Documenting the Reconstruction Process with Google Earth

Reconstructing the Oracle Temple in Siwa, Egypt

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Zusammenfassung: Die Erstellung einer digitalen Rekonstruktion in der Archäologie ist häufig ein sehr zeitintensiver Prozess. Obwohl eine digitale Rekonstruktion präzise Aussagen zu dem ursprünglichen Aussehen verlangt, können viele Fragen nicht eindeutig beantwortet werden und müssen daher offen bleiben.
In der Regel ist ein Expertenteam aus unterschiedlichen Fachbereichen wie Archäologie, Geodäsie, GIS, Architektur, Computergraphik, etc. an der Rekonstruktion beteiligt, das mit unterschiedlichen modernen, digitalen Dokumentationsmethoden wie Digitales Planzeichnen, Fotografie, Videos, 3D-Aufnahmetechniken, usw. arbeitet. Eine gemeinsame Plattform, die diese unterschiedlichen Medien integrieren den Daten- und Informationsaustausch unter den Kollegen ermöglichen kann ist unabdingbar.
In dem folgenden Projekt soll der digitale Rekonstruktionsprozess des Orakeltempelkomplexes in der Oase Siwa (Ägypten) dokumentiert und vorgestellt werden.
Obwohl die Anlage teilweise noch relativ gut erhalten ist (z.B. Orakeltempel, Königspalast, Heilige Brunnen, Dromos und Totentempel des Königs Wenamun in Umm Ubaydah), gibt es zahlreiche offene Fragen zur Rekonstruktion, da entsprechende archäolgische Hinweise nicht ausreichen oder gänzlich fehlen.
Aufgabe der Visualisierung ist es, unterschiedliche Rekonstruktionsvorschläge aufzunehmen und den Rekonstruktionsprozess nachvollziehbar zu machen. Deshalb wurden im 3D-Modell virtuelle Rekonstruktion und Bestand voneinander unterschieden. Des Weiteren wurden Fotos, Pläne, Literaturangaben, Verweise auf vergleichbare Tempelanlagen, sowie Panoramaaufnahmen, die den aktuellen Zustand zeigen, eingefügt. Zusätzlich wurden die bei Grabungsbegehungen aufgenommenen, digitalen Videos georeferenziert und als digitales Tagebuch in das Geopublikationssystem eingespielt.
Die Visualisierung kann mit einem Geobrowser (z.B. Google Earth) dargestellt werden und über das Internet für unterschiedliche, räumlich verteilte Benutzer als Diskussionsplattform dienen.

Abstract: Frequently, digital reconstruction in archaeology turns into a time-consuming process. The more advanced the reconstruction gets, the more apparent turns the demand for reliable answers to open archaeological questions – or the deplorable lack of it. Usually, the process involves a team of experts from different scientific disciplines (archaeology, geodetics, GIS experts, architects, computer

graphics experts, etc.), who work with different modern digital documentation methods such as map making, photographs, videos, 3d surveying etc.
A common platform is needed for integrating these different media as well as the input of colleagues collaborating in and from different areas.
In this project we will provide an example of how the digital reconstruction process was documented during the ongoing process of digital reconstruction of the Ammoneion Oracular Complex in the Siwa Oasis/Egypt.
Even though important parts of the Ammoneion are still in existence (e.g., the Temple of the Oracle, the Royal Palace, the Sacred Well, the dromos and the tomb-temple of king Wenamun at Umm Ubaydah) there are numerous open questions concerning the general plan of the site and the shape of individual buildings for lack of sufficient archaeological evidence. Visualization, therefore, must encompass several hypothetical reconstructions as well as the archaeological data suggesting either hypothetical approach.
Virtual reconstructed parts of the temple are indicated in the 3D-model. Images, bibliographical references and information about the building materials, and corresponding references to other temples have been implemented, as well as panoramic images that show the recent site condition. Video and audio annotations taken from on-site inspections have been geo-referenced and transferred, as a digital diary, to the geo publishing system. This can be viewed by geo browser systems (e.g. Google Earth) in order to discuss the intermediate steps and also the possible variations of the virtual reconstruction.

