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DAAHL - The digital archaeological atlas of the holy land: A model for mediterranean and world archaeology

Permalink

<https://escholarship.org/uc/item/1mh5d902>

Journal

Near Eastern Archaeology, 77(3)

ISSN

1094-2076

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Publication Date

2014-09-01

DOI

10.5615/neareastarch.77.3.0243

Peer reviewed

DAAHL –

The Digital Archaeological Atlas of the Holy Land: A Model for Mediterranean and World Archaeology

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The Digital Archaeology Atlas of the Holy Land Virtual Museum. A tenth century B.C.E. pottery sherd hovers over a Google Earth map of Khirbat en-Nahas, the famous Iron Age copper production center in southern Jordan. Screen shot from the Digital Archaeological Atlas of the Holy Land, S. Savage.

Stephen H. Savage and Thomas E. Levy

The DAAHL project is an international effort that brings together experts in information technology including Geographic Information Systems (GIS) and the archaeology of the Holy Land (Israel, Palestine, Jordan, southern Lebanon, Syria, Cyprus, and the Sinai Peninsula) to create the first online digital atlas of the region held sacred to the three great monotheistic faiths – Judaism, Christianity, and Islam (fig. 1). Using the power of spatial information systems such as GIS, the tens of thousands of recorded archaeological sites for the region – from the remote prehistoric periods to the dissolution of the Ottoman Empire in the early twentieth century – have been entered into a comprehensive database along with site maps, photographs, and artifacts. The historical and archaeological content for the project have been provided by a team of over 30 international scholars working in the region helping to provide the metadata that were used to populate it. The DAAHL database represents the first fully-developed data node of the Mediterranean Archaeological Network (MedArch-Net), a project that envisions a series of archaeological atlases for the Mediterranean basin that share a common metadata structure (Savage and Levy i.p.).

The DAAHL project brings together many of the developments in information technology that are revolutionizing the fields of

archaeology, history, and the social sciences, based on new archaeological discoveries and the latest content concerning one of the most politically complex but meaningful geographic regions in world heritage. Our effort was recently judged to be one of a small number of “Exemplary Comparative or Thematic Collections” by the Digital Collections Group of the American Schools of Oriental Research Committee for Archaeological Policy (Digital Collections Group 2011). It has been directly linked into the recently developed ASOR CAP Projects website at <http://asorrttest.org>.

The DAAHL project has produced the only regional, multi-national database of archaeological site and project metadata available for the Levant. It currently contains more than 27,000 sites and 60,000 site components from Cyprus, Israel, Jordan, Lebanon, southwestern Syria, the Sinai Peninsula, and the West Bank. The database also maintains an extensive bibliography, and information related to site conditions. It makes extensive use of embedded Google Earth and Google Maps interfaces, which provide the user with a suite of attribute and spatial query tools, and map-making components.

A Data Switchboard

The DAAHL/MedArchNet approach to archaeological site data envisions our data nodes as “switchboards” that contain top-

level site and project metadata, plus bibliographic references and extensive use of linked resources outside the MedArchNet data structure. The DAAHL data node was created with these objectives in mind. It is not our goal to corral every bit of data about every site in the Levant—an enterprise that would clearly be impossible even if it were desirable. Rather, the MedArchNet/DAAHL approach is designed to let researchers and the public easily find archaeological sites based on location and other attributes such as site type, features, time periods, etc., provide a mechanism for creating substantive maps, then point the user to the locations of substantive research on the site, whether it be on- or off-line. Participants at the recent Workshop on CyberArchaeology, held at the American School of Classical Studies in Athens, on 4 October 2013, discussed the fact that at its most basic level, there is a small set of common variables in all archaeological site databases. These include the site name, the site location (latitude/longitude), time periods when the site is occupied, features that can be found at the site, and links to additional site information, either web-based, or print-based. Participants further expressed the desirability of creating a regional, web-based system of archaeological metadata, encompassing these fields, which would be able to link other, disparate datasets.

