LISROP: A New Platform for the Spatial Analysis of Massive Archaeological and Historical Information (a Work in Progress)

Avraham Faust and Roni Shweka

The Department of General History, Bar-Ilan University,
avraham.faust@biu.ac.il, Aharon.shweka@biu.ac.il

Abstract

LISROP (*Land of Israel Study and Research Online Platform*) is an online, bilingual, English-Hebrew, integrative platform (under construction) aiming to allow scholars and interested non-academics to review a vast amount of archaeological and historical data from the land of Israel, explore it and dissect in various ways, and then analyze it using sophisticated GIS tools, some of which were specifically developed for the platform. The platform can be used for various types of studies and can be expanded thematically and spatially beyond its current limits by incorporating additional databases and applications and providing information on nature, culture, and heritage, furthering study and research into these areas. The paper briefly presents the project's background, history, development, and current aims. It then describes the platform and its components, including the geographical foundations on which the data is studied, the archaeological and historical data it incorporates, and the various GIS components it includes. The paper then outlines the platform's potential, capacity to advance research on several levels, and expected relevance for non-academics. Toward the end, the paper briefly describes some of the major challenges we encountered in our work and potential avenues for expanding the platform.

Keywords: spatial archaeology; GIS; digital humanities; quantitative history; archaeological databases.

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1. Introduction

The *Land of Israel Study and Research Online Platform* (LISROP) is an online, bilingual, English-Hebrew, integrative website aiming to allow scholars and interested non-academics to review a vast amount of archaeological and historical data from the land of Israel, explore and dissect it in various ways. The data can then be analyzed using sophisticated GIS tools, some of which were developed specifically for the platform. The platform is currently under development, and we hope to present the beta version in the coming months.

After briefly presenting the project's background, history, and development, we will outline the current aims of the platform. We will then describe the platform and its components, including its geographical framework, the archaeological and historical data it incorporates, and the various GIS components it includes. Next, we will demonstrate the platform's potential and how it can advance research on a number of levels. In the next section, we will comment on the website's potential use for non-academics. The following section will briefly present some of the major challenges we encountered in our work, and this will be followed by our future plans for expanding the platform. We will conclude the paper with a summary and conclusions.

2. Background

2.1. A brief history of the project

The platform's development is conducted in the National Knowledge Center for the History and Heritage of Jerusalem and its Environs established by a grant of Israel's Ministry of Science and Technology at Bar-Ilan University in 2018 (Grant #3-15281).[1] The initial aim of the project was to collect and digitize the vast amount of archaeological and historical data available on Jerusalem and its environs and enable scholars to study and analyze it. A number of proposals were submitted, and the Ministry of Science and Technology selected two projects for financing (for the second project, see Avni et al., in this volume). Given the

1 The proposal for the establishment of the Knowledge Center was submitted by Avraham Faust (designated as director), Maayan Zhitomirsky-Geffet, Gila Prebor, and Joshua Schwartz. Initially, the project was coordinated by David Gurevich, who served as a temporary manager. A couple of months later, Roni Shweka was selected to be the project manager. The center's work was accompanied by a steering committee, which was headed by Prof. Shlomo Bunimovitz z"l (Tel Aviv University) until his untimely death and, then, by Prof. Adi Erlich (the University of Haifa). The committee's members were Dr. Alex Altsuler, Prof. Judith Bar-Ilan z"l, Prof. Mark Levine, Dr. Gila Prebor, Prof. Joshua Schwarz, and Prof. Maayan Zhitomirsky-Geffet.

existence of a sister center, it was decided to shift our focus and concentrate on the creation of a platform to study data rather than digitalize and accumulate them.

In the first couple of months, we considered three options: (1) using an existing platform and modifying it to our purposes, (2) focusing on the platform's specifications and outsourcing its construction to an existing company, and (3) building the platform ourselves. Considering the distinctive desired specifications of the project and after lengthy deliberations, we decided in favor of in-house development.

Naturally, in the course of our work and as the development progressed, the project's foci changed several times. While this is not the place for a detailed account of the project's development, one shift ought to be stressed: expanding the project's spatial scope to encompass the entire country. After all, the platform we developed could "digest" data regardless of provenance, and the data we had when we started (based on Faust and Safrai 2015) covered the entire country anyway.[2] Furthermore, we realized that the increased costs for country-wide data collection would be marginal compared to its benefits (more below).

In the creation of the platform, we closely cooperate with a number of institutions. Survey of Israel (MAPI; https://www.gov.il/en/departments/survey_of_israel/govil-landing-page) allowed us to use the *govmap* platform (https://www.govmap.gov.il/) and its various maps as the geographic interface of our system. It also supplied us with high-quality data, enabling us to create our detailed topographical map. The Israel Antiquities Authority (IAA) provided information on many thousands of surveyed sites from its own database.

2.2. LISROP rationale

As noted, the website aims to create a bilingual (Hebrew and English),[3] integrative platform that will allow scholars and interested non-academics to analyze vast amounts of archaeological (mostly) and historical information (and in the future also information regarding heritage, nature, culture, and more) on the basis of a sophisticated GIS system, which will include some unique features (the rational for this integration is in line with the "spatial turn" in the humanities, on the one hand, and with the emerging of spatial digital humanities, on the other; see Warf and Arias 2009; Bodenhamer, Corrigan, and Harris 2010; Gregory and Geddes 2014; da Silveira 2014; Zhitomirsky-Gefft and Krymolowski, this volume).

