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# How to Deal with Adobe Architecture in the Ancient Near East: The Case of Ebla in Syria

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**Abstract:** The paper presents the restoration activities carried out at Tell Mardikh-Ebla (Syria) by the Italian Archaeological Expedition to Syria of the Sapienza University of Rome. In particular, the study focuses on the operations to preserve the mudbrick structures that have specifically suffered from erosion by rain wind which has caused the collapse of sections of walls. The programme of restoration at Ebla sought to clarify and outline a plan of excavated structures with swift, non-invasive, and reversible interventions and reconstructions. The protection of mudbrick buildings is indeed a challenge for archaeologists working in the Near East: mudbricks are extremely fragile both during the excavation and even more so after they have been excavated. Starting from the results at Ebla, the issue of preserving mudbrick structures is far from being completely solved; the lack of any archaeological research at Ebla, because of the political crisis in Syria, heavily affected the site and the restored buildings that have been seriously damaged by illicit digging and the occupation of the archaeological areas. New techniques and solutions are needed to improve the quality of maintenance and the protection of such a fragile heritage.

**Keywords:** Ebla; Syria; mudbrick architecture; Near Eastern Archaeology; restoration; enhancement

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## 1. Introduction

Materials used for the construction of the main monuments of the cities in the regions of the Ancient Near East are clay, limestone, basalt, sediment, and soil. The study and knowledge of the properties and origin of the building materials (according to their provenance and specific ductility and adaptability for architectural purposes) is fundamental for the comprehension of ancient building techniques, particularly what concerns the combination of different materials, e.g., the use of stones for the foundations and mudbrick for the elevation of walls. At the same time, these data and considerations are essential for the exact employment of local materials in the execution of the restoration and the addition of lacking portions of the architectural buildings. This phase is closely linked with the local traditional building techniques, which are free from "industrial" contamination and consequently close to ancient methods [1,2].

The most common raw material is clay. There are thousands of cubic metres of green brick masonry (Adobe). Limestone, a very common stone in Syria, comes next together with basalt, which is to be found in large plateaux, and alluvial conglomerates, and then transformation by-products, such as lime from limestone, used for floors and plaster, and pottery from clay.

Sedimentary surveys have been carried out by using the current cartography scale 1:200,000 [3,4], with additional data coming from land surveys based on the available cartography scale 1:50,000 (Figure 1).

These preliminary considerations are useful for the planning of all operations and interventions in the restoration of ancient structures, thus respecting the shape and physical characteristics of the original materials used by the ancient people; at the same time, the use of materials with the same physical and natural properties assure the homogeneity of the restoration in the archaeological landscape of the site.

