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ABSTRACT

Digital Monument Preservation in 3D

The virtual bazaar of Aleppo (Suq al-Madina) as a discussion tool for the preservation of historical monuments

Dietmar Kurapkat, Anne Mollenhauer, Mayssoun Issa, Tutku Topal, Philipp Mai

Virtual computer models have been used to visualize historical buildings for many years, becoming a standard instrument in teaching architectural history. Furthermore, virtual models have great potential as digital tools in building archaeology and heritage management. They can be used to test the feasibility of reconstruction projects, while scientists, politicians, citizens, and other stakeholders can use them to communicate and discuss possible measures. During an online workshop at the Architekturreferat of the German Archaeological Institute in Berlin, a virtual model of the bazaar of Aleppo was presented as a case study addressing these questions.

KEYWORDS

3D Documentation, Aleppo, Bazaar, Cultural Heritage Preservation, Digital Humanities, Open Access, Online Publication, Special Application Program, Syria, World Cultural Heritage

DIETMAR KURAPKAT – ANNE MOLLENHAUER – MAYSSOUN ISSA – TUTKU TOPAL – PHILIPP MAI

Digital Monument Preservation in 3D

The virtual bazaar of Aleppo (Suq al-Madina) as a discussion tool for the preservation of historical monuments

Introduction

1 Virtual computer models have been used to visualize historical buildings for many years, becoming a standard in the teaching of architectural history. They are especially effective in reconstructing the appearance of lost structures or former building conditions in a manner easily understood by a wide audience. Meanwhile, growing technical possibilities give such models an almost photorealistic accuracy. This favours the sensuous immersion of the viewer in a virtual environment, but largely obscures which parts of a reconstruction are based on solid science and which are scientists' and model-builders' speculative additions.

Project Outline

2 The present project pursues a different approach: Based on the authors' experiences during earlier work in the bazaar of Erbil (Autonomous Region of Iraqi Kurdistan) the goal is to bring together existing historical data in a virtual 3d-model in a way that is scientifically transparent and reasonably sourced, so that the model can be used as a digital tool in discussions of heritage conservation. The bazaar of Aleppo, locally known as »Suq al-Madina«, which has been part of the UNESCO World Heritage Site since 1986, was chosen as a case study for this methodological and technological objective (Fig. 1). Covering about three square kilometres, this building ensemble is extremely complex in its architectural history, function, and geometry. It consists of three parallel lanes, flanked by small shops, running from the foot of the citadel east to west. Further lanes branch off to the south and north. In between, large buildings of various functions can be found. The Great Mosque, dating back to Umayyad times, is located at the northern side. Several smaller religious complexes and commercial buildings (khans) are spread throughout the area, as are public bathhouses. In recent years, the bazaar suffered a great deal of damage of varying degrees and will be the subject of historic preservation discussions in the future.

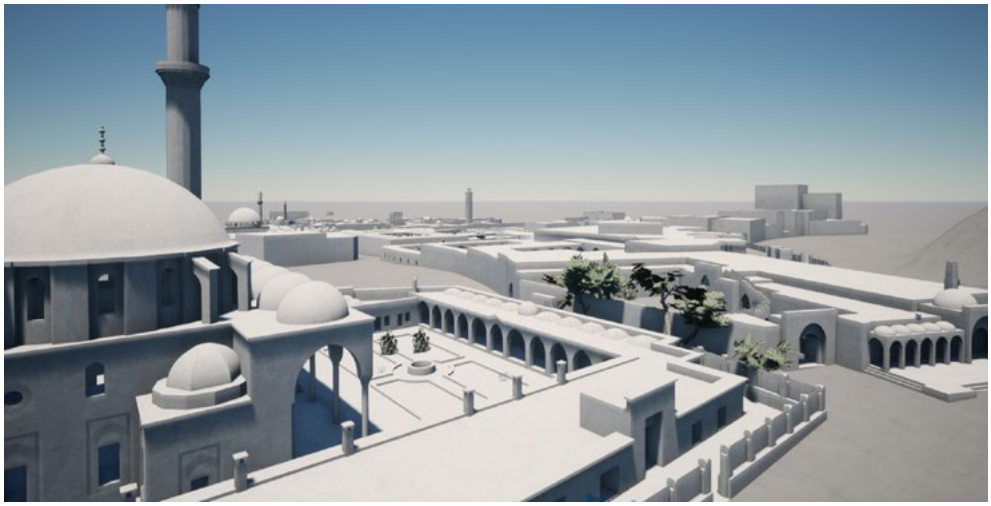


Fig. 1: Aleppo, Syria. View of part of the historical bazaar as shown in the virtual 3d-model

