Chapter 4
Lifting the Veil of Time:
Natural Hazards and Structural Problems Affecting Cultural Heritage Sites and Scientific Methods for Their Preservation

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ABSTRACT

Cultural heritage sites are fundamental elements of national and international heritage and are regarded as sensitive and critical structures of high and of national importance, exposed to a range of natural hazards, leading often structural failures. Cultural heritage sites include structures and monuments with effectively limitless lifetime, while admitting only limited intervention options. Therefore, the efficient assessment of their structural risk forms a very demanding task in comparison to similar analyses applied to modern structures. The current study is involved with natural hazards and natural disasters that have affected cultural heritage sites in the past and their consequences regarding their structural integrity. After a description of the aforementioned, specific scientific tools and advanced methods for the investigation of the geophysical/hydrological and climatological/meteorological natural hazards and their consequences at cultural heritage sites, regarding their structural integrity are presented and discussed.

INTRODUCTION

Natural hazards and natural disasters have always accompanied human history. Natural hazards are naturally occurring physical phenomena caused either by rapid or slow onset events which can be geophysical/hydrological such as earthquakes, landslides, tsunamis, rockfalls, volcanic activity, avalanches, and floods, and/or climatological/meteorological events, such as extreme temperatures, droughts, wildfires, cyclones and storms. Natural hazards have negative effects on humans and the environment (including the man-made environment), and in some cases they may escalate into natural disasters.

In around 1600 B.C., the volcano of Santorini (Thera) erupted with such force that this single event caused the collapse of the Minoan civilization (Figure 1, source: Hellenic Ministry of Culture, Greece),

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Figure 1. Akrotiri: The Ancient Town Buried by a Volcano. The cataclysmic eruption of Thera split the island of Santorini into three smaller ones

110km away, at the island of Crete (Athanassas et al., 2018). The Thera eruption is considered to be the largest one on Earth in the last 10.000 years, with subsequent earthquakes of great magnitude and tsunamis of approximately 50m height. It is also estimated that around 40 km^3 of magma and rock had erupted from the volcano. In 730 B.C., according to the Roman geographer Strabo, the city of Chalcis, located at the island of Euboea in Greece, suffered a severe drought and 10% of the city's young men were sent as an offering to Delphi (Radt, 2011). In 464 B.C., an earthquake struck Sparta, at a time when the relations of Sparta and Athens were in a delicate state. It took Sparta by surprise, killing more than 20,000 Spartans, leading also to internal and external uprisings (Holladay, 1977). In 373 B.C., the ancient Greek city of Helike, the flourishing capital of the Achaean League, was destroyed during a winter's night. The city sank into the earth and the inhabitants perished without a trace, probably due to a rapid and catastrophic landslide, and/or due to a massive tsunami (Psarropoulos & Gkantona, 2020). The dramatic destruction of Helike was widely discussed by many Greek and Roman authors and may have inspired Plato to contrive the myth of Atlantis.

In Europe, a very well-known case of an extreme natural disaster was the Great Lisbon Earthquake of 1755 A.D., in Portugal, where approximately 60,000 people died due to an 8.5 magnitude earthquake and the subsequent seismic activity (Figure 2 is for a depiction of this natural disaster). A series of earthquakes rushed-up the Tagus River, causing tsunamis of around 20m high, while in parallel destructive fires broke out in the city, leading to a significant devastation of Lisbon. The Great Lisbon Earthquake occurred on All Saints' Day when a large part of the population was in the city's Churches at the moment the earthquake struck. The Churches were unable to withstand the extreme seismic activity and collapsed, killing thousands of worshippers. The disaster was widely discussed by European Enlightenment philosophers, leading to the birth of modern seismology and earthquake engineering (Reinhardt & Oldroyd, 1983). That was the time when earthquake phenomena were studied scientifically for the first time.