Sunken Landscape

How scientific visualizations help to uncover an archaeological secret

Representations of three-dimensional landscape survey data and their influence on archaeological hypotheses

Keywords: *visualization of geodata, multibeam echo sounding, hydroacoustics, unseen, 3D models, sunken landscape, mediation of scientific data, three-dimensional landscape survey data, science-to-science visualization*

Initial situation - The „Bodensee-Stonehenge“

Located 250 meters off the Swiss shore of Lake Constance and four to five meters below the water surface resides the so-called "Bodensee-Stonehenge": a collection of approximately 170 lined-up cairns, ranging over a total distance of more than 15 kilometers. The cairns were discovered during high-precision depth surveys carried out by the Baden-Württemberg State Institute for the Environment, Measurements and Nature Conservation in 2015 (Fig.1). After initial classification in the field of geology, archaeological diving investigations came to the conclusion that the structure must be man-made. However, as of today the specific origin and purpose of "Bodensee-Stonehenge" remains unclear.[1] According to the current, yet relatively uncertain archaeological hypothesis, the cairns were built by humans around 3500 BC in a comparatively short period of time.

Since the entire structure currently hides underneath the surface of Lake Constance (Bodensee) and due to its vast dimensions, one big challenge is the proper visualization of "Bodensee-Stonehenge", essential for allowing proper understanding and conclusions of this unique archaeological finding. Therefore, the aim of this project is to visually convey the cairns to the participating researchers as accurate as possible by investigating how the representation of three dimensional landscape survey data can influence an archaeological hypothesis. Furthermore, we will support the archaeological knowledge gain by aiming for unconventional forms of representation of the data sets and by supporting the close interaction with scientists through an interactive homepage.

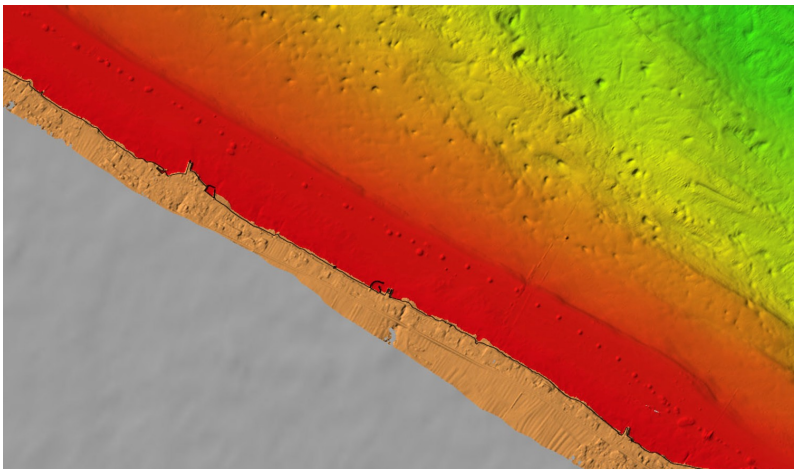


Fig. 1. Representation of a part of the cairn chain by multibeam echo sounding and sidescan-sonar by T.Wessels, Baden-Württemberg State Institute for Environment.

Among other things, the color coding of the different heights, which is typical for landscape visualizations, is examined in this work and alternative ways of representation are sought in order to make the maximum information content of the data visible and present it.

[1] https://archaeologie.tg.ch/fundstellen/ausflugsziele/weitere-fundstellen/uttwil-steinhuegel-im-see.html/9002 (Medienmitteilung vom 27. September 2019), (Accessed: 1st of June 2020).

Project objective and relevance

This project intends to show how scientific illustration with modern (3D) technologies can contribute to an archaeological project. Since „Bodensee-Stonehenge" remains a mystery, it is of high relevance to address how scientific images and 3D models support and influence the archeological research process and which specific creative elements promote it (Shalin, 2014) (Fig.2).