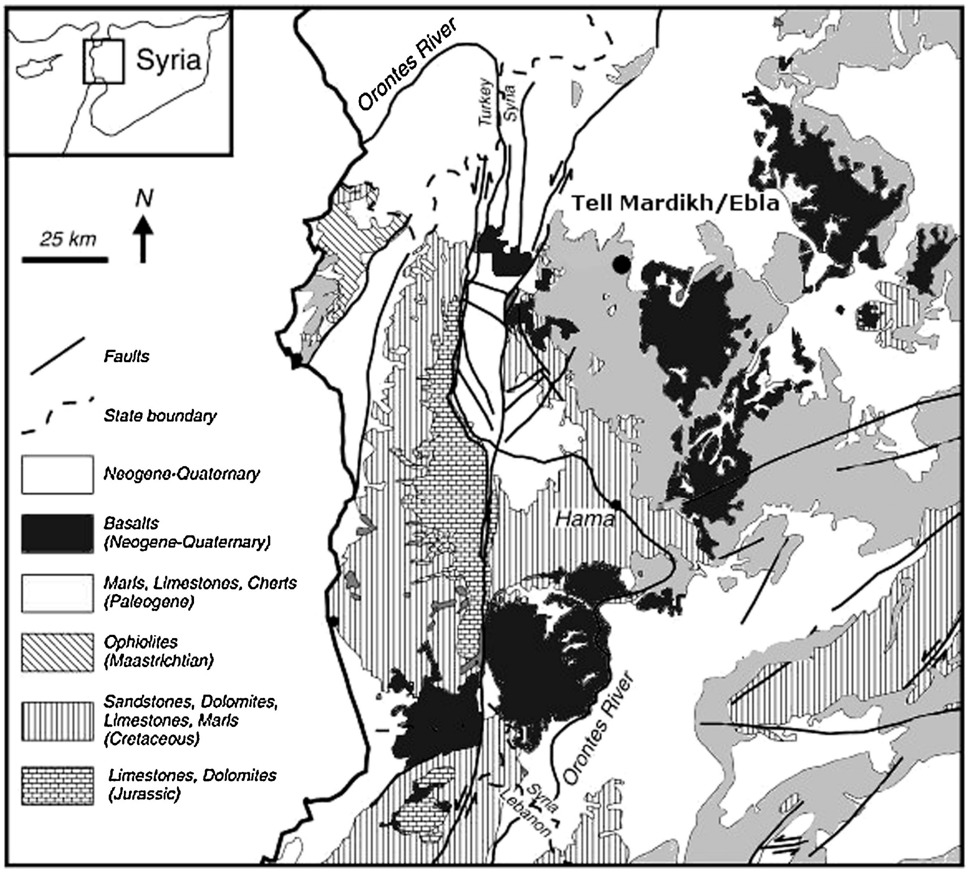


**Figure 1.** Schematic geological map of North-Western Syria. Photo after [5], Figure 1.

The process of restoration and the enhancement of mudbrick architecture required extensive preliminary research on the ancient Mesopotamian and Syrian technological building concepts and methods [6–9]; it also needed specific choices of methods and techniques which considered both the impact and effectiveness of the choices, according to the situations of preservation of the original structure, costs, difficulties of the intervention, and an evaluation of the durability of the chosen solution.

In particular, the most challenging aspect of the restoration and preservation of mudbrick structures deals with the efficacy of the actions. Mudbricks need to be protected without changing their shapes and the original shapes of the structures, on the one hand; on the other hand, the result of the action should not compromise the possibility of reversibility, i.e., mudbrick walls can be re-excavated should an area or a building need further archaeological investigation or restoration. This issue touches upon the range of heritage conservation: the choices can affect the effects of the restoration depending on both the solutions adopted and the implications, for example, of the weather condition of the region where the archaeological site is located. Taking for example the annual precipitation (about 380 mm, [10]) into account, it has been important to evaluate the type of actions to protect the ancient mudbricks from erosion (also caused by wind and, in winter, by snow) and to guarantee the endurance of the new mudbricks that cover and coat the ancient walls. While drying, the clay of mudbricks is subject to cracks and the formation of crusts on the surface; at the same time, if ancient walls are not suitably reinforced and protected, rain can cause the presence of puddles, thus increasing the level of at the foundations that can, as a consequence, be very dangerous for the solidity of foundations, the preservation of mudbricks and mud plaster and, finally, of the floors themselves [11–14].

## 2. The Restoration Project

Ebla is in northern-western Syria in the governorate of Idlib, about 60 km south of Aleppo (Figure 2). Regular archaeological excavations have been carried out by the Sapienza University of Rome from 1964 to 2010 [15].

