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Introduction

Many natural disasters have been identified in the classical Mediterranean world, but it has been more difficult to recover the responses of those who survived such disasters. A disaster is a serious disruption to the functioning of a community, at any scale, leading to human, material, economic, and environmental losses. From ancient times to now, disasters have destroyed many great cities. Some have been rebuilt and their societies have moved on, but others have been buried and forgotten for thousands of years.

From our understanding of history, cities have been developed for a host of reasons, including trade and attendant commercial opportunities, reinforcing systems of defence and security and for establishing administrative centres. Cities have constantly evolved, adapting to internal and external conditions. Undoubtedly, cities have generally succeeded in the adaptation process, building up a capacity to absorb and reduce the severity of shocks even in natural disaster contexts. Ancient Roman records contain many references to catastrophes and information on beliefs, needs, and post-disaster management strategies. Furthermore, many advancements in construction techniques and preventive solutions capable of providing resistance to disasters emerged from archaeological evidence.

Through an interdisciplinary and innovative approach, the conference offered the opportunity to discuss and question different topics related to natural hazards and the consequences of disasters in terms of development and crisis in archaeological contexts. New planning horizons for the valorisation of the Roman territory and the context of Ostia Antica and Portus broaden the temporal context of the discussion, bringing them closer to our present.

Meanwhile, ancient contexts such as Herculaneum and Pompeii launched the initial debate, highlighting the relevance of protecting their value as cultural heritage. A meeting of experts, from scientific and humanistic disciplines, examined this topic from a variety of approaches and methods in an effort to understand this topic in deeper and more nuanced manner.

This international conference drew on relevant case studies concerning our cultural heritage and how we can still very much learn from ancient times. Cultural heritage is not only a document of the identity of a community and a territory but can also be the keystone for reconstruction and building resilience to disasters. Starting from this awareness, the debate showed that even when hazards and shocks had similar features, their outcomes often varied due to

interacting with very different social, economic, political, and cultural settings, thereby exhibiting dissimilar levels of pre-existing vulnerability. Disasters can arise from human action, such as fire, vandalism; or, natural events, including extreme weather which can precipitate floods, fires and much else.

The environmental context of Ostia Antica and Portus, as sites on the coastal zones, for instance, were constantly confronted by the threat of storm surges and floods and, therefore, often formed a 'region of risk'. Although centuries can divide major disasters like the earthquake of Crete in 1600 BCE, and the eruption of Mount Vesuvius in 79 AD, many similarities exist with more recent disasters such as the 2011 earthquake which hit northeastern Japan.

Apart from the current popularity of the concept that catastrophes were powerful agents for cultural change, there are other reasons why studying natural disasters is necessary for archaeological theory and practice. Knowing the chronology of a place or a monument concerning past disasters can contribute to our understanding of historical seismology in specific and broader contexts. It can better indicate which protection strategies were adopted, what adaptive skill was developed, and more.

The collection of contributions begins with a *key phrase* that will remain in the background until it resurfaces at the end of the conclusions in an intense and relevant debate. *Learning from the past* is a key aspect of the well-being of humankind in the future. Learning is key for societal improvement to avoid natural and human-generated disasters, but alone cannot lead us to the perfect one and forever solution. Natural, environmental, and societal processes must be evaluated because each dynamic and their combined interactions often yield unanticipated concerns. In this framework, Pecchioli started to analyse the context of Ostia. This involved several colleagues who adopted an archaeoseismological approach, which provides a relevant topic about strategies for adapting to natural disasters that have contributed to its urban physiognomy and economic development. While the realities of both disaster risk and climate change are uncertain, many disasters have historical precursors and foreseeable impacts with attention to the dimensions of risk, such as physical hazards, exposure, and vulnerability of people. Constant adaptation has developed a daily practice of maintenance, repair, and advancement in preventive solutions against disasters. Building resilience to disasters requires learning from the past and the present, as well as from successes and failures.

As the archaeologist Rodolfo Lanciani noted at the beginning of the last century, the surviving masonry structures of Ostia Antica preserve conspicuous traces of damage, mainly of seismic origin, with examples of repairs using different techniques in the numerous surviving buildings. Giuliani gives us an overview of the structural mechanics of the different types of intervention in ancient repairs to trace the causes of the instability. Evidence includes the material survival of the system that aroused Seneca's amazement at the architects' ability to rebuild the ground floor without demolishing the upper floor, the repair of deflected floors by re-establishing their horizon, the replacement or securing of damaged flat arches, etc.

