



: SIG: Gestion des désastres avec l'accent sur le patrimoine c

**Sub Project DISMA
DISaster MAnagement GIS with emphasis
on cultural sites**

TECHNICAL REPORT: Volume II

**GIS FOR HAZARD ASSESSMENT OF CULTURAL LANDSCAPES
EASTERN ATTICA AS CASE STUDY**

**Centre for the Assessment of Natural Hazards
& Proactive Planning**

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Foreword

This work aims to establish an interregional operation to protect cultural heritage from damage in the face of natural events under the auspices of INTERREG IIIC-Sud Initiative and the Regional Operation Framework of NOÉ Programme - Patrimoine et prévention des risques naturels- with final beneficiary the Eastern Attica Prefecture. In the framework of NOÉ, the aim of the sub project DISMA is the risk estimation of selected sites of cultural interest within the specific pilot case studies of the region of Eastern Attica Prefecture using GIS environment.

This technical report describes the work that was conducted in order to identify and estimate the impacts of a flood event to selected cultural sites and to the economic sector of the surrounding affected area.

The research was performed by the Centre for the Assessment of Natural Hazards (CANAH) of the National Technical University of Athens. The simulation of the flood events, the model set up in HEC and GIS environment and the production of flood maps were performed by *Aimilia K. Pistrika*. She has also contributed to the building of the risk estimation methodological framework in the face of flood hazard. Data collection and analysis regarding the selected sites of cultural interest within the Eastern Attica Prefecture was conducted by *Amanda Laoupi*. Software development in GIS environment was performed by *Iraklis Klampanos*.

Also, Laboratory of Photogrammetry, School of Rural and Surveying Engineering, NTUA contributed the photogrammetric data collection and analysis to the DISMA sub-project, the Laboratory of Remote Sensing contributed the photo-interpretation data collection and analysis and finally the Laboratory of Geography and Spatial Design contributed the building of a GIS database of selected cultural sites.

The scientific coordinator of the sub-project DISMA and Director of the Centre was *George Tsakiris*.

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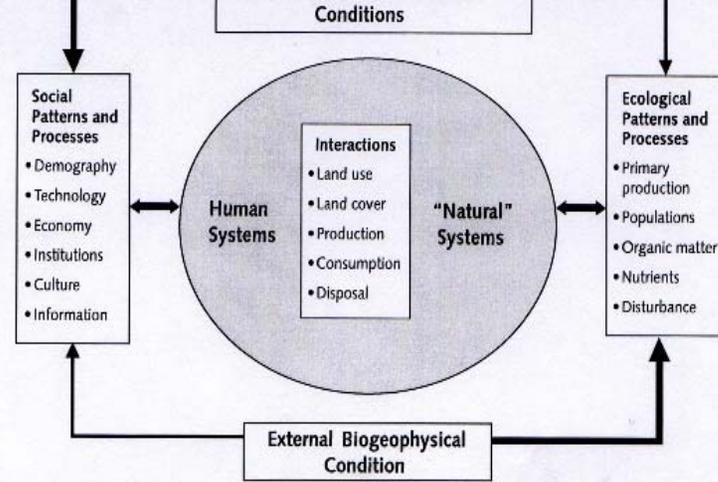
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1 INTRODUCTION

1.1 The cultural landscapes of Eastern Attica: thousands of years of civilization

† The concept of place is a vivid entity which embraces human's perception of the landscape. Each and every place has its own identity, character and expression's patterns, its own language, either tangible or metaphorical / spiritual. Each and every place constitutes of parallel and overlaying landscapes that include: rational forms & mythical symbolism, the collective unconsciousness of people passing by or settling in them, multiple coexisting cultures, traditions, customs & habits, varying environmental settings (climate, geomorphology, flora & fauna), visual, acoustic, savoury, smelling and tangible impressions and memories, as well as events, accidents and changing names.

International conferences have defined the term 'landscape' as 'the visualization' of abiotic and biotic elements and parameters within the environment, that exist in a given geographical area and have a strong relation to each other, the natural place of ecosystem's expression, an area, as perceived by people, whose character is the result of the action and interaction of natural and / or human factors (European Convention, 2000; Palermo Declaration, 14 - 16 November 2003). This is only a glimpse into the vast world of landscapes, extended from Neurobiology to Astrophysics, for landscapes are created out of people's understanding and engagement with the world around them, constantly shaped and reshaped, always temporal, polyvalent and multivocal. They are not a 'record' but a 'recording' as they provoke memory and facilitate or impede action. They embrace both the untidiness of spatial temporalities and structural inequalities, as well as the past embedded in them (Bender, 2002).



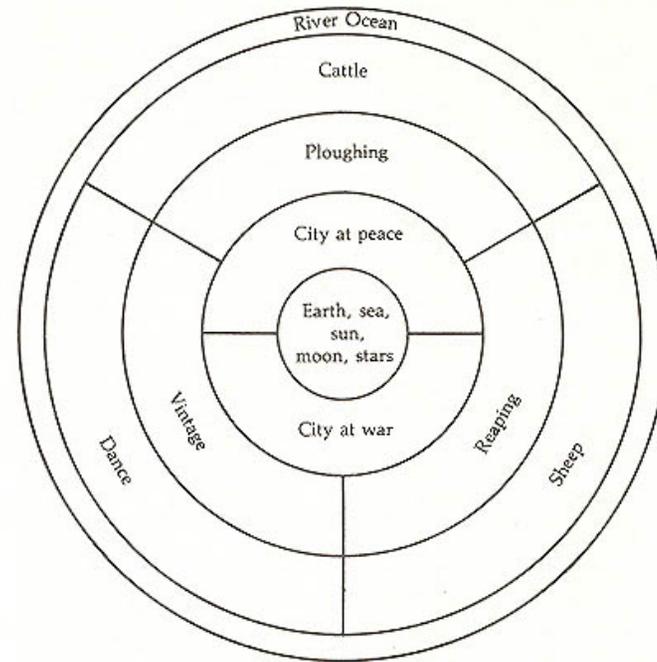
Conceptual framework for investigating the integrated human ecosystem

Source: The U.S. Long-Term Ecological Research Network (2000), "Toward a Unified Understanding of Human Ecosystems: Integrating Social Science into Long-Term Ecological Research" <http://lternet.edu/documents/Publications/sosciwhlpppr/>

The complex intersections of memory and landscape (e.g. material or idealized, mental, inner, symbolic, gendered, sacred, familiar, of diaspora, of loss, of silence) are registered on the pathways of power, fiction, architecture, symbolism, gender, art, space's organization and death's reality. Thus, landscapes are no longer to be separated from human experience or seen as purely visual, instead they include movements, relationships, memories and histories through space and time (Feld and Basso, 1996). Modern archaeologists try to understand the landscapes that work and are worked on many different scales (Tilley 1994; Bender, 2001).

Greece, having a complex geomorphological, environmental and geographical reality, offered the ideal scenery to their inhabitants, since Prehistory, for the creation of varied physical, biological, abiotic and socio-economic systems. Mediterranean world is composed of scores of thousand physically differentiated microregions, the local ecologies of which have separable identities that continually interact each other. Their evolution and transformation had to take into account longer time frames, in particular intergenerational and historical dimensions, along with other socio-cultural parameters, such as the urban hierarchies and the shift of populations, ideas and products.

Furthermore, the Mycenaean city-states were autonomous physical, socio-economic and cultural entities dispersed within the Greek landscapes, with their city-centre, the rural and peri-urban space, the acropolis and the sanctuaries, the established political alliances and the commercial network. Later on, Homer describes the natural environments that characterized those centres, by giving different ecological elements for each of them (i.e. Catalogue of the Ships in II., 494 ff.). In the Homeric narration about Achilles' shield (II. XVIII.474 - 617).



Achilleus' shield in Iliad
home.att.net/~a.a.major/wrapup.htm

From the Homeric terms (polis, acropolis, asty, agora, gaia, aroura), gradually, the perception of urban and peri-urban landscapes gets more and more differentiated (Pritchett, 1953 & 1956), including various spaces that reflect human management of the natural and modified environments: A. (1) soil that is appropriate for cultivation (agros), (2) cultivated field with cereals, vineyards and other vegetables (ge psile), (3) plot (gepedon), (4) forest of oaks (dryinon), (5) forest of pines (pityinon), (6) mountainous woody area (orgas), (7) cultivated area (aroura), (8) pasture land (nomos / nome), (9) woods (hyle), untouched, aboriginal landscape in the extremity of the city-state (eremia) and B. (1) sacred space / sanctuary (temenos), (2) city-center (asty around acropolis), (3) 'market place' (agora), (4) city as center of the periphery (polis), (5) land property (chorion), (6) garden (kepos), (7) house (oikia), (8) plot above which a house is built (oikopedon), (9) cheap & quickly constructed building (synoikia).

Consequently, the categorization of resources and the relevant human activities within the ecosystems of the 'polis' in the form of balance: input / output (water supply, timber supply, agriculture, pastoralism, hunting, mining, energy sources, sewage disposal, climate exposure, pollution rates), along with the hierarchies within human society at geopolitical, religious, socio-economic, biological, cultural and administrative level, formed the complexity of ancient cities. These formations, in fact, never stopped functioning in the nucleus of Greek history, even if larger or different socio-economic patterns transformed the type of their government. Thus, the Greek landscapes are from the very

multi-temporal echoing collective memories (Tuan, 1974; Penning-Rowse and Lowenthal, 1986; Cosgrove and Daniels, 1988; Gregory and Walford, 1989; Bender, 1993; Ingold, 1993; Fleming and Hamilakis, 1997). The landscapes of memory have always been multi-cultural and mutable intersecting landscapes. Homer, Aristotle and Pausanias, as well as the majority of ancient writers described such units (astrea). Their words reflect the richness of physical and human worlds in a vibrating chorus that encompasses a variety of components, characteristics, functions and levels. For example, Attica with its thousands of years of civilization, includes 'urban' environments with both physical and human landscapes. The first Neolithic inhabitants of Eastern Attica selected coastal areas and hills to settle (Rhamnous, Kato Souli, cave of Pan at Oinoe, Plassi at Nea Makri, Kazarma at Rafina, Loutsas, Three sites around Brauron, Thorikos, Megalo Lithari at Anavyssos, Lagonissi, Kitsos cave). On the other hand, modern constructions such as the recently built Attiki Odos enriched dramatically the archaeological evidence in Attica (Late Roman agro-pastoral unit at Phylli, farms, civil constructions & cemeteries at Acharnai dated from Archaic to Roman Times, significant archaeological elements from Early Helladic II at Kato Kifissia, cemeteries & ancient roads at Maroussi, ruins of the famous Freres Mineurs at Francoklissia - Chalandri, ancient road network at Mesogeia, cemeteries on the banks of local torrents, removal and restoration of the byzantine church of Saint Thekla at Stavros Agias Paraskevis, important Early Helladic settlement at Gerakas & the Mycenaean cemetery at Glyka Nera, important Neolithic settlement on Levidis' hill at Palleni along with Classical farms all over Mesogeia plain).

