3 ENVIRONMENTAL BACKGROUND

Current environmental data about vegetation, soils, and climate (rainfall) are used to represent the past. This approach is problematic as landscapes change over long periods, but research has shown that the distribution of rainfall (which controls the vegetation and the availability of dry farming) generally remained similar in the northern Negev during the last 2,500 years (Vaks et al., 2006; see below Chapter 3.2 Paleoclimate). Nowadays, the Be'er Sheva–Arad Basin receives on average approximately 200 mm of rain. This is precisely the edge of dry farming practicability for barley, although for wheat about 250 to 300 mm is needed (Grigg, 1974; Rosen, 2017: 88). Minor shifts of rainfall would significantly affect whether farming is viable without run-off irrigation technologies. However, during the Classical period new technologies were introduced and a sophisticated understanding of flashflood water harvesting was established. These new technologies could mitigate, to an extent, the impact of climatic fluctuations.

In the first sub-section below, current environmental data for the northern Negev are presented, and in the second, the paleoclimate data available for the northern Negev during the Classical period are analyzed.

3.1 Present-day environmental conditions in the northern Negev

The Negev, in its modern configuration, is located in the southern part of present-day Israel (Stern et al., 1986; Rosen, 2015; Vaiglova et al., 2020: 2). It is a triangular area stretching from the Mediterranean coast to the southern tip of the Dead Sea and south on each side to the Red Sea, Gulf of Aqaba/Eilat (Evenari et al., 1982: 31–32; Stern et al., 1986; Rosen, 2015). It can be divided into four geographical regions and climatic zones: the northern, central, and southern Negev. Along the eastern side of the Negev, between modern Jordan and Israel, the Jordan Rift Valley runs. The Jordan Rift Valley is a geological graben and part of the Syro-African Rift system (Rosen, 2017: 76). South of the Dead Sea in the Jordan Rift Valley, the Arava Valley (Wadi Arabah) is embedded between the hills of the central Negev and those of the Jordanian Plateau (Rosen, 2017: 76). In total, the Negev covers an area of about 12,000 square km, equivalent to some 60% of the country. It is also a continuation of the Sinai Desert.

The geographic borders of the northern Negev (study area) are roughly defined as follows: to the north, the foothills of the Judean Mountains; to the east, the watershed of the Be'er Sheva–Arad Basin and the Arava Valley; to the south, the central Negev Highlands; and to the west, Nahal Besor (Wadi Gaza). The study area is a transitional region between the Mediterranean Coastal Plain and the coastal cities of Gaza and Ashkelon, and the desert to the south. It is a transitional steppe zone, at the edge of subsistence dry-farming practicability, with regions farther south absolutely requiring runoff irrigation systems, and those farther north falling well within the Mediterranean zone.

The elevation in the northwestern part of the study area is relatively low, up to 150 m above sea level. Further to the east, the elevation grows to 700 m above sea level, forming hilly ridges mainly composed of bare limestone (Horowitz, 1979: 15) as shown in Figure 3.1.

The springs resulting from the Besor stream, part of the western study area, are the only natural perennial water sources in the region. Nahal Besor and its tributaries serve as the main drainage channel of the area and run from southeast to northwest. To the north of the study area, Nahal Gerar and Nahal Assaf flow into Nahal Besor, and about 9 km to the southwest, Nahal Besor runs into the Mediterranean Sea (ca. 5 km south of modern Gaza). Deep wadis partially dissect the banks of Nahal Besor. The Be'er Sheva–Arad Basin is located to the east (central and eastern study area), spanning the majority of the northern Negev. Narrow at the eastern part, it widens as it expands westward. Its wadis drain into both the Mediterranean Sea and the Dead Sea (Magness, 2003: 130). Nahal Beersheva is one of the important tributaries of Nahal Besor, and all wadis in the study areas flow directly or indirectly into Nahal Besor. The Be'er Sheva–Arad Basin is mostly covered by reworked loess, and its elevation is about 400 m above sea level in the east, grading toward the west to about 150 m above sea level. There are no perennial rivers in the basin, but its structures allow for the collection of large quantities of groundwater (Horowitz, 1979: 15).