Keywords: Archaeological Reconstruction, Visualization, Multimedia, Google Earth

The Ammoneion Excavation at Siwa

The Siwa Oasis is situated on the far side of Egypt's "Western Desert", some 80 km from the border with Libya and 300km south of the Mediterranean coast. Extending an average of 17m below sea level the depression is characterized by large expanses of water and "Inselberge". One of the latter carries the Acropolis and the Temple of the Oracle, while a "contra temple" (i.e., Umm Ubaydah) is situated on a low rise amongst the palm groves below, some 400 m further south. Both temples were connected by a „dromos“ or processional road (Fig.1).

Fig. 1 - The Ammonein: Umm Ubayda (front), Acropolis of Aghurmi (center), “Dromos” in between

The Oasis Siwa is first mentioned in the 6th century BC when the Temple of the Oracle on the Aghurmi Acropolis, was dedicated under King Amasis II (of the 26th Egyptian Dynasty). In pre-Roman times, Siwa was an independent „kingdom“ ruled by Egyptianized Libyans. Although the latter had adopted the Egyptian language and the cult of Egypt’s paramount deity, Amun (Ammon to the Greeks, who equated the god with their own Zeus) the oracle finds no mention in Egyptian sources. The Greco-Roman Mediterranean world, however, by mediation of Greek emigrant settlers in Cyrenaica, became very interested in this mysterious Libyan „oasis-retreat“ of Zeus and his outlandish Egyptian-style oracle, its most famous visitor undoubtedly being Alexander the Great.

Since 1994, the German Archaeological Institute / Cairo has been carrying out excavations and restorations at the Ammoneion.

The objectives of the project are to record the archaeological and architectural remains of the oracular complex, to define the original plan and shape of its several buildings (e.g., sanctuaries, palace), to understand their communal functions and the religious and oracular practices performed at the Ammoneion.

The antique buildings have sustained severe damage (often down to their bed-rock or building-platform foundations) principally anthropogenic in nature, but also by erosion and humidity. In the course of the last 1500 years ancient structures had been either removed (by quarrying activities) or converted into dwellings (above) and stables (within) causing much structural damage. The famous Temple of the Oracle, e.g., became fully visible only in fairly recent times when the Egyptian Government’s Archaeological Service had most of the modern village of Aghurmi covering the ancient remains (Fig.2) removed around the 1970-ies. Until the late 19th Century the Temple of Umm

Ubaydah was the main quarry for Siwa and became nearly totally destroyed except for the lower-most layers of foundations (Fig.3).
Given these circumstances, the reconstruction of the original layout of the complex and the exact plan of individual buildings remains frequently rather hypothetical.

Fig. 2 –Temple of the Aghurmi Acropolis (left) and Umm Ubaydah (right)

The TU Vienna and the DAIK co-operate in using digital visualisation methods to support the digital reconstruction of the oracular complex and to gauge the probability of different reconstruction models. For this reason, a visual information system has been developed allowing the integration and publication of all two-dimensional data of the documentation (such as plans, images, videos, etc.) as well as the three-dimensional data of the virtual reconstruction (such as 3D models of the remains, virtually reconstructed parts of the temple and different versions of reconstruction) [1]

Data for the Reconstruction

The virtual reconstruction of the complex relies on digital plans (Fig.3) and sections, digital images as well as panoramic images, where information has been highlighted and comments added into the panoramic image (Fig.4).

Fig. 3 – Floor plan: Acropolis of Aghurmi

Fig. 4 – Panorama Image: indicating column foundation within a photograph of Umm Ubaydah

On Site Inspection – Digital Diary

Additional to the existing excavation documentation as there were excavation diaries, images, maps etc., digital on - site videos were taken to document the excavation results audio-visually.