The physical landscapes (soil, hydrology, topography, vegetation, climate, animal communities) dictate the kind, rates and limits of human exploitation over the natural resources, by enhancing some strategies / choices against some others. In addition, the landscapes of human activities (humanscapes) play a prominent role within urban environments. Within the afore-mentioned realities, during each historic period there existed, simultaneously, many forms of landscapes that are reflected into the environment leaving direct (archaeological) or indirect (intangible) traces:

(1) Landscapes of Identity

a. Unfamiliar, alien or hostile landscapes are characterized as landscapes of separation

Ancient poleis of Attica hosted a variety of 'moving' or 'alien' population which had its own particularities and experienced the deprivation of 'home', e.g. slaves, metoikoi, political / economic refugees, orphans, very poor, aged or handicapped people, victims of war. The reverse procedure includes the merchants, the soldiers, people in exile or the nomads, the emigrants and the colonists. These landscapes of loss may have been originated in environmental (catastrophic phenomena such as earthquakes, soil liquefaction, volcanic eruptions, tsunami, landslides), or human-induced causes and experienced by individuals (e.g. heroes, philosophers, geographers, historians, groups of people (e.g. masters with their pupils, artistic workshops), 'houses' / families

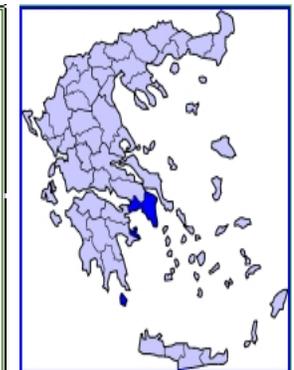
For example, the geographical distance, created the concept of borderlands, as many Athenian colonies were built at the margins of the circum-Mediterranean world. Equally, alienating forces of modernity may rework a landscape, or a person may at the same time feel at home and powerful within a local landscape but marginal in terms of a larger political and economic landscape.

The case of the first years of the Peloponnesian War, when the peasants of Attica were forced to move within the Athenian Walls (Aristophanes Peace, 306 - 8, 551 -5 & 582 - 600; Thucydides, II.xiii & xiv; Aristotle Ath. Pol.XXII.24.1), having as a result the disturbance of the socio-economic and sentimental equilibrium of the Athenian society, is quite indicative of the stress experienced in similar cases by people who move violently away from their 'homeland', even if they still live within the larger geopolitical boundaries of the same state.

b. Landscapes of return, reconciliation, unification

Places of commemoration, of socio-cultural identity (e.g. cemeteries, agora, monuments), familiar paths / strategies / reactions, social bonds, myths & memories of homeland, genealogies & stories for the ancestors, the sense of self and belonging, shared language (idioms), familiar topography, familiar places within the landscape, feeling of safety. Home sickness (homeric 'nostos') of Odysseus and the Oath of young Athenians Ephebi (Herodotos, VIII.53; Euripides Ion, 495; Aristophanes Thesm., 533; Lykourgos Against Leocr., 76; Ploutarchos Alc., 15.4; Hesychios, s.v. Aglauros. Dumont, I, 1876 : 8 - 15; Farnell, 1907: 19; Pelekides, 1962 : 76; Der Kleine Pauly, 1967: 287 - 291) reflect in the best way the multi-sensory elements that forge the concept of landscape in the mind and heart of ancient people, as sight, sound, smell and touch, mind and body acted inseparably.

Ὀὐκ αἰσχυνῶ τὰ ἱερά ὄπλα οὐδὲ λείψω τὸν παριστάτην ὅπου ἂν σ(α)γχήσω·
 ἀμυνῶ δὲ καὶ ὑπὲρ ἱερῶν καὶ ὁσίων καὶ ο(ὐ)κ ἐλάττω παραβάσω τὴν πατρίδα,
 πλείω δὲ καὶ ἀρείω κατὰ τε ἔμμαντόν καὶ μετὰ πάντων,
 καὶ εὐηκήσω τῶν ἀεὶ χρ-αινόντων ἐμφρόνας καὶ τῶν θεσμῶν τῶν ἰδρυμένων
 καὶ οὐς ἂν τὸ λαπὸν ἰδρύσωνται ἐμφρόνας·
 ἐὰν δέ τις ἀναρῆι, οὐκ ἐπιστρέψω κατὰ τε ἔμμαντόν καὶ μετὰ πάντων,
 καὶ τιμήσω ἱερά τὰ πάτρια.
 Ἱστορες θεοὶ Ἄγλαυρος, Ἔστια, Ἐνυώ, Ἐνυάλιος, Ἄρης καὶ Ἀθηνᾶ Ἀρεία,
 Ζεὺς, Θαλλώ, Αἰξό, Ἥγεμόνη, Ἡρακλῆς,
 ὄροι τῆς πατρίδος, πυροί, κριθαί, ἀμπέλοι, ἔλαια, συκαί.



The Oath of Athenian Ephebi

Map of Greece - Attica

(2) Functional Landscapes

Landscapes of 'power' / production / maintenance / disposal / redistribution include natural features that provide resources for humans (e.g. woods, drinkable water, mines, cereal fields), areas where production takes place (e.g.

(3) Landscapes of human-made boundaries

^Ancient poleis recognized various physical elements (e.g. shorelines, rivers, mountain heights and other natural features) as natural boundaries or characteristic points of reference within their landscapes. On the other hand, the human landscape was always segmented and shaped by the needs of daily life and the conventions of political organization (Cole, 2004: 7- 8). Although the word 'extremity' (Greek *eschatia*) has not yet been found in the Mycenaean Greek (Casevitz in Rousselle, 1995: 19 - 30), the Ionian word with its derivatives already exist in the Homeric Poems, where they belong to an agricultural terminology (i.e. Il. II, 508 & 616; IX, 84; X, 206. Od. iv, 515 - 6; v, 488 - 491; xiv, 104). Later on, they are found in the majority of Greek authors (i.e. Hesiod, Archilochos, Pindar, Plato, Xenophon, Aristotle, Suidas).

Moreover, human societies are characterized by a number of human -made 'boundaries' reflected to the landscape, political (citizen / foreigners or cast off), religious (people of the same or another religion), economic (rich /poor), biological (young / old, healthy / sick or crippled), social (private / public), within which the various groups have their own role and function. Three of them deserve special mention:

a. Core / periphery & geopolitical boundaries:

Territorial organization depended on the terrain and other geomorphological & natural features. Greek literature, which is notoriously centred on cities, recognizes 6 ecological zones (plains, cultivable hill-slopes, uncultivated hill-slopes, mountains, fens & sea). Their character varied with climate, geology and time, as did the ancient Greek cities, which varied hugely in size, territory and resources (Rackham in Murray and Price, 1990: 101 -109).

Most Greeks played out their roles living and working in the countryside. The archaeological evidence suggests a wide variety of settlement patterns, while many people lived in the urban centre and commuted daily to work in their fields. Especially where a family's parcel of land was located further from the urban unit, the preferred ekistic mode was living in farmsteads during seasons of high agricultural demands. Labourers who did not own their own land could hire out themselves to those who did, at least on a seasonal basis. Even more, most social levels of society were involved in the production of food that was needed to support the population inhabiting the urban unit.

According to the political reform of Athenian Kleisthenes (507 / 6 B.C.), Attica with its 2.650 km² during the period of maximum expansion, was divided into 10 tribes (phyles), 3 geographical departments (Paralia = coastal areas, Mesogaia = inland areas, Asty = city) & 30 trittyes (administrative units of racially related demes). Paralia had 10 trittyes, as Mesogaia and asty did also. So, each tribe included 3 trittyes (one from Paralia, one from Mesogaia and one from Asty). The lately acquired areas (Oropos, Salamis, Lemnos) were not

during the reign of Theseus when Attica was unified into one major geopolitical entity.



Some important locations of ancient and modern Attica

Although the population levels in the demes of Classical Attica were constantly fluctuated, there was a standard per deme, perhaps of 65 men and of 130 - 1.500 inhabitants in average. In a total of 127 (+3?) demes of Classical Attica, 683 rich families and 491 members of the parliament (Boule) are registered (Osborne, 1987: 38-46 & Table 2a, 197-200). The anatomy of Athenian society and the archaeological evidence show a powerful periphery with a high level of autonomy and various strong local profiles (Osborne in Murray and Price, 1990: 265 - 293). This observation is detected in the local geographical differentiation of the attic landscapes that encouraged the geopolitical system (Eliot, 1962; Langdon, 1985) and in many political /social conflicts between the members of different demes / clans (Glottz, 1953).

Finally, some areas of the ancient poleis were shielded from human contact because they were sharply disputed by neighbouring states, for example the plain of Eleusis (hiera orgas) between Megara and Attica, sacred to Demeter, while others were artificially marked for communal institutions needed protection, for example the Athenian agora (Cole, 2004: 57 - 65).



The Classical geopolitical boundaries of ancient Attica. Many modern municipalities hold the same old name (History of the Greek Nation, Ekdotiki Athenon)

b. Gendered landscape (Cole, 2004: 21 - 29):

The hierarchies of divine authorities and the language used, reflect the human categorization of population (e.g. as feminine were considered the Earth, the continents, the countries & cities, the lakes & springs, many fixed locations, etc., while the Sky, the oceans, most rivers & streams, the winds, the flowers, and the long-distance movement were considered as masculine).

c. Ritual space (Cole, 2004: 35 - 36, 136):

The Greek ideology of pollution recognized three categories of existence, the dead, the living and the immortal. There was also an internal categorization of sacred space within the hieron, for example, the boundary stones (horoi), the fenced enclosure (peribolos) and the basins of water (perirrhanteria) or the temenos (a place cut off). Furthermore, differences in ritual standards for males and females reflect the existing social differentiations. On the other hand, sacred landscapes were acting as protective shields against nature's over-exploitation by individuals (Dillon 1997: 212 - 4; Sinn in Hägg 1992: 177 - 187). Political, and other kind of borders were always subject to challenge and change.

Urban and peri-urban (transitional zones) habitats are often fragmented and disrupted reflecting human activities, roles & hierarchies. In every built environment three variables can be determined (Wilk in Kent, 1990: 34 -5 & 44), the naturally fixed (by the environmental surroundings and the climatic conditions), the flexibly interrelated (from the existent resources, the technical level and the economic subsystem, meaning the time, the capital invested and the energy consumed) and the culturally fixed (by the behavioural conventions and the cultural functions of the space).

b. Symbolic landscape (belief system, worldviews, cultural configurations, habitus):

Landscapes are reflections of cultural identities, rather than of the natural environment. The physical environment is transformed into landscapes, and cultural groups transform it through the use of different symbols, symbols that bestow different meanings on the same physical objects (Abrahamsson, 1999).