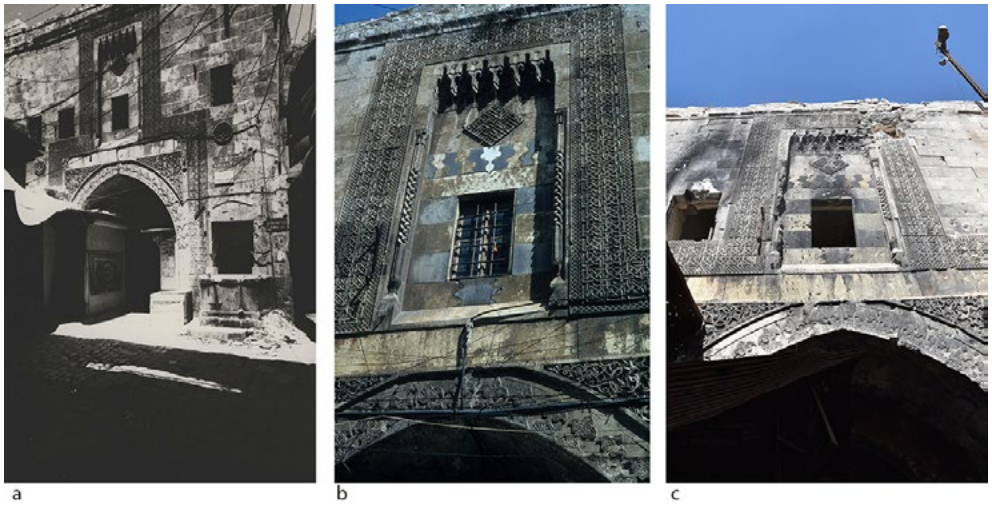
1

3 The project is financed by the Gerda Henkel Foundation in the context of the initiative »Die Stunde Null – a future for the time after the Crisis« of Germany's Federal Foreign Office, coordinated by the Archaeological Heritage Network and implemented by two working groups at the German Archaeological Institute (DAI) in Berlin and the Ostbayerische Technische Hochschule (OTH) Regensburg. The group in Berlin was led by Anne Mollenhauer (along with Martina Müller-Wiener in the first phase), coordinated by Mayssoun Issa and assisted by Zoya Masoud and Hossen Alkhash. This group was responsible for investigating data on the bazaar in the pre- and post-war periods. The group in Regensburg was led by Dietmar Kurapkat and was in charge of the digital modelling, as well as for the back end and the front end of the online tool, including the design of the graphic user interface. The modelling itself was technically supervised by Martin Fleischmann and Franz Außerstorfer, coordinated by Tutku Topal and conducted by Simon Stolz, Paul Bader, Stefan Hafner, Cornelia Gmeiner, Melanie Nguyen and Kerstin Engel/Hien with additional contributions by many students in the Bachelor and Master programs in Architecture and Building Archaeology at the OTH Regensburg. Media information scientist Philipp Mai was responsible for programming the online tool, which enables the use of the overall model as a working instrument.

Data Sources

4 The available data, consisting of plans, photos, aerial photographs and written documents, were evaluated for the accuracy of their localization, as well as the dimensions and shapes of individual buildings. The contradictions and uncertainties that inevitably arise in the course of generating a model are not obscured, but are clearly represented and reflected in the model, with images sourced and texts referenced. They are displayed on different levels, which will be explained further below: Firstly, the level of details (LOD) gives a visual impression of the data base; secondly, text and photo references show contradicting information; thirdly, »Reconstruction Certainty«, a meta-level (an annotated aerial rendering of the site) that demonstrates the availability of reliable data for each individual building.