Information on the date, the excavated or inspected area, the subject and the team has been added to the videos as well as written and spoken annotations. Important information on findings or

architectural features has been highlighted in the video. These Digital Diaries have been geo-referenced and were added (according to their subject) at the appropriate positions in the 3D-model. As they can be accessed using a geo-browser (e.g. Google Earth) such diaries may aid the exchange of information between collaborators efficiently.

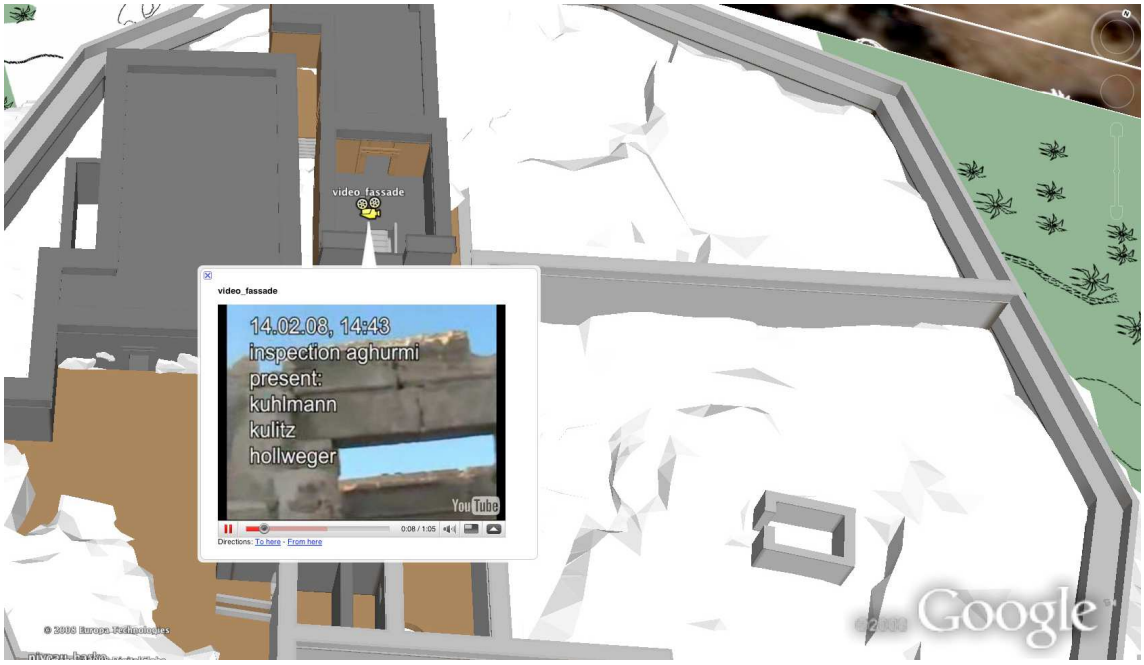

Fig. 5 – Georeferenced Site Inspection Videos (Youtube in Google Earth) as Digital Diary

Illustrational Rendering for encoding Uncertainty

As, in some cases, the amount of archaeological data is very limited (e.g., the Umm Ubaydah Temple, the dromos) the reconstruction of the entire complex could not be generated with the same amount of confidence. Therefore, the idea of encoding the levels of uncertainty in the 3D-reconstruction was explored with several approaches of illustrational renderings methods.