Rinaldi accompanies us on a reading and interpretation of traces of instabilities, or ancient construction devices, closely linked to the type and quality of restoration work carried out in Ostia from the Unification of Italy (1871) until today. Collapses caused by sheer stress, probably due to seismic actions, are almost exclusively visible in the urban sectors investigated in the second half of the nineteenth century. On the other hand, the re-composition or elimination of fallen wall sections, frequently adopted in subsequent interventions, drastically reduces analysis possibilities. The same applies to the ancient preventive measures dictated by the problematic hydro-geological situation in the Ostia area, which the local builders had to consider. Clamping techniques, the insertion of wooden chains, and technological expedients to combat rising dampness can only be read if they are adequately recognised and respected during conservation or reconstruction work.

The response to an earthquake depends on the structural characteristics of the building, including a defect in design, the materials employed, craftsmanship, and so on. Furthermore, earthquake dynamic response also depends on the site's geology, promoting or diminishing ground shaking¹. The campaign of seismic noise measures and a review of available stratigraphic logs performed in the investigated area have provided information on the subsurface geology and two interesting hypotheses of possible earthquakes. In the *Piccolo Mercato*, Betti, Pecchioli and Pintucchi show through seismic effects evident in the masonry and some of the pillars that supported ancient times an arcade, the results concerning a nonlinear time-history analysis, performed with finite element models of one of these pillars assuming natural earthquake records provided a possible dateline of the damage.

The Roman town of Ostia provides a unique opportunity to study a wide spectrum of structural damages affecting different typologies of ancient buildings. Compared to modern constructions, antique buildings show damage patterns like those observed in recent earthquakes. Seismic damage to ancient buildings can represent a major source

of information about the parameters of past earthquakes (intensity, directivity, etc.). Pecchioli and Cangi's contribution focuses on the relevance of considering the picture of earthquake damage to so many structures in the context of Ostia Antica. A study opportunity that derives from the moral obligation to maintain a source of knowledge useful to understand and improve the seismic behaviour of existing structures. It seems appropriate to demonstrate that the value of the ruins of Ostia is also linked to the signs of collapse, which tell of the vicissitudes of the entire city and individual buildings. This ancient rule is based on the evolution of anti-seismic construction techniques and the definition of appropriate criteria for the analysis of historical masonry structures through the study of collapse kinematics, also in the case of Ostia Antica.

Ostia underwent a drastic reconstruction after the Flavian Age when, in many areas of the city, it was necessary to rebuild buildings at a level approximately one metre higher. That increase in activity caused a revolution in town planning (extension to the northwest of the area reserved for warehouses, new residential blocks, etc.). Pensabene explains that the scale of reconstruction is such that it must include more than explaining the increase in sea and trade traffic alone. The restructuring of Claudius' harbour with the insertion of the hexagonal basin in Trajan's time led to the opening of new canals to drain the waters of the Tiber, causing a significant increase in sea traffic and the transport of goods. Consequently, there is a need to build new warehouses and quarters for the port workers' dwellings to unload goods and their services (baths, latrines, *fullonries*, etc.). That increase in activity caused a revolution in town planning (extension to the northwest of the area reserved for warehouses, new residential blocks, etc.). Still, the scale of reconstruction is such that it must include more than explaining the increase in sea and trade traffic alone.

Milana showed us various possible scenarios with related interpretations between Ostia and Portus through the results of geophysical and seismic in situ investigations in 2017 and 2019 and with future developments. From observing possible earthquake-induced damage in Roman masonry structures in Ostia, an original multidisciplinary (geological-structural-geomorphological and seismological) study was performed to evaluate the possibility of relating this damage to a previously hypothesized ENE-WSW trending local fault. The latter would be located bordering the morphological height upon which the ancient town of Ostia was founded. A brief geological description of the area is presented to describe its structural setting characterised by active faults that could be potential sources of low to moderate-magnitude earthquakes as a source of potentially damaging events in Ostia. The results of a campaign of geophysical investigations based on ambient vibration seismic analysis and geoelectrical profiles are also presented. This study aims to detect the presence of resonance frequencies related to the soft sedimentary layers that characterise the entire area of ancient Ostia. Furthermore, this approach allows inferring information on

¹ The strength and duration of the ground shaking normally depends on many factors, predominantly the magnitude of the earthquake, distance to earthquake origin, and local soil conditions.

the sedimentary cover's deep and shallow parts, generating seismic amplification effects of ground shaking.