5 For the creation of the hard-surface models almost 10,500 images from various sources were used. One of the most important sources of information is the Syrian Heritage Archive Project (SHAP) of the Museum for Islamic Art, Berlin, and the German Archaeological Institute. It collects hard-to-access photos, postcards and plan archives (Fig. 2). Almost 1800 images from the SHAP-project were used, drawn from



a b c

2

Fig. 2: Aleppo, Syria. Khan as-Sabun documented in various states of damage through photographs from private archives, accessed through the SHAP project

the collections of 20 researchers who have conducted decades of research in Aleppo. Furthermore, almost 700 plans and 2600 photos provided by students' works on the bazaar and its buildings were evaluated. Also of crucial importance were images that Zoya Masoud took in 2018 during on-site visits for her PhD research.

Digital Modelling

6 Due to the heterogeneity of the building structures, their state of preservation and available data, any sort of automatization was excluded. Each building had to be examined and built as a hard surface model individually. Depending on the amount, comprehensiveness, and reliability of the information, a building was modelled with up to three different levels of detail (Fig. 3a. b. c). These different levels make it possible to model a building only as precisely as the specific database allows, and also to represent various complex geometries in a technically staggered manner in the final model.

a b c

3

Fig. 3: a–c, Aleppo, Syria. The Khusruwiyyah Mosque, modelled in three different levels of detail

7 A special challenge was the contiguous character of the building structures, which prevents the consideration of individual buildings in isolation. Models must show the bazaar's architecture as an ensemble, provoking many questions about the details of floor and roof level connections. Contrary to first impressions, the ground surface on which the bazaar is built is not flat but rises several meters from west to east. That and the fact that no reliable contour map for the bazaar was available, made it necessary to generate a 3d-surface model based on an analysis of Pleiades Tri-Stereo satellite data, with the help of Bernd Teichert and Christiane Richter at the Hochschule für Technik und Wirtschaft Dresden (Fig. 4). Working from this imaging and a digital ground Nolli-map of the Old City of Aleppo (Aleppo Archive in Exile - Plan of the Old City of Aleppo) generated by the Brandenburgische Technische Universität Cottbus-Senftenberg, all the buildings were modelled individually by team members and students of the Ostbayerische Technische Hochschule Regensburg. In doing so, several digital modelling software