2 For explanations and links to the data, see https://lisa.biu.ac.il/sites/lisa/files/shared/faust_safrai_introduction.pdf (in Hebrew).

3 We hope to add more languages in the future.

The common denominator of the data used is its spatial dimension—i.e., it has map references—which grounds all the information the platform processes. This is an inherent feature of archaeological data, and hence incorporating archaeological information was a fairly straightforward, even if often time-consuming, process. Indeed, the fundamental databases are archaeological, and the platform will include information on tens of thousands of excavated and surveyed sites (and site phases) of all periods.[4] This will be accompanied by historical data. Here, adding the geographical dimension was far more complex; therefore, the amount of historical information currently available in the system is comparatively limited. The main exception is information about specific sites mentioned in historical sources, depending on our ability to correctly identify and locate them. While this is not always a simple task, it is often more straightforward than identifying activities and the location of events (more below).

We elaborate on the platform below. Nevertheless, it is worth indicating already now that the platform provides users with the opportunity to analyze the vast abovementioned archaeological and historical information on two different levels. First, users can employ various mechanisms to search and dissect the data and create their own maps (databases) according to their interests and needs. Second, the users can employ various GIS applications to analyze the data and produce cutting-edge and sophisticated contextual analyses (Fig. 1).

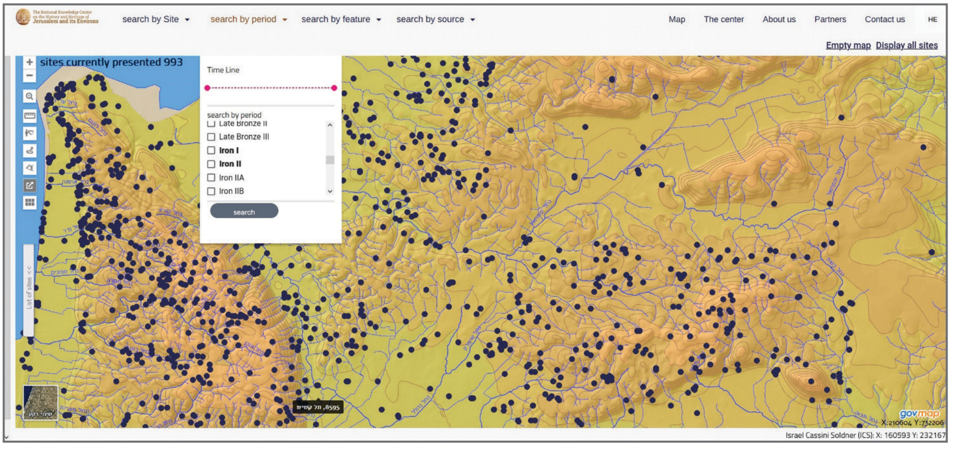

Fig. 1. A screenshot of the platform, exhibiting some of its features (explained below).

4 Archaeological studies have a central role in the Spatial Digital Humanities (see Earley-Spadoni 2017).

3. The Website's Structure

The website includes the following elements:

3.1. The geographical interface

LISROP's geographical interface is based on MAPI's *govmap* platform and offers the following: a detailed and updated street map, high-resolution photomap, printed map (scale 1:25,000), and several historical maps. Additionally, we provide a new high-resolution topographic map produced by Eli Yitzchack, specifically for our project, and based on a high-quality DTM (digital terrain model) provided by the Survey of Israel (MAPI). The elevation intervals in the Jerusalem area are 1 m (Fig. 2), while in the rest of the country, they are 5 m.

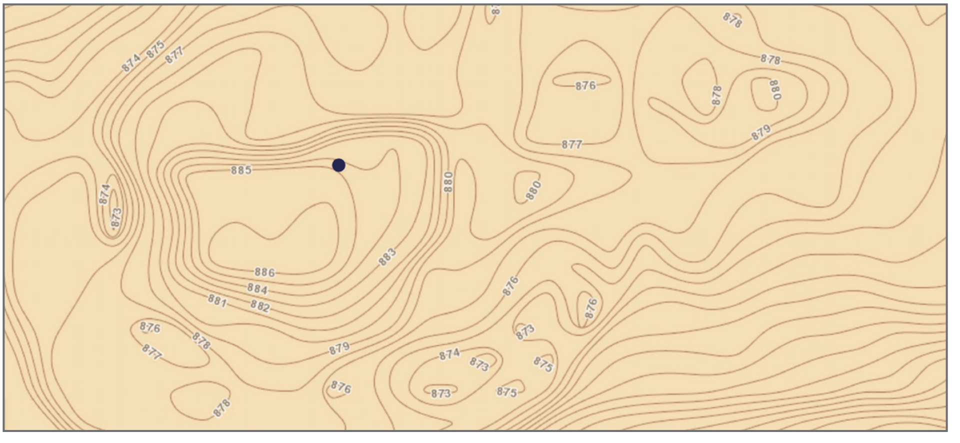

Fig. 2. High-resolution topographic map of the Nebi Samuel (Nebi Samwil; Tomb of Samuel) area.

The *govmap* platform includes basic functions for measuring the distance between two points and the area inside a polygon. Our website offers three additional GIS functions developed by our team:

- *Viewshed* (Fig. 3). The user selects a vantage point by clicking the map, which generates a 360° circle with the visible area colored on the map. The user can also adjust the height from above the terrain to simulate standing on a wall or building and change the selected distance.