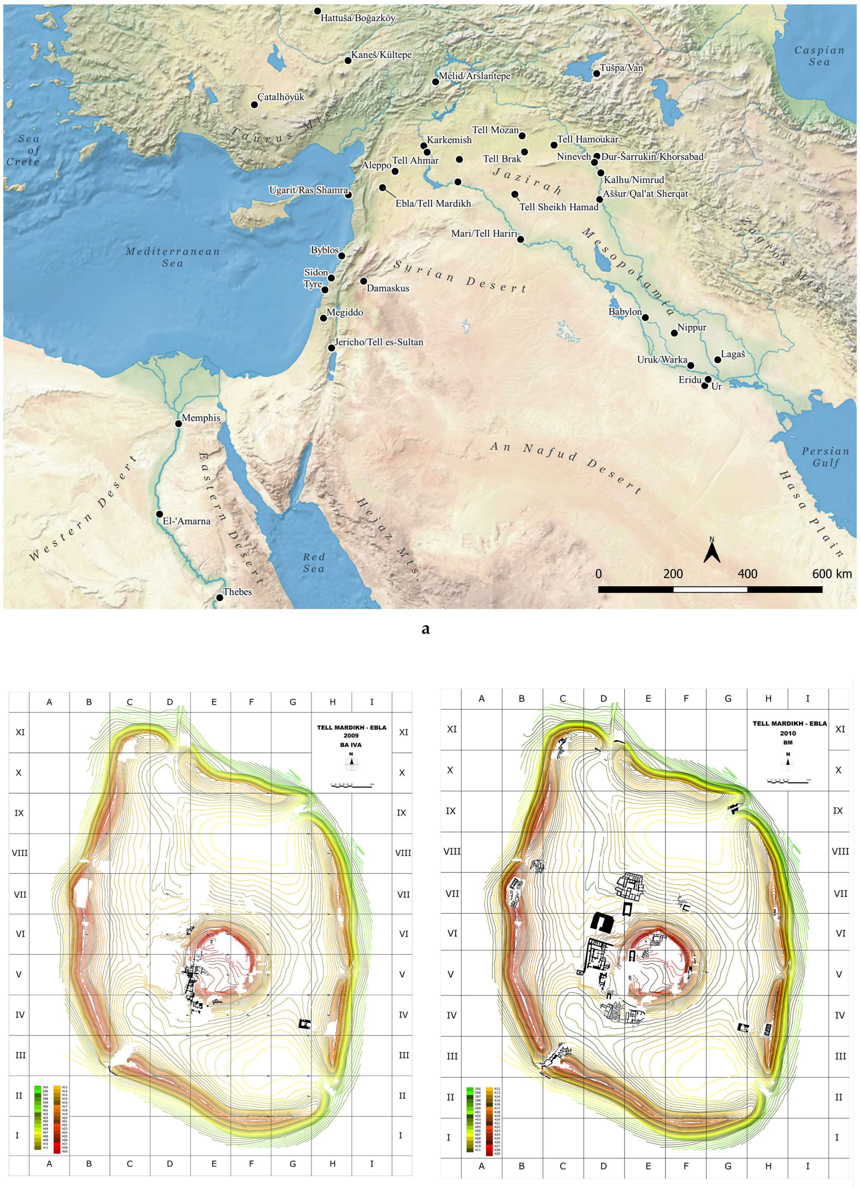


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**Figure 2.** (**a**) Map of Syria with the indication of Ebla. Source: author; (**b**) Topographic plan of Ebla with the archaeological evidence dated to the Early Bronze Age. Photo: Missione Archeologica Italiana in Siria, Sapienza Università di Roma; (**c**) Topographic plan of Ebla with the archaeological evidence dated to the Middle Bronze Age. Photo: Missione Archeologica Italiana in Siria, Sapienza Università di Roma.

The ancient city was occupied in the mid-third millennium BC, and a very important historical phase dates to the Early Bronze Age IVA (2400–2300 BC), when the city was an important kingdom in the region, ruling and controlling other minor cities (thus seeking for the establishment of strategic alliances for commercial and military purposes). The rich corpus of cuneiform texts, discovered in 1975 in the archive (L.2769) of the Royal Palace G, sheds light on this network of relations between the city of Ebla and contemporary cities and kingdoms (such as Egypt, the city of Nagar in the Jazirah region, the city of Mari on the middle Euphrates, and the city of Kish in central Mesopotamia).

