can make or break crops. Ultimately, and given these and other considerations, Blakely and Hardin (2018) identified the larger Hesi region as best suited for pasturage. Much of the historic grazing is gone today, and we primarily observe a synanthropic vegetation zone,¹ sustained by modern cultivars, irrigation, and herbicides.

Beyond the pasturage, the Hesi region was on the main road connecting Gaza with Hebron and, ultimately, Jerusalem. It was a well-traveled route from the Middle Bronze Age until 1948 (Eusebius, *Onomasticon*; Burke 2007; Cytryn-Silberman and Blakely 2013; Conder and Kitchener 1880: Map XX). Thus, in many periods, Hesi was a governmental outpost on a road in an extensive grazing ground. But why here specifically? Was Tell el-Hesi established at this location because it was a fortuitous spot along a road, or was the road established in part to service the site? I believe it was the latter and that the site came into

¹ A botanical survey of the Hesi region was conducted in the early 1960s, before modern herbicides came into use and extensive plowing reshaped the landscape. It provides a helpful benchmark for appreciating the premodern region (Pilot Project 1967: 236–239). To be sure, however, over-grazing goes back millennia.

being for various other reasons. The most critical factor for its location, however, and the one explored here, is a unique spring, Ayun Hesi, found just below the mound, in the bed of Wadi el-Hesi. Equally important in this investigation is the question of why the only village or possibly town ever to occupy this location was a short-lived, over 10-hectare EB IIIA settlement.

In order to answer these questions, the following sections will discuss various observations pertinent to the matter. They will review and discuss Bedouin knowledge of the springs of Hesi, the work and impressions of multiple expeditions to the region (19th-century CE Western explorers), the Royal Engineers at Ayun Hesi in 1917, the United Nations Development Program in the 1960s, the environmental conditions during the EB IIIA, and Tell el-Hesi in the EB IIIA. Drawing on these discussions, I suggest that the EB IIIA saw a brief but significant increase in rainfall that produced a perennial stream flowing past the mound. After summarizing and concluding the paper, a short excursus is offered, examining the existence of potential dams at Tell el-Hesi. Each section builds on the preceding one.

2. Bedouin and the Springs of Hesi

According to Clinton Bailey, the migration of the Sinai Bedouin to the Beersheba and Hesi regions occurred at about 1600 CE, roughly at the advent of the Little Ice Age (Bailey 1985; 1990; White 2011). While movements of tribes and subtribes have been documented through 1948, they were affiliated with these earlier groups. In the early 20th century, Aref al-Aref, one-time governor of the Beersheba district, published several books about these groups and their folklore. Among these was *Bedouin Love, Law, and Legend: Dealing Exclusively with the Badu of Beersheba*, where he noted that “there are only seven *wadis* of considerable size: *Shallaleh*, *Sharia*, *Imshash*, *Hissi*, *Aslouge*, *Araba*, and *Saba*. Each has a number of tributaries. With the exception of *Hissi* and *Saba* Wadis, the water is salt.... Government efforts have been made to secure water supplies from bores, but in every case it was found that where there was ample water, it was salt, and where fresh water was revealed, the flow was too light to be of use” (1944: 185–186, italics in original; Fig. 1). While al-Aref’s work represents the state of knowledge as of the early 1930s, it reflects Bedouin wisdom that goes back centuries.

It is important to emphasize that Bedouin Arabic nomenclature for streambeds is unlike that of English or Hebrew. Crucially, what the British called *Wadi el-Hesi* is not what the Bedouin called *Wadi el-Hesi*. To the British mappers of the Mandate era, *Wadi el-Hesi* extended from beyond Tell

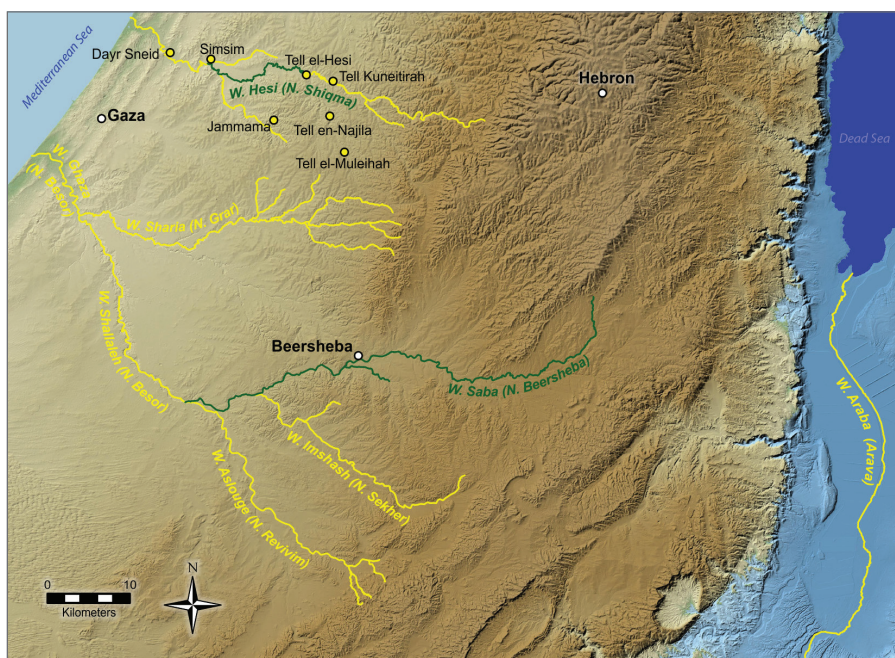


Fig. 1. Map of the Beersheba-Hesi Region, tracing the major *wadi* systems described by al-Aref; *wadis* traced in yellow have briny springs, and those traced in green have fresh-water springs (map by W. Isenberger and J. A. Blakely).

Muleihah in the Hill Country, through Tell el-Hesi, Simsim, Dayr Sneid, to the sea. To the Bedouin, however, *Wadi Muleihah* extended from Tell Muleihah to Tell el-Hesi; *Wadi el-Hesi* extended only from Tell el-Hesi to Simsim; *Wadi Simsim* extended from Simsim to Dayr Sneid; and *Wadi Sneid* extended from Dayr Sneid to the Mediterranean (Blakely and Huster 2016). Thus, when al-Aref noted that the Bedouin said Wadi el-Hesi had sweet water, we should infer that only the segment running from Tell el-Hesi to Simsim had sweet water and nowhere else along its course (Fig. 1).

Petrie's site plan of Tell el-Hesi clearly shows "Wadi el Hesi" starting at Tell el-Hesi with the junction of "Wady Muleihah" and "Wady Jizâir" (Petrie 1891: 12, Pl. I). Bliss, however, heard "Wady Jizâir" called "Wâdy el-Kaneitrah" instead, which is the name this study uses after Tell Kuneitirah (Tel Qeshet in Hebrew), upstream to the east.² In addition, regarding Tell el-Hesi, Bliss noted that "as far as I could make out, the mound is called Tell el-'Helu, or the Sweet Mound, from the springs of sweet water, as often as Tell el-'Hesy, which is spelled with a hard 'H and pronounced to rhyme with missy" (Bliss 1891: 291).³ Thus,

² *Kuneitirah* is also spelled *Kaneitrah* and *Kuneitrah* in direct quotes.