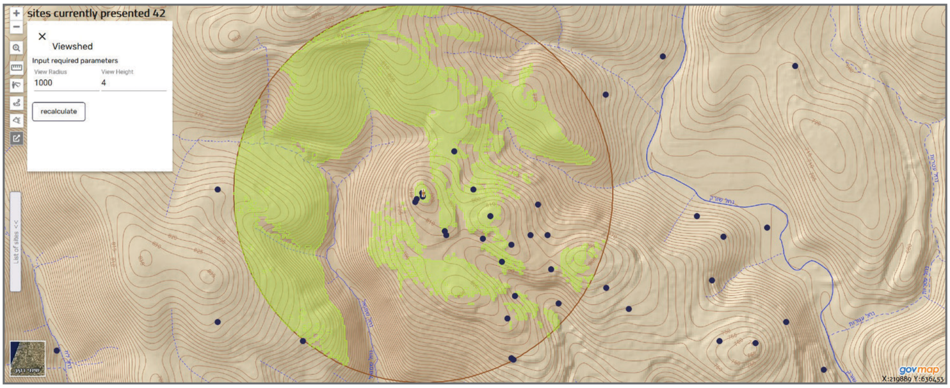

Fig. 3. A 360° viewshed from Khirbat el-Burj to a distance of 1,000 m (4 m-high observation point).

- *Walking path* (Fig. 4). Like on Google Maps, the user can ask the program to calculate the distance of a walking path between two points and the estimated walking time. However, while Google Maps and other platforms like it calculate the route according to current road and trail maps, our platform, which serves archeologists and historians, cannot presume the current maps relevant to the task. Hence the route is projected as a straight line, regardless of the roads that exist today, and the user can manually reconstruct the route by indicating as many points as needed. The program draws a height profile and calculates the actual walking distance implicated by the route, including climbing and descending (and as the crow flies).
- *Azimuth*. The user selects the origin and target points, and the function calculates the azimuth between them.

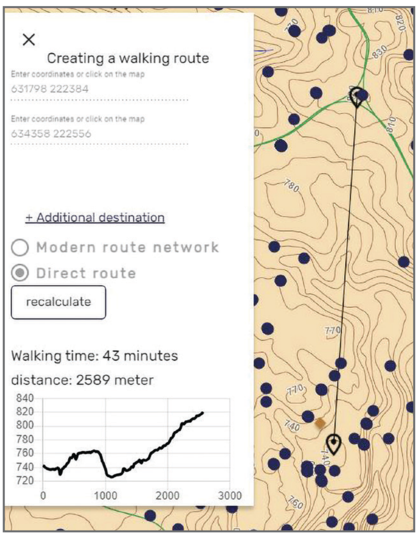

Fig. 4. Height profile from the Temple Mount to Mount Scopus and a walking time estimate.

3.2. The information cards

The website's database contains tens of thousands of locations on which we possess archaeological and historical information. Each location is a site represented by a point on the map. Clicking the point opens an information card for this site. The content varies according to the site's type and the source of the data. In general, an archeological site will include its name, the archeological and historical periods attributed to it, its type, and the general nature of each period's remains. Every record also includes the source of the cited information. The card may also contain images and links to sources of information accessible online (if relevant). While in most cases, the information on a site is derived from one source (see below for the sources), if information from a number of sources is included, the data will be integrated.

3.3. The search interface

By default, the map displays all the sites in the database, which the user can filter by performing a search according to several categories. The main search function is by period, and the user can multi-select the desired periods out of a fixed list of 50 archeological and historical periods (and subperiods) spanning the Paleolithic period and modern Israel. The list is hierarchal, as some of the major periods are subdivided. For example, four sub-periods are listed under the Neolithic period: Pre-Pottery Neolithic A–C and Pottery Neolithic. Moreover, major periods can, even if rarely, be incorporated within an even broader one. For example, the Early Islamic period, which in itself is subdivided into subperiods, is also regarded as part of the Middle Ages. In the platform, if a user selects a major period, all the sites which belong to its subperiods will be retrieved as well. Similarly, when users select a subperiod, they will be presented with the sites which belong to this specific subperiod along with all other sites listed under the relevant major period. In order to differentiate the various levels, the sites retrieved by the query are colored in three different colors: Red indicates an exact match between the selected period and the site; orange indicates a site that belongs to a subperiod of the requested one; and yellow indicates a site that belongs to a major period which includes the requested one (Fig. 5).

The user can also search for a specific range of years with a slider, which our system will convert into the corresponding periods. This task is achieved based on a unified periods' table we have formulated and is available on-site. Additional search categories include the type of site (tell, cave, cemetery, etc.), the source of information, and a textual search of the site name. Every category encompasses a multi-select dropdown list, which enables selecting several values retrieved with the OR operator between them. Different categories can

