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Priene, an ancient tale about the fury of Nature

Digital technologies applied to the archaeological site

by Elisabetta Caterina Giovannini,
Vieri Cardinali

What remains today of the ancient city of Priene, a Hellenic settlement in Asia Minor, is an archaeological site located in the modern region of Aydın in Turkey. Nevertheless, the story behind these ruins highlights the rise and decline of an ancient population that endured natural disasters and enemy invasions. Advanced research using new digital tools makes it possible to identify traces of this past, offering insights into the city's development and helping to enhance the value of what survives.

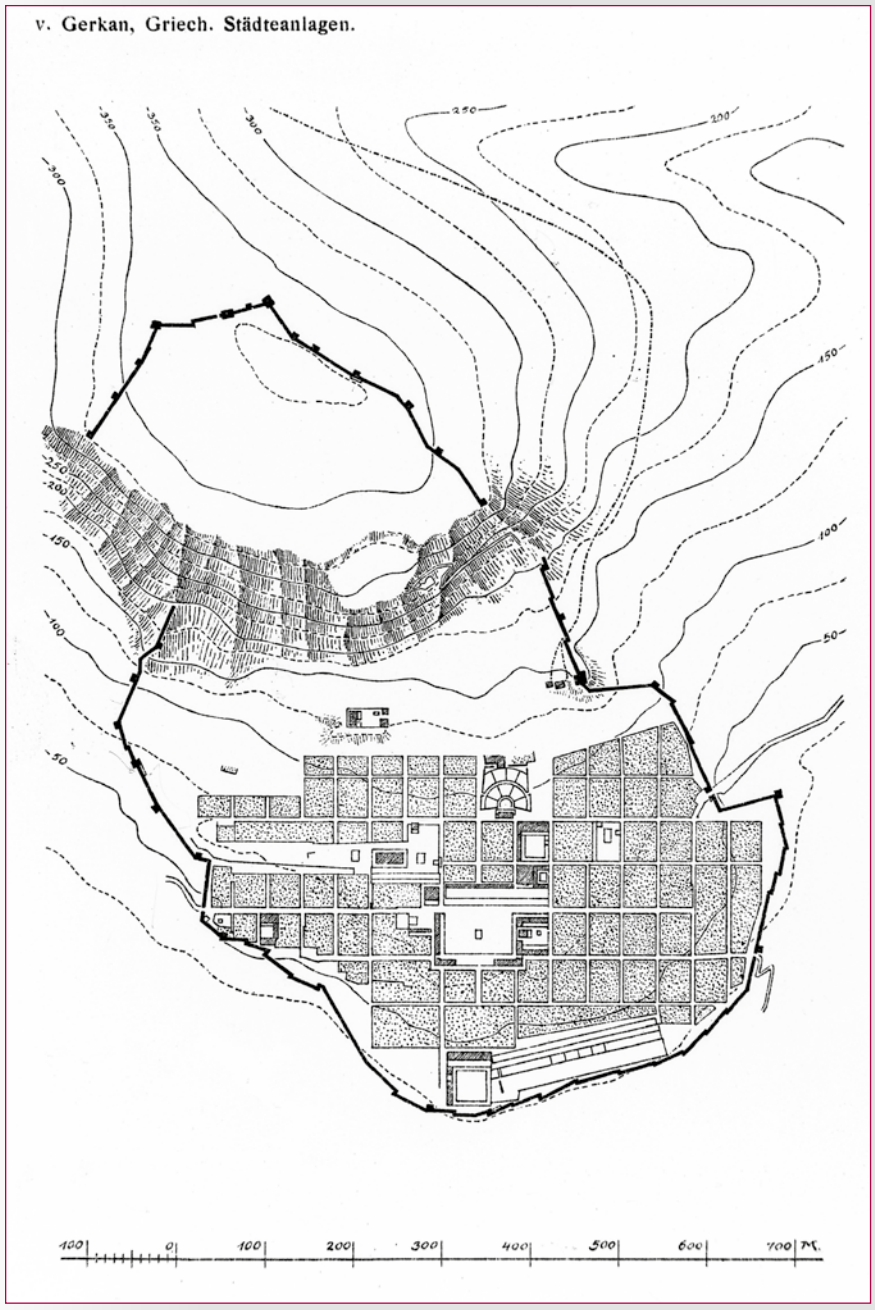

Fig. 1 - Plan of Priene, in Griechische Städteanlagen. Copyrighted work available under Creative Commons Attribution only licence CC BY 4.0. Credit: Wellcome Library, London.