³ Bliss was a native Arabic speaker and had no difficulty whatsoever in carrying on conversations with his workers in a subtle and colloquial Arabic.

the good sweet water of Tell el-Hesi was known and appreciated by the Bedouin population in the 1800s, and the spot occupied by Tell el-Hesi was likely the one good source of fresh water in the area. In the next section, 19th-century CE descriptions of Hesi's water are examined.

3. Western 19th-Century CE Explorers

While the maps and works of Robinson (1841), Carel M. Van de Velde (1854; 1858), Guérin (1869), and Conder and Kitchener (1880: Map XX, 1883) provide an abundance of data about wells and springs, it was Charles Warren's report of his PEF-funded mapping project in Philistia that first produced a big picture for discussing water in the Hesi region (1867; 1871). Warren described how torrents of water descended through ravines in the limestone Hebron Hills before reaching the alluvium and loess sediments of the Coastal Plain. Upon reaching that point, marshes formed and the water percolated through gravel, sand, and silt until reaching an impervious layer and producing a layer of groundwater flowing toward the sea. On the surface, however, the streambed might have only been "a narrow ditch some 6 ft wide and 4 ft deep" that collected surface water from local flash floods and led them toward the sea. However, these waters also tended to seep through the sands and be lost below (1871: 83).

Modern mapping allows this to be illustrated for the Wadi el-Hesi watershed (Fig. 2). In total, the *wadi's* catchment basin covers 223.8 km² of rocky slope in the Hebron Hills before reaching the alluvium and loess interface. Figure 3 zooms in on parts of this interface, and 1945 aerial photographs show light colored areas along the *wadi* paths; these were the seasonal marshes and pools described by Warren.

On June 23, 1867, Warren (1871: 95) also made specific observations on Wadi el-Hesi: "At 11.5 a.m. we arrived at Tel Hessy ... water running in Wády; left 11.23"; a bit further upstream, "we now found a beautiful stream of brackish water in Wady Hessy, and turned south to Tel Nargily.... [A]t 12.40 p.m., arrived at the Tel. Here, there is a spring of fresh water welling out of the rocks in the midst of a salt and barren land." While Warren rarely found water to report, these sightings of water at three locations along Wadi el-Hesi appear to contradict his previous description of the groundwater sinking and the water flowing underground to the sea.

Moreover, this was not an isolated observation. In late April 1890, Petrie photographed the *wadi*-face cut of Tell el-Hesi, featuring a flowing stream

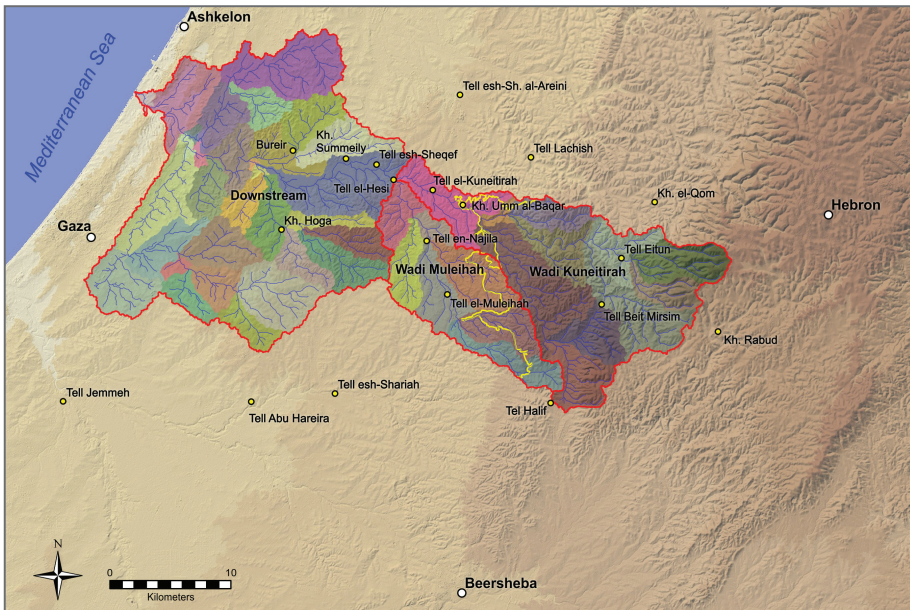


Fig. 2. A map of the Wadi el-Hesi drainage system, showing the Kuneitrah and Muleihah drainages merging at Tell el-Hesi; the yellow line traces the interface between the hill country and the loessic plains; the red lines and colorful shadings indicate local and sublocal drainages, respectively (map by W. Isenberger).

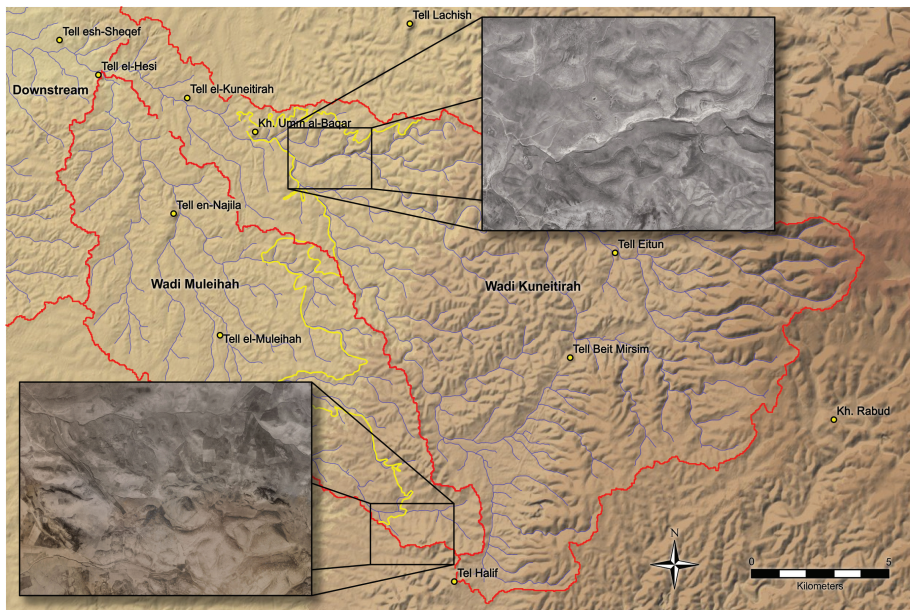


Fig. 3. A close-up view of the Wadi el-Hesi drainage system; the yellow line marks the edge of the Hill Country and the start of the loessic plains (map by W. Isenberger and J. A. Blakely).

beneath it (Fig. 4). He also provided a terse but invaluable description: “Now at Tell Hesi is the only spring for many miles around, a brackish brook trickles down from Tell Nejileh, where in ancient times it was confined by a massive dam;⁴ and at Tell Hesi it is joined by a fine fresh spring, while the whole of the water is swallowed in the stony wady within a few hundred yards lower, and never reappears” (Petrie 1890: 161).

While Petrie did not provide a long and colorful description, his guest, Camden Cobern (1890: 167), did in early May 1890:

I am not sure whether this tell got its name, “The Mound of the Water Pit,” from the hollows in the bed of the little creek which yet runs through the wady, in which water can be found in the summer after the stream is dried up everywhere else, or, whether it comes from the spring of good sweet water which trickles out of the rocks at the base of the tell. I was in the camp several days before I found this spring, and delighted enough I was to find it, for it was the first draught of cool water that I had been able to get for a week. It was a novel sight to sit on the cliff in the



Fig. 4. The Tell el-Hesi *wadi* face showing the running stream flowing in Wadi el-Hesi, Spring 1890 (photo: W. M. F. Petrie, PEF-P21, courtesy of the Palestine Exploration Fund, London).