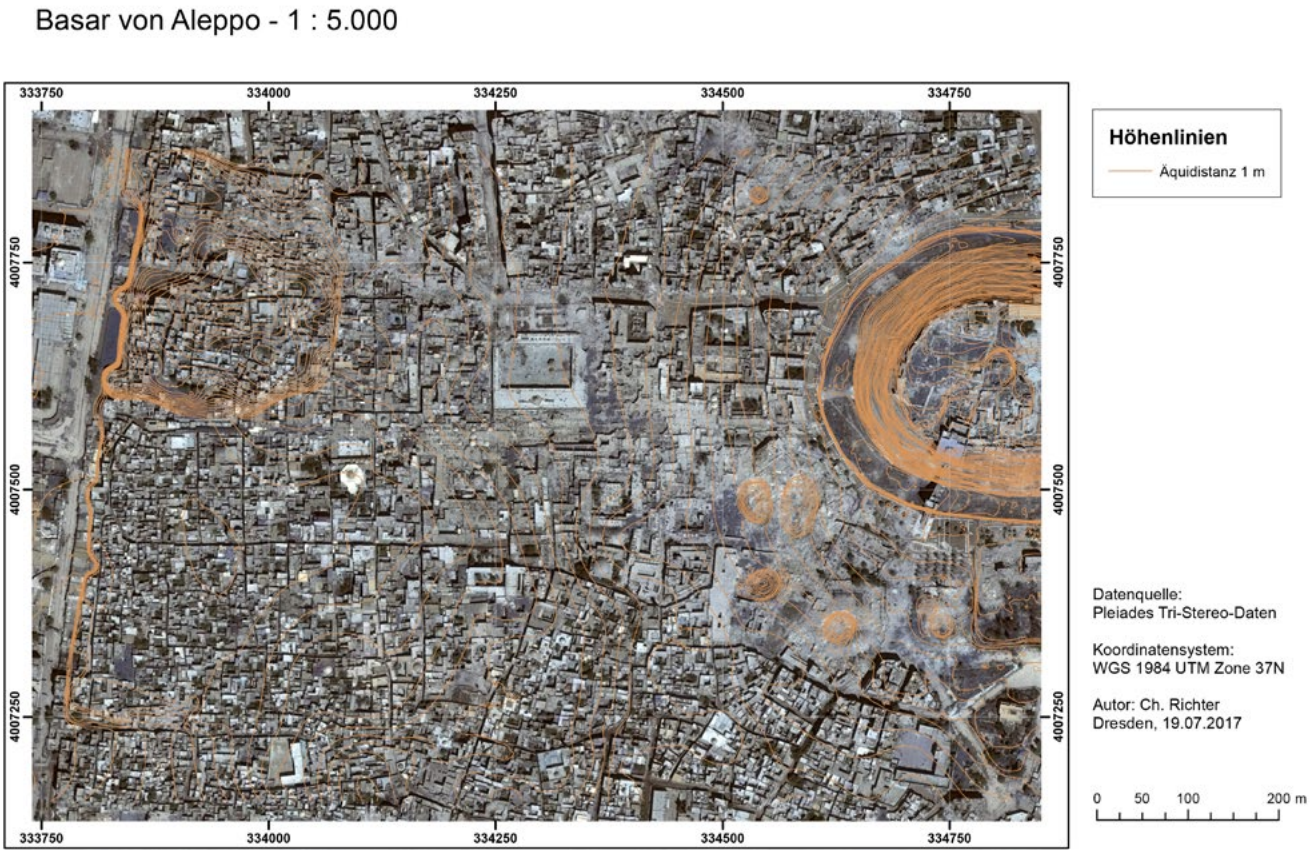


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Fig. 4: Aleppo, Syria. Contour map of the ground surface on which the bazaar architecture was built, generated by analyzing Pleiades Tri-Stereo satellite data

tools were used (Autodesk 3ds Max, Graphisopft ArchiCAD, QuickArch, Allplan Nemetschek, SketchUp), depending on the demands of the particular building geometry and the individual software skills of each team member. After an intermediate processing in the software cinema 4D, all model data were assembled finally in the software Unreal Engine (Fig. 5).

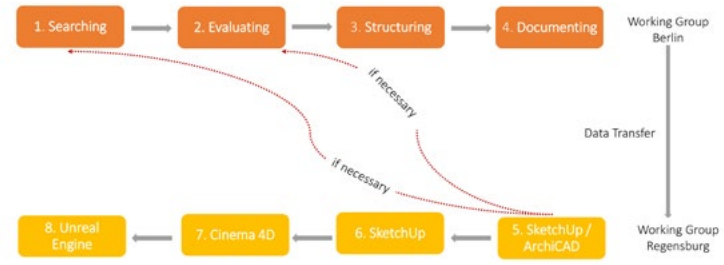

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Fig. 5: Illustration of the workflow between the working group in Berlin and the one in Regensburg

Scientific Transparency

8 Addressing scientific transparency was one of the major challenges of this project. As a first step in raising the user's awareness of the different levels of reliable scientific information, a tool was created to visualize the database of each individual building via three different »levels of detail« (LOD). LOD 1 shows the fabric as a simple volume model; LOD 2 displays facades; LOD 3 includes the inner structure. The closer the user zooms to a building, the more detail is displayed of the building, depending on the available data. Prompted by the use of different levels of detail, a number of individual decisions were made, which were documented in an easily replicable manner. Rotating book pictograms in the model represent so-called info points (Fig. 6). These pictograms serve as three-dimensional digital footnotes that allow the user to comment on the underlying process from the database to the model. Here, the decision-making (due to the incomplete or contradictory source material) is explained in text form, and occasionally documented with relevant photographs. The scientific transparency of the database and the line of reasoning underlying the final product are directly integrated into the model.