Holmes's contribution is novel because it specifically explores ancient Roman disasters in the context of Roman sporting stadia and traditions. Natural and non-natural disasters in ancient Rome have been chronicled since the seventh century BCE. From various sources, we know that Ostia and Portus have been subject to disasters as early as the Republican Period, such as the tsunami recorded in 44 BCE and the violent storm that destroyed 200 harboured ships in 62 CE. Holmes examines the implications of disasters on public games in ancient Rome and speculates on the situation in Ostia and Portus, where the evidence could be more forthcoming. He considers the extent to which public games (chiefly gladiatorial contests and chariot races) offered a form of social resilience to adversity and what public games meant to its citizens during these times. To understand the social and cultural significance of sport in Roman society, we must recognise what assumptions the Romans brought with them, which we can infer from textual and material sources. Moreover, from the geophysical investigations along the coast by Heinzemann and his colleague Tucci, new hypotheses are trying to identify new structures and their functions such as the possibility of a circus. There is conjecture that a circus must have existed based on literary and artistic evidence—and, indeed, most Roman towns had them—though a circus is yet to be located. Nevertheless, examining public games in Rome and its provinces, together with what evidence we currently have from Ostia and Portus, will steer us towards a picture of the role of sport in this area during times of adversity.

Among the possible factors of calamity, the Pavolini article focuses on seismic risk, in Ostia during late antiquity. Reviewing the literature since 2000 on the colony, one observes the frequent and widespread recourse to the 'seismic hypothesis', not only to explain single episodes of collapse or instability of buildings but also as a possible cause of the more general urban crisis of that period (although counterbalanced by moments of recovery and attempts at reorganisation).

As a result of his Ph.D., Trockles presents us with a study of the repairs and possible restoration of the Capitolium with an archaeological approach, Hadrian's building of remarkable quality of workmanship and building materials. In this context, this biggest known temple of the city represents the most dominant structure, enthroned on a high podium over the plaza, within the Hadrianic conversion of ancient Ostia's main forum. What is surprising is that, apart from the dating of the building's ornaments and the brick stamps, which deliver the date to the building's construction phase, there are no direct dating criteria for maintenance works and only very little direct information on the individual history of survival to the present day mentioned. Equally, this observation counts for detailed archaeological investigation and contextualisation of the building with the surrounding structures of the forum

based on actual archaeological data. But, indisputable about Ostia's history is that floods regularly hit the city. In contrast, there has been no consensus in the scientific community concerning other natural catastrophes, first and foremost earthquakes, although a first article in 2002 provided evidence.

During the structural analysis undertaken at the *Case a Giardino* complex in 2019–2021, several observations about the buildings could be identified as probable evidence of seismic damage or landslides. Such proofs are due to natural causes and related to the soil condition: foremost to be named are cracks in the masonry and walls leaning towards one side. Falzone, Adnstedt and Ruggendorfer analysed the construction technique and the decorative elements, combined with these structural modifications, allowing us to point out the different temporal frameworks, which could also help support the chronological placement of possible seismic activities within Ostia.

Recent excavations and archival research by the UT•OSMAP project led by Professor L. M. White have identified evidence for significant episodes of destruction caused by earthquakes. This evidence is supported by documented accounts of earthquakes in ancient records at Ostia, Rome, and Lazio dating from the late 3rd century to the beginning of the 9th century CE. Most importantly, some of these documented episodes correlate precisely with archaeological evidence for the phases of renovation and reuse in the Synagogue complex. For example, one of the later, such episodes was likely a contributing factor in the final abandonment of the Synagogue at the beginning of the 7th century CE. The most important of these events, however, seems to have been the earthquake of 443 CE, which destroyed the Intermediate Phase of the complex (351-443 CE – the 'Early Synagogue').