⁴ While this structure appears to have been built on bedrock, it has not been studied, and its identification as a dam has not been verified.

evening and watch the Bedawin girls crowding about this spring, each seeking to be the first to fill her black jars and lift them into the wicker baskets hung on each side of her donkey's back.

Notably, these descriptions speak of a running stream in the months of April, May, and June, which are after the rainy season. In 1917, during the Great War, British engineers studied the nature and character of the water sources in the Hesi region in more detail; this is the topic of the next section.

4. Royal Engineers and Ayun Hesi in 1917

In 1916 and 1917, the Egyptian Expeditionary Force (EEF) headed north from Egypt in an attempt to smash through Turkish lines and conquer Palestine. While this army had some automobiles and airplanes, and even a few tanks, the vast majority of its forces were infantry and cavalry, both horse and camel. Under the sequential leadership of Generals Archibald Murray and Edmund Allenby, the EEF's strategic planners were well aware of Tell el-Hesi and the sweet water springs, also referred to as *Ayun Hesi*. They knew this because they had access to all PEF records, including those of Field Marshal Earl Kitchener, who had codirected the region's survey in the 1870s. Furthermore, they produced aerial photographs of the entire front and reserve areas to create an extensive photomosaic for 1:40,000 and later 1:20,000 topographic maps, which they augmented with data from numerous Bedouin spies (Thomas 1920; Grainger 2006).

To conquer Palestine, the army needed to break through the heavily fortified Gaza-Beersheba line and pass through the Hesi region. Once they broke through this line along the coast, they would have had easy access to water through wells tapping into the coastal aquifer. However, inland water was a logistical nightmare because the region was virtually a desert, except for the inexhaustible, good and sweet water supply at the modern city of Beersheba, which had numerous wells with pumps (Grainger 2006). The only other natural source of drinkable water was Ayun Hesi (al-Aref 1944: 185–186). As it happens, in 1912, the nearby Ahuza Ruhama settlement had drilled a deep and plentiful well, and two more were drilled thereafter at neighboring Jammameh (Blakely 2021), reaching waters that were hitherto inaccessible. The water was a bit briny, as could be inferred from al-Aref, but nowhere near the point of being unusable (Nogales 1926: 337–339; Cnaani 1981). In fact, the Germans and Turks set up a hospital and rest area, which relied on the water supply provided by these pumps and deep wells.

Thus, in 1917, the Ruhama-Jammameh wells and Ayun Hesi were the only good water sources north of Beersheba until beyond Irak el-Menshiyya (modern Qiryat

Gat). Figure 5 is one of many maps used to guide the EEF units. It marks all water sources of any quality and their estimated volume. Hesi was considered sufficient to quench the animals' thirst. The biggest problem at Hesi was the limited potential for rapid water distribution so that the march north could continue unabated.

On October 31, 1917, aided to no little measure by Bedouin knowledge of obscure waterholes, the EEF took Beersheba by surprise. Gaza fell a week later, and the race was on. Along the coast, soldiers headed north, obtaining water from the many coastal wells. However, most troops traveling inland were routed through Ruhama-Jammameh for rewatering (EEF 1917a: November 8–12, 1917; 1917c: November 9–17, 1917). For a day and a half, the army did not move (Grainger 2006).

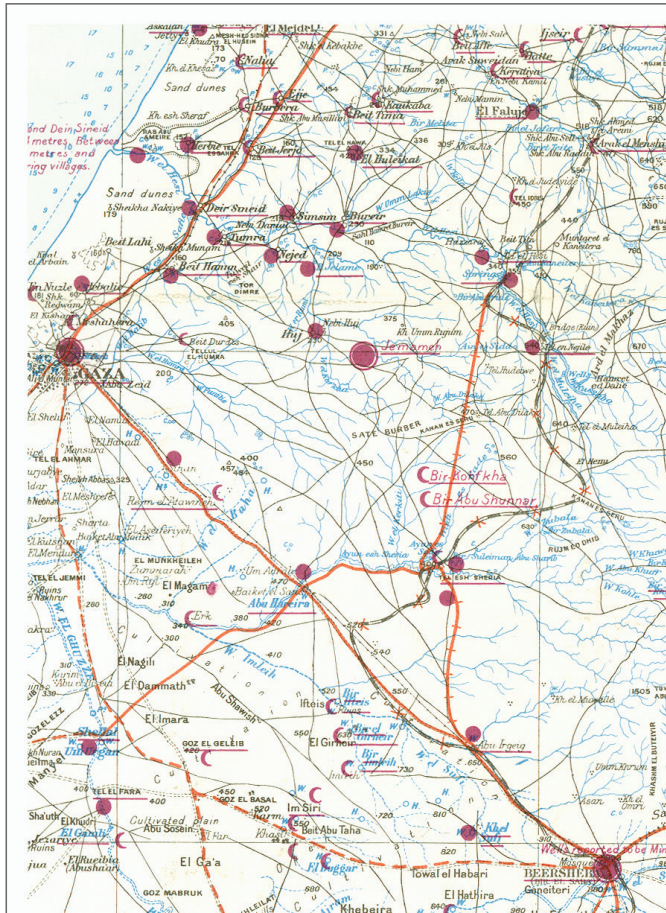


Fig. 5. Map produced by the 7th Field Survey Company of the Egyptian Expeditionary Forces in 1917; the purple full moon symbol indicates sufficient water, and the purple crescent moon symbol marks limited quantities of water. There are a couple of notable errors on this map: No railroad ever passed Tell el-Hesi, and the two water symbols should have been one centered on the site (courtesy the British Archive, London, Shelfmark WO 153/1200).

Some units on the periphery had to water at far less desirable locations, such as Tell en-Najila. The Yeomanry Mounted Division Headquarters passed there on November 10, “[finding] water in green, muddy ponds, full of leeches—‘It was crawlin’ and it stunk’” (Hamilton 1936: 167). Sydney Frank Hatton also described the water at Najila: “However, bad as was the water in the *wadi*, it revived the horses a little and, drinking it ourselves with two chlorine tablets, it somewhat allayed our thirst, although it tasted like the ‘stink cupboard’ in a ‘chemmy lab’” (1930: 174).

Ayun Hesi serviced far more units than Najila (Fig. 6). Oskar Teichman reported that “The Wadi Hesi, fringed by rushes beneath Tel El Hesi, proved a good watering place” (Teichman 1921: 186–187), and on the November 12, Charles G. Nicol reported that “The New Zealanders arrived at Tel El Hesi at 1:30, finding some fine pools of water in the *wadi*, the result of the rain the previous night” (1921: 16). The Yeomanry Mounted Division Headquarters 20th Royal Heavy Artillery was at Tel El Hesi on November 11, noting “large pools where horses could water a regiment at a time” (EEF 1917d).

The Royal Engineers provided additional descriptions of the springs’ scope, which they quickly improved. The diary of the 519th Field Company Royal Engineers summarizes the work conducted (EEF 1917b): “[On November 13, the] company moved to TEL EL HESY 0900 arrived and commenced work. 180 Bde [i.e., Brigade] moved to HESY at 0900 hrs. 10 horse troughs erected, with pumps and filled, two storage tanks erected and filled. Pools enlarged and wired in, and sumps dug. [On November 14], work on water supply continued. Progress: horse drinking water, Battn washing area, 3 other washing areas 70%, 50%, 30% completed. Bde Camel water area complete.”