In the natural context, the human being has always looked for places to live in safety. Shelters against predators, protections from the cold and the rain, the realization of houses to live in can be seen as an outcome of a research of protection.

At a wider scale, the urban settlements, the villages and the cities, have represented the association of more individuals into stronger societies. The anthropization of the environment has been, in history, the response to the human need to accommodate nature to their will, passing from an hostile place to an Eden garden providing foods and supplies.

Nonetheless, the unequal battle between humans and nature has revealed on many occasions the power of planet Earth, capable of destroying rapidly what has required years of work. Floods, storms, earthquakes, volcanos are the most catastrophic ways to point out the ephemeral presence of human settlements in the world.

In history, the battle for ancient civilisations was harder than nowadays. Despite the more famous events, e.g. the Pompeian destruction occurred in 79 BC., many minor episodes have led to the collapse of ancient societies. In this context, earthquakes are within the most dramatic natural hazards. The unexpected ground shaking is causing the collapse of the constructions, leading to death and injuries. In the unfortunate cases, this can bring further destruction. The most iconic and well-known example is given by the Lisbon earthquake of 1755; after the mainshock, which led to damage and collapse of constructions, fires started in the houses, while a tsunami hit the lower part of the city. When the fury of nature stopped, around 85% of the city was destroyed, with around one third of the population's death.

Dealing with the topic, when an urban settlement was devastated by an earthquake, in many cases, the easiest way to re-start was to relocate the city to another place.

This is something still documented in recent years (e.g. the case of Gibellina, in Sicily IT), as in ancient times.

NATURAL AND HUMAN FURY IMPACTING PRIENE

In minor Asia, the history of the city of Priene, its ascent and decay, are a testimony that reminds the perseverance of human beings to realize their spaces and protect them against the force of nature and the changes of the world.

According to tradition Priene was founded in the eleventh century BC by Aepytus, grandson of the legendary Athenian King Codrus, in association with the Theban Philotas.

Priene represented an important town in Ionia and according to ancient historical sources such as Pliny the Elder and Strabo, the city was struck by a devastating earthquake in the fourth century BC. The event caused significant damage, leading to the collapse of many buildings.

Priene was destroyed not only by natural disasters but also by human activity, enduring repeated attacks from the Cimmerians, Lydians, and Persians. Following the Persian Wars, it joined the Delian League under Athens, which intervened in 441 during a dispute between Miletus and Samos over control of Priene. (Cook & Spawforth, 2016) However, it appears that Priene was relocated to a different site during the time of Alexander the Great; he himself visited around 334 BC, and it was then that the transfer took place, reportedly accompanied by an inscription granting an exemption from tribute. The new city was built on a series of terraces along the steep slope of Mount Mycale, facing Miletus and overshadowed by its acropolis on Teloneia Hill.

This second Priene, relocated about 3.7 km from the original city (roughly twenty stadia), is a prime example of urban planning and the best surviving instance of a town from this period. With its walls stretching along a broad ridge, descending from the steep face of the Teloneia toward what must have been the estuary of the Maeander, the new settlement featured a systematic, symmetrical grid layout based on the Hippodamian grid plan, designed to accommodate a population of perhaps 5,000 (Fig. 1).