Between 2010 and 2013, all of the Forum's porticoes were re-excavated and documented by the Ostia-Forum-Project (OFP). The history of the collapse of ancient Ostia became the focal point of a detailed study based on the old excavation journals and new documentation techniques with high-resolution 3D models. Since 2012, our focus on documentation has shifted gradually from the destruction-history of buildings to the active overcoming of collapse, i.e., the late-antique repairs of collapse and the surprisingly 'booming' marble-recycling industry. Due to the analysis of several well-preserved marble piles of ancient marble workshops in the Forum, there is clear dating evidence for a cluster of collapse events around the middle of the 5th century AD; thus, suddenly, a lot of marble architectural elements were available for secondary use. Gering and Daviddi's contribution provides an overview of the excavations carried out by the Ostia Forum Project in the Forum area of Ostia Antica, which have led to the discovery of a large amount of numismatic material. The study, focused on the more than 600 coins found in a single room located in the corner of an *insula* facing the south-west of the porticos of the Forum, takes a

closer look at the coins found in the context of this marble deposit and immediately underneath: the history of this building can be dated quite exactly thanks to the stratified coin evidence. Based on the supplementary observation of several massive cracks in all supporting walls of the insula's ground floor, this history can be understood as a process of radical change of function with a certain 'catalyst' of one or more catastrophic events around the mid-5th century AD.

Marcelli and Pacciani address one of the most topical issues: how much cultural heritage is at risk and how to enhance the territory by better-targeting investments in local resources. Fundamentally, the importance of educating tourists with critically elaborated information remains, providing the territory with a network of infrastructures suited to the urban bearing concerning the archaeological and historical landscape. The widespread area examined, between the Castel Fusano pine forest and the Castel Porziano manor, appears paradigmatic from the point of view of the changes that took place from late antiquity and then, more so, during the Middle Ages. The coastal zone along which the Via Severiana developed was, in fact, abandoned at the end of antiquity due to general depopulation and the risk of incursions from the sea. The phenomenon that had the greatest impact on the destiny of this territory, however, was the advancement of the coastline by more than 600 metres compared to the ancient one, mostly due to the lack of maintenance of the Tiber channel. The result is that today the ruins of monuments from the imperial period, such as the so-called 'villa of Pliny', are situated inland, originally located in front of the sea.

In the framework of the suburbia of Ostia, Pannuzi and Rosa illustrate how it was exposed to the frequent ruinous floods of the river, well known by historical sources from its origins until the twentieth century. These river floods deposited the silt in suspension and contributed to forming a thick alluvial stratification. This was the cause of an adaptation of the roads and settlements to the progressive growth of the soil, with progressive abandonments and re-functionalizations of the spaces closest to the river. Near Ostia, the post-Tiberian floods changed the ancient route via Ostiense to get to the town. For these emergencies and the better functionality of this important road, archaeological research has revealed the creation of protective structures, such as viaducts and massive walls. Furthermore, in the Ostiense area, in addition to the problem of the Tiber flooding, there were difficulties created by the arrangement of the banks of the Stagno. It was also characterised on the western side by a substantial rise of the groundwater, contrasted with a capillary work of water drainage in stagnant areas.

Between 1988 and 1989, a long season of excavations was carried out in the Necropolis of Isola Sacra, dictated by the need to create a drainage system to counteract the water table's periodic rise, which threatened the monumental

tombs discovered by G. Calza in the 1930s. The excavation interests the western side of the road leading from Ostia to Portus, on the so-called 'Campo dei Poveri' (Field of the Poor), and the spaces between the monumental tombs. Despite the constraints imposed by the needs of the building site and various operational difficulties, it was possible to investigate an area of a little less than 2,000 m², in which 670 depositions were identified, with different burial methods and rites. The number of burials was already surprising and unexpected during the excavation. Besides, the available space was occupied in a particularly dense manner. There were burials, but mostly in a haphazard manner without any signs of organisation. Some rested against the monumental tombs, even on the side of their entrance. This evidence suggested to Olivanti and Spanu a certain compulsiveness in this necropolis area due to the need for intensive and almost systematic use of the areas outside the monumental tombs.

Genovese, Lo Blundo and Spagnoli's contribution takes into consideration the theme of 'disasters', about those events not so much attributable to natural causes but rather attributed to human activities and, in this specific case, to the series of incursions/invasions of those barbarian populations that shook Rome and the territory considered here during the 5th century AD, as attested on a literary and archaeological level. It is, therefore, a question of reflecting on the coincidence between the reading of archaeological data and the explanation of a disastrous event, the repercussions this may have had on the monumental configuration of the area, or its continuity or discontinuity of occupation and frequentation. With regard to the territorial area examined, the famous inscription mentioning the 'vandalica rabies', now lost but believed to have come from the Isola Sacra. It has been understood in various studies as eloquent evidence of the aggressiveness of the incursions, in this case of the Vandals, that struck this important territorial district and is in direct relation to the imperial ports serving the Urbe, and the repercussions they must have had on the area, according to literary tradition and in the light of the existing archaeological documentation.