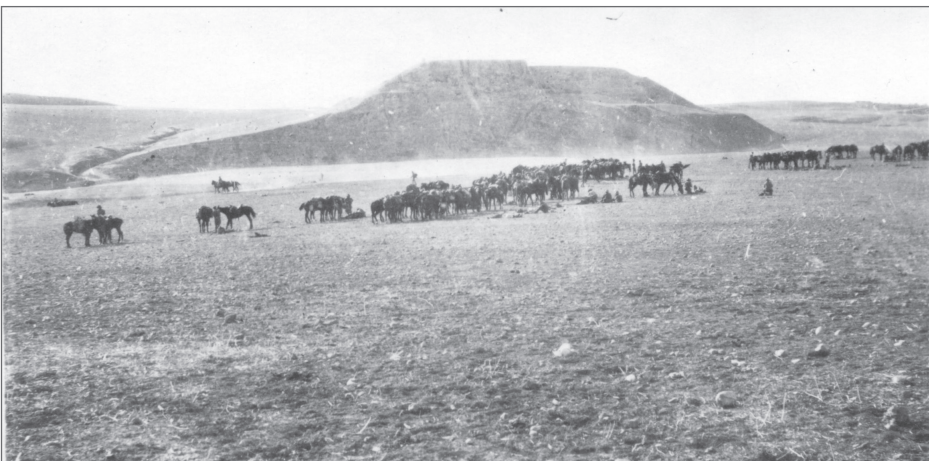


Fig. 6. Australian Light Horse watering at Tell el-Hesi, probably November 10, 1917; note the barren, overgrazed landscape (courtesy of the Elisabeth Barsham collection, Lindisfarne, Tasmania, Australia).

Significantly, this was mid-November, after eight months of little or no rain and still before the rainy season properly began. Yet, the pumps at Ayun Hesi provided much good water from not far below the surface that could be used for many purposes beyond drinking. These descriptions, especially compared with neighboring Tell en-Najila, highlight that Ayun Hesi was unique, providing substantial quantities of fresh water in an otherwise barren region (Figs. 1, 5). This description also corresponds with al-Aref's discussion. No other location north of Beersheba and south of Irak al-Menshiyya was remotely like it.

No other known source explicitly describes the waters of Ayun Hesi or the stream by the Tell. However, in the 1960s, a United Nations development program discovered a plentiful sweet water aquifer a few kilometers upstream at Tell Kuneitrah. The next section describes this aquifer and suggests it is the source of Ayun Hesi and the stream.

5. The United Nations Development Program

In the early 1960s, the United Nations Development Program and the Food and Agriculture Organization undertook a pilot project seeking to improve agricultural production. As it happens, one of their two test units, Test Unit B, was immediately adjacent and upstream from Tell el-Hesi, where detailed analyses of the geomorphology, soils, flora, rainfall, erosion, the aquifer, and the water table were conducted. Thirty-four bore holes and two exploitation wells were drilled, and data from previous boring operations were also included (Fig. 7). Bar-Joseph (1964), who participated in the project, published an account of the region's geology, whereas the UN's formal report was published several years later (Pilot Project 1967). While unaware of the region's cultural history discussed above, the study of the aquifer and water table helps explain and synthesize the existing observations in a straightforward and understandable manner.

Ultimately, four separate aquifers were distinguished in the Hesi region (Pilot Project 1967): the Turonian-Cenomanian, Eocene, Neogene, and Kuneitrah Gravel Aquifers.

5.1. Turonian-Cenomanian, Eocene, and Neogene Aquifers

The deepest aquifer lies far beneath the Hesi region in the Turonian-Cenomanian dolomites and limestones. It is the major aquifer in Israel, often called *the Judea Group Aquifer* or *the Yarkon-Taninim Basin Aquifer*. It is primarily from this source that Wadi es-Saba receives its water. While these formations are also exposed in the Hebron Hills to the east (Sneh 2008), by the time they reach the Hesi region, they are 330 m below sea level or 445 m below the surface and thus unreachable by any traditional means (Bar-Joseph 1964: Table Entry 79, Lakhish S. L. 2).

as one approaches Tell el-Hesi (Pilot Project 1967: 155). According to the Pilot Project, this aquifer is more productive than the Eocene Aquifer; still, it only provides about 100,000 m³ per year across the entire region (Pilot Project 1967: 162). Most Mandate-era wells in the area and possibly also a few of the earlier hand-dug field wells seem to have accessed this aquifer (Blakely 2021). The Pilot Project did not report on the water composition of the Neogene Aquifer, but personal experience years ago recalls a mildly saline taste when presented with hot tea by a local Bedouin.

5.2. The Kuneitrah Gravel Aquifer

By far the region's most productive aquifer, the Kuneitrah Gravel Aquifer, is located outside the project's original study area (Fig. 7). Apparently, the UN workers decided to investigate the source that fed a very productive pipe well in the vicinity of Tell Kuneitrah (Pilot Project 1967: 150, 155). The Abu Jaber tribe probably dug this well during the Great War and reached a significant supply of fresh water. In 1951, it was deepened and equipped with a pump that yielded 50–70 m³/hour. The Pilot Project drilled eight boreholes to investigate this rich water source (Pilot Project 1967: 150, Figs. 47, 51). Simply put, this aquifer derives from “a local accumulation of gravels in Wadi Kuneitra deposited on an erosional depression in the Eocene chalks” (Pilot Project 1967: 140; Fig. 8).

Wadi Kuneitra ... joins Nahal Shikma (Wadi Muleiha) near Tel Hassi. Deep erosion in the stream bed chalk formed a depression. This was later filled by a thick layer of gravel and loams to a depth of 25 m. The gravel was deposited in a lens-like structure within the chalky relief, the base of which lies about 10 m below the water table of the Eocene aquifer.... Two sources feed the gravel aquifer. The first is the groundwater flow from the Eocene Aquifer.... The second and evidently more important water source is winter floods in the *wadi*, which seep into the gravel (Pilot Project 1967: 150).

The Pilot Project also noted that the gravel's mean saturated thickness was 15 m in the early 1960s and that it held about 450,000 m³ of water, about half of which could be exploited. However, given that the depression's top is at least ten meters higher, its potential storage capacity is probably more than double (Pilot Project 1967: 155).