After the destruction by the Akkadian king Sargon, the city was not completely abandoned, although its power and influence accordingly decreased; indeed, new archaeological data, from excavations carried out in areas P, HH, G, and D since 2004, show this continuity in the following historical phase, named Early Bronze IVB. The cause and the agents of the collapse of the second city of Ebla which flourished between the years 2300 and 2000 BC are still unclear.

The last phase of Ebla covers the first half of the second millennium BC. In the Middle Bronze Age (2000–1550 BC), Ebla was still an important city, an independent kingdom strictly tied to Aleppo and the kingdom of Yamkhad in northern Syria. Indeed, many of the architectural monuments and artefacts recovered by the archaeologists belong to this last historical phase. The city was definitively destroyed during the military expeditions in Syria by the Hittite kings Hattusili I and Mursili I. However, the city was not abandoned but continued to be occupied during the Late Bronze and Iron Ages, albeit with different systems and finalities. Surely, the city after the destruction of the mid-second millennium by the Hittites was no longer identifiable with the Ebla of the main and golden ages of the Early and Middle Bronze [15] (pp. 163–167).

In 1999, the Italian Archaeological Expedition to Syria of the Sapienza University of Rome started a programme of restoration of the archaeological areas which had been extensively investigated and excavated at Ebla since 1964, aiming at the creation of the Ebla Archaeological Park [16–18]. The restoration project of the site of Tell Mardikh-Ebla was funded by the European Union within the programme of restoration interventions and operations in Syria on archaeological sites and areas.

The restoration work carried out by Italian specialists coordinating local specialised workers covered a total area of about 25,000 square metres (Figure 3), with interventions on stone and mudbrick structures to improve the stability of walls and buildings, on the one hand, and to preserve the integrity of mudbricks, on the other. Indeed, restorers and archaeologists studied and registered a system for the preservation of the original mudbrick structures (some walls measure from 4 to 5 m in height), presenting and testing the most suitable solutions to preserve the original shape and nature of ancient bricks and adobe architecture (thus avoiding overly invasive reconstructions and systems of covering) and to achieve the most reliable result. Exactly like other small and large archaeological sites, Ebla is part of an ancient ecological system. It is, therefore, closely bound together with the environment and all its aspects, encompassing mineral and vegetable kingdoms. Research and the restoration plan have been based on and aim at understanding this interrelated system. In this respect, the purpose of the restoration project is not simply to preserve and/or reconstruct man-made elements. It also aims at completing the extensive knowledge of this subject with archaeometric data.

The first phase of the work was thus devoted to the evaluation of procedures for restoring mudbricks, by taking into consideration the previous literature and studies on the subject [19–30] and already existing examples of the restoration of ancient buildings in Syria and the Near East (such as, for example, the works and solutions adopted for the protection of mudbricks in Tell Mozan and Mari [31–35].

The previous literature and experiences have thus been used to create the restoration programme and the pattern of actions at Ebla. In particular, the effects of weather (high temperature and rain) studied in Iraqi archaeological sites have been used as an important reference to test and evaluate the condition at Ebla [36,37]. The main philosophy of the restoration of mudbrick structures aims at the preservation of the original state of the buildings and walls detected in the archaeological excavations. The conservation and enhancement of the archaeological finds were the main points of the Italian restoration operations at Ebla, with no intrusive reconstructions of the destroyed portions of walls and architectural elements. Within the philosophy of the restoration project, the architecture of the ancient buildings must be identifiable and readable without altering the state of preservation discovered by the archaeologist. Restoration and preservation must not be intended as a way for reconstructing and the addition of missing parts.

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**Figure 3.** (**a**) Aerial view of Ebla; the photo was taken before 2000. Photo: Missione Archeologica Italiana in Siria, Sapienza Università di Roma; (**b**) Area P in the Lower City of Ebla after the restoration has been completed; the photo was taken in 2010. Photo: Missione Archeologica Italiana in Siria, Sapienza Università di Roma.