The DAAHL project serves these functions for the Levant. It highlights the research of the archaeological community, rather than subsume it under the DAAHL umbrella; it furthermore fulfills the desire of the Athens Cyberinfrastructure Workshop for an inter-regional metadata system that can unite different regional databases under a single query umbrella, without subsuming any of them. The DAAHL database (as does each data node in MedArchNet) maintains a table of data donors, including contact information and links to primary websites, and each site contributed by a donor will be “branded” with the donor’s information. Whenever a contributed site is displayed, the donor information is also shown, so the links to the donor’s website are clearly shown, along with specific external resources for individual sites.

Highlights and Features

The need for an archaeological site metadata search tool is fulfilled by the DAAHL website, but these basic features have been significantly enhanced through a series of interactive tools and content from experts in their various time periods. The DAAHL database is further enhanced by organizing site data around two

major themes, Time Periods and Empires. We also include a number of detailed Case Studies by regional experts.

The DAAHL relies on leading archaeologists working in the Holy Land to produce on-line “chapters” that summarize the socio-economic and cultural dimensions of each archaeological period. Selecting the Periods option on the website opens an interactive Google Map and information about 60 time periods, from the Lower Paleolithic through the Late Ottoman, and an introduction to the period from one of its leading experts. The periods can be animated or selected individually from a drop-down list, and the map displays site clusters from the selected period. The user can manipulate the map, zooming in to see “clickable” sites from the selected period. When a site point is clicked a window opens in the browser with detailed information about the site (figs. 2–3).

Figure 1. The homepage of the *Digital Archaeological Atlas of the Holy Land* can be found at <http://daahl.ucsd.edu>. Screen shot from the *Digital Archaeological Atlas of the Holy Land*, S. Savage.

The Empires theme in the DAAHL database presents an interactive map of each of the major land empires that have ruled the Levant, along with a textual summary. The user can animate the map to show the march of empires across the region through time, or can select one from the drop down list. When an Empire is selected its summary information is displayed, and the map displays archaeological sites contemporary with the selected empire. Like the Time Periods theme, the user can click on the site points and get detailed information about them.

Case studies can be enhanced with their own interactive Google Maps or Google Earth windows. For example, Levy et al. used an embedded map to illustrate the development of early states in the DAAHL study area during the Iron Age. A case study page can be further enhanced by streaming video and pre-set site tours – Savage and Levy used the Google Earth API’s ability to display tours to illustrate Shishak’s campaign

through southwest Asia (fig. 4). When the user runs the tour, each significant archaeological site Shishak occupied or attacked (listed on the wall of the Karnak Temple in Luxor, Egypt) is visited in turn.

Among its other rich data display and query tools is the ability to display the latest archaeological survey and excavation information against an interactive Google Maps background that contains the Palestine Exploration Fund maps—classic archaeological and topographic maps created in the 1870s and 1880s. The PEF maps were scanned and converted into an image pyramid of more than 250,000 tiles for embedded Google Maps display. Site points from the DAAHL database are displayed on top of the historic maps, and each site is back-linked to the database, so that its records can be called up simply by clicking on the site point (fig. 5). Another highly innovative feature is the DAAHL's Virtual Museum, which displays interactive, 3D objects at their original find locations through a Google Earth window (banner). The user can manipulate the object in all three dimensions as well as the map itself.

The most recent development to the DAAHL data node is a mapping function that allows the user to query the database by time period and/or site/feature type. Results are displayed as a series of interactive site clusters on the terrain layer of the Google Maps interface (fig. 6). The site clusters are clickable, where doing so zooms to the next level and displays smaller clusters, and individual sites. Site points are also clickable. These maps are suitable for presentation or publication.

Data Retrieval

The site record contains the basic DAAHL metadata for the site, and is linked to other tables in the database that capture information related to site periods and site/feature types. The combination of period and site/feature type is termed a “Site Component,” and is the preferred method of assigning temporal and archaeological attributes to the site record. Our experience in developing the DAAHL database, MedArchNet, and predecessor archaeological database applications has shown that most attribute queries that users make involve a time period and a site/feature type. For

example, a typical query might be “Show me all the Early Bronze Age Dolmen sites,” or “Let me see all the Iron II period fortress- es.” We encode site components/features with the combination of time period and site/feature type, so that these kinds of queries can be performed. Simply recording a list of occupation periods and another list of site features does not allow for the kind of query that most users want to conduct. Queries can be performed on attribute data, such as time period (by itself), site/feature type (by itself), condition, or keyword, or spatially (drawing an area of interest on an interactive map and fetching all the sites that fall within the query footprint).