Imagined landscape had many forms: cosmic environments recognized by the gods themselves (Earth, Sky, river Styx), residence of fantastic / mythical creatures (e.g. Amazons, Centaurs), sinister / shadowy transitional place where weird beings were said to dwell (e.g. Sirens, Gorgons, Geryon, Cerberus), or on the contrary, places which act as shelter, nest and purgatory (e.g. caves).

There are not 'non-places' but places around which imagination weaves itself (Bender, 2001).

Sacred landscape had many forms: Mycenaean ruler's residence which integrated sacred activities within political authority and decentralized new authorities dispersed in the territory of Classical cities, where the gods were substituted for the rulers by guarding the surplus wealth and by serving as moderators of human competition (Cole, 2004: 14 - 15). The sanctuaries protected the landscapes and served as 'markers', for they were placed at or near natural borders indicating the limits the community's political reach. Particular divinities were associated with certain kinds of space or land, for example Hermes was associated with caves, Hephaistos with the island of Lemnos, Demeter with hills and springs, Apollo, Artemis and Hera with the marginal landscapes of the polis outside the settlements (Cole, 2004: 16 - 21).

Educational / spiritual landscape: ordered or magical, centred or marginal, where exploration of ideas and expression of learning took place (agora as the nucleus of the socio-political life, stadium, academia, theatre).

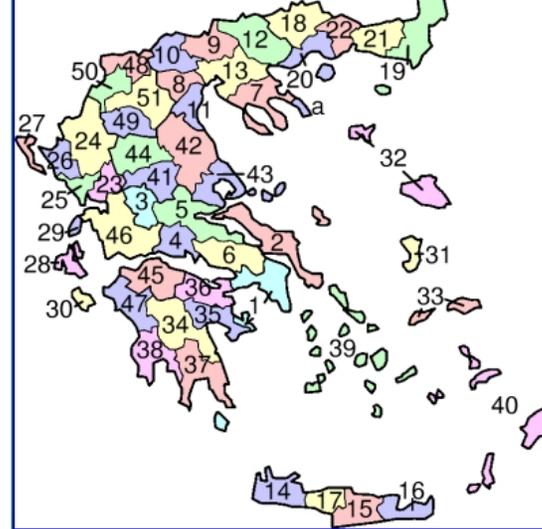
Therapeutic landscape: ideal (e.g. the various 'utopias' of ancient writers), mental or religious (e.g. temple, sanctuary, oracle, physical feature with a 'healing' energy).

Cognitive landscape: "a more or less coherent, geographically grounded frame, through which we interpret the meaning of objects and events that can be connected to a specific area". Such landscapes have an emotive charge that

dynamically.

⚡ The destructive Peloponnesian War resulted in the destruction of Attica's naval forces and the restriction of the state to Athens and island Salamina. The territory was not powerful enough to avoid the Macedonian King Phillip II (338 B.C.) to include Attica to the Macedonian states. In 146 B.C. Athens was occupied, together with the rest of Greece, by the Romans, who although they actually were conquerors, they showed respect to the city's personality. Nevertheless, despite troubled times in the Peloponnesian Wars and the wars against the Macedonians, Athenian achievements in philosophy, drama and art continued even when the city's glory faded in the 3rd century BC. The city's cultural legacy conquered the world as Hellenistic culture. The gradual integration with the Byzantine Empire was completed with the shut down of Philosophic Schools, the modification of shrines to Christian temples and the general rural confrontation of Athens. During the Byzantine period, Athens became a provincial capital and the centre of religious learning and devotion. After the first years A.C., Gothic tribes brought destructive invasions and looting to Athens. In 396 there was a serious barbarian incursion. Alaric the Goth advanced upon Attica and devastated the countryside. During the tenth century Attica was subject to sporadic attacks by Saracen pirates. Near the end of that century it is possible that for a brief time they actually captured the city and erected a mosque. In the 10th century, "St. John of the Hunters", also called the Philosopher's Monastery, was built on the North side of the mountain Hymettos. In A.D. 996, the Bulgars plundered Attica and Boiotia. After year 1214, when Konstaninopolis was occupied by the Franks, Athens was given to French dukes. Their successors were Catalans and Napolitans. In 1458, the Turks occupied Attica. When the last Turks were driven from the Acropolis in A.D. 1833, the small town of Athens became the capital of modern Greece and hosted the first modern Olympic Games in 1896.

Nowadays, the Attica Basin is the urban conglomeration of the Cities of Athens, Piraeus and suburban towns. The periphery of Attica is divided into four major geopolitical units: Athens, Piraeus, Prefecture of Eastern Attica and Prefecture of Western Attica.



1. (see right)	27. Corfu
2. Euboea	28. Kefallinia
3. Evrytania	29. Lefkada
4. Phocis	30. Zakynthos
5. Phthiotis	31. Chios
6. Boeotia	32. Lesbos
7. Chalcidice	33. Samos
8. Imathia	34. Arcadia
9. Kilkis	35. Argolis
10. Pella	36. Corinthia
11. Pieria	37. Laconia
12. Serres	38. Messinia
13. Thessaloniki	39. Cyclades
14. Chania	40. Dodecanese
15. Heraklion	41. Karditsa
16. Lasithi	42. Larissa
17. Rethymno	43. Magnesia
18. Drama	44. Trikala
19. Evros	45. Achaea
20. Kavala	46. Aetolia-Acamania
21. Rhodope	47. Elis
22. Xanthi	48. Florina
23. Arta	49. Grevena
24. Ioannina	50. Kastoria
25. Preveza	51. Kozani
26. Thesprotia	

a Mount Athos

According to the reports of Eastern Attica Prefecture (September 2004), the area, which is located east of the city of Athens, covers a surface of c. 1.800 square kilometres with a population of 410.000 inhabitants (last census). Fourth among the biggest prefectures in Greece, with 20 municipalities & 26 communities, the Prefecture is considered as the most developing area in our country. Apart from the dynamic infrastructure works (e.g. International Athens Airport 'Eleftherios Venizelos', motorway 'Attiki Odos'), two significant commercial ports (Rafina & Lavrion), services companies, energy production installations, five industrial zones and tourism enterprises along the 160 km of tourist coasts, the study area could be characterized as one of the richest and most promising cases of cultural landscapes in Greece. Its vicinity to Athens and its potential of tourist development multiply the necessity for a GIS management of the cultural heritage.

Additionally, the Prefecture consists of many municipalities and communities.

Furthermore, the area has been experienced natural disasters, such as earthquakes (e.g. Parnitha 1999; Oropos 1938), landslides, wild land fires (e.g. repeatedly during the last decade), severe floods (every few years), snowstorms (once or twice every decade), continuous threat of the industrial risks, even climatic & coastal hazards. All things considered, the whole area needs immediately a hazard management of cultural landscapes. An indicative presentation of major cultural attractions within the boundaries of Eastern Attica Prefecture (in a 3-grade scheme: A = non-mentioned in the GIS map, B = mentioned in the GIS map, C = mentioned and further analyzed in a GIS environment) is the following.

Avlona
Gerakas
Glyka Nera
Kalyvia Thorikou
Keratea
Kropia
Koropi
Lavreotiki
Lavrion
Marathon
Markopoulo Mesogaias
Nea Makri
Paiania
Pallini
Rafina
Spata
Vari
Voula
Vouliagmeni

Anthousa
Dionysos
Drosia
Grammatiko
Kalamos
Kapandriti
Kouvaras
Kryoneri
Malakasa
Markopoulo Oropou
Nea Palatia
Oropos
Palaia Fokaia
Pikermi
Polydendri
Rodopoli
Saronida
Skala Oropou
Stamata
Sykamino
Thrakomakedones
Varnava

1.2 Caves with palaeontological / archaeological interest

GROUP A

Rock shelters and caves, apart from their ecological and environmental value, have played a prominent role in the study of man's adventure on Earth. From Palaeolithic Times onward, humans used, worldwide, these geological formations for a variety of reasons categorized and listed below: 1. residence, 2. animal pen / shelter, 3. work / production place, 4. water source, 5. storage place, 6. mine / quarry, 7. dump, 8. burial place, 9. sacred place, 10. ceremonial place, 11. tourist site, 12. place of execution / disposal of bodies, 13. refuge for danger, 14. refuge for outlaw / resistance fighters, 15. refuge for castout / victims of epidemics and 16. scientific destination.

Throughout the whole human history, caves and rock shelters have provided Archaeologists, Anthropologists and other scientists of multidisciplinary origin with a plethora of artefacts / mentifacts of our ancestors (e.g. the famous rock art, the palaeolithic tool industries, the first fire hearths, burials), along with palaeoanthropological remains of tremendous scientific value, creating thus, unique archaeoenvironments which require autonomous investigating methodologies.

According to a brief summary of bedrock Geology of Attica, southern and eastern Attica, structurally, is part of the metamorphic / crystalline Attic - Cycladic massif, the southernmost of the three massifs forming the Pelagonian ridge or zone of the Hellenides mountain chain. Attica is also water poor due to

The Greek Speleological Society (ESE) has catalogued about 300 karst forms in Attica, of which nearly half are caves or shelters and about 75 are varathra or caves with varathra. After 1986, about 50 additional caves and shelters were found by individual researchers / scholars. Roughly half of those 350 features are found on Hymettos (ca. 100) and in the area of mount Parnis (ca. 75), because these two regions show the greatest karst development. The Late and Final Neolithic exhibit the first significant use of caves in Attica, e.g. Kouvaras, Kitsos, Keratea, Lion, Oinoe, Lychnospilia caves (Wickens, 1987). A sub-category of non-cult caves can also be mentioned. Daveli and Keratea have water sources within them.

- Daveli Cave

This large geofom is located at the Spilia marble quarry and could only been uncovered during quarrying activities, thus, in Classical times at the earliest. It could certainly have served as a water source, shelter or storage area for the quarrymen and others.

- Keratea Cave

This large closed cave is often assumed to be the Paneion of Anaflystos mentioned by Strabo (ix.398). It may have been visited by shepherds, travellers and other workers since Classical Era.