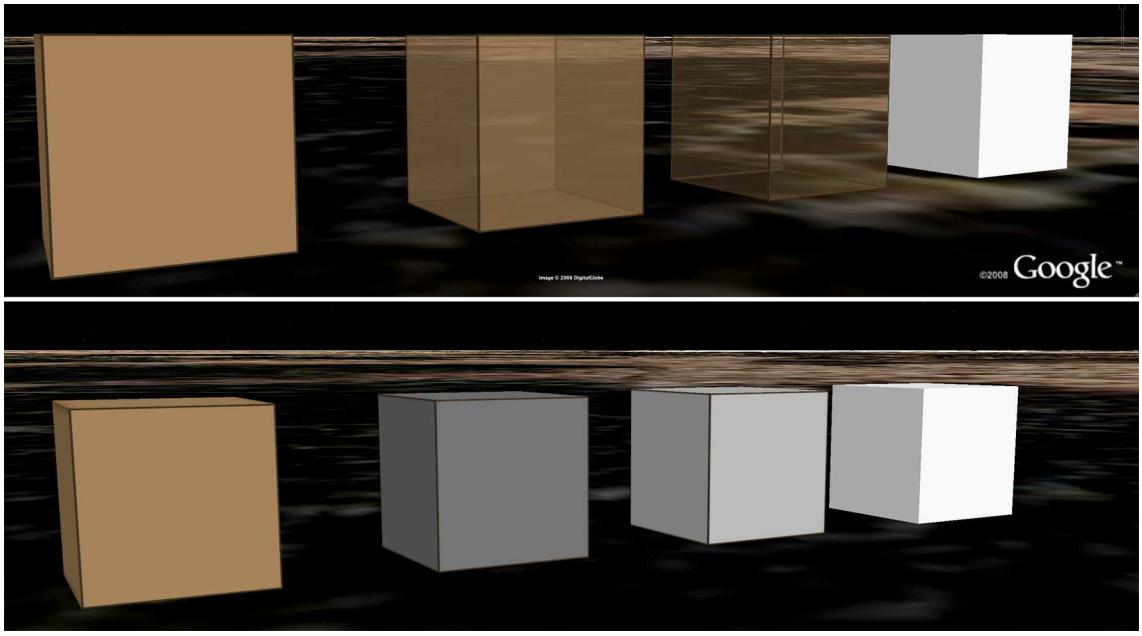

Fig. 6 – Encoding “Uncertainty” with levels of transparency vs. levels of grey

To indicate excavated parts of the model, a solid-coloured appearance was chosen to indicate existing architecture (referring visually to (lime)stone as building material). Natural features (rock, etc.) were displayed in white to provide a neutral background.

The first attempt of encoding “uncertainty” was to indicate the level of uncertainty by increasing transparency, as shown in the upper part of fig. 6, which lead to an intuitive understanding at the reference implementation with cubes as visual reference.