According to the project, the main archaeological areas of Ebla have been restored, following this method and process:

(1) Completing the excavation of the area when necessary (new operations were intended to promote new archaeological investigation, on one hand, and to mark the area with new protecting contour modern walls, on the other);
(2) Digging the baulk squares originally left to 'protect' the (mudbrick) structures;
(3) Consolidation of mudbricks, foundations walls, and floors;
(4) Demarcation of each area with removable concrete block walls [16,17].

After ten years of intensive activity (during this time excavation and restoration progressed in parallel), the excavated monuments of Ebla had a readable plan: the restored parts were easily and recognisable from the original mudbrick and stone structures of the buildings. In this way, viewers and specialists can observe the level and nature of intervention on each monument without any possibility of misunderstanding. In fact, since even partial reconstruction of the height of the walls has been avoided, the imposing mudbrick structures of the Royal Palace G and the Temple of the Rock (in Area HH), both dated to the most ancient phase of Ebla (Mardikh IIB1—Early Bronze Age IVA), are entirely original, being covered with a single layer of modern mudbrick on the top and with a mud plaster to protect the integrity of the ancient structures.

**3. Project Phase I: Analyses of Mudbrick Structures**

Mudbricks structures require special attention in the planning of the restoration. Indeed, even in the archaeological process, mudbricks are complicated stratigraphic units since they might be difficult to identify in the archaeological sequence, within a similar archaeological deposit made of the same soil deriving from the collapse of mudbrick structures and filling.

Once properly excavated, mudbricks strongly suffer from the exposition to sun, rain, and wind that cause severe erosion of the original shape of the structure. Mudbrick walls are thus strongly affected by external agents and a correct and accurate plan of restoration might limit the agency of environmental changes and phenomena. The process of erosion is not immediate; however, if not adequately considered and monitored, it can irremediably alter and destroy the ancient mudbrick structures.

As recognized, for example, in the site of Mari (on the Middle Euphrates in Syria), the stagnation of water, due to the groundwater in the subsoil of the site, can dangerously affect mudbrick walls causing a high-degree erosion at the base of the walls which is then visibly reduced up until the final collapse (see the study of the different degrees of erosion of the mudbrick walls of Mari, [3,14]). Indeed, mudbricks, as well as other architectural features in general, need to "breathe". Closed contexts and the use of improper materials in the restoration that allow the creation and persistence of extremely humid places can compromise the integrity and preservation of mudbricks. For that reason, ventilation and dry contexts must be accordingly created to preserve the original structures with artificial interventions (such as the opening of niches at the base of the walls to favour the evaporation of water and excessive humidity, [14]) and the use of natural materials that fit in with the chemical and physical composition of the ancient mudbricks.

As a necessary preliminary step to the restoration of mudbrick structures, analyses of the chemical and physical properties of ancient mudbricks and the natural raw materials used by ancient people must be contemplated. Accordingly, analyses have been programmed on the clay used to fabricate the ancient Eblaic mudbricks; recent new analyses have also been repeated on different kinds of mudbricks (different in colour and date, belonging to buildings dated to either the Early Bronze or the Middle Bronze Age). The results of the analyses are useful and interesting to discuss the qualitative properties of mudbricks for their use in architecture, on the one hand; on the other, these analyses can indicate and point to the correct solutions to preserve the integrity and those qualitative properties of the ancient mudbricks in the restoration process.

The study of previous restoration experiences and activities in similar contexts shows:

(1) Very efficacious products as the ethyl silicates are very expensive; their use might create problems;
(2) Acrylic emulsions, when properly used, are really good but they require constant interventions of maintenance;
(3) White cement added to the traditional mortars, is particularly successful (at the beginning, when the local kind of white cement was used, it was necessary to test its quality by analysing the presence of salt).

For that reason, analyses and experiments in situ are required and are important to test the quality and effectiveness of the interventions and, most significantly, their durability over time (it has been clear, however, since the beginning, that annual programmes of maintenance were necessary, at least for some structures and types of interventions—such as, for example, the covering of mudbricks with mud plaster, see [4]).