GROUP B

- Lion Cave

The cave is situated on the eastern slope of mountain Hymettos (Municipality of Glyka Nera), 691 m. asl, in the wider region of the fertile plain of Mesogaia, where recent rescue excavations brought to light important finds of various Neolithic phases. Moderately accessible, it exhibits archaeological finds from Neolithic to recent times. Known as 'Spoleon Panos' from Classical Times onward, it is characterized by continuous use. Recent excavational periods (2003 - 2006) have brought to light interesting new findings. The excavations in Leontari Cave (Lion's Cave) began in 2003 as a joint project of the University of Athens and the Greek Ministry of Culture. Many other cave and open air sites of various periods are located in the vicinity of Leontari cave forming a complicated, mountainous cultural landscape. The location of the cave is significant, with a panoramic view over Attica, both the mainland and the coast, and in good weather conditions South Euboea is visible. Leontari Cave consists of two areas, with the main one taking direct light from the entrance and a second one which is formed by a sudden drop of 1-1.5m in the floor level, forming the deepest section of the cave. It has a length of c. 50m, maximum width c. 20m, maximum height c. 20m, and maximum depth c. 6m. Pottery finds show that the cave was used during the Late Neolithic Ia-Ib and IIa phases, ranging from about the first half of the fifth millennium BC to the beginning of the fourth millennium BC. Except for the prehistoric habitation of the cave, many finds, such as metal artefacts, coins, pottery, and clay figurines, indicate that it also has been used as a shrine since at least the end of the fifth century BC. Few Mycenaean, Geometric and Early Bronze Age sherds have also been found. So far, some male figurines and many female



View from cave's entrance facing SW
(photo: F. Mavrides)



Lion cave's entrance (photo: F. Mavrides)

- Koutouki Cave

Koutouki is a vertical cave (38.5 m. depth) on the eastern slope of mountain Hymettos (510 m. asl), via a 4 km asphalt road from Paiania. It is considered as one of the most famous karst attractions in Greece, with its magnificent colourful stalagmites & stalagtites. It was discovered by accident several years ago, when a goat fell into the cave through a hole in its roof. The shepherd climbed in to rescue the animal and discovered one of Europe's most beautiful caves. The cave system (60 x 60 m.) is made up of passages and caverns, each one with its own distinctive atmosphere, created ca 2 mya. A guided tour of the cave starts every 30 minutes.



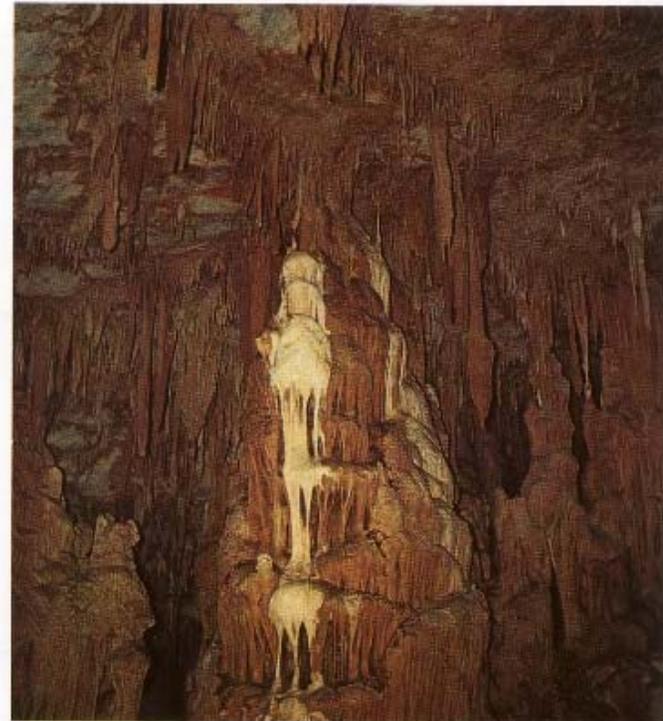
Koutouki cave. Entrance facilities
Mountain Hymettos



Koutouki cave. NE view of Mesogeia plain



Σαρύ, υπό κοιλίας, σταλακτίτες και σταίλκμιτες γιορξουν σε θολάριους τα μεγαλύτερα τμήματα του σπηλαιού δημιουργώντας ενόνας ασύληπτης ομορφείας.





Koutouki cave. sketch plan (Petrocheilou, 1994)

- Kitsos Cave

High on the eastern slope of Mikro Ripari Mountain (298 m. asl), north of Kamariza / Agios Konstantinos (Lavrion). Moderately accessible, it is situated 35 km away of Athens and 5 km away of Lavrion Port at east. Discovered in 1966. Archaeological finds are dated from Neolithic to recent times. Kitsos cave, till now, provides the only well-established evidence relating to the economy of its occupants. The fauna recovered support the herding of goats (and perhaps sheep), and pigs, and the hunting of hare as the primary subsistence activities. Land and marine mollusca were also gathered from the coastal regions four to five kilometers away, and there was some evidence for the use of cereals. Finally, almost 200 scattered human bones from at least 18 individuals indicate primary or secondary burials (Wickens, 1987).



Kitsos Cave. Zoomorphic bear-shaped pendant made of *Spondylus gaederopus*. Late Neolithic (c. 5300-4500 BC). Laurion Museum 905. Hellenic Ministry of Culture/ARF.

Papathanasopoulos, G.A. (ed.), *Neolithikos Politismos stin Ellada*, N.P. Goulandris Foundation-Museum of Cycladic Art, Athens 1996, cat. no. 294

- Cave of Pan 2 (Lychnospelia or Antron of Pan at Parnitha)

Situated at the SW edge of Parnitha's mountain, on Tamilthi, ca one hour

(Lamp Cave) due to the approximately 2.000 oil lamps, which were found there during the archeological studies. The European travellers of the 19th cent. A.C.E (Dowdell, Ross, Lolling, Milchhöffer) note the difficulties in accessing the place. The excavated occupation layers are mainly three, the lower dated in Bronze Age Period (before 1.000 B.C.), the medium dated in the years between 1.000 and 500 B.C., and the upper dated from the Classic Era till Roman Times (1st - 2nd cent. A.C.E.)

- Cave of Pan 3 (Nympholeptos' or Archedemos cave at Vari)

On the top of a hill of mountain Hymettos (290 m. asl), the cave lies N.E. from the modern community of Vari. First visited in 1765. First excavation works in 1902. Although it was extensively used in historical times, archaeological evidence proves its use since Bronze Age Period, for Vari / Varkiza and other Bronze sites of SW coasts were not far away. Worship place of Apollo, Pan, Graces & Nymphs. Continuous use.



Archedemos from Thera planted a garden, decorated the cave and engraved inscriptions on its walls

GROUP C

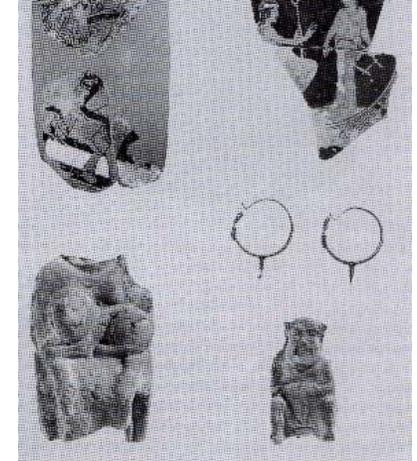
- Oinoe Cave or Cave of the god Pan or Oinoe B' (area of Marathon)

Located on 118 m. a.s.l., on the northern side of the hill of ancient Oinoe's acropolis, one of the four settlements of ancient marathonian Tetrapolis, the cave is situated 3 km west of the modern village. It was discovered in 1957 – 58. Excavations have brought to light valuable archaeological finds dating from Neolithic to recent times, which echo its periodical use. The whole place was considered as sacred sanctuary of Pan & the Nymphs from Classical Times onward. During the working period of the project for 'the Archaeological Unification of the Monuments of Marathon' before 2004, the cave was inaccessible to visitors, as local people claimed that rocks and fallen debris had blocked the entrance.



Τὸ ἐσωτερικὸ εἰς σπηλιᾶς τοῦ Πανὸς σπίν Οἰνίου.

Inside view (Petrakos, 1995)



Oinoe cave. Classical votives

1.3 Open-air Monuments

GROUP A

- Holy Monastery (abbey) of the Assumption of Virgin Mary
It is located at the southern feet of mountain Pentelikon, 18 km. N.E. from Athens. It was established in 1578 by Saint Timotheos and evolved into a famous spiritual and educational centre during the period of Turkish Rule. Although destroyed by the Ottomans, it was rebuilt in 1953.



Penteli's Monastery 12-JUN-2006 (photo: D. Lampridis)

- Church of Zoodochos Pigi at Oropos
It is located at Markopoulo, Oropos, belonging to the village of Neo Libyssio. It is a post-byzantine monument with remarkable architectural elements, dating from the 16th or the 17th cent. A.C. and wall paintings dating from the end of 18th cent A.C.

due north of Athens. The Acharnians chiefly grew cereals, grapes, and olives, although Aristophanes in his comedy *The Acharnians* caricatures them as charcoal-burners. Pindar characterizes them as notably brave. A temple to Ares was later moved to the Athenian Agora. The Menidi tholos tomb, suggests Acharnae was once an independent entity and dates to LH IIIB. It was a fairly large bee-hive tomb yielding interesting finds. A most remarkable fact is that the cult at this was continued down to the time of the Peloponnesian war. At Aphidna in northern Attica Professors Wide and Kjellberg excavated long ago a big tumulus. This excavation is remarkable because here for the first time Middle Helladic vases were found in a regular excavation and taken up in scientific discussion. The place was inhabited in the Mycenaean age also. The acropolis was not explored, but walls of an uncertain date are recorded and on the terraces toward the east Mycenaean sherds were found. The mythological importance of this site is such that it ought to be searched more thoroughly.

- The Church of Agia Triada at Markopoulo Mesogaia

It is located on the crossroad to Braurona, with well-preserved wall paintings dating from 11th cent. A.C.

- Basilica of Saint Athanasios at Paiania

In the eastern part of the modern settlement, this monument shows two construction phases (Early Christian Era c. 6th cent. A.C. and 17th cent. A.C.), with wall paintings in four layers (palimpsest). It is proclaimed as preserved monument, as it hosts hagiographies made by the prominent painter 18th cent. George Marcos from Argos.

- Church of Palaiopanagia

North of Paiania, between Kantza and Papaggelaki, this church was built before the Ottoman Occupation (? 12th cent. A.C.), destroyed during the Turkish rule and rebuilt. Its wall paintings are dated at the beginning of 18th cent. A.C.

- Church of Saint George, at Kouvaras

Located in the eastern part of the modern settlement, on the road connecting Markopoulo with Keratea, this monument is characterized by three construction phases (Early Christian Period, Middle Byzantine Period c. 1.000 A.C. and during the Ottoman Occupation) and wall paintings dating in the 13th cent. A.C.

- Church of Saint Athanasios at Koropi

In the plain of Koropi, N.W. of the settlement, across the low hill of Kontra and the Castle of Christ, the monument is located on the top of a slight elevation of the ground. Built at the same site where the Byzantine village of Filiati was situated, within the limits of the ancient deme of Sphettos, the church was close to a Byzantine fortification tower. Architectural elements and wall paintings date it in the 18th cent. A.C.