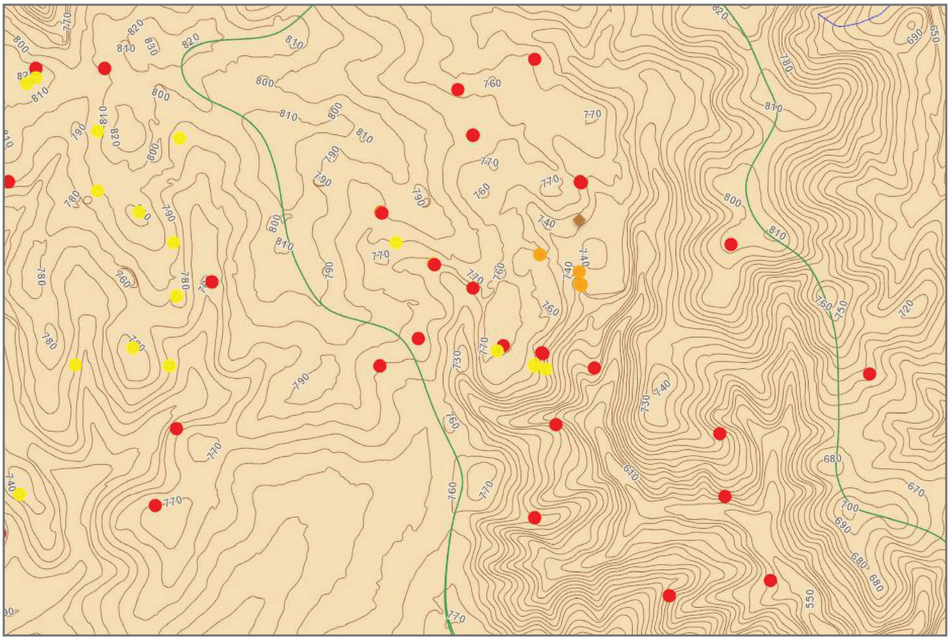

Fig. 5. Query results for the Early Islamic period. Sites dating from the Early Islamic period appear in red; sites more narrowly dated to the Umayyad, Abbasid, or other Early Islamic subperiod appear in orange; and sites broadly dated to the Middle Ages appear in yellow.

participate in the same search. The results will comply with the values selected in all participating categories.

3.4. About the center

The website presents some information on the center, its team, and its partners. There are also pages dedicated to the dear memory of the late Prof. Shlomo Bunimovitz, who chaired the center's steering committee, and the late Prof. Judit Bar Ilan, who was a member of the steering committee.

4. The Database

The database includes a number of corpora comprising archaeological and historical information, which is then placed on maps and analyzed.

4.1. Archaeological data

When work was initiated, we relied mainly on the information collected by Faust and Safrai (in Hebrew; for discussion, see Faust and Safrai 2005; 2008; 2015; 2022) and which is available online (see https://lisa.biu.ac.il/sites/lisa/files/shared/faust_safrai_introduction.pdf, with basic guidelines and links to the tables). These databases included (1) basic information extracted from the first four Hebrew volumes of *The New Encyclopedia of Archaeological Excavations in the Holy Land* (Stern 1992) and (2) basic information on salvage excavations published in the IAA's journal *Khadashot Arkheologiyot* until 2003 (from 1982, the data was also published in English in *Excavations and Surveys in Israel*, and as of 1999, the two journals have been merged). The two databases supply unique but very different types of information, enabling scholars to carry out sophisticated studies (e.g., Faust 2015; 2021), but this is beyond the scope of this article. These databases allowed us to manipulate real data as we developed the platform's various components; the information contained in these databases was sufficient for the development of the platform.

In order to make the platform useful, a much larger dataset is needed, and the following databases will be included:

- **The New Encyclopedia of Archaeological Excavations in the Holy Land (NEAHEL).** The initial four Hebrew volumes were studied by Faust and Safrai and were incorporated into our original platform (above). The Hebrew data (names of sites, excavators, and authors) are now being translated into English in order to suit the bilingual platform. Additionally, data extracted from the fifth volume is presently being converted into tables.
- **Salvage excavations database**. The initial database created by Faust and Safrai included a table with information on all salvage excavations published in *Khadashot Arkheologiyot* until 2003. We intend to translate this database and update it to include all salvage excavations published in *Excavations and Surveys in Israel* up to the present.
- **Surveys**. We received from the IAA all available survey data, including thousands of sites from all parts of the country.
- **Additional archaeological data**. While these databases will never be complete, we strive to make them as comprehensive as possible. For this, we intend to include additional sources, like the numerous excavations reported over dozens of years in journals like *Qadmoniot* and *'Atiqot*.[5]

The following details are recorded for each excavated stratum or level at a site:[6] name (or names), reference points, region, subregion,[7] excavator(s), author(s) of the article, period reported, period as defined by us (see also Section 6.1, below),

5 We attempted to mine data using NLP (a project headed by Yuval Krymolowski), but the results were too partial at this stage (see more details below).

6 A site with two occupation strata receives two lines in the database.

7 The region and subregion are manually entered but automatically examined using exact polygons on the maps. Should a discrepancy arise between the reference point's location and the designated region or subregion, it will be manually checked and corrected.

the general nature of the finds (e.g., architectural remains, only sherds, and more), type of site (e.g., a mound, *Khirbe*, etc.), the nature of the site (e.g., urban, rural, etc.; this is the most subjective category in the database), special finds (this is where major finds and additional discoveries can be reported in greater detail), date of the excavations, their extent (i.e., the area excavated, if given), and reference to the source (see also Faust and Safrai 2015; 2022, from which the system was borrowed and modified).

4.2. Historical data

Unlike archaeological information, historical texts, even when mentioning places, do not provide map references. This means that each textual reference to a place requires its identification on the map. Sometimes, this is easy (e.g., when the reported activity took place in a well-known location), but in most cases, this is not straightforward. Occasionally, the data is insufficient to suggest any location at all (e.g., when a site is mentioned once and with no additional information as to its location), whereas, in many other instances, there are a number of possible identifications for each textual reference (for theoretical considerations concerning the process of transferring texts to maps, see Eide 2014; 2016).