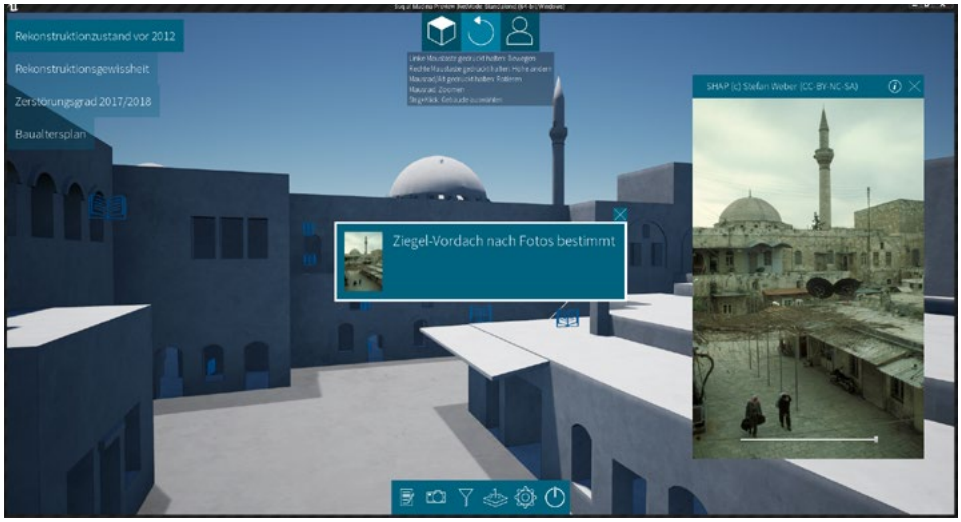

Fig. 6: Aleppo, Syria. Rotating book pictograms serve as three dimensional digital footnotes in the virtual 3d-model of the bazaar which are clickable and offer underlaying informations and sources

6

Functionality and Open Accessibility

9 In order to make the content accessible to a broad spectrum of experts and local communities, a technological solution had to be found to make the data-intensive building geometries and metadata accessible in a way that is interactive, facilitates exploration and works on ordinary devices like PCs, laptops and tablets. A smartphone version will soon be available as well. The solution was to adapt the open-source software »Unreal Engine«, which was originally developed by the computer gaming company Epic Games.

10 In addition to the standard view of the bazaar in its pre-2012 reconstruction state, it is possible to choose from among further meta-levels. The meta-level »Reconstruction Certainty« shows how thorough and reliable the sources are for the reconstruction model of a historic building. This information can be very helpful when deciding on reconstruction measures on the ground by pre-empting misguided reconstructions that are not based on solid scientific knowledge. The meta-level »Grade of Destruction« shows the state of the site in 2017/18, after the damage caused during the war (Fig. 7). Another meta-level enhances the scientific value of the model: The 1984 map of Heinz Gaube and Eugen Wirth offers a bird's eye view of the site's ground floor plans while showing individual buildings' dates of construction. Due to the scarcity of reliable data on construction phases for most of the buildings and since on-site research in Aleppo was impossible, the map was not rendered in a 3d-perspective.

Front End User Interface

11 Other tools let the user switch perspectives (aerial view, bird's eye and first person) and orientations with the help of an overview map. A notebook feature allows users to record preliminary results of monument-conservation discussions in a space within the model. Screenshots of specific virtual viewpoints can be generated and used for further work processes outside the model environment. A torch-function helps to illuminate the bazaar's dark alleys. A filtering option allows the selection of building types: Mosques, Khans, and Hammams etc., which helps in the analysis of the morphological layout of the vast bazaar area.

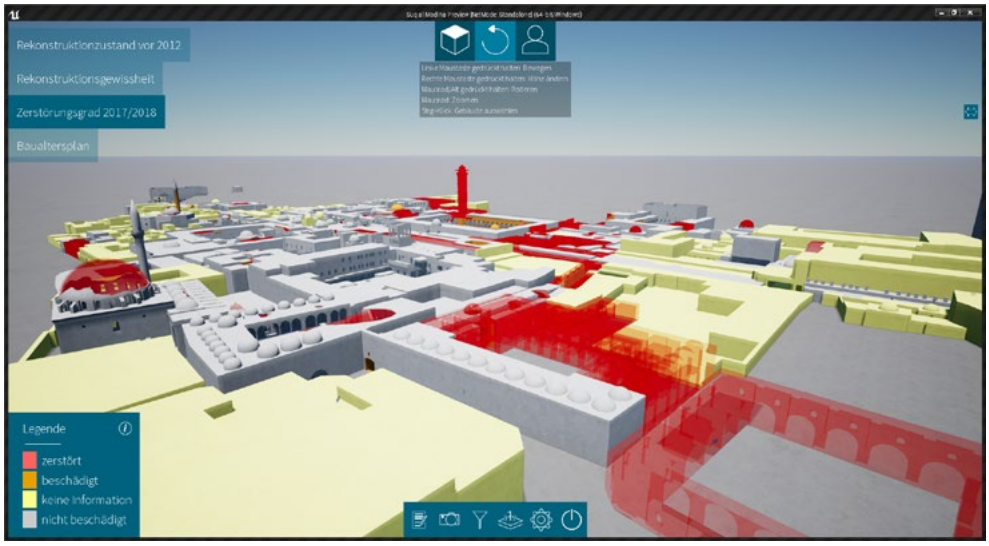

Fig. 7: Aleppo, Syria. Meta-level »Grade of Destruction« showing the damages in 2017/18 caused by the previous acts of war. A colour-coded visualisation of destroyed (red), damaged (orange) and undamaged (grey) parts of the building, as well as those for which no information is available regarding possible destruction (yellow)