The overall aim of this project is to unravel what effect design and representation of three-dimensional landscape survey data has on the generation of an archaeological hypothesis. Specific questions asked therein are:

- Which role do design and technical design aspects play regarding the visualization of data of three-dimensional landscape surveying for the effective knowledge gain of an archaeological finding situation?
- How does three-dimensional data need to be visualized to achieve the most accurate knowledge gain? Which image components play a role?
- What role do image details, sectional views and the choice of perspective play?
- To what extent do the choice of color, creative medium and abstraction influence archaeological interpretation?

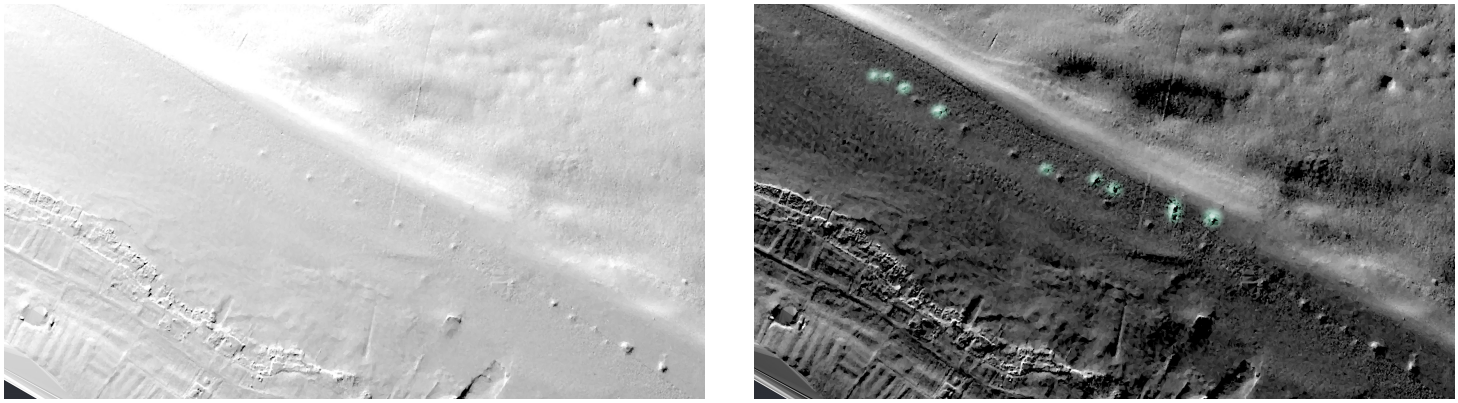


Fig. 2. Example of a first visualization experiment: The standard lighting situation of the echo sounder and sidescan sonar data in GIS makes it impossible to analyse the recorded structures precisely. Only an artificial, strong grazing light situation makes further structures and thus new, previously undiscovered cairns visible.

To answer these questions, the selected methods and image compositions will be optimized by creating variants. To find the specific design components (perspective, design means, contextualization and others) contributing to new or different archaeological findings, directly involving the archaeologist researchers is key for our project. On one hand, we will do so through direct personal contact and on the other hand, a website was created, on which archaeologists can exchange ideas with geologists and designers via blog entries directly underneath the created image proposals (https://www.sunkenlandscape.com/) (Fig.3).

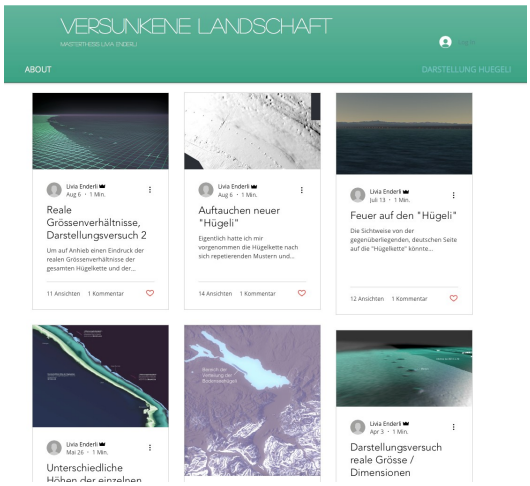


Fig. 3. Insight into the communication website: The various visualization experiments are presented on the website, arranged according to the topics of the content. The archaeologists, geologists and designers involved in the project have access to the password protected website through their profile. Each contribution can be commented and, if desired, supplemented with own pictures. In this way, direct communication can take place digitally, which can be an advantage for an international team, especially in Covid times.