The most prominent building, towering above a lofty terrace with a Doric Stoa, was the sanctuary of Athena Polias. It was designed, according to Vitruvius, by Pytheus, the architect of the Mausoleum at Halicarnassus. Initially dedicated to Alexander the Great (though not completed at that time), it was later rededicated to Athena and Augustus. The shrine was adorned with various sculptural groups dating from the late fourth century BC to the early second century AD. In front of the temple stood a monumental

altar designed by the renowned Hermogenes of Priene (c. 150 BC), of which little has survived. (Cordan & Besgen, 2022)

Research has shown that the vulnerabilities and resilience of Priene's inhabitants shaped their responses to seismic activity, influencing the city's reconstruction efforts after major earthquakes recorded in various periods, including 68 AD and 1653. (Altunel, 1998; Topal, 2019; Mozafari et al., 2019)

These discussions highlight the interplay between cultural heritage, societal structures, and technological advancements in understanding and mitigating the impacts of disasters.

DIGITAL TECHNOLOGIES IN DISASTER DOCUMENTATION

Despite advancements in documenting Priene digitally, challenges remain, including the need for standardised methodologies and collaborative approaches among interdisciplinary teams. The integration of emerging technologies with traditional archaeological practices offers promising pathways to ensure the sustainability of cultural heritage while addressing ethical concerns about accessibility and community engagement. (Giovannini et al., 2023).

Digital technologies are vital for documenting and safeguarding the cultural heritage of archaeological sites, especially during disasters. As disasters become more frequent and severe, the ability to monitor, manage, and protect architectural heritage has become increasingly important. These technologies enable the creation of digital archives that not only record the current conditions of sites but also support disaster response and recovery efforts (Mendoza et al., 2023).

One of the primary methods used in disaster documentation is 3D scanning and photogrammetry. These techniques enable the collection of highly accurate data for the virtual reconstruction of archaeological artefacts and sites. The combination of historical records with 3D outputs improves understanding of site contexts and helps in conserving fragile items that might be threatened by environmental damage or disasters. The use of these technologies enables the creation of detailed digital models that serve as references for future preservation and restoration efforts. (Maietti, 2023).

Alongside technical documentation, digital technologies support the creation of virtual exhibits and online databases. Platforms like Europeana, the Smithsonian's Digital Collections or commercial