Two points are noteworthy. The lowest water level elevation was recorded near borehole T/27 in 1963, a year of little rain. It was about 132.90 m above sea level, 10 m below the *wadi* floor, and about 20 m below the adjacent terrace deposits. The elevations further downstream remain undocumented. Second,

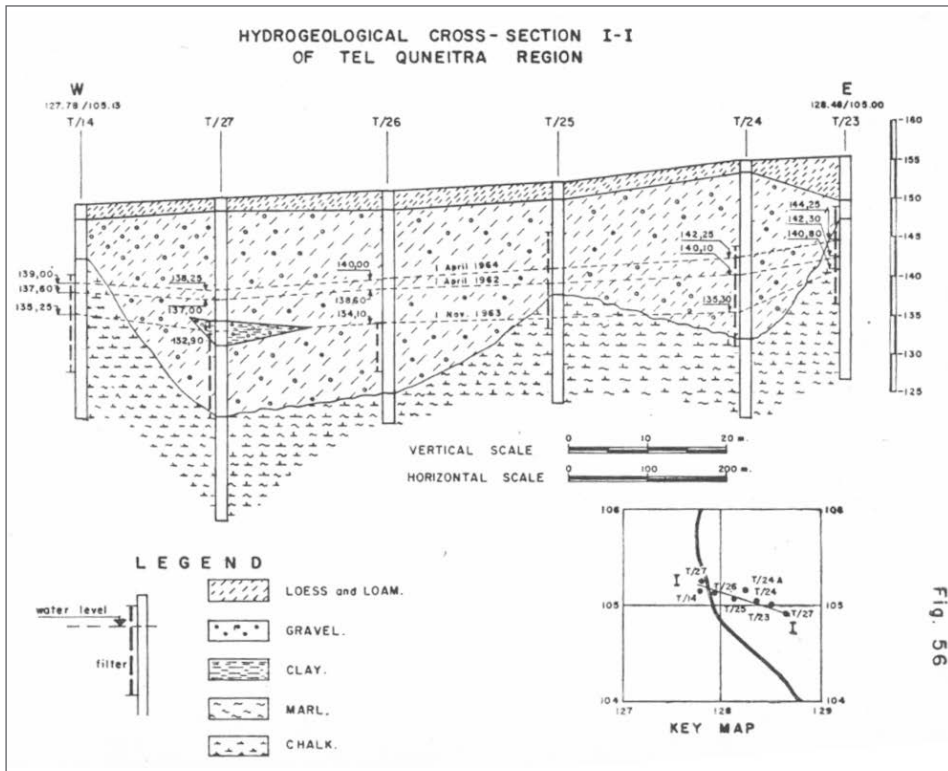


Fig. 8. A geological section according to the boreholes drilled through the Kuneitirah Gravel Aquifer in the early 1960s; note the erosional channels and the seasonal and annual variations in water level (after Pilot Project 1967: Fig. 56, reproduced with permission from the United Nations).

the Kuneitirah region is the only location in the study area where they actively sought a gravel-based aquifer; whether there is another along Wadi Muleihah, for example, remains indeterminate.

The local Kuneitirah Aquifer seems to be the underlying common thread, linking all previous accounts: The Bedouin's sweet water lore; Warren's disappearing flood water from the hills; Warren's, Petrie's, and Cobern's freshwater stream rising and disappearing at Tell el-Hesi, and Allenby's freshwater spring and waterhole at Hesi. The Pilot Project describes an erosional event that removed and scoured many meters of Neogene and Eocene deposits to create a trough system that was subsequently filled with gravels, sands, and clays. I suggest that the trough extends more or less underneath Wadi Kuneitirah (Nahal Adorayim) from where it debouches from the Hill Country onto the plains and all the way to Tell el-Hesi. Recall Warren's observation that the flood water is lost at the interface of the plains with the Hill Country, approximately 2 km upstream from Tel Kuneitrah. I suspect the water drops into this trough

system far below the surface, where it slowly flows west through the gravels, clays, and sands, eventually emerging at Ayun Hesi.

Moving west from Tell Kuneitirah, the distance between the surface and the Eocene and Neogene strata upon which the aquifer rests decreases. At Tell el-Hesi, that distance approaches zero, allowing the water of the Kuneitirah Aquifer to emerge on the surface and flow as a stream along the base of the mound. Immediately west of Tell el-Hesi, the edge of the Eocene and Neogene strata is reached, and one encounters Miocene sand of Nilotic origin. Upon reaching this sand, the stream seeps from the surface and is lost below ground as described by Warren, Petrie, and Cobern, and then illustrated in the Pilot Project (1967: Fig. 53).

Thus, the freshwater aquifer discovered around Kuneitirah is most likely the source of the freshwater of Ayun Hesi. Does the current Wadi Kuneitirah follow the same path as the underlying trough? Given the location of Ayun Hesi in the current Wadi Muleihah, apparently not. I suggest that a similar, undiscovered aquifer system likely also exists in the eroded Neogene platform, following the course of Wadi Muleihah from the edge of the Hill Country, passed Tell en-Nejila, until Ayun Hesi. If correct, it follows that the troughs beneath Wadi Kuneitirah and Wadi Muleihah merge to feed Ayun Hesi.

At some point during the summer, the springs would dry out, and the Hesi stream would vanish. However, when precisely this occurred depended on the volume of water accumulated in the aquifer during the winter. It would end earlier in dry years and later in wet years. Still, as the Royal Engineers noted, some water continued to flow not far underground and even persisted into the next rainy season. The shallow Hesi well, used by the Royal Engineers and still visible today, could access these waters.

Today, the Hesi stream described by Warren, Petrie, and Cobern no longer flows. I have been in the Hesi region during June and July of most years since 1971, and I have never seen, nor would I have suspected, flowing freshwater at Tell el-Hesi. I would have been shocked to see it. I believe that extensive use of the Abu Jaber well at Kuneitirah (Fig. 9), upstream from Tell el-Hesi, probably starting during the Great War, depletes the aquifer to such an extent that the Hesi stream remains dry throughout the year.⁵ If this is true, it is additional proof of a direct connection between the aquifer and the stream at Tell el-Hesi.

⁵ When precisely the Abu Jaber well was drilled is impossible to determine with certainty. On March 5, 1930, Regional Antiquities inspector Ory noted that Sheik Hassan Abu Jaber wanted to build a house atop Tell Kuneitirah (IAA Sites Files, vol. 154). Figure 9, an air photograph from October 1917, shows an orchard and what appears to be Abu Jaber's wellhouse, suggesting the well's presence. Not a single EEF unit described stopping and watering at Kuneitirah in November 1917, and given their need for water, clearly they did not recognize its presence.

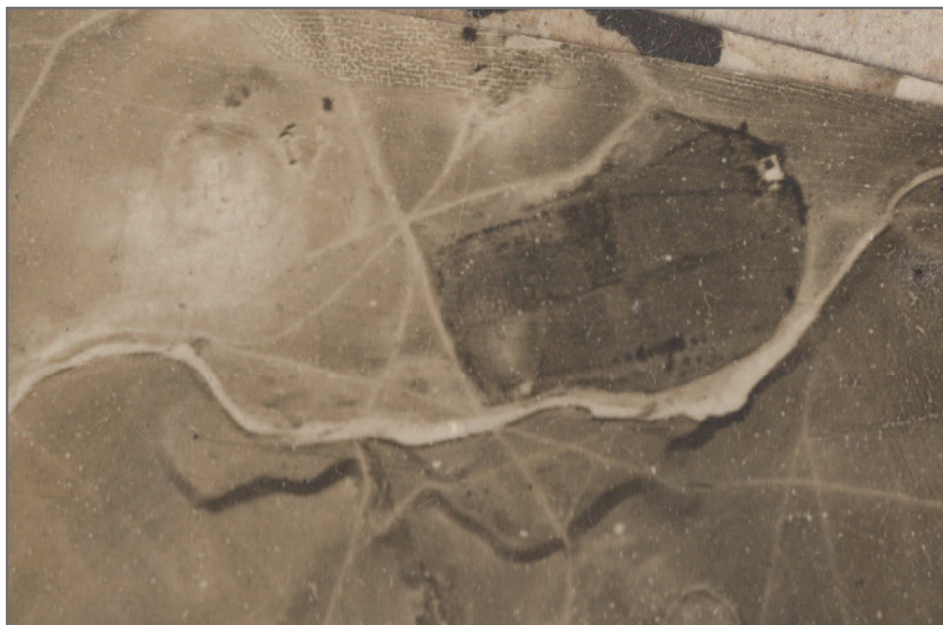


Fig. 9. A Royal Flying Corps aerial photograph of the Abu Jaber well house (the small white rectangle on the upper right) and its adjacent orchard along Wadi Kuneitirah; it was taken on October 19, 1917, Images E95–E98 (a photomosaic at Hebrew University’s Department of Geography, used with permission).