Figure 2. The “Periods” theme in DAAHL, showing the Early Bronze Age. Screen shot from the *Digital Archaeological Atlas of the Holy Land*, S. Savage.

Site Condition Assessment

One of the most significant attributes of the DAAHL approach to archaeological site data is the inclusion of a Site Condition Assessment module. We recognize that archaeological sites are under tremendous pressure from development, agricultural expansion, warfare, and other factors. These are facets of modern life that have created extremely adverse effects on a finite cultural resource base (see Savage and Rempel 2013). Too often, though, the tools that are required to help manage and monitor ongoing impacts or threatening developments on sites are lacking. The DAAHL project addresses this pressing need by including an assessment module that lets authorized users create what we term a “Visit” record, for any site in the database, and attach to it records related to Site Disturbances (things already happening on a

site that are damaging it), Site Threats (things that have not yet come to pass, but are easily foreseen, such as a road development that will cut through a site in five years’ time), and Site Hazards (conditions on a site that are dangerous for people or animals, such as the presence of unexploded ordnance, oil or chemical spills, or other factors of this type). Researchers can report on the current conditions of any site in the database by using the online data entry module, and there they can record current disturbances, threats,

Figure 3. Detailed site data for al-Murayghat includes a detailed description of the site and recent fieldwork, and Landsat image draped over a digital elevation model. Screen shot from the *Digital Archaeological Atlas of the Holy Land*, S. Savage.

and hazards, and they can upload digital photographs that will be permanently attached to the condition report. In this way, sites that are especially at risk can be continually monitored, which

Figure 4 (above). Shishak's campaign in southwest Asia, animated through a Google Earth tour.
Figure 5 (below). The Palestine Exploration Fund maps displayed as a backdrop for the DAAHL site points.
Screen shots from the *Digital Archaeological Atlas of the Holy Land*, S. Savage.

provides the depth of information necessary to make intelligent site management and preservation decisions.

In addition, the query capabilities that come with each node in the DAAHL system include a spatial-based query—users can draw an area on a Google Map window, which might represent an area of potential effect for a planned project. The application takes the user-drawn area and queries the DAAHL database for sites that fall in or near it; the results are returned to the user as a web list of sites and a KML file, which can be opened in Google Earth. Each site in the KML file is back-linked into the database so it can be examined in detail. This allows planners to use the system to interactively design development projects in such a way that they minimize the impact on known sites.

Summary and Future Plans for DAAHL and MedArchNet

New developments in telecommunications and information technology are revolutionizing the fields of archaeology, history, and the social sciences. The *Digital Archaeology Atlas of the Holy Land* represents a signature project of the GAIA Lab at ASU and the Qualcomm Institute at UCSD that brings together many of these advances based on new discoveries and the latest content concerning one of the most politically complex but meaningful geographic regions in world heritage. The control of time and

space allows archaeologists to address the “big questions” of human history and social evolution. These include answering how and why major technological revolutions of history occurred and influenced social and historical change in the Middle East. In broad strokes, the control of time and space are essential commodities in the construction of a heritage-based cyberinfrastructure, which come together for scholars and the general public in DAAHL. New developments in GIS, high-precision radiometric dating methods, and archaeological fieldwork carried out in the Holy Land (Israel, Jordan, Palestine, Lebanon, southern Syria, and the Sinai Peninsula) have helped identify significant “Global Moments” of fundamental social change in this region, which the DAAHL project documents and illustrates.