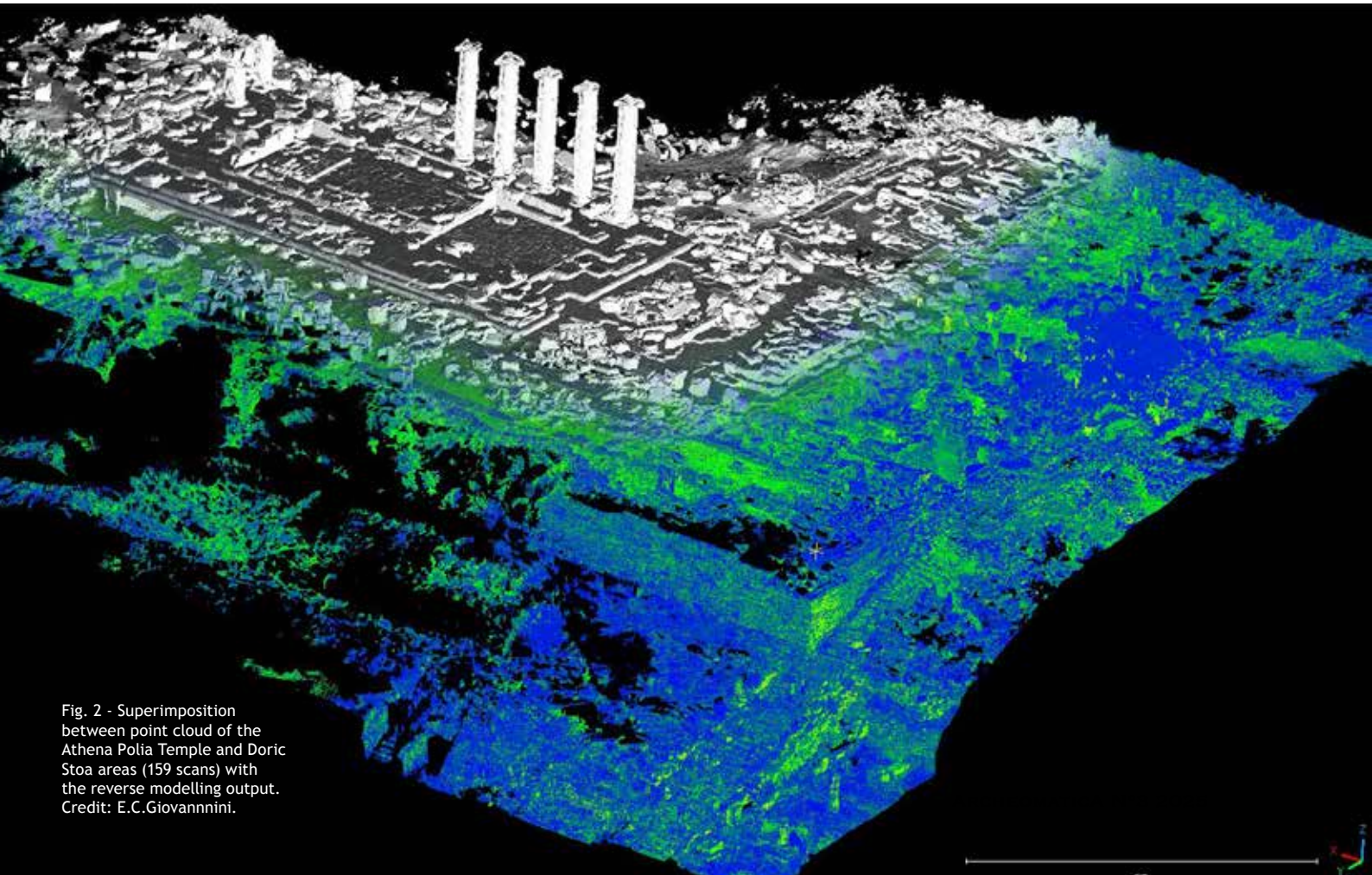

Fig. 2 - Superimposition between point cloud of the Athena Polia Temple and Doric Stoa areas (159 scans) with the reverse modelling output. Credit: E.C.Giovannnini.