We sought to use Josephus as a test case and determine when events and places attributed to the Jerusalem area can be mapped. The results are included in the databases but are admittedly very partial. A more promising approach is to "bypass" the primary sources and use data included in studies that systematically collated identifications of historically recorded places. Thus, we include in the platform a database of hundreds of Yohanan Aharoni's (1979: 424–443) site identifications. We plan to add also the identifications made by Kallai (1967), Elitzur (2012), and others.

5. Academic Use and Potential

The data collected and the platform developed can serve as the basis for an endless array of new, advanced, and sophisticated historical and archaeological studies. While the GIS platform is essential for many studies and the unique GIS features could enhance the applicability of the platform even further, we must stress that the magnitude of the data handled by the platform can revolutionize the study of the past in itself, even before using the unique GIS features (below).

5.1. Large-scale studies

The databases include tens of thousands of site and site-phase entries, which derive from different sources, are of different types, and date from various periods. With LISROP, scholars will be able to search the data and generate a series of maps tailored for certain regions (the region can be selected from an array of pre-defined regions or with a polygon created by the user), periods, or both; one could, for example, select "Iron II" sites in the "southern coastal plain."

These selections can be further refined (1) by referring, for example, only to excavation results (and not surveys) or even salvage excavations (hence excluding not only surveys but also academically initiated, planned, excavations), (2) by selecting specific site types (for example "mounds only"), (3) by focusing on particular find types (e.g., installations, cemeteries, rural sites, etc.; note that some of these searches, for example the category "rural sites," depend on the subjective judgment of the individual recording the data), and (4) by limiting the search to a distinct source of information (e.g., the NEAHEL, Salvage excavations, surveys from the IAA database, etc.; some of the searches can even be limited according to the years of publication).

Another feature is a free-text search that is not restricted to pre-defined terms but engages all types of finds reported. Like any other search, the free-text search can be combined with other queries by period or region, hence providing more in-depth information (given the nature of the recording, this will not be exhaustive).

The operations described above, which make only partial use of the platform's GIS features, provide scholars not only with an unprecedented amount of data but also with a unique ability to sift through and manipulate them. In this capacity, LISROP will provide scholars with an extensive database on the themes that interest them and, at the very least, will serve as a foundation for more detailed studies. For example, it can be used to generate maps of sites relevant to a certain theme, which can then be used to find the necessary literature in order to study it in greater depth. While such an application will be a contribution in its own right, we think scholars are more likely to employ the platform to manipulate data and conduct various searches as part of their intended research. Furthermore, the fact that LISROP presents the data on maps rather than in tables will allow (even force) the users to "think" spatially whenever they dissect the data, hence making it easy to identify settlement patterns and observe changes over time or between regions as a basic component of the research itself. In this way, the platform will provide new venues for research simply by the way it presents the data, even without its additional GIS capabilities. We hope that the detailed spatial presentation will enhance what could start as "traditional" studies of archaeological and historical data.

Moreover, while archaeological data are spatial almost by definition, the fact that the historical data are rendered spatial for and by the system forces historical studies to "think" spatially, too. Indeed, the platform has the potential to promote the integration of the two classes of data, simply by highlighting converging dots on the map.

Similarly, the platform's ability to define areas of research (whether with pre-defined regions and subregions or with manually drawn polygons) will enable scholars not only to arrive at lists of sites but also—probably mostly—create easily comparable period maps in which data convergences are readily discernable. In this manner, scholars will easily identify changes in the number and distribution of sites in any region and subregion or trace the association between historical information and an archaeological site. Indeed, the simple use of the GIS features enables users to compare contemporaneous settlement patterns in different regions on a map by a simple comparison.

Given LISROP's ability to facilitate search by source, type of find, region, period, etc., the range of possibilities for using the databases and the platform for large-scale studies and for furthering research into specific finds or phenomena are practically endless.

5.2. Region and site-level analysis

It is at the region and site levels of analysis that the added value of the platform's additional GIS features becomes apparent. Thus, the viewshed component becomes very important at this stage. For example, a scholar interested in regional Late Bronze Age settlement patterns can use the platform to populate maps of a region with all the Late Bronze Age sites and then explore what can be viewed from each and every one of them. Various types of analyses are likely to benefit from this: military, trade, domination, and even "communities of sight" (Fig. 6). Sometimes, this sort of analysis can even help resolve historical questions (e.g., Faust 2020: 122–128; Fig. 7). Notably, as noted above, the platform enables scholars to determine the observer's height above the ground; thus, for example, we may assume that the onlooker stood on the roof of a multi-storied tower or observation post. Indeed, this sort of analysis is relevant not only for regional studies but also for the study of settlements, neighborhoods, and specific buildings (see Faust et al. 2017: 140–141; Fig. 8).