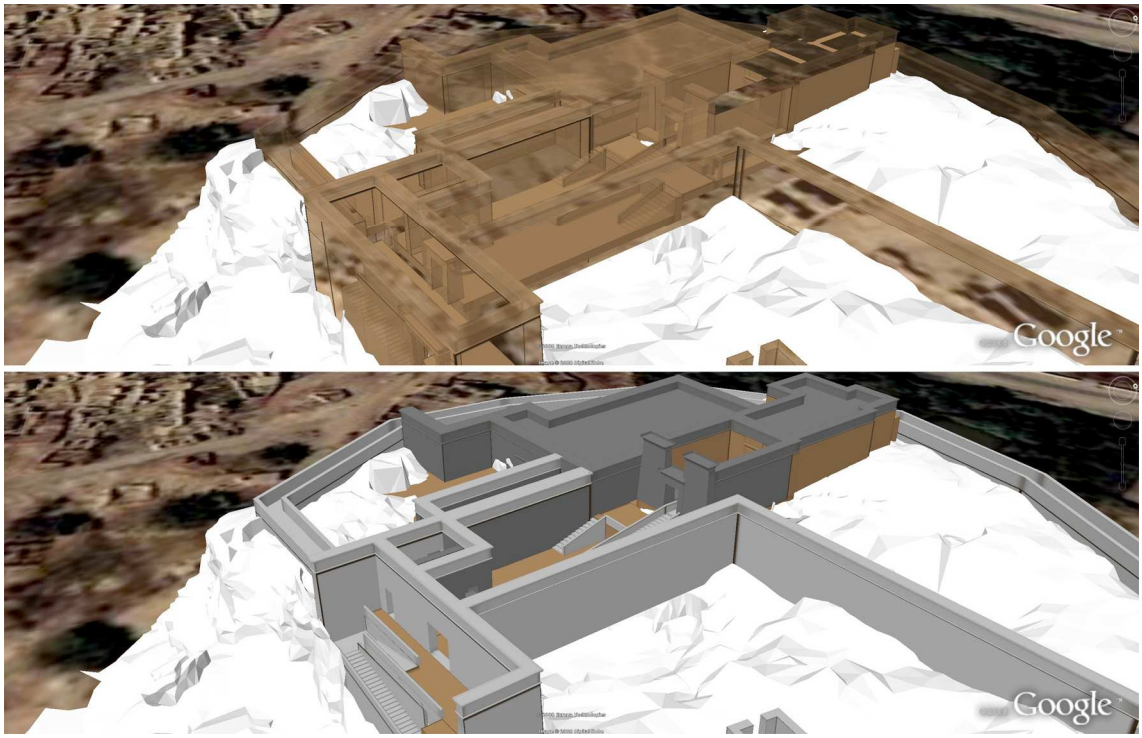

Fig. 7 – Effect of different “uncertainty” methods in the complex structure of Aghurmi

Unfortunately, applying the transparent materials to the complex environment of Aghurmi showed the bad visual performance of this method for mainly two reasons. A bug in the display algorithm of Google Earth (Version 4.x) showed the underlying satellite image being visible through the transparent walls (where it would be correct to see the rock structures). Additionally the 3D-structures themselves were not very clearly visible by using transparent materials.

Therefore, an alternative visualization scheme – encoding “uncertainties” as grey levels, and displaying rather more certain structures with darker shades – was chosen. This way, structures remained clearly visible and uncertainty levels can be perceived intuitively.

The colour scheme was extended adding a green material to indicate areas of vegetation, and for additional aid a colour legend was inserted at the bottom of the screen.