The soil in the northern Negev consists mainly of three types: loess, calcareous steppic soil, and sandy regosols. While loess covers the majority of the western and central northern Negev, the eastern part has more calcareous steppic soil

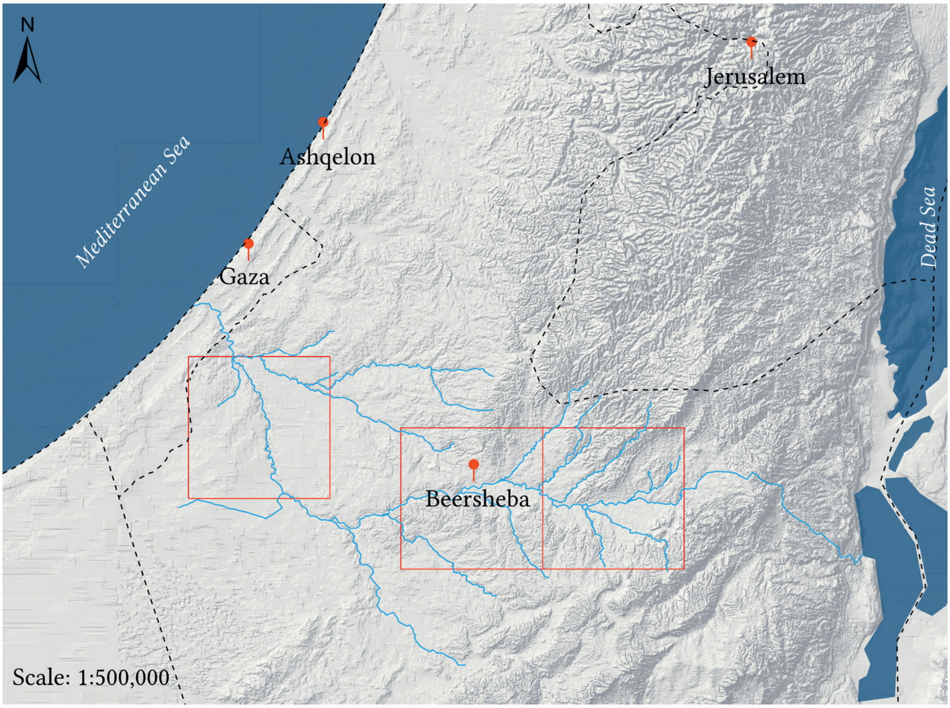

Figure 3.1 Hillshade map of the northern Negev and the surrounding area. The map includes the location of the three study areas, modern cities, and the main wadis of the northern Negev. ArcGIS pro 2.5 Hillshade tool. Background was created from the 12.5 m-resolution ALOS-PALSAR DEM.

(Figure 3.2). Around Nahal Besor, the western study area, the northern region is covered by loess soil and the southern part by sandy regosols. There are some kurkar ridges (calcareous sandstone), especially in the northwestern part (Sneh et al., 1998). The loess soil is in many places deeper than 15 meters (Gat, 2012). Some areas, such as wadi beds, are covered with red-brown soil from sand from eroded kurkar (Gat, 2012).

The northern Negev is a semi-arid region where the vegetation is classified as Irano-Turanian steppe (semi-desert vegetation), comprising scrub and brush vegetation. To its north is the Mediterranean zone, and the degraded steppe and Saharo-Arabian Desert zone lies to the south. The flora of the Irano-Turanian steppe makes up only about 13% of Israel's plant species, and animals comprise about 15% (Horowitz, 1979: 31). Riverbeds, or wadis, are ephemeral streams running only after rainfall during the rainy season, with the exception of Nahal Besor.