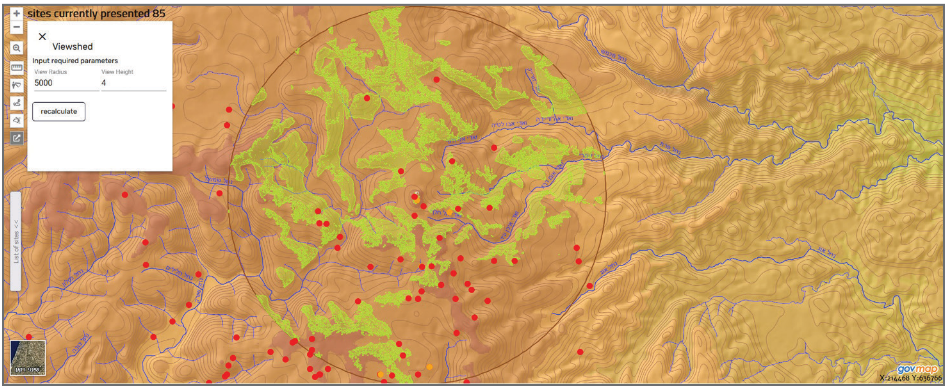

Fig. 6. A 5 km-radius viewshed from a 4 m-high vantage point at Tell el-Ful featuring Iron II sites in its vicinity. Areas and sites visible from this location are marked in green.

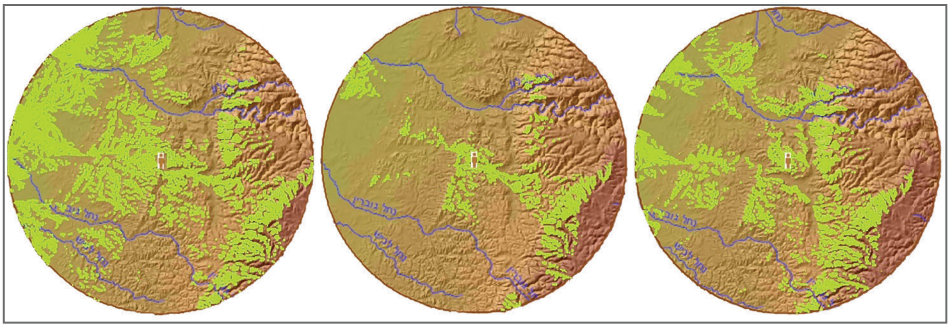

Fig. 7. Comparative viewshed analysis (20 km radius; 4 m observation height) of Tel ʿAzeka (left), Kh. Qeiyafa (center), and Tel Yarmouth (right), demonstrating that Tel ʿAzeka and Tel Yarmouth were strategically positioned, whereas Khirbat Qeiyafa was not.

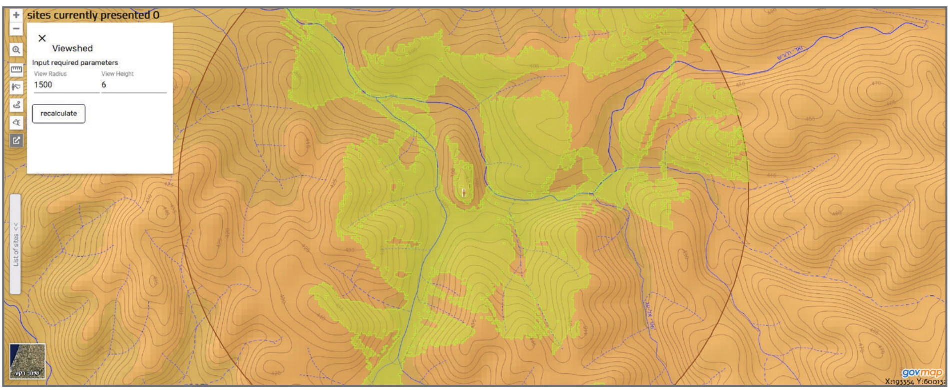

Fig. 8. Viewshed from Building 101 (the Governor's residency) at Tel ʿEton, demonstrating what could be seen inside the city and in the surrounding hills (6 m observation height; 1.5 km radius).

The platform also allows scholars to easily calculate settlement sizes with the measure function of *govmap*, which is the initial stage in any demographic analysis. The platform will facilitate easy measurement of distances, both as the crow flies and as ground distance, over a route selected (and created) by the user. In the latter case, the program will also calculate the elevation differences and will provide users with the actual walking distance (accurate) and even an estimated walking time (only roughly estimated, of course).

6. Potential for Non-academics

While many of LISROP's sophisticated analytical capacities are likely to primarily appeal to scholars, many of the platform's features can also be used by non-specialists. Thus, the ability to find the ancient remains in a given area and even locate sites mentioned in historical sources (e.g., sites mentioned in the Bible, when relevant) is expected to appeal to many travelers and tourists. This is true whether traveling the countryside and using the platform to locate all ancient sites (and relevant information about them) along a designated route or whether visiting cities and employing LISROP to explore all available information on past remains and, for example, decide if to walk 50 m farther to visit them (if still visible) or learn about them (if no longer visible or not open to the public). We also anticipate that some travelers will use the more advanced features, like the viewshed analysis, to determine if a mountain is worthwhile the climb and explore in advance what would be visible from its top.

Additionally, we should point out the platform's utility for another class of users comprising non-professional but serious amateurs. The field of biblical archaeology and biblical studies attracts a great deal of enthusiasm, and there are thousands of very serious non-professionals who will probably use the platform extensively. Since such enthusiasts have sometimes made interesting discoveries and even published books that furthered our knowledge (e.g., Grena 2004), we hope the platform will contribute to scholarship by supporting enthusiasts too.