- Church of Saint George at Koropi

This church is located in the eastern part of the modern settlement, near Soteira. Its remarkable wall paintings date it in the late 17th cent. A.C.

interesting architectural elements dating from the Ottoman Occupation Period and wall paintings dating in the late 17th cent. A.C.

- Byzantine church of Saint Theodori

It is situated in the area of Oinoe, near the cave of Pan, in a picturesque natural landscape.

- Church of Saint Apostles at Oinoe

This small post-byzantine church is situated in the area of the cave of Pan at Oinoe. Works of anastylosis were programmed to be held before 2004.

- Church of the Saint forty (40) Martyrs

This small post-byzantine church is situated in the area of the cave of Pan at Oinoe. Works of anastylosis were programmed to be held before 2004.

- Church of Agia Paraskevi at Oinoe

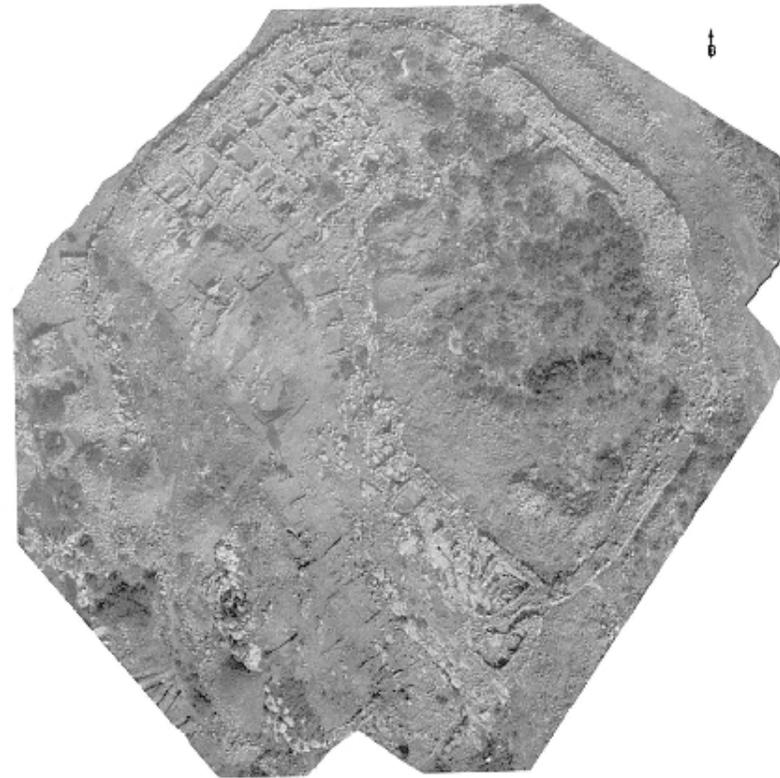
This small post-byzantine church is situated in the area of the cave of Pan at Oinoe. Works of anastylosis were programmed to be held before 2004.

- Sanctuary of the goddess Athena at Vranas

The monument probably lies east of the church of Agios Demetrios, at the foot of the mountain Agrielikí, at Vrana. The archaeologist G. Sotiriades located the sanctuary of Hercules in the same area, where the Athenians were camped before the historic battle of 490 B.C. A boundary stone found by the same archaeologist identified the place. After this discovery, another scholar, the American E. Vanderpool deduced that the ancient deme of Marathon was located at the foot of the mountain Agrielikí, in the SW part of the plain.

- Zagani

A prehistoric settlement from Early Helladic I (3.200 – 2.800 B.C.) was detected on the top of Zagani Hill, at Spata. It is considered as a rare fortified case (remaining surrounding wall = 150 m. long and < 1 m. high). Although the archaeological elements were partly restored at the airport museum (El. Venizelos), the hill was demolished before the construction of the international airport.



The final orthophotograph

GROUP B

- Archaeological site at Rhamnous

One of the most prominent among the ancient athenian demes, Rhamnous was situated in N.E. Attica, on the Euboian gulf. Evident human activity in the area dates from Neolithic Times. The excavated settlement includes country houses, cultivated and pasture land, the fortress, quarry & workshops, wall, towers & gates, pier, 2 ports, gymnasium, theatre, acropolis, public buildings, various temples, remains of houses, roads & many grave enclosures, the Archaic temple of Nemesis (as a chthonian and rural deity) destroyed by the Persians and two 2 temples forming the most important sanctuary of that divinity in ancient Greece (5th cent. B.C.). Final destruction of area occurred in A.D. 399. First excavation took place in 1813. Other excavation periods took place in 1880, 1890-1892, 1958 and 1975 up to now.



Site of Rhamnous – panoramic view facing Euboia. View of the 5th BCE (L) and Archaic (R) temples looking east

- Amphiaraeion at Oropos

The most famous of the sanctuaries devoted to Amphiaraos (chthonian deified hero, prophet and doctor) was built in a green ravine near Oropos and Boeotia, at Kalamos area. The holy area included the sanctuary & place of healing/ oracle (from 5th cent. B.C. to 3rd cent. A.C.), a sacred spring, the banks of the river, a theatre, a stoa, private houses, inns, baths, clepsydra, shops and offices, as well as the road to the sacred port of Delphinion and Oropos. Excavation works lasted from 1884 to 1930.



- Archaeological site at Sounion cape

The peninsula of Sounion was inhabited from Prehistoric Times, as a form of cult is dated in Mycenaean Period. It was firstly mentioned in the Odyssey of Homer. An organized sanctuary appeared in the Geometric Period (10th – 7th cent. B.C.). The Kouroi erected in the open-air sanctuary of Poseidon (early 6th cent. B.C.) now are exhibited at Athens National Archaeological Museum. The Temple of Poseidon and the propylon (early 5th cent. B.C.) destroyed during the Persian invasion. The second Temple of Poseidon with stoas and a monumental propylon were built during the 5th cent. B.C. The area also includes strong defence wall, the sanctuary of Athena Sounias on the lower hill

but systematic investigation took place between 1897 and 1915. Since 1994 excavations run in the area of the Fortress.



Temple of Poseidon



Sounion promontory. East view

- Technological Park at Lavrion

At St. Constantine Community, historical mining shaft (French company and I.B.Serpieri) with auxiliary buildings, as well as underground tunnels (max. depth 165 m. and length about several dozens of kilometres) dated in the 19th cent. A.C., are well preserved. After the ministerial decree of 1950, the area was pronounced 'Historical and Preserved monument'. Today is a Technological & Cultural Park (since 2000).



- Archaeological site at Thorikos

Thorikos was the greatest ekistic centre with the most significant ports in Lavreotiki area. Fortified organized prehistoric settlement and a tholos tombs on the top and around the hill of Velatouri, are dated in the 3rd millennium B.C.. The nucleus of the historic settlement was on this hill and included houses, mining installations & workshops, one of the oldest theatres in Attica (6th cent. B.C.), temples and an extensive communication network.



Thorikos – theatre



Entrance to Mine 3 and Velatouri hill.
(Photo D.Gill)



Thorikos. Washery number 1 in the industrial quarter looking south



Velatouri hill from the south

- Moni Daou at Penteli

Holy Monastery (abbey) of Pantokratoras is located on the mountain Pentelikon, in the area called Daou . It consists of the main temple with two floors and & remarkable architectural elements dated in the 19th cent. B.C., and a castle with three floors dated in 1648. It is characterized as a unique post-byzantine monument. It had been deserted for 273 years (1680-1953).



- Fortress at Phyli

Rarely visited, this fortress was built in the 5th century B.C. to guard the strategic pass into Attica from Megara and Theba. The Attic Ephebi, during the



Phyle, the fortress seen from the east (photo: M.H. Munn, 1993)

- Pikermi paleontological site

Accidentally found at Megalo Rema ravine, in 1838, the area was excavated between 1839 and 1912. The paleontological finds are dated in the Upper Miocene and represent the famous 'pikermian fauna' dated back to 13.000.000 years B.P. They include about 53 different species of vertebrates (e.g. mastodon, rhino, machairodus, lion, giraffe, dog, birds, turtle, hyena, hipparion, monkey) that lived in steppe environment. Nowadays they are dispersed as fossil exhibits to various paleontological museums of the world.

- Church of Saint Petros & Pavlos at Spata

Dating in the late 15th cent. A.C., the monument was situated in the area of new airport of El. Venizelos. The place also included a cemetery from 11th cent. A.C. and a group of buildings (organized agricultural unit) dating from 11th to 13th cent. A.C. Before the airport's construction it was removed about 340 m. away from its original place. The main research period was during 1997.



- Middle-Age Tower of Brauron

Known as Vraona Castle, the severely destroyed monument lies west of the archaeological site of Brauron and south of the airport of El. Venizelos.



- Basilica of Brauron

Dated in the early years of first Christian communities in Greece, it is situated at the foot of the hill near the modern road, 500 m. before the temple of Artemis.



Brauron basilica from South



Overall view of Byzantine basilica from West

- Tower of Oinoe

Situated in the area of the cave of Pan, it is dated in the years of domination by the Franks (after A.D. 1204). It is strategically built on the northern part of Marathon's valley. Unfortunately, the landscape is brutally hurt by an external waterpipe of EYDAP (the National Service for water disposal) and a group of buildings probably a deserted industrial unit, which alter the view. The tower is rectangular in its groundplan and consisted of three stores.

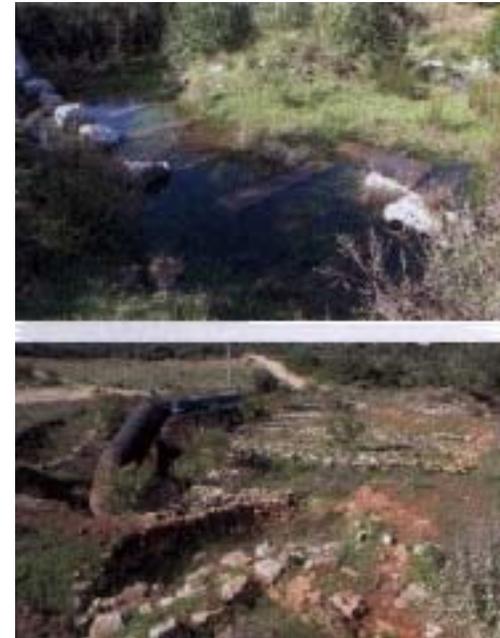


Tower of Oinoe looking East



Tower of Oinoe looking South

tragic poet Sophocles calls the coast of Marathon "Pythian" because from these coasts the official Athenian deputies departed for Delphi. During excavation works of Sp. Marinatos, in 1972, a building (13.60 x 17.30) had been come to light, which later was identified with the sanctuary of Apollo by the archaeologist I. Travlos. The marshy waters make the monument inaccessible.