I have linked the good, sweet-water seasonal stream of Hesi to the gravel aquifer of Tell Kuneitirah, which itself is fed from the winter runoff of the Hebron Hills. This entire discussion has been premised on the character of the current climate, some years being better and some years being worse. In the next section, evidence is presented that the earlier part of the EB IIIA saw more rainfall. The section examines how that appears to have impacted the Hesi stream.

6. Climate, Rainfall, and Tell el-Hesi’s Snails

Blakely and Hardin (2018; Orland et al. 2012) have suggested that the current climate of the Hesi region extends back to the mid-4th millennium BCE, but with discrete periods of greater and lesser moisture. Recent research has suggested that the late EB II and EB IIIA enjoyed greater rainfall (Faust and Ashkenazy 2007; 2009; Bar-Matthews and Ayalon 2011; Langgut et al. 2015; Laugomer 2017: 69, Fig. 29). According to these studies, the Kuneitirah Aquifer is likely to have supplied the Hesi stream with freshwater at least on a seasonal basis.

In the mid-1980s, Arlene Rosen examined terrace deposits in the Nahal Shiqma (Wadi el-Hesi) drainage system between the Hill Country and Tell el-Hesi. Among others, she analyzed an alluvial terrace just downstream and west of the mound (called the *High Terrace* by the Joint Expedition). She attributed it to a phase that was more moist than normal, dated it to the Chalcolithic period or Early Bronze Age, and dubbed it the '*Erani Terrace phase*' (Rosen 1986: 15–16, 18, 23, 32–33). Elsewhere, Rosen noted that the type of deposit evidenced in the 'Erani terraces may result from the stream flowing longer during the rainy season than witnessed today. She also suggested that during such a phase, rainfall could have continued even into the summer (Rosen 1991: 196).

Frank Koucky studied the geomorphology of the Hesi region from 1970 through 1983, but did not publish his results until after Rosen (Koucky 1989). He focused on the Terrace Section of the High Terrace, which he dated to the EB III based on EB IIIA pottery found throughout (Figs. 10, 11). He concluded that the sediments of this terrace were deposited when Wadi el-Hesi was a continuously flowing stream (Koucky 1989: 30). His interpretation was influenced by Henk Mienis' observation of freshwater mollusks (*Melanoides tuberculata* and *Melanopsis buccinoidea*) in these deposits, presumably indicating that Wadi el-Hesi was at the time a year-round flowing stream (Mienis 1985). Subsequently, Blakely and Ktalav found a significant occurrence of *Melanopsis buccinoidea* and, to a slightly lesser extent, *Melanoides tuberculata* throughout Hesi's EB IIIA stratigraphic sequence (Blakely and Ktalav 2017: 12–15).

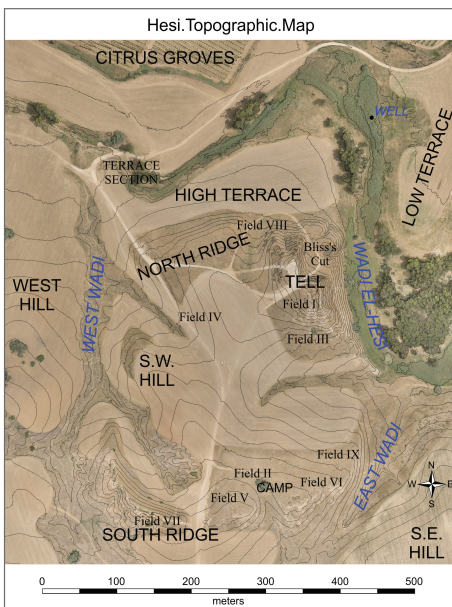


Fig. 10. An up-to-date orthophoto of Tell el-Hesi, showing major landform features and the fields excavated by the Joint Expedition between 1970 and 1983 (photomosaic by W. Isenberger).



Fig. 11. The erosive section in the High Terrace, looking west-southwest; note access road crossing the *wadi* on the right (photo: R. Adams and C. Peachey).

Rosen's and Koucky's observations and conclusions fit well. They imply that during the EB IIIA, greater moisture and probably a longer rainy season allowed the *wadi*'s segment running past Tell el-Hesi to become a perennial freshwater stream. This would have continued until the climate reverted to the long-term norm and rainfall declined, an event Laugomer's (2017) work suggests occurred later in the EB III.

The presence of such a stream during at least part of the EB IIIA probably influenced humans to build the settlement, now known as Tell el-Hesi, on its southern bank. In the next section, this Early Bronze Age settlement will be examined and dated.

7. Tell el-Hesi in the EB IIIA

The Joint Expedition excavated its Fields V, VI, and IX between 1975 and 1983 (Fig. 10). These Fields were located in what the project called *the Lower City*, which comprised EB IIIA remains over more than 10 hectares. Ultimately, six phases of EB III were discerned in Fields VI and IX, which were located at the far southeastern edge of the site and presumably functioned as an industrial area: Phases 4D2, 4D1, 4C2, 4C1, 4B, and 4A. The first five phases were EB IIIA in date, whereas overlying Phase 4A was assigned to the EB IIIB, when the Lower City was abandoned and occupation contracted to the site's acropolis.

The Joint Expedition applied a rigorous program of flotation and carefully collected botanical samples for dating. Carbonized seeds were chosen for radiocarbon analysis based on the author's unpublished stratigraphic reading of the fields. Altogether, 12 samples were radiocarbon dated: two by Roger W. Anderson (2006) and ten more recently by Erika M. Niemann (2024) as part of her MA research at Mississippi State University. These samples span the entire sequence except for the extremities: Phase 4D2 produced no useful samples, while Phase 4A was excluded due to its proximity to the surface. All analyzed samples form a very tight cluster of overlapping dates. Based on these dates, I suggest a cardinal date for the EB IIIA occupation of Fields VI and IX at Tell el-Hesi at 4170 $\pm$ 25 BP, which yields a median calibrated date of 2770 BCE.

The EB IIIA occupation of Hesi's lower city appears to have been brief, yet remarkable. There are no signs of an EB II occupation at the site, not even a single identified sherd. Nonetheless, when the lower city was built in the EB IIIA, it immediately emerged as a 10-hectare walled settlement. This is not organic growth. A powerful entity most likely appropriated the land, and the location must have been selected with some forethought. Insofar as the geological, geomorphological, malacological, and climatic observations made above hold, it is likely that the prime reason was the perennial freshwater stream that sprang forth just east of the mound and disappeared to the west. As long as the water flowed, a large settlement, its people, and its animals could be sustained.

Toombs, Anderson, and Blakely (2020) examined the economic underpinnings of the EB IIIA settlement. They concluded that the site's economy gradually shifted away from pastoralism and came to depend more heavily on agriculture. This development unfolded throughout phases 4D1–4B. Since all the radiocarbon dates closely cluster within the EB IIIA, the large walled settlement of Hesi is likely to have been abandoned shortly thereafter. As de Miroschedji noted (2000: 336), a few EB IIIB pottery sherds were found in Fields I and III of the site's small acropolis (less than a hectare), suggesting that the settlement's size dramatically decreased before it was abandoned. I suggest that the reason for these developments was a marked decline in Wadi el-Hesi's flow, from a perennial freshwater stream to a lesser seasonal stream that could no longer support a large population of inhabitants and herds.