For mudbricks specifically, results from more detailed and refined examinations must be taken into account, as well as simple analyses to detect the basic materials used to fabricate the mudbrick (clay, sand, straw, etc.):

(1) Chemical and physical composition of the mudbricks and their components;

(2) Analyses of calcium phosphate and carbonate;
(3) Analysis of the shape of small particles;
(4) Considerations about colour;
(5) The humidity of mudbrick walls by using the Humidtest to verify the rate of humidity and presence of salt both on the surface and in-depth. The detail of humidity is particularly important if the surface of mudbrick walls is decorated and covered with white or coloured plaster.

According to this list of activities, mudbricks from Ebla have been analysed to detect their components, their particles, and, consequently, the reaction of products used in the restoration process. At Ebla, we can distinguish two types of mudbricks that have different colours and dimensions. Rectangular red/reddish mudbricks (60 $\times$ 40 cm) are used in the architecture dated to the Early Bronze Age IVA (Mardikh IIB1 according to the internal chronological nomenclature of the site) (Figure 4), while brownish-beige/pinkish square mudbricks (33 $\times$ 33 cm) are employed in buildings dating to the Middle Bronze Age (Mardikh IIIA–B) (Figure 5). Based on past and recent analyses, the content of clay is very similar, while differences might be observed in the greater or lesser presence of calcium carbonate (much more present in the brownish/pinkish mudbricks). This different composition might depend on static reasons and exigencies of the buildings and recent studies are thus pointing to verify this possibility taking into consideration both kinds of Eblaic mudbricks in buildings of the Early Bronze and Middle Bronze Age. In particular, the data of the new excavations in the sacred Area HH in the south-eastern sector of the Lower Town can add new and significant results in the composition of clay and additional elements. In the monumental Temple of Rock (HH1, dated to the Early Bronze Age IVA and contemporary to the Royal Palace G), the standard rectangular reddish mudbricks are used, while later temples (Temples HH4 and HH5), dated to the Early Bronze Age IVB (2300–2000 BC), are built with similar mudbricks, slightly different in colours and thinner [15] (pp. 297–300). Current analyses of this intermediary type of mudbrick might explain the different use in architecture and the transition to the Middle Bronze canonical mudbricks, pointing out technical and static characteristics and chemical and physical features (for example, on the origin of the clay used in the fabrication).

**Figure 4.** Ebla: Early Bronze Age mudbricks (Mardikh IIB1). Photo: Missione Archeologica Italiana in Siria, Sapienza Università di Roma.

**Figure 5.** Ebla: Middle Bronze Age mudbricks (Mardikh IIIA-B). Photo: Missione Archeologica Italiana in Siria, Sapienza Università di Roma.

## 4. Project Phase II: Restoration and Preservation of Mudbricks

Syria, the northern edge of the Arabian Plate, is lithologically characterised by very widespread lime deposits covered by large basalt plateaux located in a closed basin produced by tectonic uplifts of some parts of the so-called "Aleppo Plateaux" [38,39].

During at least the last two million years, this caused the creation of lake basins, whose traces still exists in Quaternary sediments. The so-called "Red Soils", which characterise the outside areas of the lake basins, can be traced back to fossil palaeosols of a warm, humid, tropical climatic period. These soils are not suitable to produce either green bricks or pottery. They are made of iron oxide, iron hydroxide, and aluminium together with a large quantity of limestone. They are almost free of clay and consequently without cohesion, which is fundamental for both the above-mentioned products.

All around Ebla there are no outcrops of clay soil, at least not presently noticeable. The nearest ones are, to the East, the still existing lake, and marshy areas near Tell Tuqan, and, to the North, the deposits next to Tell Afis; brown soils result from ephemeral fluvial, torrential supply, and paedogenesis of local soils in a warm, humid environment [40,41]. Although systematic research into the petrographic, mineralogical, and typological affinities has just been undertaken, and therefore it is not possible to go beyond mere suppositions, it can be assumed that clay and/or final products to manufacture pots and bricks were imported from these areas.