Choice of method and material

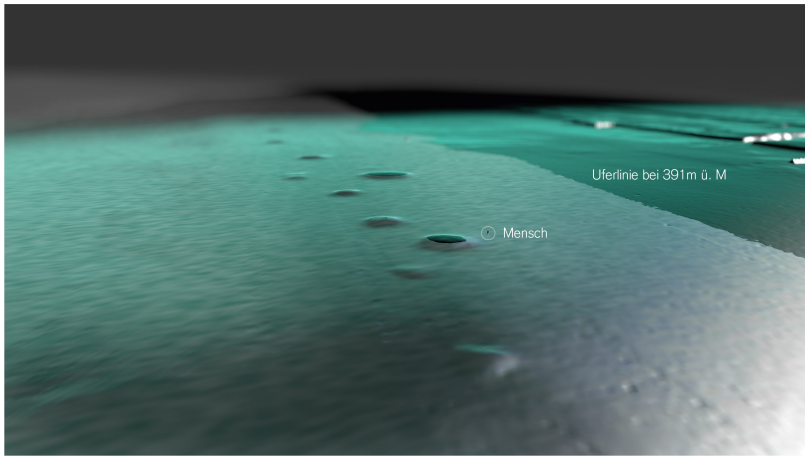
In a theoretical part of this project, conventions in the depiction and representation of three-dimensional landscape survey data will be analyzed (Wissen, 2009). The aim is to find which content on topography and geology should be conveyed using the respective representation conventions. What stands out are the strong exaggerations in height with which irregularities in the landscape are often depicted. In this work it is assumed that precisely these exaggerations could presumably lead to archeological misinterpretations (Fig. 4).

First, own analyses and possible hypotheses for an alternative presentation of the desired contents should be formulated. Second, in the research-oriented practical part, the conventions in the visualization of three-dimensional landscape surveying data shown by the theoretical research will be extended by own alternative ways of representation (Shalin, 2014). Specifically, we will:

- Create manageable 3D models that were surveyed during the depth measurement of "Bodensee-Stonehenge" with echo sounder and other hydroacoustics, so that the various design experiments could be carried out in computer graphics programs.
- Capture at least one hill of the cairns-chain as a precise 3D model using underwater SFM (Structure From Motion). To interpret the entire structure it is essential to study the exact morphology and the characteristics of individual cairns. In addition to a "best practice manual" for designers for the technical handling of such data sets, mainly image experiments will be created.

The three-dimensional data will be processed playfully with different design media. Analog as well as digital means can be used to study their influence on the perception and interpretation of the archaeologists. Comparisons of classical visualizations of the datasets, which follow the usual presentation conventions in landscape depiction, and additional new presentation approaches will help finding the specific image components that can support archaeological hypothesis formation (Bardera, 2017). For a constantly improving process, the scientists are integrated into the visualization design process through conversations or the interactive homepage mentioned above.

Fig. 4. First alternative visualization proposal of the multibeam and sidescan-sonar data. In this experiment, the true proportions of the cairns shall be shown. Previous visualizations of the datasets showed the cairns with a highly height exaggeration, according to the common convention of representation in the field of geology. In order to underline the real size of the cairns, a clearly defined reference object (human) was added. Attention was also paid to the choice of perspective.



Affiliation

The work described will be developed as part of a master's thesis at the Zurich University of the Arts in close cooperation with the Department of Archaeology of the Canton of Thurgau, Switzerland. The thesis will be evolved at the Department of Design, within Knowledge visualization. The final submission of the thesis will be in June 2021.

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