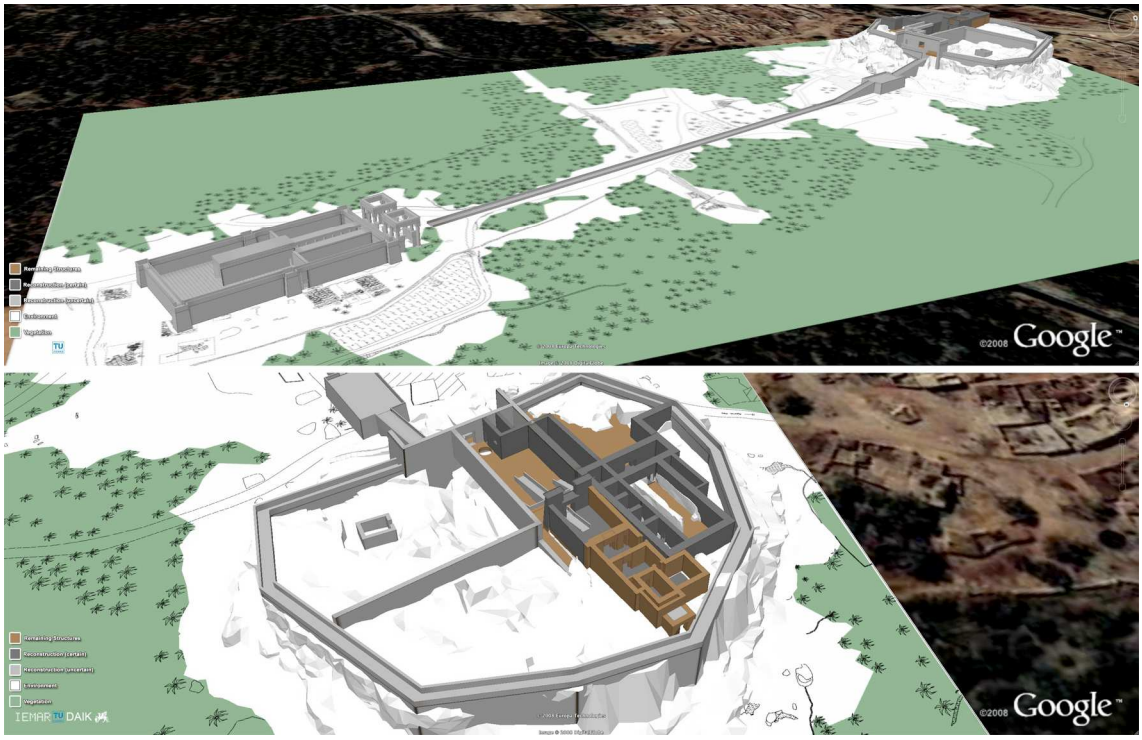

Fig. 8 – Visual display of the entire area of reconstruction (upper image) and a close up to the Acropolis of Aghurmi (lower image)

Versions of Reconstructions

Despite the uncertainty of parts of the reconstruction, it was also not clear how to interpret the remaining structures of the valley temple, as the excavated evidences were very sparse as also visible in Fig. 2 (right) and Fig.4. So at the discussion process for the reconstruction two versions seemed plausible.

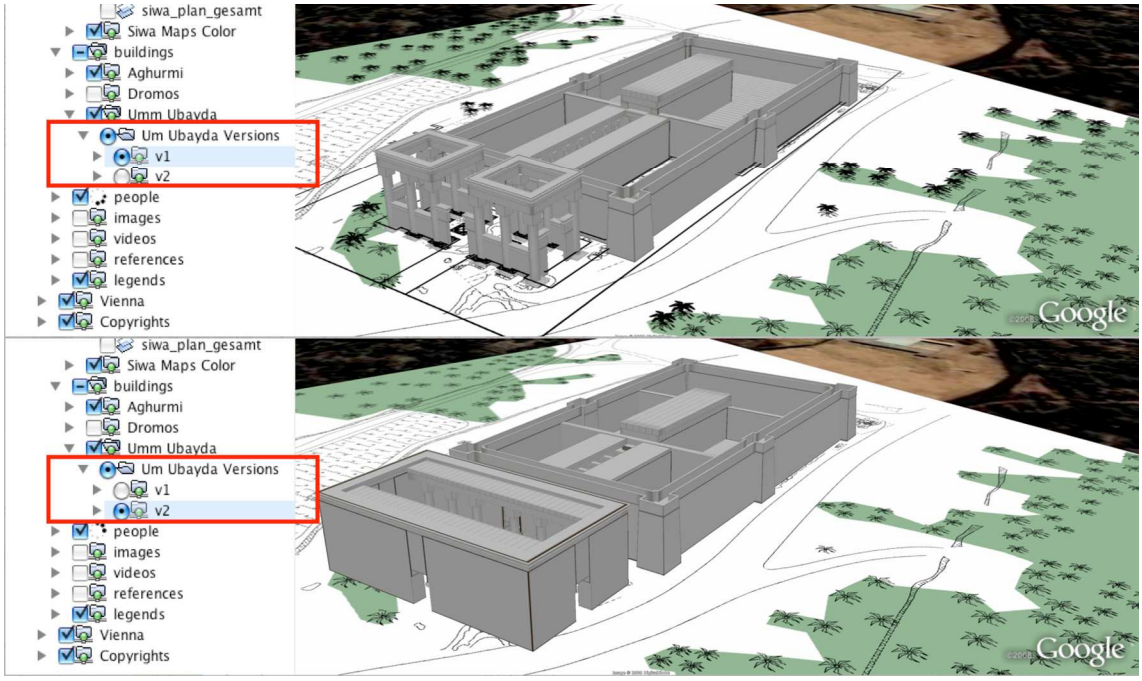

Fig. 9 – Comparing two versions of the Umm Ubaydah Temple

To help to compare these two versions, a layer system was used, that allowed the easy switch between both reconstructions.