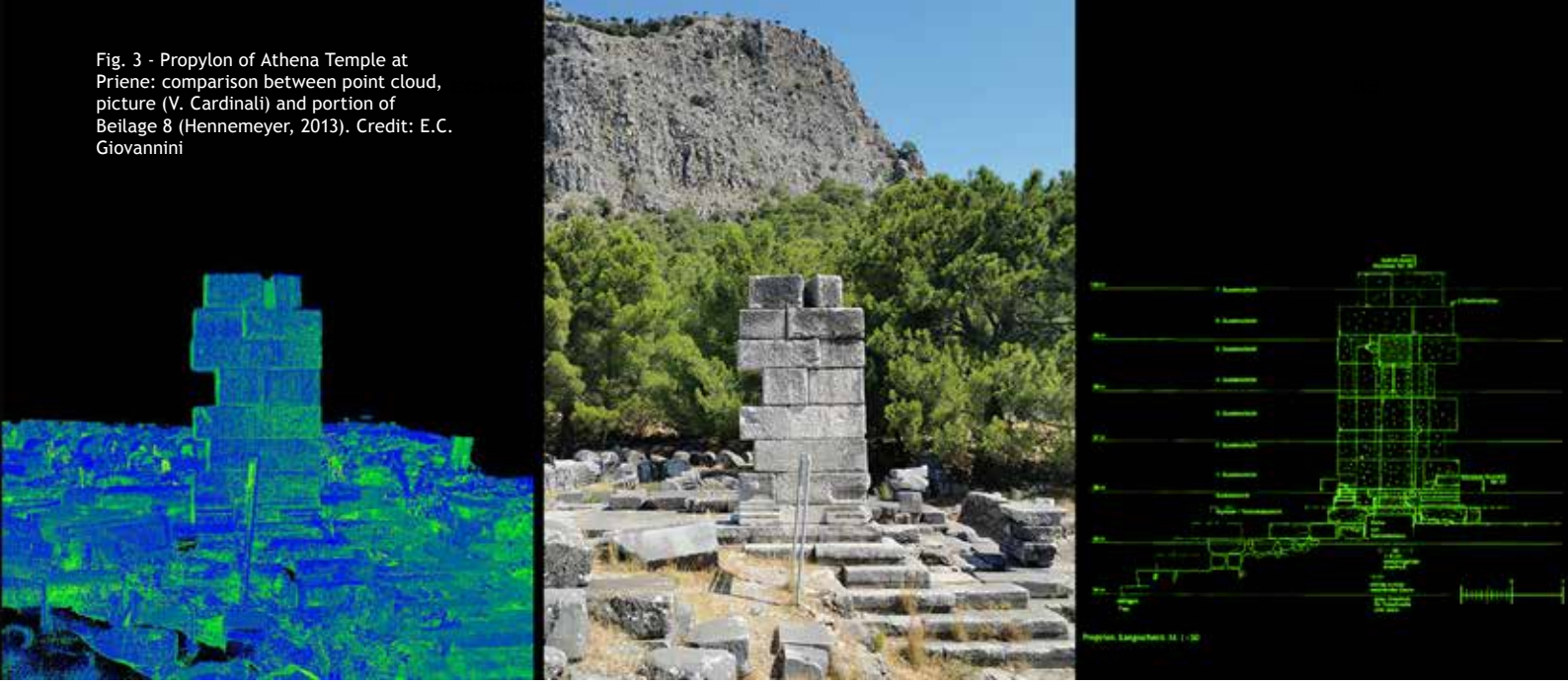

Fig. 3 - Propylon of Athena Temple at Priene: comparison between point cloud, picture (V. Cardinali) and portion of Beilage 8 (Hennemeyer, 2013). Credit: E.C. Giovannini

ones like sketchfab offer access to millions of digitised items, including artefacts threatened by disasters. By making these resources available online, researchers and the public can engage with and study objects that may be physically inaccessible due to fragility or location. (Champion & Rahaman, 2020).

DIGITAL TECHNOLOGIES APPLIED TO PRIENE RUINS

Digital preservation not only helps protect cultural heritage but also ensures that knowledge about these artefacts is shared globally. The methodologies used in the study of Priene involve a systematic literature review and bibliometric analysis based on previous German research. One of the main challenges is balancing technological innovation with the authenticity of cultural narratives. The risk of oversimplifying complex histories to engage broader audiences requires a careful approach to digital preservation.

As digitisation projects continue to digitise artefacts and create virtual exhibits, best practices for data management must be established. Within digital acquisition in Priene, an integrated workflow was