- Spring Makaria (modern name : Megalo Mati)

Close to the road Bey - Kato Souli, on the NE. part of the plain of Marathon, on the foot of the mountain Stavrokoraki, the spring is located near the churches of the Saints Athanasios & Paraskevi.. The spring gushes water since the ancient times onward, in fact during the period of German occupation, a guard was installed in the place. This spring supplied with water the lake of Marathon, which was notorious for its dense mosquito populations and the unhealthy climatic conditions of the area.



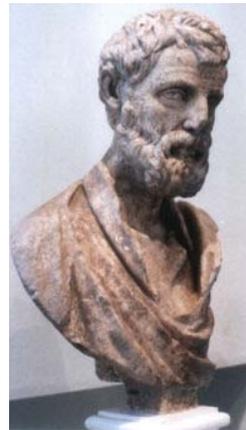
Installations of Magaria Pigi facing East

installations and an active inn. Although it is a private area, the estate is quite abandoned and further ruined by modern mushrooms' cultivation and foreign labourers who stay there. This is a unique case of 19th cent. farm, at a 20' walking distance from Schinias coast.



- The Farm of Herodes of Attica

In the area of 'Mandra tes Grias', slightly NW of the mountain Kotroni and SE of the cave of Pan at Oinoe, Herodes had his famous farm. The precinct, 3.3 km long, is still visible. Restoration works were programmed to be held before 2004.



Herodes Atticus bust (copy ?).



Road leading to the estate From his villa at Kephissia. Found 1961. Mid 2nd cent. C.E. National Archaeological Museum, no 4810



*Τμήμα της Μάντρας της Γριάς, επί ἀγροκαταμάτος τοῦ Ἡ-
ρόδου Ἀττικοῦ.*

Precinct of Herodes farm at Marathon (Petrakos,
1995)

Lucius Vibullius Hipparchus Tiberius Claudius Atticus Herodes, commonly known as Herodes Atticus (ca. 101-178/177) was a Greek rhetorician, notable as a proponent of the Second Sophistic. He was born in Marathon in Attica to a distinguished family. His grandfather Hipparchus (born AD 40) was estimated to have a fortune of 100 000 000 sesterces (and was the richest man in the Greek World at the time). Herodes (Juvenal, Satire III), received an education in rhetoric and philosophy. Hadrian appointed him prefect of the free cities in Asia in 125. Herodes returned to Athens, the Cultural Metropolis of the Roman Empire, became famous as a teacher, and was elected archon. So, Herodes Atticus became one of the most distinguished men of his time. Philostratos, the biographer of the Sophists, gives a detailed account of his life and fortunes at the beginning of Book II. In addition to his literary work, Herodes funded a number of public projects: a stadium - Athens (some scholars place the tomb of Herodes under the running track in the Panhellenic Stadium), a theater at Corinth, a stadium at Delphi, baths at Thermopylae, an aqueduct at Canusium in Italy, an aqueduct at AlexandriaTroas, an exedra (or nymphaeum) at Olympia, and various benefactions to the peoples of Thessaly, Epirus Euboea, Boeotia and Peloponnesus. Furthermore, another Herodes' beloved location was his farm at Marathon (the precinct of which is today known as 'Mandra Grias'). In fact, he was a generous donator to the deme of Marathon. Due to his generosity, a monumental complex of buildings, which lays just north of the former American Base (10' walk from the central avenue) and includes the sanctuary of Egyptian Gods /Goddesses such Kanobos & Isis (central altar, rectangular stoa, rectangular wall, four gates & piscine / fish pond), as well as roman baths were built there. The architecture of the sanctuary does not follow the usual Greek forms and it is considered as a rare case of Egyptian worshipping within Greece.

- Monastery of Saint George at Vranas

- Church of Saint Nikolaos at Vranas

A post-byzantine basilica with wooden roof and few roughly preserved wall paintings (1681, 1725, 1779) of distinguished taste. It belongs to the Holy Metropolis of Attica and it is periodically restored. It is situated at 10' walking distance from the Archaeological Museum of Marathon through cultivated land.



- Church of Saint Athanassios at Vranas

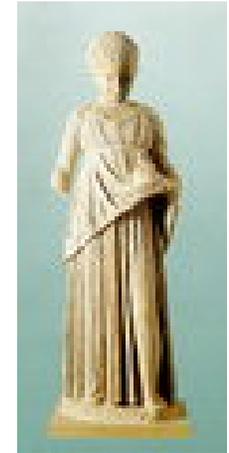
A post-byzantine basilica with wooden roof and few roughly preserved wall paintings of distinguished taste. It belongs to the Holy Metropolis of Attica and it is periodically restored. It is situated at 10' walking distance from the Archaeological Museum of Marathon through cultivated land. The NE corner of the building is damaged by an extended fissure and soil's slipping due to the neighboring greenhouse's installations.



- Plassi ancient settlement

A very interesting archaeological example of continuous use from Neolithic to Roman Times, it is damaged, apart from modern constructions around the site (coastal settlement of Nea Makri), by stagnant waters and lush vegetation which covers the area. It is situated at 15' walking distance from the Tumulus of Athenians, near the coast.

acropolis was built during the Bronze Age on the top of the hill Chamolia and a Mycenaean cemetery (c. 1.200 B.C.), was dispersed at the foot of the hill east of the Museum. The rural Sanctuary of Artemis Brauronia or Kourotrophos (cult evidence by the end of 8th cent. B.C.) was one of the earliest and most revered of the sanctuaries of Attica, including the sacred spring, a very well-preserved ancient bridge, the banks of river Erasinos since ancient times, the big doric stoa (5th cent. B.C.), the temple of Artemis & the heroon of Iphigeneia as an honouring place of death and burial. Maximum activities are registered during the Classical Era (5th – 4th cent. B.C.).



Statuette of Arktos



Heroon of Iphigeneia



Byzantine church of Saint George – after restoration works

The cult of Brauronia Artemis & Iphigeneia was systematically reinforced by many Athenian leaders such as Peisistratos, Miltiades & Kimon. The worship of the goddess of vegetation and hunting and protector of women in child-birth & of the newborn was famous throughout the ancient world, due to the unique ceremonial duty of the 'Arkteia' and the Brauronian festival held every four years and the procession made from the Braurion of Athens to the sanctuary at Brauron. The first systematic excavation was conducted in 1948

male statues are more commonly nude. Both male and female statues hold what is thought to be their favourite possessions such as balls, birds, and a rabbit. These statues are some of the most realistic renderings of children that survive from all of antiquity. Each statue differs from the other so there is the possibility that they are in fact idealized portrait votives. Originally statues such as this of a female child were thought to be arkttoi. Arkttoi, literally meaning she-bear, were girls between the ages of five and ten who would dress as bears and dance during the festival of Artemis. Each year young girls and women would go to the site of Brauron and re enact a legend of Artemis in order to appease her anger and incite her good will. The young girls who dressed as bears and dances around were named arkttoi. It was believed that this statue was a representation of an arkttoi because it was found at the site of Brauron. It is now more commonly thought as a votive to Artemis not pertaining to the Arkteia. Instead these statues, which could be of girls or boys, stood as thank offerings on the part of the parents for the goddess' help during childbirth.

- 'Polyandrion' or Tumulus of Marathon

This famous monument is 9 m. high and 50 m. in diameter (today), and dates in 490 B.C. It was firstly excavated in 1884 and mainly excavated in 1890 & 1891. It is a artificial mound used as burial monument raised in honour of the 192 Athenians killed at the battle of Marathon against the Persian army. Their remains were buried after cremation of the dead and accompanied with funerary items.

The Battle of Marathon (490 BC) was the culmination of King Darius I of Persia's first major attempt to conquer the remainder of Greece and incorporate it into the Persian Empire, to secure the weakest portion of his western border. Most of what is known of this battle comes from Herodotus. Darius first sent Mardonius, in 492 BC, via a land route to Europe to strengthen Persia's hold of Thrace and Macedon, which had been weakened by the Ionian Revolt. Although successful, most of this force perished in a storm off Mount Athos, and the remainder was forced to return to Asia, losing men along the way. In 490 BC, Datis and Artaphernes were sent in a maritime operation to subjugate the Cyclades islands in the central Aegean and punish Eretria and Athens for their assistance in the Ionian revolt. Eretria was besieged and fell; then the fleet landed in Marathon bay. There they were defeated by a small force of Athenian and Plataean hoplites, despite their numerical advantage. The long run of the messenger who conveyed news of the victory to Athens became the inspiration for the Marathon race, which was first staged at the 1896 Olympic Games.



hundred meters east of the Museum of Marathon, this monuments included burials and cremations, having 4 m. height and 30 m. diameter. It was excavated in 1970.



- Archaeological site of the Trophy in the Big Marsh

The trophy of the victorious battle of 490 B.C., today close to the church of Panagia Mesosporitissa., was raised immediately after the conflict by the Athenians, as a monument made of the weapons and the other booties from the dead Persians. The whole construction was made of white marble, remains of which had been later incorporated into the construction of the Middle-Age tower near the church. Herodotus, Aristophanes and Plato are among the ancient writers who mention the monument with pride.



The restored monument of the Trophy



Panagia Messosporitissa

Furthermore, the Church of Panagia Mesosporitissa was built SW of the big marsh, on the place near the grave of the ancient Persians, where Athenians buried all the dead soldiers in a burial. Herodotus narrates that during the famous battle of Marathon 6.400 soldiers were killed. It is celebrated on November 21st.

- The Early Helladic Cemetery at Tsepi

At the feet of the small mountain Kotroni, the peak of which has been transformed into a basis for fighter helicopters, the excavator, Sp. Marinatos, spotted a very important Bronze burial place. From the finds he deduced that the cemetery was used by inhabitants of the Cycladic islands, who were

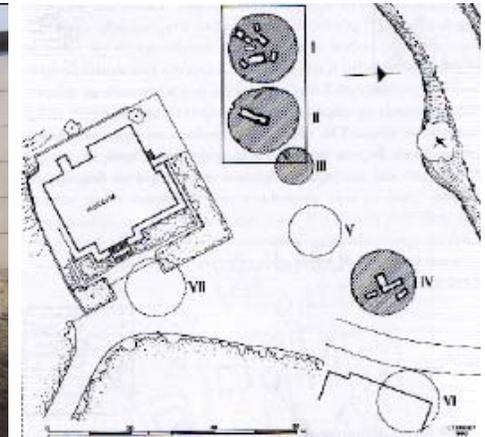


- The Middle Helladic Cemetery at Vrana

With seven (7) burial tumuli, at the feet of the mountain Agrieliki, this place is dated in the period between the 20th to the 13th cent. B.C. The area is located 700 m. away from Tsepi and is an active archaeological site, next to the archaeological Museum of Marathon.