Comparing 2D & 3D Sections

As the topographical situation of Aghurmi Hill is quite complex, a 3D section was constructed along the same plane that was used to generate the section drawing used by the archaeologists.

The 3D section model and the corresponding 2D section plan were integrated into Google Earth to help further studying the still unclear question, how the barge-procession descended from the Temple of the Oracle on the Acropolis towards the Temple of Umm Ubaydah some 400 m further south.

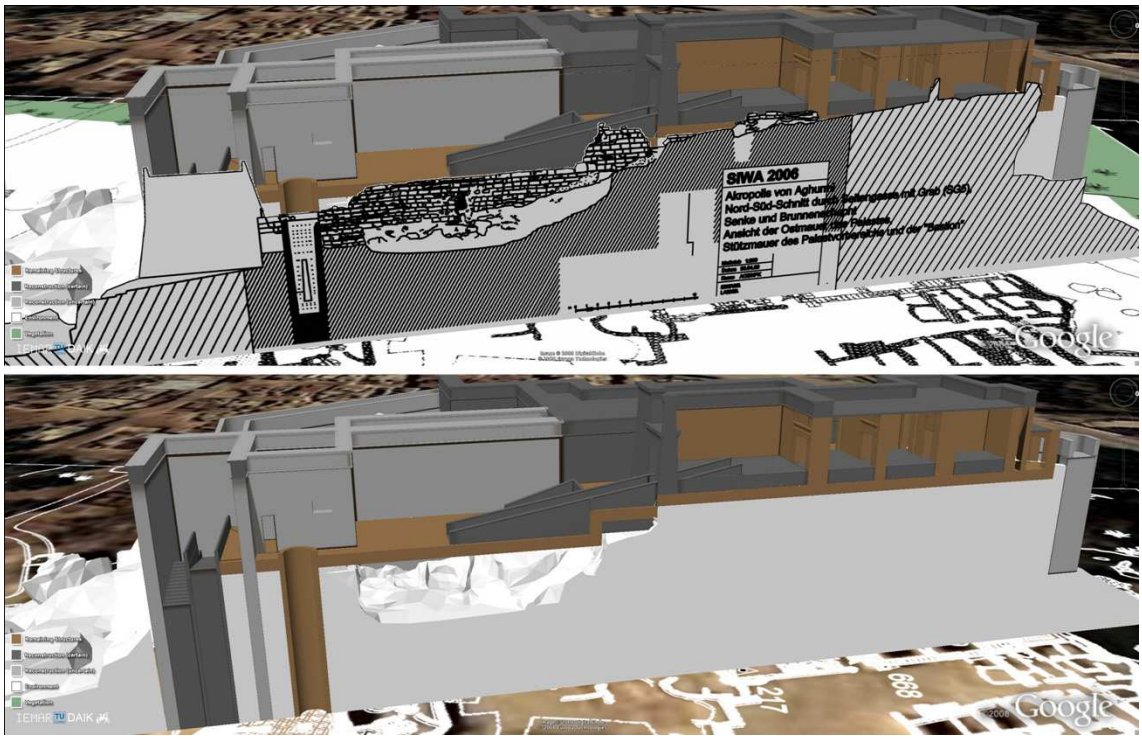

Fig. 10 – 2D & 3D sections: Acropolis of Aghurmi

Animating the Barge Procession

As mentioned beforehand, one of many remaining problems is how the procession of the god’s barge descended from the Temple of the Oracle to the dromos leading towards Umm Ubaydah. To aid the understanding of this problem, a script at the Google Earth server allowed animation of a divine barge proceeding along a simulated path.

Fig. 11 – Simulated Animation in Google Earth: procession with the barge of Amun.