7

Conclusion

12 An online, open-source 3d-model can be a powerful tool not only to present scientific results to specialist and broader readerships but also as a means to discuss planned conservation or reconstruction interventions. The interactive tools integrated into the model (notebook and screenshot functions) shall underline this character.

13 After having tested beta versions of the virtual bazaar of Aleppo with several peer groups (among them a group of Syrian, Lebanese and German architecture and archaeology students during a one-week summer school in Beirut in September 2018) the model can now be downloaded or used online in German, English and Arabic at this location:

14 http://www.3d-denkmal.oth-regensburg.de.

15 We hope that this digital model will contribute to a better understanding of the outstanding architectural heritage of humankind, heighten the utility and applicability of scientific knowledge of historical buildings, and facilitate the preservation of this heritage for future generations.

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ZUSAMMENFASSUNG

Digitale Denkmalpflege in 3D

Der virtuelle Basar von Aleppo (Suq al-Madina) als ein Diskussionswerkzeug für die Erhaltung historischer Bauwerke

Dietmar Kurapkat – Anne Mollenhauer – Mayssoun Issa – Tutku Topal – Philipp Mai

Die Nutzung virtueller Modelle zur Visualisierung historischer Gebäude stellt seit vielen Jahren einen Standard in der Vermittlung von Architekturgeschichte dar. Darüber hinaus besitzen diese Modelle ein großes Potenzial, um als Werkzeuge in Arbeitsprozessen von historischer Bauforschung und praktischer Denkmalpflege genutzt zu werden. Sie können beispielsweise dazu dienen, die Plausibilität von Rekonstruktionsvorschlägen frühzeitig im 3D-Raum zu überprüfen und mögliche Maßnahmen zwischen Wissenschaftler:innen, Politiker:innen, Bürger:innen und anderen Stakeholdern zu kommunizieren und diskutieren. In einem Workshop am Architekturreferat des DAI in Berlin wurde das virtuelle Modell des Basars von Aleppo als Fallstudie zu den genannten Fragen präsentiert.

SCHLAGWÖRTER

3D-Dokumentation, Aleppo, Basar, Denkmalpflege, Digital Humanities, Open Access, Online-Publikation, Spezielle Anwenderprogramme, Syrien, Weltkulturerbe

ملخص

الحفاظ على التراث الرقمي في 3D

بازار حلب الافتراضي (سوق المدينة) كأداة نقاش للحفاظ على الآثار التاريخية

أصبحت النماذج الافتراضية للمباني القديمة طريقة شائعة في تدريس تاريخ العمارة وذلك منذ سنوات عديدة. علاوة على ذلك يمكن استخدام هذه النماذج كأداة عمل رقمية تساعد في دراسة المباني الأثرية والتاريخية وفي نقاش أعمال الصيانة والترميم المقترح إجراؤها عليها. على سبيل المثال يمكن عن طريق هذه النماذج اختبار مدى معقولية التصورات الموضوعة حول شكل المبنى الأصلي، كما تسهل على المختصين عرض إجراءات الحفاظ التي يخططون لها على المجتمع المحلي وعلى المسؤولين والمهتمين الآخرين ونقاشها معهم. في إطار ورشة عمل جرت في قسم العمارة في معهد الآثار الألماني في برلين تمّ عرض نموذج افتراضي لسوق المدينة التاريخي في حلب كمثال على ذلك

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Fig. 4: Christiane Richter, HTW Dresden
Fig. 5: Zoya Masoud
Fig. 6: Stefan Hafner, Paul Bader, Philipp Mai et al., OTH Regensburg/DAI
Fig. 7: Tutku Topal, Melanie Nguyen, Phlipp Mai u. a., OTH Regensburg/DAI

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