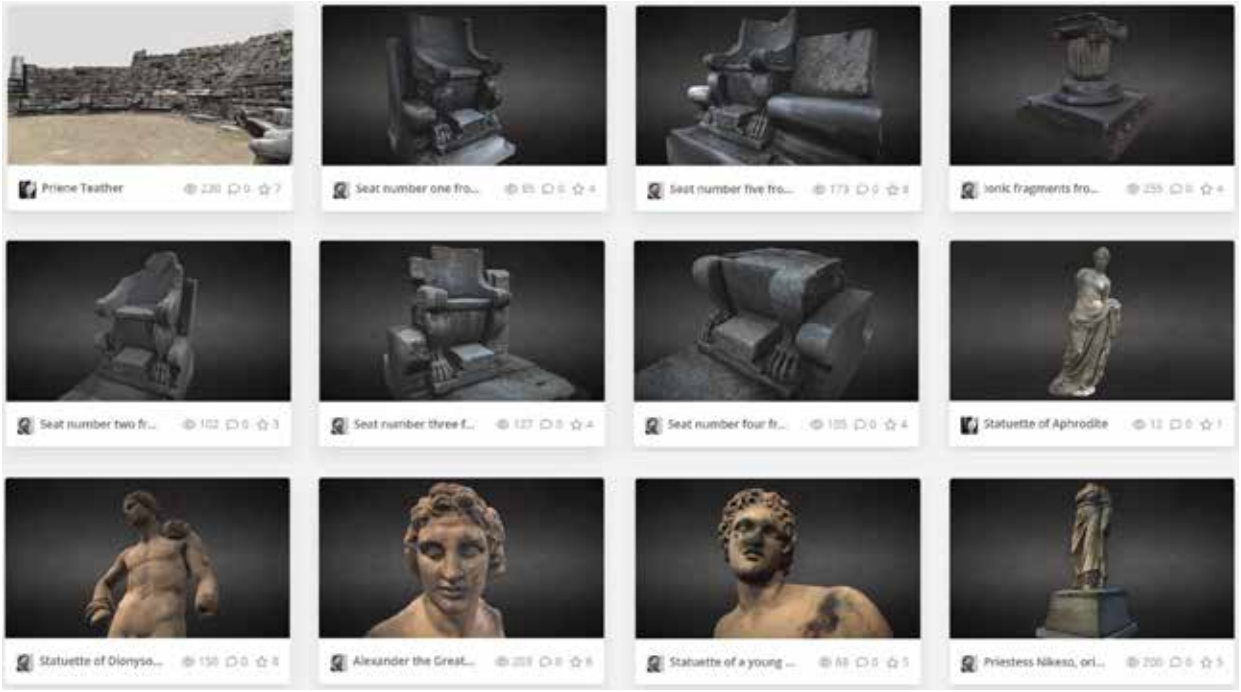

Fig. 4 - Collection of 3D models about monuments, fragments and statues of the Priene archaeological area. Credit: E.C. Giovannini & G. Verdiani.

implemented to acquire and disseminate Priene monuments digitally, demonstrating how digital technologies can transform the understanding, preservation, and communication of archaeological heritage (figs. 2-3). These approaches include the practical storage of raw collection data, processed files, and related metadata.

The point clouds obtained (raw data), document large-scale survey campaigns using laser scanning, UAV and terrestrial photogrammetry. 3D models (processed files) allow the analysis of major structures such as the Doric Stoa terrace wall and the Theatre, revealing construction methods, structural behaviour, and patterns of historical damage, particularly from seismic events. (Giovannini et al., 2024)

Archival research (from online platforms, e.g., iDAI.world repository or Census database) and 360° images and virtual tours provide remote, georeferenced access to Priene's artefacts. This includes not only monuments but also marble statues now housed abroad, showing how digital acquisition, object biographies, and virtual tours can virtually reunite objects with their original context (fig. 4). (Verdiani & Giovannini, 2024)

By integrating reality-based models, historical documentation, semantic structuring, and online dissemination platforms, the projects demonstrate how digital tools validate and expand prior archaeological knowledge, support conservation planning, and make cultural heritage more accessible to specialists and the general public.

As researchers continue to explore the complexities of the past, Priene stands as a testament to the enduring relationship between humanity and nature, illuminating the lessons learned from the past as we face the uncertainties of the future.

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Abstract

The paper describes Priene's long history of natural and human destruction, focusing on how earthquakes shaped its urban development and relocation. It highlights the role of modern digital technologies, such as 3D scanning, photogrammetry, and virtual archives, in documenting damage, preserving cultural heritage, and reconnecting dispersed artefacts. Through integrated digital workflows, the study demonstrates how these tools enhance archaeological understanding and support future conservation.

Keywords

Digital Archeology; Integrated survey; 3D digital assets; digital applications to archeology; virtual reconstructions

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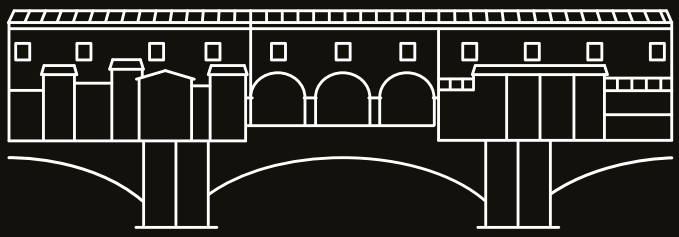