Conclusion and Future Extensions

As the reconstruction of the Oracle Temple in Siwa was a rather challenging process, Google Earth proved a valuable tool for visualizing the entire reconstruction process. The concept of a digital video diary helped to be able to clarify important details that were illustrated by an extensive on-site inspection. Visual encoding of uncertainties in parts of the reconstruction is an effective means to gauge the validity of archaeological data, leading perhaps to focus on certain areas for further

investigation. In future, an extended version of our Google Earth publishing system will be able to handle larger amounts of data. The initial experiment with simulated movement encourages the incorporation of animations into archaeological reconstructions. Integrating databases into Google Earth’s accessible data structures is also a high-priority issue as, quite often, databases are now being used at excavation sites and their integration might immediately provide new insights. Last but not least, web-based access with the web plugin of google earth is in its early test phase and will be expanded with more detailed explanation of the site and the visible results of the reconstruction process, which will make up-to-date scientific work accessible to a more general audience. (Fig. 12)

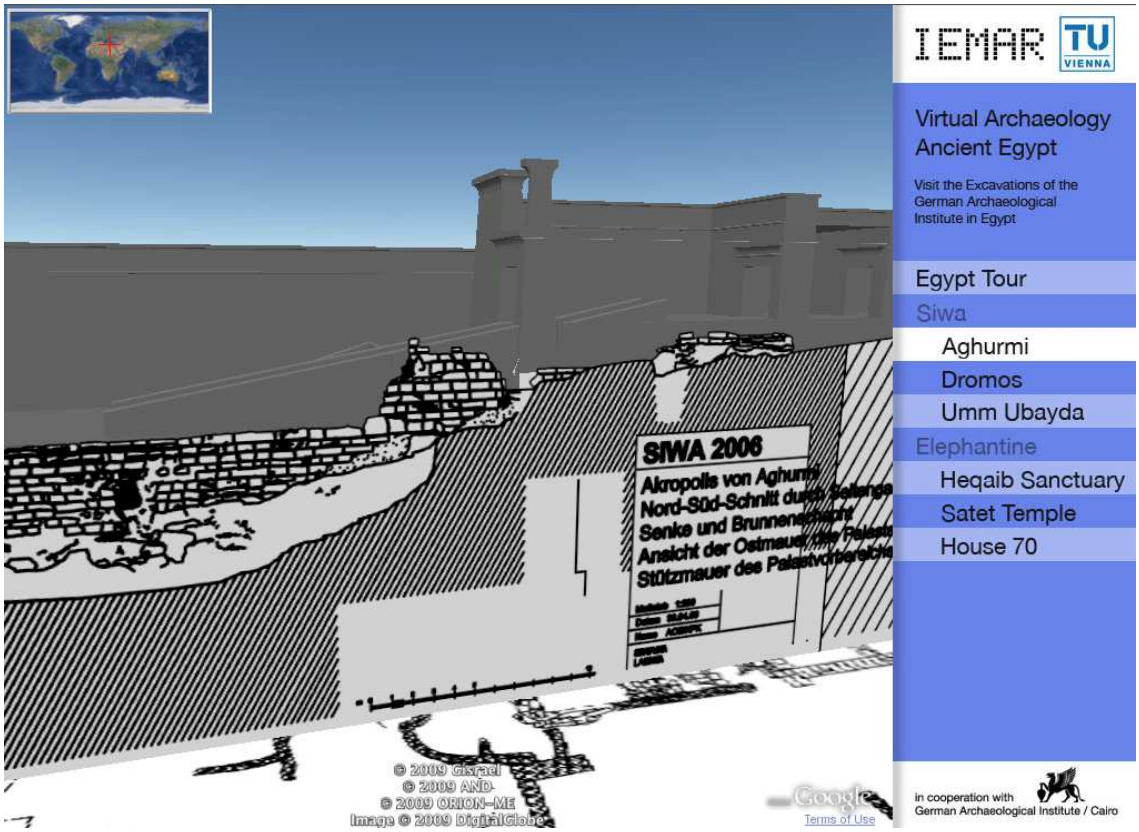

Fig. 12 – Web Presentation: automated tours through several excavations.

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[1] The Aghurmi Acropolis was rendered into a 3D-model by the DAI mission’s surveyor Birgit Fleischmann with the help of Simone Jansen.