Koucky (1989) found no evidence for a flowing stream in any period following the EB IIIA. As noted above, all subsequent occupations of the site—the LB I, LB II, LB III/Iron Age I, Iron Age II, and Persian period—appear to have been governmental posts and not hamlets, villages, or towns (Blakely and Hardin 2018). It never again extended beyond the acropolis. These observations are probably connected to the water provided by Ayun Hesi; during the later

summer and fall, before the rainy season, the springs and wells in the *wadi* floor could normally only sustain a small settlement. The same logic implies that as the stream became seasonal in the later part of the EB IIIA, it could no longer support the sizeable 10-hectare settlement, which consequently collapsed. A small, possibly residual group, occupied the acropolis until the site was completely abandoned in the EB IIIB.

Placing Hesi in the broader EB III context, Greenberg described the period's settlement patterns as "characterized by a discontinuous landscape of heavily fortified polities with few secondary villages between them" (Greenberg 2017: 34). The Hesi region fits this description well. Hardin and Blakely surveyed the Hesi region and found very few Early Bronze Age sites. Beyond Hesi itself, the few Early Bronze Age sites on the banks of Wadi el-Hesi (Tel Sheqef, Tell Kuneitirah, and Tell en-Nejila) might best be described as isolated, unwallled settlements near wells, akin to sites Gophna and Gazit described as forming the southern frontier of EB III permanent settlement (Gophna and Gazit 2006: 38). While not the southern frontier, most of the Hesi region, nonetheless, had limited access to water in an otherwise semi-arid pasturage.

The over 10-hectare walled settlement at Hesi was the exception in the region and seems to have been located at the sole permanent water source in the area. Greenberg also noted that EB III sites were not necessarily settled all the time, and settlements might have shifted between pairs or even clusters of sites. Greenberg cites the "Hesi-Sakkan-Halif triangle" as an example (Greenberg 2017: 37). This is a valid suggestion, but it does not address the question of why. Maybe for Hesi, we can now offer an explanation: The dwindling of the site's water supply caused the settlement to be abandoned. Given that EB III Hesi was built as one large-scale undertaking at a previously uninhabited spot in someone's hinterland, seemingly capitalizing on a unique water resource in its hinterland, it implies the sponsoring entity had significant resources. Whether the sponsor was Yarmuth (Miroschedji 2006: 74, 75), 'Erani (Finkelstein 1995: 63), or the clustered entity (Greenberg 2017) remains unknown.

What is known is that Hesi's EB IIIA settlement probably functioned for less than 50 years around 2770 BCE, and during that period, the stream probably declined from a perennial stream to a seasonal stream. The following section draws an inference about climate.

8. A Suggestion about Climate Fluctuation in the EB IIIA

Up to this point in the discussion, climatic data provided by archaeologists, palynologists, botanists, malacologists, and geologists studying speleothems from Soreq Cave and elsewhere have been accepted as a given (e.g., Faust and

Ashkenazy 2007; 2009; Bar-Matthews and Ayalon 2011; Orland et al. 2012; Langgut et al. 2015; Laugomer 2017). The argument that during the site's EB IIIA, brief, 50-year occupation, Wadi el-Hesi went from a flowing permanent stream to a seasonal stream supports arguments for declining rainfall at this time. Since the Hesi EB IIIA dates cluster tightly, we obtained a rather precise date of around 2770 BCE for the transition from relatively substantial rainfall to amounts similar to, or even less than, those of today. This suggests that the transition was rapid. To be sure, the Hesi data do not suggest precise ancient rainfall totals.

9. Summary and Conclusions

The data for this study primarily derive from historical sources and have been collected over many years. Most of the conclusions herein were drawn a decade ago, and efforts were made to engage geologists and geomorphologists to test them in the field. However, the Gaza Wars of 2014 and 2023–2025 and the COVID pandemic did not allow such testing to take place. As a result, it seemed appropriate to publish the research and the model so that others could test it in the future.

Tell el-Hesi, or to some Bedouin Tell-el-'Helu, the Sweet Mound, was known for its sweet water. Historical data have shown that a seasonal freshwater stream flowed past Tell el-Hesi from time immemorial,⁶ seemingly ceasing during the Great War when its source was tapped by Sheik Abu Jaber's well at Tell Kuneitirah. Blakely (2021) has already discussed how drilled pipe wells altered the region's settlement patterns and landscape soon after the Great War. The environmental and cultural significance of a local seasonal water source above Tell el-Hesi remains unaccounted for, since its presence had been forgotten by the 1960s.

For most periods from the end of the Chalcolithic to around the time of the Great War, a seasonal aquifer carried freshwater from the edge of the Hill Country to just east of Tell el-Hesi. At that point, the water emerged from the ground and flowed for less than a kilometer before seeping into the Miocene sands to the west of the tell (Fig. 12). Drawing on seasonal rainfall and runoff from the southern Hebron Hills, the stream's catchment area was 223.8 km².

⁶ Less than 500 m upstream from Tell el-Hesi, there is a Middle Pleistocene Acheulian site called Nahal Hesi. Yossi Zaidner and his team from Haifa University dated it to about 430 ± 35 ka (Zaidner et al. 2018: 19). This site is located very close to where Petrie and Warren saw the seasonal stream originate. Given the relevant geology dated by the UN project and assuming a climate at least as moist as today (at least part of the time), I suggest that a seasonal or permanent stream appeared here in the Middle Pleistocene and possibly earlier. Such a natural feature would have been particularly attractive to fauna as well as humans in an otherwise barren region.



Fig. 12. A reconstruction of Tell el-Hesi and its close surroundings as it would have looked like between April and July before the Great War; the blue line marks the course of the seasonal stream, and the black dashes suggest the course of the underground aquifer (map by W. Isenberger and J. A. Blakely, based on 1945 RAF photos from Hebrew University, used with permission).

Under the current climatic conditions, the seasonal flow is likely to have ended in the heat of the late summer. Thus, throughout most archaeological periods, from the Early Bronze Age to the Mandate era, the water was only enough for sustaining a small settlement no larger than one hectare in size. Such occupations are suggested by the archaeological remains of the Late Bronze Age, late Late Bronze Age/early Iron Age I, late Iron Age I, Iron Age II, and Persian period at Tell el-Hesi. While some years were better than others, Hesi's small governmental installations persisted for a millennium.

What would happen, however, if a relatively short-term, half-a-century-long weather anomaly brought more rain to the southern Hebron Hills? Water would have flowed west from the hills through the Kuneitirah Gravel Aquifer. Since this aquifer's water capacity is at least double the historically documented amounts passing through it, one can hypothesize that with greater rainfall and longer rainy seasons, the seasonal freshwater stream would persist longer and with greater vigor, possibly becoming a permanent stream.