Vranas tumuli. Entrance of modern constructions



Vranas tumuli

- The Arnos tholos tomb at Vrana

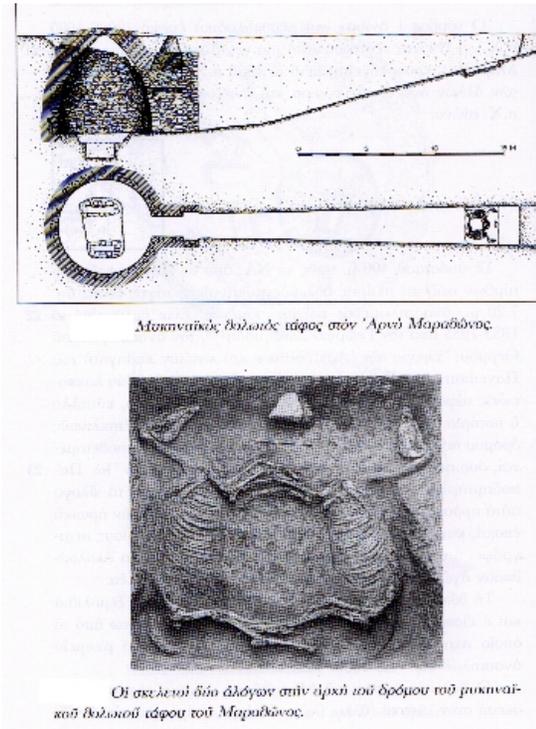
This burial monument is located 400 m. SE of the above-mentioned cemetery. It is considered as a rare construction within prehistoric Attica (others exist only at Menidi and Thorikos) and it is dated in the period 1450 - 1380 B.C. The excavation works took place during the years 1933 - 1935.



Access to Arnos (2004)



'Dromos' of the tomb



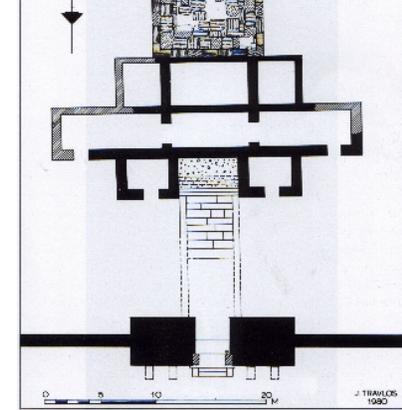
Groundplan of the tholos & the skeletons of the two horses buried underneath the 'diadromos'. The finds inside and near the tomb verified the verses of Homeric Iliad, where the poet describes the offerings and the sacrifices in honour of the dead hero

- Archaeological site at Brexiza

The main archaeological features are: (1) the temple of the Egyptian Gods (Kanobos, Isis, et al.), protected within a precinct immediately north of the American Base, that is dated in the 2nd cent.A.C., and (2) the baths, on the eastern side of Egyptian temple's precinct, dated in the 2nd cent. A.C., a luxurious construction attributed to the generosity of Herodes of Attica. Today it is very difficult either to visit or study the place due to the water-loving vegetation in the area of the small marsh.



Copies of monumental statues before the pylon at Brexiza



Sanctuary of Kanobos. Brexiza (after Travlos)

1.4 Museums

GROUP A

- Archaeological Museum at Oropos
Officially under repair / construction works
- Archaeological Museum at Acharnes (Menidi)
Officially under repair / construction works
- ILEA Folkloric & Historic Museum at Acharnes
Established in 1977, it holds 20.000 exhibits from Roman to recent times (archaeological finds, spiritual objects, traditional jewels & costumes from all regions of Greece, paintings, photos and arms. It also includes an extended library with historical & folkloric books and other archival material (photos, documents & newspapers).
- Peliounis' Folkloric Museum at Paiania
It is a private collection hosted in a traditional building, with works of local folklore, including paintings of Theophilos.
- EUARCE
European Art Center is widely recognised, even by the Ministry of Foreign Affairs, aiming at the enhancement of international cooperation in terms of cultural, educational, editorial and scientific issues.

GROUP B

- Vorres Folkloric & Modern Museum at Paiania
It was founded by Ionas Vorres and donated to the Greek State as an artistic and cultural foundation. It consists of a complex of buildings, courtyards and

Pyrgi (or tower) and is composed of a complex of two traditional rural houses, the remains of a stable and an old wine-press dating from the end of the period of Ottoman rule, in the early 19th century. The exhibits are mainly Greek folk objects of everyday use, rare pieces of furniture, hand-made rugs of various types, troughs, large jars, millstones, stone well rims, a large pottery collection, interesting oil paintings and engravings which depict historic events of modern Greece, as well as various important ancient finds.



- Archaeological Museum of Lavrion

On the outskirts of the town of Lavrion., it was built in 1970. Its exhibits include metal objects & inscriptions related to the mines, panel explaining the extraction and processing of the ore, archaeological map showing possible itineraries for visiting the local antiquities, marble sculptures, funerary & votive reliefs, relief slabs from the frieze of Poseidon's temple at Sounion, part of mosaic floor from the presbytery of the Early Christian basilica at Lavrion, finds from Kitsos' Cave, finds from the cemeteries of Thorikos, Limani Pasha, Agrileza & Sounion.

- Mineralogical Museum of Lavrion

Inaugurated in 1986, it is dedicated to the memory of A. Kordellas (1836-1909), the major contributor to the revival of modern-day Lavrion. The Mineralogical Museum of Lavrion is housed in a small but noteworthy example of the industrial architecture of the 19th century (1873), in the remains of the important metal-washing plant of the Greek Society. Its exhibits include 700 samples of 115 different kinds of metals, classified according to the norms of mineralogical science (DANA 1850) into categories (sulphides, sulphates, native elements, halogens, limes, oxides-hydroxides, arsenides, vanadiums), special showcases with gangue, other minerals & samples of various crystals, rare specimens of the famous "slag minerals", objects related to the extraction & refining of metals.

GROUP C

- Archaeological Museum of Brauron

the sanctuary of Artemis), Geometric pottery from the cemeteries of Myrrhinous, Anavyssos e.t.c. and votive & funerary reliefs of the Classical Period found in the region of Mesogeia.



Entrance of the museum (west view)



Main hall with sanctuary's replica before restoration works of 2007

- Archaeological Museum of Marathon

Near the Early Helladic cemetery at Tsepi (at the feet of small mountain Kotroni) and close to the Middle Helladic cemetery of Vrana (at the feet of the mountain Agrieliki), the tholos tomb and the second tumulus of Classical Era, this museum was inaugurated in 1975. Among its exhibits are finds from Oinoe B', the cemeteries of Tsepi & Vrana, the cemeteries of Marathon from Geometric to Classical times, the settlement of Plasi, finds related to the historical battle against the Persian army, funerary & votive reliefs, statues from the Egyptian sanctuary at Brexiza, inscriptions and parts of sculpture works. The whole place has been modified and restored for the Olympic Games of 2004.



Entrance of the museum (east view)



Parking area

GROUP A

- SW coasts of Attica

The maritime orientation of the inhabitants of Eastern Greece since Prehistory is beyond doubt attested via archaeological evidence (i.e. finds at Franchthi have shown navigation of Aegean since 10th millennium B.C.). The number of good natural harbours and the geopolitical autonomy of the various geographical units since Neolithic Period had accelerated sea communication network. Even if eastern coasts of Attica were the main gates to Eastern Mediterranean (the first seafarers of the Aegean are traced along the eastern coasts where we have clear evidence of large Neolithic settlements at Marathon & Nea Makri), the SW coasts of Attica have also to display significant coastal presence, being in close contact with Argolid, Crete and the Ionian Sea which needs further investigation. The historically wealthy Saronic Gulf has, in addition, includes submerged or risen sites that echo past environmental changes (an estimated 25 m. sea-level rise since the Mesolithic, and 10 - 12 m. since the Neolithic era are calculated for this area). The Bronze Age settlement at Aghios Kosmas, the material culture of which shows clear affinities with the Cycladic Keros - Syros culture and the Geometric sites of Aliki Glyfadas, Vouliagmeni, Vari & Anavyssos are prominent examples.

- Ancient harbour of Rafina

On the coast of the ancient classical deme of Arafen, where modern port facilities are built. From the Prehistoric Times it was used as commercial station of the maritime roads to the Aegean. Especially the major Early Helladic II sites of Askitario & Rafina gave finds that represent the Cycladic contacts that were facilitated by the meltemia winds during summer (May to October).

- Ancient Port of Thorikos

The bigger harbour of Lavreotiki area. It has provided the earliest definite evidence for Early Helladic mining.

GROUP B

- Ancient Port of Kamaraki / Delphinion

On the coast of Agioi Apostoloi, probably the sacred harbour of Amphiareion sanctuary. In the summer of 1988 underwater remains of harbour installations were investigated in the area of Kamaraki-Vlastos, ca 5 km to the east of Oropos, in NE Attica. The remains were first discovered at the end of the 19th cent. by the German scholar H. G. Lolling, who identified them as the ancient Delphinion, the sacred harbour of Oropos. Since 1885 they had, however, been almost completely forgotten (cf. Milchhofer, 1901; Petrakos, 1968:11), and they were never surveyed nor investigated. The rapid development of the area during the last few years brought many tourists to the beach of Kamaraki and created risks for the remains. It is hoped that these risks will be reduced by bringing the walls to the attention of the public. In the present article a description of the walls is given and an attempt is made to relate them to the



View of the Kamaraki beach from a hill at the southeast. The walls are indicated by lines

- The two ports of Rhamnous

On the coast beneath the settlement of Rhamnous, two harbours on both sides of fortified area, were built during ancient times, northerly (West Port) and southerly (East Port). The area was selected as one of the most significant location for the control of nautical routes to the Euboian Gulf and the North Aegean.

- Sounion harbour

On the S.W. of the promontory of Sounion, under the fortified hill where the temples of Poseidon & Athena were built during the Classical Period. One of the most significant location for the control of nautical routes to the Aegean.

GROUP C

- Prassiai harbour

The ancient harbour of Porto Raphti, on the bay of Porto Raphti, near the inland centre of classical deme of Prassiai and Perati (where the 13th & 12th cent. B.C. necropolis was found, was a safe harbour of great importance, serving military and commercial uses since the Prehistoric Times.

- Underwater elements at Marathon Bay

At least since the Bronze Age, dense communication with the Cyclades and the S. Aegean portray the existence of harbour installations in the area, on the coast from Schinias to Nea Makri, where was situated the settlement of Marathon (modern site of Plassi, near the coast), one of the four allied settlements of Mycenaean Tetrapolis. The habitation was continuous from

mountain AgrieliKI. The waters of the marsh flooded periodically by sea water, joining in this way the islet and the land. Local people before 1933, when the marsh dried out, spoke of ancient ruins of quay and canal in the area.