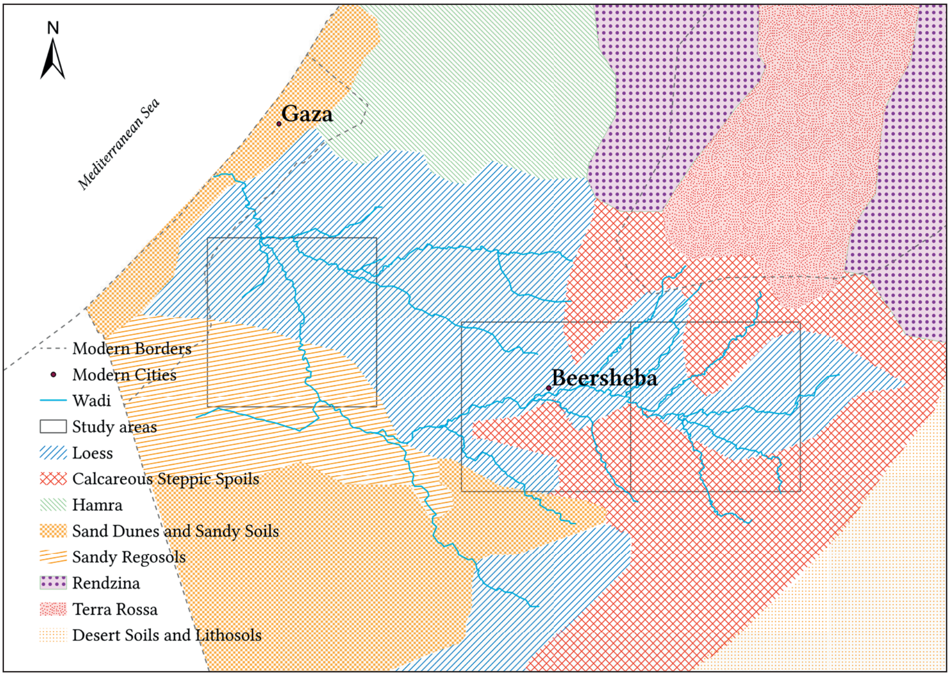

Figure 3.2 Soil map of the northern Negev (after Horowitz, 1979).
Soil map of the northern Negev with the three study areas, most of the study area are covered by loess. The southern part of the western study area is covered by sandy regosols and the mountain range in the Be'er Sheva–Arad basin are calcareous steppic soils and the area in between by loess.

In general, there is no rain from June until September, and the region receives rainfall mainly in the winter months, November through April, concentrated from December to March (Tsoar and Yekutieli, 1992; Vaks et al., 2006; Rosen, 2017: 73). Yearly rainfall in the northern Negev averages between ca. 150 and 300 mm, based on the annual mean rainfall between 1931 and 1960 (Sharon and Kutiel, 1986). Similar rainfall was recorded between 1981 and 2010 (Ziv et al., 2013), which is the barest minimum for subsistence dry farming[2] (Magness, 2003: 131; Rosen, 2017: 76). Today, a clear shift is visible between the northwestern part, where the average yearly rainfall is between 250 and 350 mm, and the southeastern part, where it is between 150 and 250 mm (Figure 3.3).

2 Dry farming: about 250 to 300 mm of rainfall per year is needed for wheat (Grigg, 1974; Rosen, 2017: 88) and 200 mm for barley (Rosen, 2017: 88).