The article, presented by Daffara, Coccia and Galadini, aims to investigate a working hypothesis formulated by Lidia Paroli during the excavation of the Christian Basilica of Pianabella in 1988–1989. The monument in the city's southern outskirts stood within a vast necropolis and was striking from east to west. Observing the collapsed longitudinal walls of the building, the scholar concluded that the collapse occurred simultaneously in the southern direction and became convinced that it was caused by a seismic event, which struck the investigated area shortly after the abandonment and spoliation of the basilica in the 11th century. By reviewing the archaeological record and comparing data on other known seismic events, an attempt will be made to identify this earthquake among those attested by sources in the Middle Ages. Moreover, the authors attempt to correlate the collapse of the basilica to

the evidence of other disruptions documented in the Ostia and Portus framework.

Döring-Williams and Albrecht illustrate the results of their studies on the collapse dynamics of the Basilica of Maxentius. From a structural analysis perspective, there are several indications that the Basilica collapsed partially in the first devastating earthquake of Late Antique Rome in 443 AD. However, with the tools of building archaeology alone, only a relative chronological dating approach is feasible. The results to date have now been considered in a more complex way, particularly in comparison with selected archaeological studies.

In the context of Pompeii, Amoretti, Calvanese, Russo, Mighetto, Russo and Zuchtriegel present the House VI, 17, 41, also known as the House of the Library. This belongs to the group of houses on slopes (Hanghauser) distributed along the front of the *Insula Occidentalis* of Pompeii. The blocks' houses, subdivided between *Regiones VI* and *VII*, scenographically exploit the height difference created by Pompeii's urban walls, grafting themselves behind them to enjoy the panorama of the Bay of Naples. The name of the house is linked to the functional interpretation of the room (18) as a library, both due to the presence of the recessed wooden cupboard for storing volumina in the north wall and the iconographic interpretation of the frescoes with two characters characterised by their attributes as poets.

The tragedy that struck the Vesuvian area in 79 AD is among the best-known and most studied in antiquity. Herculaneum, a small and elegant town overlooking the Gulf of Naples, offers a precious snapshot of the city and its unfortunate inhabitants who were caught in the tragic moment of destruction. Today, Herculaneum is a large open-air laboratory, where research and conservation activities, conducted with modern investigative technologies and a multi-disciplinary approach, provide an increasingly in-depth understanding of Roman society in the 1st century A.D. The tangible culture, thanks to the special circumstances of the eruption, is here extraordinarily well represented and preserved. Sirano introduces us to recent discoveries on the ancient beach, which have shed new light on past discoveries, further defining the dynamics of the eruption and the effect it had on the landscape, buildings, and, finally, on the people and their desperate search for salvation. The match with literary evidence is impressive and almost unique in archaeological studies.

Over the last few decades, studying high-energy natural events throughout history has been relevant in scientific studies. The succession of these events and their impact on coastal populations currently represents an interesting line of research in which archaeological and geological studies must be applied jointly. In their article, Meléndez, Muñoz, Campos and Carrasco review the tsunamigenic evidence (archaeology, economy, sedimentology, paleontology, dating) during the III-IV centuries along the southern coast of Spain, in more detail the coast of Huelva, with

the application of the latest data on the regional reservoir effect to the dating carried out.

The volume closes with Nunn's contribution to his anthropological approach that reconnects the themes presented at the event and gives voice and value to the oral tradition, the most primitive knowledge, and the spirit of adaptation. Nunn introduces several relevant topics that relate well to the history of disasters, the identity of places, and the importance of preserving an oral culture, especially in several countries such as Australia and Indonesia. An oral culture on building techniques and how they can be a solution to cope with calamitous events. At the same time, he introduces a factor that has influenced historical events since ancient times: climate change. In this context, he highlights the demand to adapt our knowledge of risks to create a risk culture. In pre-literate (oral) societies, important knowledge was acquired and communicated for the same reasons as in today's literate societies. This knowledge included information about memorable impactful events (like natural disasters) that had occurred in the past. This information included details of the causes and control (spiritual and physical) of disasters, the recognition of their precursors, and the responses that enabled people's survival and recovery. While much of this knowledge has been lost, largely because of the replacement of oral with literate contexts, enough remains for us to obtain a general picture of its importance and persistence.

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