The DAAHL project represents the first implementation of a content-rich archaeological data node in what we hope to be a circum-Mediterranean Archaeology Network. As such, it is designed as a product that will be made available to the public freely, through a web-based portal that is designed to be interoperable, enabling the use of dynamic queries, scripting and Google Earth mash-ups, online digitizing of archaeological sites and projects, and adding/editing base information into the DAAHL database, including digital images and documents. The very nature of the project and the collaborators we have assembled for the various themes and case studies in DAAHL attests to its collaborative nature. The DAAHL project has brought together scholars working on both sides of the Jordan, who have in the past been limited in their ability to conduct large, regional studies because of “Balkanized” datasets. DAAHL has unified these disparate, scholar-contributed datasets in a way that makes them accessible for the entire scholarly community and the public. It encourages digital scholarship through the use of its online querying and reporting tools; it encourages scholars to share data and cooperate in its analysis and information dissemination. And the interfaces provided by DAAHL provide researchers with unparalleled methods for experimentation with

the underlying data, through dynamic querying and production of site distribution maps. For the first time, researchers will be able to ask truly complex questions of archaeological and historical data throughout the Holy Land, and get virtually instantaneous results in the form of Google Earth mashups, which can be layered with different symbology to develop unique maps for scholarly presentation and publication.

Ultimately, the DAAHL node for the MedArchNet will have applicability for any group interested in building cyberinfrastructures for cultural heritage around the world in regions such as North America, South America, India and China. With the establishment of DAAHL, the basic digital atlas infrastructure for the Levantine region is now in place. The DAAHL project, and its MedArchNet parent, has been recognized by ASOR as essential tools for addressing “big picture” issues of archaeological dissemination (Levy 2013, LaBianca 2009) and site conservation. Currently, ASOR provides a platform for its Committee on Archaeological Policy (CAP) recognized projects to present “snap shot” overviews of their research in Cyprus, Egypt, Israel, Jordan, the Palestinian territories, Turkey on the ASOR website. The basic project data are shared with the DAAHL database, and our goal is to reach out to these ASOR projects to contribute settlement pattern data from their research to strengthen DAAHL and initiate new nodes for MedArchNet.

There are other archaeological databases available online, but the DAAHL project remains unique in a number of important ways. First, the DAAHL database employs the basic data structure of the MedArchNet approach to serving archaeological information to the public: it is based on a simple metadata structure that is easily expandable and adaptable to other regions. Thus, it facilitates data sharing and research on a much larger scale than do databases that are customized for a small region or a single country. And the DAAHL database itself contains archaeological site data from more than half a dozen countries. Second, DAAHL’s approach to data sharing recognizes the importance of the data contributors through the branding method we use to connect site information to the research projects that donated it. This kind of approach means the DAAHL project functions more as a data switchboard than as a final repository for all the information related to a given archaeological site, and this ensures that the data owners remain in control of their information and its final presentation. Third, the DAAHL project has created a suite of online tools that enable users to create powerful maps in Google Earth and Google Maps formats, based on an extensive querying capability. Many online applications simply

present maps designed by the website developers, which may or may not fit the research needs of the end user. DAAHL’s query and mapping tools enable the user to create customized maps for a variety of platforms, which greatly aids research. Finally, the DAAHL data structure accommodates not just archaeological site data, but also project information, and most importantly, information about site conditions, which is stored in a data structure that allows site conditions to be monitored on a periodic basis. Recent events in the Middle East have underscored how much the protection of archaeological sites relies on continued vigilance by the archaeological community and the public. The DAAHL database was built to allow ongoing site condition monitoring, and it has built-in tools that can be used to help planners avoid archaeological sites when a development project is being designed. By its recording of archaeological surveys, the DAAHL project can easily identify those places in a development project’s area of potential effect that have already been surveyed versus

those that need further survey work. Armed with this information, project planners can adjust a project’s area of potential effect to avoid significant archaeological resources, or to minimize the impact of the new development on archaeological resources. Thus, unlike other online archaeological databases, the DAAHL/MedArchNet approach provides important research and planning tools that help users to not only learn about archaeological sites in broad regional contexts, but also to help preserve those sites in the face of explosive development.♀

Figure 6. The Map Maker function in the DAAHL application uses a clustering method to display thousands of sites at once. The clusters and individual site points are clickable, and the map can be copied and pasted into presentations and documents. The example shows the distribution of Roman period sites. Screen shot from the *Digital Archaeological Atlas of the Holy Land*, S. Savage.

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