This appears to be what happened in the EB IIIA, when the region enjoyed greater rainfall (e.g., Bar-Matthews and Ayalon 2011). Terrace deposits located just downstream from Tell el-Hesi suggest a permanent stream and a more moist environment during the EB IIIA (Rosen 1986; Koucky 1989). Cattle, which require dependable water sources, were relatively plentiful in EB IIIA Hesi (Toombs, Anderson, and Blakely 2020). *Melanoidea tuberculata* and *Melanopsis buccinoidea*, freshwater snails that require a year-round flowing stream were present. Since there is evidence of both species in the terrace deposit and in Hesi's EB IIIA Fields VI and IX stratigraphic matrix, this also indicates a permanently flowing stream (Mienis 1985; Koucky 1989; Blakely and Ktalav 2017). Together, these observations point to a period of continuously flowing water during the EB IIIA. However, the best evidence for such an interpretation is provided by EB IIIA Tell el-Hesi itself, a more than 10-hectare walled settlement that surely had considerable water needs. This EB IIIA town witnessed multiple phases but is unlikely to have lasted more than 50 years (Niemann 2024). I interpret these rapidly changing phases as a reaction to declining rainfall. The town was erected when the permanent stream flowed and abandoned when the climate reverted to the norm. The flow consequently dropped, and the stream turned seasonal, rendering it unable to sustain Hesi's considerable EB IIIA human and flock populations.

One can only speculate on what precipitated EB IIIA Hesi to be built in the first place. The seasonal stream is likely to have flowed for centuries and been regularly visited by herders, possibly affiliated with Tel 'Erani, Ma'ahaz, Tel Arad, or even Tell es-Sakan. Only in the EB IA was there a small settlement on Hesi's acropolis (Ludvik and Blakely 2020: 310),⁷ but not in the EB IB or EB II. Once rainfall increased and the stream began flowing continuously, the herders would have noticed. How many years or decades of continuous flow would it have taken for a neighboring city's leader to decide to build and populate a more than 10-hectare walled settlement at this location? How significant was the expenditure of human capital in doing so? What was the eventual cost when it ultimately failed and was abandoned, no doubt within the then living memory of some? These questions remain for others to answer.

⁷ The ceramic sherds and the silo bases in Hesi's Field III were initially identified as Chalcolithic (Coogan 1989). However, following Dessel's ceramic and stratigraphic analyses of Site 101 at Lahav (Dessel 2009), Ludvik and Blakely proposed to reassign these remains to the EB IA (Ludvik and Blakely 2020: 310). Support for this interpretation is provided by parallel EB IA silos at Amaziya (Milevski et al. 2012).

Excursus: The Possibility of Dams at Tell el-Hesi

The presence of a flowing stream, whether seasonal or perennial, that sprang forth just to the east of Tell el-Hesi and then disappeared just to the west of Tell el-Hesi must have attracted attention. Could it have been dammed to facilitate agriculture? It was noted above that once reaching the leossic plains, the water of the Hesi drainage system would percolate through the *wadi* sands and feed the aquifer. This would be the case regardless of whether the water is dammed or not. However, Tell el-Hesi is located at the one spot where the impervious rocks beneath the Kuneitrah aquifer persist very close to the surface.⁸ At this location, a dam could work. In fact, the archaeological record in the immediate environs of Tell el-Hesi provides clues and evidence that the *wadi* was dammed at various times in antiquity.

The first clue was provided orally by the Joint Expedition's Geologist, Koucky. We were standing atop the mound in 1977, looking northeast at the confluence of Wadis Kuneitirah and Muleihah. Koucky noted that the geomorphology at the confluence was all wrong for a stable system and that some unseen barrier was forcing Wadi Kuneitirah to join Wadi Muleihah right below Tell el-Hesi.

Petrie recorded the first concrete evidence of a dam (Figs. 13, 14). It comprised a stone and concrete wall set perpendicular into the terrace on the north side of the Wadi Kuneitirah about 1 km upstream from Tell el-Hesi (Petrie 1891: 18). In 1930, the preserved structure was 47 paces long and cut by the active *wadi*. It was identified as the archaeological site al-Quneitira (IAA files, Quneitra, el-; Blakely 2010: 219–220). The northern extent of this feature is still visible, but the southern end is either buried or no longer extant (Fig. 13). Pottery found in the concrete of the structure appears to be Byzantine or Umayyad in date.

In the summer of 2015, William Isenberger was doing drone photography to create a photomosaic of Tell el-Hesi. Among other things, his images captured an eroded trench produced by a flash flood east of the mound, in which the foundations of a stone wall were observed (Fig. 13). Unfortunately, the local *moshav* had backfilled the trench before we had a chance to get a closer look. Still, the stone wall could be the remains of a dam that crossed the *wadi* and created the barrier Koucky hypothesized was forcing modern Wadi Kuneitirah south.

A final clue is the late Byzantine and Islamic period town of Ajlan, just under 1.5 km downstream from Tell el-Hesi (Blakely 2010). It is located in the broad Hesi floodplain that is shallowly incised into the Miocene sands and well beyond where the waters of Hesi descend (Blakely 2010: 219). How did this site get its

⁸ It is possible that the underlying impervious rocks adjacent to Tell en-Negila were also close enough to the surface to allow this to happen, and this could explain the “dam” noted by Petrie (1890a: 161).

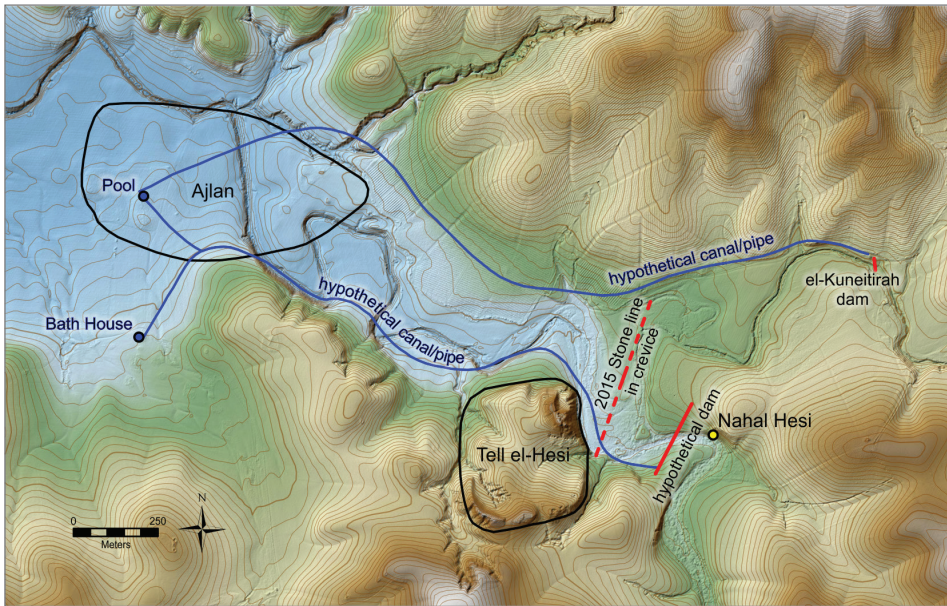


Fig. 13. Map of the Tell el-Hesi and its immediate vicinity, showing the location of dams and hypothetical canals and pipelines (Map by W. Isenberger and J. A. Blakely).



Fig. 14. The dam reported by Petrie as observed in 1930 (photo: Antiquities Inspector J. Ory; IAA Site Files: el-Quneitira, Photograph 1572; courtesy of the IAA, Jerusalem).

water? An appealing possibility is that a canal or pipe fed water from one or more low-head barrage dams at Tell el-Hesi. Before the Byzantine period, such dams could have watered fields, but in the Byzantine and Islamic periods, they could have provided water to Ajlan and its associated gardens. How many dams might have provided the water over the millennia is certainly unknown.

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