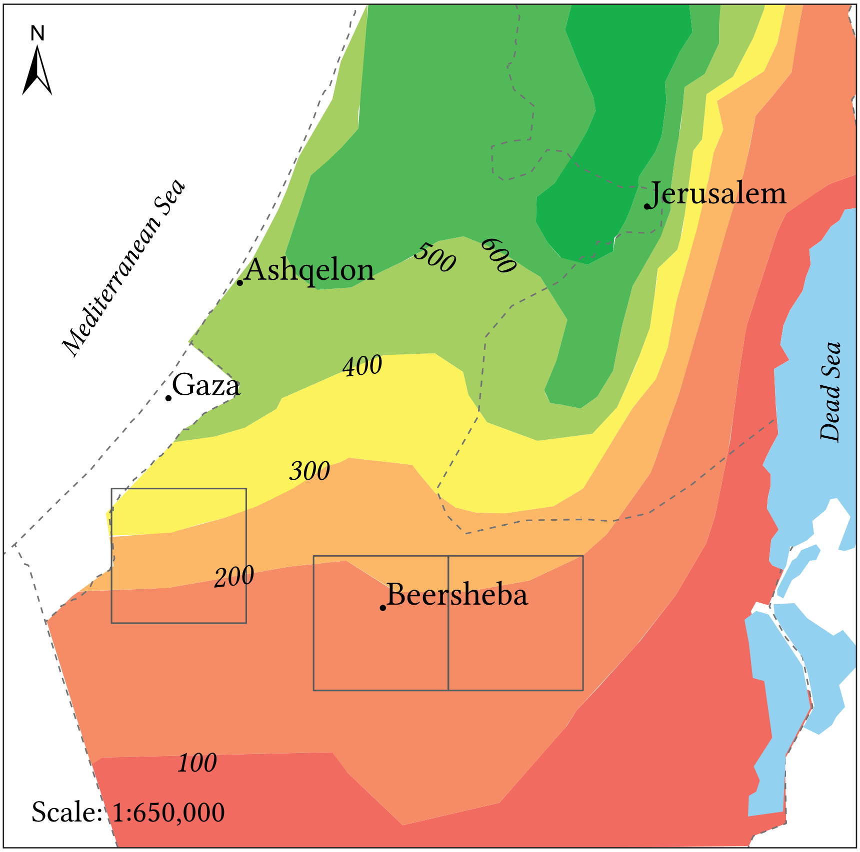

Figure 3.3 Present-day average precipitation (after Halfon, 2021)
Annual average rainfall in Israel (1991–2020). The northern Negev is located between the 100 mm isohyet and the 400 mm isohyet, including the three study areas.

However, the rainfall has a high annual variability: the 200 mm isohyet, which represents the border between the semi-arid and arid regions, varies strongly and can differ each year. For example, in the extremely dry year 1998–1999, the most northward transition of the 200 mm isohyet took place; it was located about 50 km to the north, far into the Mediterranean zone. When there is a year with a high amount of rain, the border can transit as far south as the borders of the central Negev Highlands (see Ziv et al., 2013). As previously stated, the 200 mm border also represents the bare minimum for dry farming, which is important to note considering the high annual variability. It most likely influenced the settlement patterns of the northern Negev.

All these different factors, topography, geology, and climate, have influenced the three study areas. The vegetation varies in all parts of the northern Negev (Figure 3.4).