7. Some of the Challenges Encountered

We encountered numerous problems and challenges while building the platform, and it would be impossible to even mention all of them within the scope of this paper. In the following lines, we will briefly outline some of these challenges and simply mention others (some will be discussed at length elsewhere).

7.1. Unifying periods (the periods' table)

Considerable effort has been invested in preparing a fixed periods' table that provides a continuous chronological cover of the region from the Paleolithic period to the 20th century. The table consists of 50 periods and subperiods featuring the most commonly used periodic terminologies in contemporary archeological and historical studies of the land of Israel. The periods are not necessarily mutually exclusive: When a period is subdivided, the general, inclusive period is listed separately besides the subperiods. For example, the Late Bronze Age is divided into four subperiods (Late Bronze Age IA, IB, II, III), but it is also listed by itself. Thus, every site dated to one of the subperiods will be retrieved when a search of the Late Bronze Age as a whole is conducted; and vice versa, sites only generally dated to Late Bronze Age (i.e., with no sub-periodization) will show up on a search of any of the subperiods. As we mentioned above, in these cases, the color of the site will indicate that the match is inexact and suggest that a more careful investigation of the results is required.

In order to accommodate the collected data to our periods' table, we built a conversion table that converts the hundreds of English and Hebrew variants of period names cited in various sources to our standardized form.

7.2. Handling reference points

One of the major problems we faced was the accurate interpretation of the reference points provided in many sources. Most of the data were recorded in the old Israeli grid (ICS, Israel Cassini Soldner). Even though the conversion function to the current grid is simple enough, and there is software that calculates and even corrects the reference points, incautious use produced an unexpected fault, as we explain below.

The data input precision greatly varies across sources. While in modern literature, archeological sites' locations are usually cited in 10–12-digit formats providing a high, 1–10 m resolution, in other sources, either due to old standards or the sites' nature, the reference points might be recorded in 8 or even 6-digit formats corresponding to a low, 1 km resolution. In these cases, we automatically filled trailing zeros, modifying all reference points to a full 12-digit format. In view of these circumstances, we programmed the system to regard reference points with trailing zeros as wildcards, as placeholders rather than accurate map references. Significantly, there is a 0.1 probability that data recorded in a high-precision, 12-digit format produced a figure with a trailing zero. Nevertheless, as we cannot differentiate between the two cases, we prefer to handle all cases of trailing zeros as insignificant, which is usually the correct interpretation.

The problem is that when reference points are automatically converted from the Old Israel Grid to the new one, the conversion function will often change any trailing zeros in the old reference to other digits in the new grid, given minute corrections of the data in recent years. Consequently, the trailing zeroes will be replaced by other digits, and the system will misidentify the new reference points as high-resolution, 12-digit reference points. It was, therefore, necessary to keep track of the number of trailing zeros in the original reference points and, when necessary, change the corresponding digits in the new map reference back to trailing zeros. This proved to be a cumbersome and unnecessary procedure. For various reasons, we ultimately preferred to modify the reference point with our own, much simpler, albeit slightly less precise program, which converts the Old Israel Grid to the New Israel Grid while maintaining the trailing zeros (although MAPI's automatic conversion feature is more accurate, the differences are too minute to have an impact for sites' locations).

The correct interpretation of the reference points becomes essential when comparing records of close and similarly named entries, albeit with different reference points. If the only difference between the map references is that one has a trailing zero, then, by token of trailing zeros' status as wildcards, the two points are considered equal. When the points differ otherwise, a certain threshold of tolerance is considered. In any case, all these similar and adjacent points are signaled out by the system and reexamined by the project staff for the final decision (more below).

7.3. Map referencing historical data

As mentioned above, the website's scope goes beyond strict archeological data and also incorporates geo-historical data. By this, we basically mean attaching place names (toponyms) and events recorded in ancient literature to locations on the map. Although we often benefit from existing toponymic studies, geographical databases, and historical maps, every location's final reference point is decided by the project's staff. It is important to note in this context that original historical or archaeological research is not in the project's scope and is not considered one of our missions. Still, a qualitative description or a vague location cited in the literature (e.g., "between here and there") necessitates much extra work to determine its reference point and position it on the map. We will elaborate on this elsewhere.

7.4. One site or many?

A well-known problem in the analysis of archaeological data is how to define a site and delineate its boundaries. Thus, when several excavations are conducted in proximity to one another, how do we decide if they feature different parts of one site or different sites? What complicates things further is that sites tend to shift in size. Hence, Hellenistic Ashkelon was huge and incorporated numerous distinct earlier sites. Thus, the remains unearthed in a single excavation might be deemed part of a sizeable comprehensive site if they date to the suitable period but to a separate site if the finds date to another. Another complication lies with the fact that the identification of sites mentioned in historical sources, even when quite secure, might be placed (in terms of the reference points) at the center of an ancient site, whereas excavations in the very same site may be carried out in its periphery, a few hundred meters (and sometimes even more) away, obliterating the association between the two.

Deciding whether different dots on the map (regardless of their source) belong to one settlement is, therefore, a complex matter. While most problems could be solved by an expert, this is impractical, given the data's magnitude. Instead, we devised a number of basic methods that allow the platform to make the initial assessment (based, for example, on the distance between dots, their names, and more) and alert us when the decision is not straightforward. This reduces the number of instances requiring a human's decision; when such an alert is raised, the team will make an informed and contextual decision. We will elaborate on this in a separate publication.