However, according to experiments and local workers' knowledge, the soil of Mardikh must be mixed with cohesive substances to produce bricks. Some walls were made up of the alternation of red bricks (local soil) and yellow bricks ("enriched"), others only of "enriched" soil bricks, but never of red soil alone (there is a single acknowledged case, which however presents a different technique, *pisé* rather than adobe).

According to analyses, the content of clay is similar. On the other hand, "enriched" bricks are far richer in limestone. The addition of limestone powder to the soil would have caused a change of colour, not cohesion, whereas lime alone can. Moreover, analyses carried out on floors and plaster prove that lime was known and widely employed.

At Ebla, the restoration of mudbrick structures followed three main directions. Most of the time, they are complementary operations (as, for example, the reinforcement of ancient mudbricks and the covering of ancient structures with new artificial bricks).

(1) Ancient mudbricks are systematically consolidated through injections of ethyl silicates or acrylic resins [42]. Liquids are filtered through small pipes (Figure 6) into the mudbricks from different heights and pressure so that the consolidating material can be absorbed from within the core of the walls towards the external surface. The vice versa process can cause the formation of a crust on the surface that, once dried, splits and falls together with portions of the original mudbricks [4] (p. 934).

(2) After the first intervention of consolidation, ancient mudbricks are covered with a layer of new-fashioned mudbricks. These new bricks are made from the same soil of the site—thus presumably the same the ancients used. Clay and straw are enriched with an acrylic resin (Primal in a 5% solution) that diminishes the growth of vegetation, on the one hand, and guarantees a natural colour (the addition of new lime would cause an extremely white colour), on the other. However, the colour of the new mudbricks is different from that of the original ancient bricks. Indeed, different colours have been purposely used to distinguish the original parts from restored sections (Figures 7–9).

(3) Based on a traditional local system of preserving modern mudbrick buildings, ancient mudbrick walls have been covered with a mud plaster (tin) made of soil, lime, and straw; a 5% acrylic resin solution has been added to the water of the mixture to make the plaster more resistant in protecting the mudbricks. This mud plaster must be renewed each year, but it is an excellent solution for the protection of mudbricks since it relies on local traditional workmanship and the impact on the ancient structures is not (aesthetically and substantially) invasive. Rain, wind, and snow consume this external film of the plaster without damaging the mudbricks underneath (Figures 10 and 11).

**Figure 6.** Ebla: consolidation of mudbricks through injections of ethyl silicates or acrylic resins. Photo: Missione Archeologica Italiana in Siria, Sapienza Università di Roma.

**Figure 7.** Ebla: the new mudbricks purposely made for the restoration of ancient structures. Photo: Missione Archeologica Italiana in Siria, Sapienza Università di Roma.

**Figure 8.** Ebla: an example of the use of the new mudbricks to cover the ancient mudbricks. Photo: Missione Archeologica Italiana in Siria, Sapienza Università di Roma.

**Figure 9.** Ebla: an example of the use of the new mudbricks to cover the ancient mudbricks. Photo: Missione Archeologica Italiana in Siria, Sapienza Università di Roma.

**Figure 10.** Ebla: the ancient mudbricks are covered with modern plaster made of clay and straw. Photo: Missione Archeologica Italiana in Siria, Sapienza Università di Roma.

**Figure 11.** Ebla: the ancient mudbricks are covered with modern plaster made of clay and straw. Photo: Missione Archeologica Italiana in Siria, Sapienza Università di Roma.