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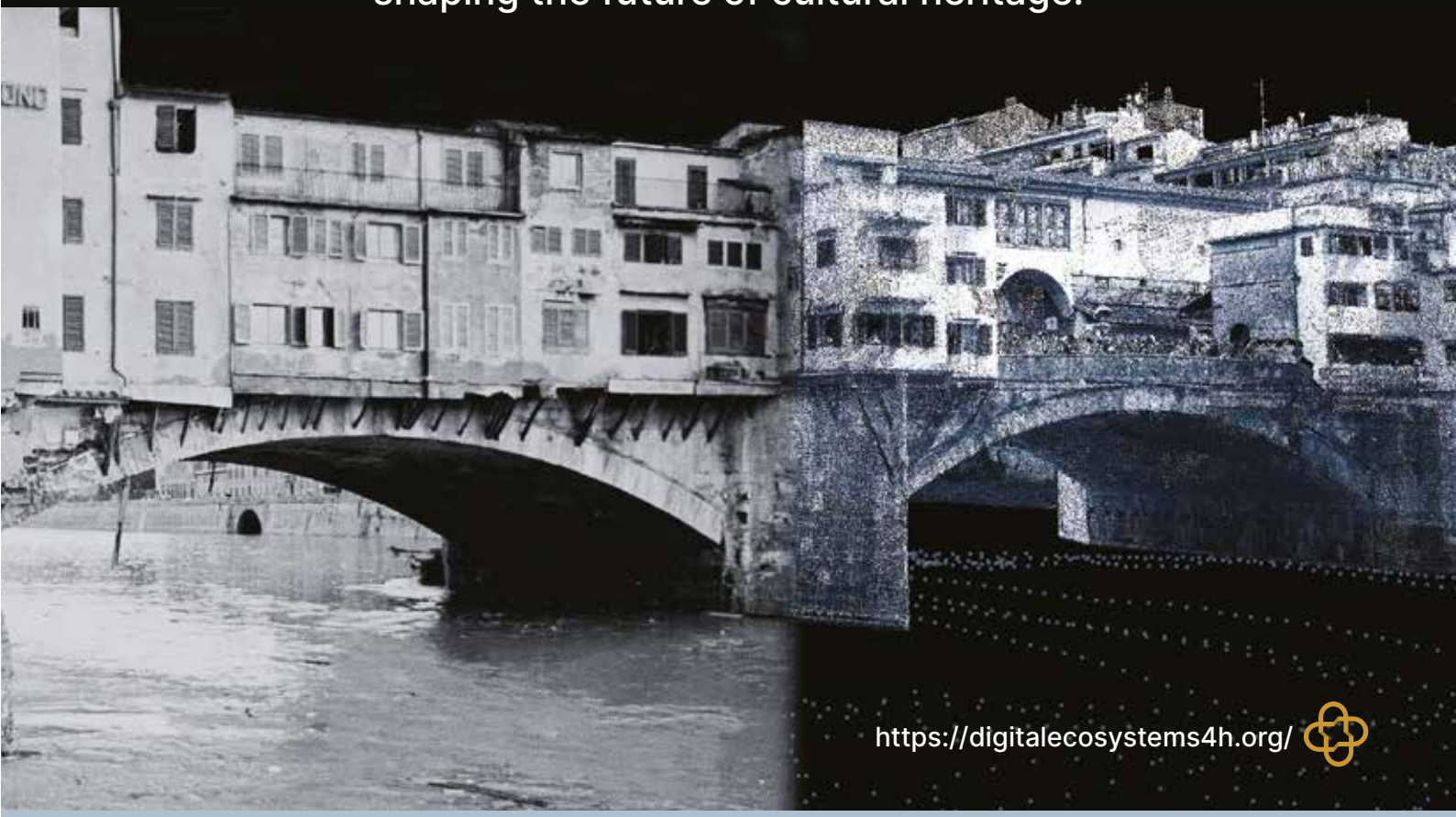

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