7.5. Automatic analysis of archaeological reports

A considerable part of the data gathered by the project is produced via analyses of archaeological reports and scientific publications written as free text. In order to simplify and expedite the process of analyzing this corpus and converting it to structured data suitable for our platform, we initiated a research project for building an NLP (Natural Language Processing) tool that will automatically extract relevant data from archaeological reports. This tool's output should be a table with two columns: One column records archeological finds recovered at the site, while the other associates these finds with the appropriate archeological or historical periods. To accomplish this, we used deep learning techniques and a training set of 30 documents analyzed by the project's staff. This initiative was guided by Dr. Yuval Krymolowski, a researcher at the Natural Language Processing Laboratory headed by Prof. Ido Dagan at Bar Ilan university.

While the project produced some interesting results, it also came up against some difficult problems which are yet to be resolved. Altogether, the current output is unsatisfactory, and this initiative still has a long way to go before the data can be used. We hope to continue this study and publish its results somewhere else in the future.

7.6. Additional issues

Among the technical problems we encountered was the need to unify the terminology for sites and finds and to define regions and subregions (surprisingly, we could not find satisfactory lists or maps and had to work out these issues ourselves). Another surprising problem pertained to the map's resolution, which proved impractical for viewshed analysis. The map's high resolution implicated that every small pile of stones could block visibility, and if we clicked the mouse 10 m away from the hilltop of the hill (and it is impossible to be so accurate), the visibility in one direction would be blocked. We intend to elaborate on these issues elsewhere but note that a possible solution to the last problem is selecting observation points after zooming into the sites, making sure that the location is as precise as possible.

8. Future Additions and Potential

The main part of the paper briefly presented the platform, introduced the existing components, and outlined features currently under development and which we hope will be incorporated into the platform within two-to-three years or so. We are building the platform, however, in a way that will allow its future expansion through the inclusion of new types of data as additional layers on the map. These layers will eventually be accompanied by additional features and components, which we hope will be incorporated at a later stage.

These include, for example, data relating to heritage, culture, and nature, like photos, postcards, and stamps depicting specifiable places. Since these elements can be given accurate reference points, they can also be embedded in the platform (photographs can be embedded into the database, or a link can be supplied); and since many of these have a date, they are well suited to facilitate fine-tuned periodic and temporal analyses. A somewhat similar type of data includes songs about places, which can also be collated and incorporated into the platform (again, possibly with links to the songs). Similarly, information on vegetation, including the blossom date of various flowers, could also be incorporated. A somewhat more complicated but still feasible exercise will be to add routes traced by ancient travelers, modern scholars, or even military campaigns.

A different type of data that could be added to the platform is high-resolution excavation results. Thus, the addition of map-referenced architectural plans will accurately position ancient walls and buildings, as well as finds published in the final reports. As sites are currently represented on our maps as dots, the above would simply be a "zoom-in" into sites that are currently reported in the databases at the site level. Some of these data (most archaeological plans, in fact) can be used for three-dimensional reconstruction, possibly supporting, in the future, a detailed virtual reality experience (see below).[8]

We should note that while the data on the platform covers the land of Israel, mostly west of the Jordan River (but not only), this was a function of the data available. The platform can easily be expanded to cover the entire world. Should the LISROP project succeed, we hope it will expand into other regions (which will also call for a new title).

9. Summary

LISROP aims to integrate detailed high-resolution archaeological and (to a lesser extent) historical information and enable its geographical analysis. First and foremost, it includes a vast archaeological database of tens of thousands of sites and strata, each furnished with basic (relevant) data and extensive map-referenced information. Once launched, the platform will enable scholars to dissect the data across an almost endless array of queries; for example, according to regions, subregions, periods, sources of information, and the nature of the finds. At the bare minimum, it constitutes a huge data catalog, which can be used even in the most conservative fashion as a starting point for more contextual research.

There is, however, much more to the platform. Thus, the data can be queried in a way that is in itself research. For example, one can search the databases to comparatively study the nature of the rural settlements in a micro-region during several successive periods; suitable queries will produce new data worthy of publication in their own right. Moreover, the fact that the data is presented on maps rather than in tables will force the users to "think" spatially and render various patterns immediately visible (even without necessarily looking for them).

8 If there are few strata or phases, we could use the existing periodization system to host the various finds. Still, when there will be a number of phases within the same "period" (for example, when there are two Late Bronze Age IA phases), additional accommodations will have to be made in order to allow all the information to be presented.

Furthermore, the platform's geographical capabilities help advance studies by establishing them on more systematic, even scientific, grounds. This is clear when we zoom into regional or site-level analyses. Here, some of the unique applications developed specifically for the platform enable it to perform cutting-edge analyses, which can easily result in the identification of new patterns. Thus, for example, the application of viewshed analyses in a certain subregion can provide many insights into the relative importance of various sites, their locational considerations, the importance of security and defense, economy and trade, and even the social and cognitive aspects and perceptions of the environment.

We should note that while the platform is aimed first and foremost at academics and academic research, it has much to offer travelers and tourists, as well as enthusiasts who would like to study the data and mine it for further insights. Finally, we view the current platform as a core that can and should be thematically and spatially expanded by adding new databases and applications concerning nature, culture, and heritage, which, in turn, will further the research into these topics and their (when relevant) preservation.[9]

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9 We note that, given the inevitable errors in such large datasets, one must verify the information's accuracy when conducting research. This is especially acute for the reference points, which for many reasons are highly susceptible to errors.

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