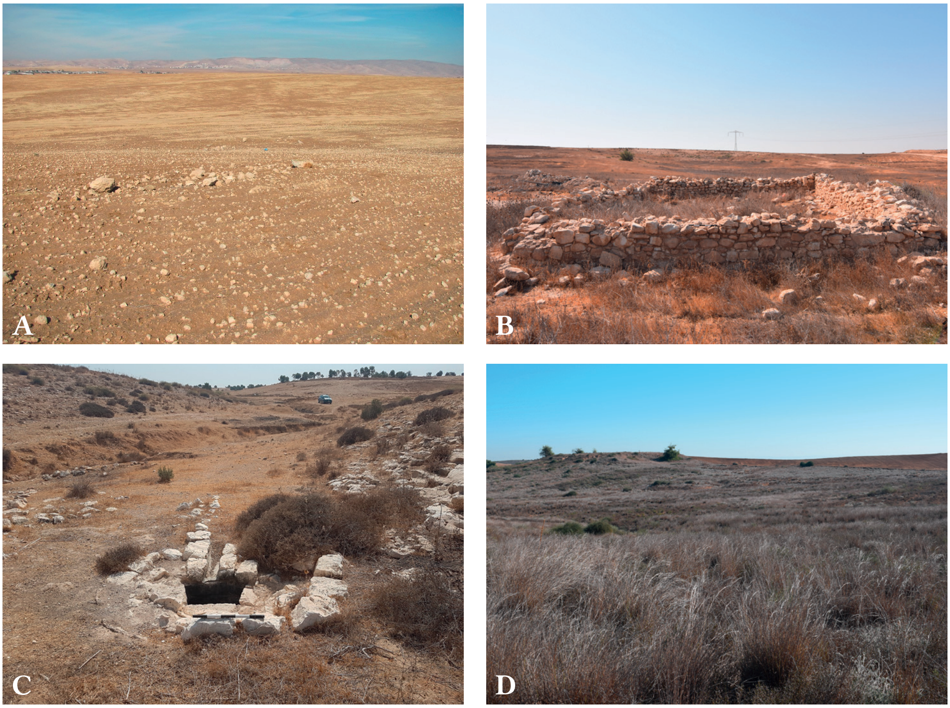

Figure 3.4 Vegetation of the northern Negev.
(A) Eastern study area: fields near the Bedouin town of Kuseife; winter 2018. (B) Central study area: fields near Be'er Sheva (north) with a Byzantine field tower; summer 2019. (C) northern Negev: scrub and bush vegetation and a Classical period cistern with channel south of Rahat (outside survey sample, ca. 10 km north of Be'er Sheva); summer 2019. (D) Vegetation in the western part of the study area; autumn 2017 (pictures taken during archaeological surveys by the author).

3.2 Paleoclimate

The ancient environments and climates can be analyzed using a range of methods. Methods that have been applied in the region include analyzing isotopes data from karstic caves (Bar-Matthews and Ayalon, 2004; 2011; Vaks et al., 2006), Dead Sea Lake levels and hydrological analysis (Frumkin et al., 1991; Bookmann et al., 2004), radiocarbon dating of wood collected from caves at Mount Sedom in the

Dead Sea area (Frumkin et al., 1991), and alluvium dating (Rosen, 2007: 95–96). Bar-Matthews and Ayalon (2004) calculated the average paleorainfall during the last 7,000 years using carbon and oxygen isotopes from the Soreq Cave in Israel. The cave is located ca. 60 km north of Be'er Sheva, so the rainfall reflected in Figure 3.5 represents the calculated rainfall of the Soreq Cave area, located well inside the Mediterranean climate zone. The authors showed an increase in rainfall at the end of the 1st Millennium BCE, followed by a period of relatively low rainfall during the Roman-Byzantine period that increased in the Early Islamic period. The data from the Soreq Cave speleothems indicate changes of up to 10% of calculated rainfall during the Classical period. Between 1000 BCE and 1000 CE the results show calculated rainfall varies between ca. 450 mm and 520 mm per year (Figure 3.5).

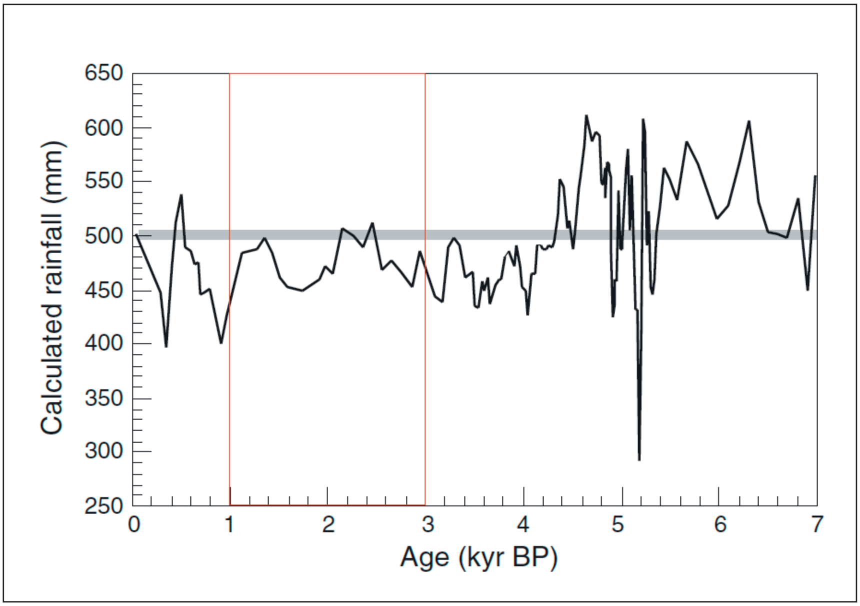

Figure 3.5 Paleorainfall during the last 7,000 years.
Age (kyr BP 1–3) 1000 CE to 1000 BCE, highlighted in red (Classical period, fourth century BCE–9th/10th century CE). Adapted from Bar-Matthews and Ayalon (2004: 382).