## 5. Conclusions

In 2010, during the last season of work at Ebla, the restoration programme was nearly entirely completed and accomplished. The restoration project aimed at an important result: concerning the mudbricks, walls and structures were suitably provided with new adobe cover and mud plaster that guaranteed good protection against sun, rain, and wind. However, further actions were purposely planned to monitor the results and effects of the restored buildings and mudbricks; in particular, special attention was given to the replacement of the plaster upon the mudbricks that needed to be redone even twice or three times per year. Moreover, the programme for the refinement of the analyses of mudbrick samples aimed at getting new and precise information that needed to be tested and related to new products and solutions for the protection of ancient adobe structures. Finally, the project encompassed the creation and codification of a risk map that registered all occurrences in the restoration and preservation of ancient Ebla showing the process of making, outcomes, problems, and critical aspects to provide a stable programme of maintenance of the Ebla Archaeological Park, according to its initial premises, future archaeological investigations, and the enhancement of the site for tourism and visitors.

After the political crisis in Syria in 2011, the work at the site was interrupted. The lack of any activity for the monitoring of the restoration and the site, in general, caused the heavy collapse of ancient structures, mudbricks, and adobe buildings. Next to the natural erosion, the site suffered from the military occupation that caused further damages and heavy destruction with the excavation of trenches, tunnels, and bunkers as well as the construction of small buildings made of concrete blocks.

During a visit to Ebla in September 2022, it has been possible to register the major damages, on one hand, and the endurance of the restoration of some mudbrick buildings that are poorly and partially ruined, on the other (Figure 12). The collapse of mudbrick walls was heavier when buildings have been purposely destroyed or illegal excavations have been conducted; mud plaster that coated the ancient walls is no longer present and thus large portions of mudbricks are exposed to sun and rain, an aspect that can further damage and undermine the ancient structures. During the survey of registration of the damages, it has been possible to observe that the results of the restoration project at Ebla somehow mitigated the total ruin of ancient mudbricks. Therefore, the philosophy of the restoration project was still essential to recover the damaged parts of the site. For that reason, the accomplishment of the procedure of the restoration project is extremely important to save and retrieve the archaeological park of Ebla. The purpose of the rehabilitation programme concerns the study and feasibility of new intervention protocols for the protection and restoration of damaged adobe structures, because of abandonment, looting, and anthropic destruction that have inevitably had repercussions on the state of preservation of the historical and archaeological heritage. In particular, alongside the recovery of traditional methods already explored and used in the past restoration project at Ebla, the research intends to promote at the same time the definition of new methods of intervention in the field, favouring effectively the choice of eco-compatible material (clay without chemical additions of artificial consolidation) for the repair of damages, the protection, and restoration of damaged structures or the creation of spaces for the fruition and communication of the narration of the history of the settlement, its discovery, and its historical importance. The new plan of action is currently under study and development, and it includes:

(1) The study and design of new eco-compatible protocols for the rehabilitation of mudbrick structures. Thanks to advanced 3D modelling, prototypes of architectural models, and photorealistic renderings, environmental insertion simulations and films will be created;
(2) The realisation of a faithful reproduction of sectors of ancient Ebla to be displayed in situ, in correspondence with the original buildings or their parts, protecting and preserving the original excavation;
(3) The creation of a risk map for monitoring the original structures and restoration interventions: Compilation data (operator, date, any updates); Location; Contextual data; Artifact made of clay (typological identification, dating; brief description); Use of adobe (construction element; location of the construction element; type of use; dating; quantitative consistency; specific restoration work carried out; added protective elements; current status); Risk conditions (categories Risk Card Istituto Centrale del Restauro); Reliefs; Dated photographic documentation);
(4) The creation of a WEBGIS atlas, which can be consulted online and continuously updated via sensors in situ, of the condition of adobe architectures and archaeological evidence and which takes into consideration periods and geographical areas with the identification of peculiarities and environmental problems for the conservation of mudbricks (wet areas, extremely dry areas, rainfall, etc.).

**Figure 12.** Ebla: the collapse of ancient mudbricks and the restoration during the year of military occupation of the site between 2014 and 2019. Photo: Missione Archeologica Italiana in Siria, Sapienza Università di Roma.

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