In contrast, Vaks et al. (2006: 396) analyzed speleothem deposits in karstic caves in the northern Negev in order to reconstruct the paleoclimate of the border between the Mediterranean climate region and the Saharo-Arabian Desert, concluding that the climate in the northern Negev during the last 13,000 years was similar to the present, or even more arid. The karstic caves studied in the research by Vaks et al. (2006) are located in the northern Negev, just outside the eastern study area, to its north: Ma'ale Dragot cave systems and to its east, the Tzavoa cave. Frumkin et al. (1991: 196) analyzed data collected from caves at Mount Sedom (Dead Sea area): passage elevation of the caves' width ratio and driftwood distribution. The wood samples were used for radiocarbon dating. Their results suggest a dry period between the years 1000 BCE and 0, followed by a short, moister period (0 to 300 CE). This was followed again by a dryer period between 300 CE and 900 CE. After 900 CE, a moister period followed again. Similar results were reported by Bookman et al. (2004), who determined a rise in the Dead Sea level at the end of the 1st Millennium BCE and the beginning of the 1st Millennium CE. The authors also indicated that the level was relatively low during the sixth century CE, rising again only toward the end of the 1st Millennium CE. These results correlate well with the paleorainfall data from the Soreq Cave (Bar-Matthews and Ayalon, 2004); however, the sea-level results indicate a longer, wet period during the first Millennium CE up until 300 CE, followed by a dry phase between 300 and 900 CE and a further increase in rainfall in the 9th and 10th centuries CE (Frumkin et al., 1991). It has to be taken into consideration that the Dead Sea level is not only affected by rainfall, because it also receives water from the Jordan river and runoff rainwater; therefore the data presented are influenced by areas with higher paleorainfall (i.e., the Galilee and Jerusalem area) more than the northern Negev.

In general, all the researchers mentioned (Frumkin et al., 1991; Bar-Matthews and Ayalon, 2004; Bookman et al., 2004), with the exception of Vaks et al. (2006), point to climatic fluctuations and environmental shifts in the northern Negev during the Classical period. However, several questions have to be asked (1) can the data from central Israel or the Dead Sea be extended, even partially, to the northern Negev? (2) If there were fluctuations, were they enough to impact settlements, especially in an environmentally marginal or transitional area? (3) what kind of influence these climatic shifts had on settlement patterns and populations in the northern Negev during the Classical period?

During the Roman-Byzantine period, the area saw a settlement boom (Avni, 2014: 191), followed by a gradual decline after the Muslim conquest. Some scholars have claimed that climate change was the main factor in the expansion and decline of settlements in the area (see Issar and Govrin, 1991; Issar, 1995; 1998; Hirschfeld, 2004a; 2006; 2007;), while others have argued that agriculture and settlement flourished during the Roman-Byzantine period as a result of historical and cultural factors, not as a result of climate change (see Rubin, 1989; 1991; Rosen, 2000; Avni, 2014).

A recent study by Vaiglova et al. (2020) measured stable isotopic proxies from zooarchaeological remains (goats and sheep) from Nessana, Shivta, and Elusa;

the authors concluded that during the 6th and 7th centuries CE, no significant climate deterioration took place. They argued that other factors such as the collapse of trade patterns (connecting the Arabian Peninsula with the Mediterranean world) or the Justinian plague led to a decline in the Byzantine population. Furthermore, they concluded that the settlement abandonment at the end of the Byzantine period was more likely the result of a reorganization of economic or territorial priorities within the wider Byzantine empire (Vaiglova et al., 2020).

The studies from Vaks et al. (2006) and Vaiglova et al. (2020) point to the fact that during the Classical period no significant climate fluctuation took place in the northern and Central Negev. An additional point to take into consideration is that according to Bar-Matthews et al. (1998) the period from ca. 1050 BCE to 950 CE was the most stable period in terms of rainfall amount, and according to A. Rosen (2007: 168) the stability of rainfall quantities is far more important than the rainfall quantities in marginal farming areas such as the Negev.