1.6 Natural Landscapes

GROUP A

- Vineyards land in Mesogaia

This is a fertile piece of land extended in an area of 145 km², the birthplace of the famous wine 'retsina'. The local product is exported and functions as an element of living heritage and a symbol of local traditional culture. Unfortunately, the recent construction of the international airport deprived these landscapes from its cultivating dynamics.

- The eastern slopes of mountain Hymettos

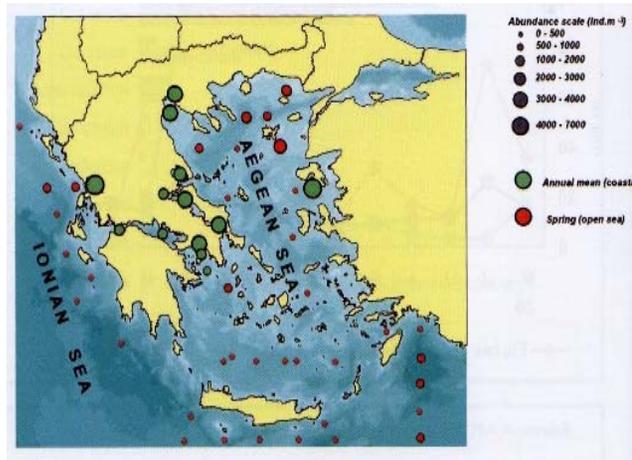
East of the modern city of Athens, 16 km long from N. to S., this is an area with geological, ecological and historical interest, strongly suffered from human greed and carelessness since ancient times. A true botanical paradise, Mt Hymettos, also known as Trelas - Crazy - in more modern times, has been renowned since antiquity for its honey and the colour of its marble, of a slightly darker hue than that of Penteli. The mountain is long, narrow, rocky and arid, with flora that numbers over 600 plant species. These include 31 endemic species, whilst the most interesting plants are to be found among the shrubs. This low mountain has one of the richest assortments of orchids in all of Greece and Europe (44 species). When walking through the brush above the Monastery of Kaesariani, you can easily come across over ten orchid species in under an hour. The mountain provides refuge to endangered bird species including the rare Sardinian warbler, the rock nuthatch, peregrine falcon, osprey and long legged buzzard. Island grouse are rife on the mountain, and can easily be recognised by their clucking. There are sites of cultural importance in the area, dozens of caves and coves, but the Paeonia cave is the most impressive. The entire mountain, from the Paeonia cave in the north to Lake Vouliagmeni in the south, is a NATURA 2000 conservation area.

- Penteliko mountain

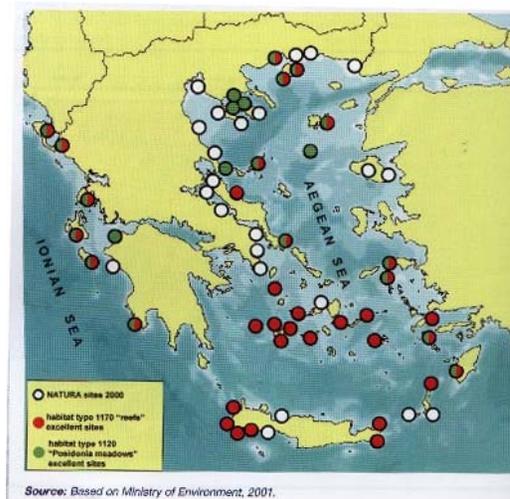
Pentelikon (Vrilissos or Vrilittos) is a tall mountain and mountain range situated NE of Athens and southwest of Marathon. The elevation is 1.109 m. The mountain is mainly covered with forests (about 60 or 70%). The mountain can be seen in southern Athens (Attica), the Pedia plain, Parnitha, and the southern part of the northern suburbs of Athens. Houses surround the mountain, especially in Vrilissia, Penteli, Ekali and north of Gerakas. Even since antiquity, Penteli has been famous for its marble which was used for the construction of the Acropolis and other buildings of ancient Athens. Penteli marble is flawless white with a uniform, faint yellow tint, which makes it shine with a golden hue under sunlight. The ancient quarry is protected by law and used exclusively to obtain material for the Acropolis Restoration Project. The

- Underwater heritage

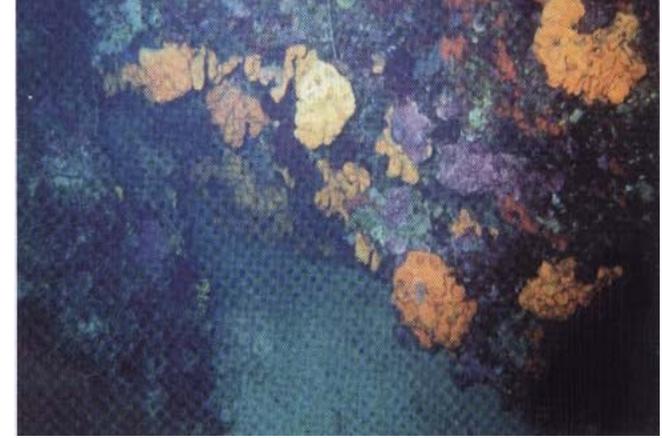
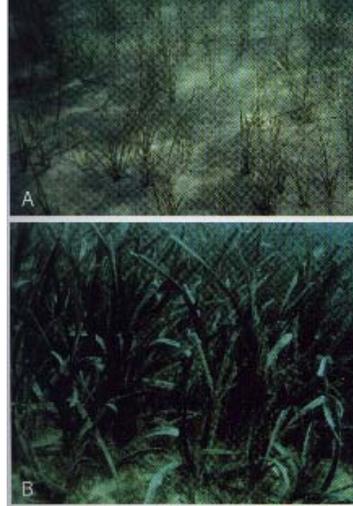
The waters of S. Euboikos Gulf as well the waters of SE Attic coastline are of very good quality. Ecological quality of coastal areas based on seasonal concentrations of PO_4 , NO_3 & NH_4 (data of 1996). The distribution of total mesozooplankton abundance (ind. m^{-3}) in coastal and offshore waters and the marine flowering plants are two encouraging indications for the future state of marine life. According to NATURA 2000, Hellenic sites where habitat type of benthic macrophyta 1120 & 1170 present excellent representation and conservation status, are included in the map of Attica (Papathanassiou & Zenettos, 2005). Respectively, the nine beaches of Attica that received the 'Blue Flag Award 2007' are in the boundaries of Eastern Attica Prefecture (Schinia & Brexiza, Avlaki, Pounta Zeza at Lavrion, Mavro Lithari & Central beach at Anavyssos, Varkiza, Aster Vouliagmenis & Voula A').



Distribution of total mesozooplankton abundance (ind. m^{-3})



Source: Based on Ministry of Environment, 2001.



Underwater view

- A. Sandy bottom covered by *Cymodocea nodosa* meadow at Schinias coasts
 B. *Posidonia oceanica* meadow in the Saronic Gulf

Sciaphilic vegetation in a marine cave of Cape Sounion, Attica, habitat type 8330 (Papathanassiou & Zenetos, 2005)

GROUP B

• Brauron Wetland

Between the small valley of Brauron and the sea which penetrates the land creating a deep natural harbour, the torrent Erasinos fills up with carried soil material the local bay, as it overflows periodically, from ancient times. The coastal wetland of Vravra is included in NATURA 2000 scheme. The site is characterised by: 1) extensive vineyard cultivations; 2) coniferous woodland in a good condition; 3) maquis and phrygana affected by grazing locally; 4) a wetland habitat type, although restricted, with *Phragmites australis*, *Juncus* sp. and *Arundo donax* being important for its structure; 5) the protected archaeological site near the wetland; 6) a not well balanced sea bed, with the species *Cymodocea nodosa*, *Posidonia oceanica*, *Zostera nolti* being important for its ecological balance; 7) restricted building activities. The Habitat Types of the area consist of : Sandbanks which are slightly covered by sea water all the time, *Posidonia* beds, Estuaries, Mudflats and sandflats not covered by seawater at low tide, Large shallow inlets and bays, Vegetated sea cliffs of the Mediterranean coasts (with endemic *Limonium* spp.), Mediterranean salt meadows (*Juncetalia maritimi*), Mediterranean and thermo-Atlantic halophilous scrubs (*Arthrocnemum fruticosae*), Mediterranean temporary ponds, Floating vegetation of *Ranunculus* of plane submountainous rivers, Intermittently flowing Mediterranean rivers, *Juniperus oxycedrus* arborescent matorral, *Juniperus phoenicea* arborescent matorral, Low formations of euphorbia close to cliffs. Aegean phrygana (*Sarcopoterium spinosum*). Eu-

the archaeological site with the temple of Artemis nearby the wetland acts as a barrier for extensive human activities since it has a protection status; 3) the position of the site, nearby Athens (40 km); 4) the importance of the wetland as a refuge for many bird species; 5) the traditional vineyard.



- Schinias wetland

The area of the famous Marathon Battle (September of 490 B.C.), between Athenian (10.000 Athenians & 1.000 Plateeis) and Persian army. Situated in river Charadros' delta, it is considered of high ecological and historical interest. Part of the area is now transformed into various installations for the Olympic Games of 2004, which alterate the landscape and restrain the natural ecosystem dramatically. Herodotus & Pausanias describe the battle which tended to be one of the most critical moments in ancient European History. In fact, the later notes that in the area existed a lake, the biggest part of which was in reality a marsh. There the goddess Athena was worshipped since the Bronze Age, her epithet 'Ellotis' referring to the existence of the marshes in the area. Most importantly, the Greek Government agreed in 2002 that the Schinias wetland site would be included in the EU NATURA 2000 list of protected areas. Upon request of Mr Costa Carras, Vice-President of Europa Nostra, representing Elliniki Etairia, a Resolution was adopted demanding that urgent action be taken to ensure the protection of the Marathon Historic Site and Schinias Wetland, currently threatened by the proposed development of the area for the 2004 Olympic Games. The Greek Government and the International Olympic Committee (IOC) had planned the construction of a permanent rowing facility in view of the 2004 Olympic Games. The location selected for this future rowing facility possesses great historical value (Marathon) and is an ecological area of international importance (Schinias wetland). Four Greek conservation organisations have joined their efforts to

Affairs will be sensitive to international pressure. Europa Nostra therefore wrote a Resolution that was sent to the Greek Prime Minister and to the President of the IOC. The campaign was further backed by an email and letter campaign. There were three substantial successes: The Olympic slalom event was removed from a site close to Marathon. Parts of the plain where the initial engagement had been fought in 490BC were declared a protected archaeological site. Most importantly, the Greek Government agreed in 2002 that the Schinias wetland site would be included in the EU NATURA 2000 list of protected areas. The campaign stirred up further commotion in 2002 when excavations for the Olympic Rowing Centre lakes uncovered buildings of the second millennium BC, finally refuting original official claims that the area had been sea in antiquity, including at the time of the Marathon battle. Europa Nostra continues to follow this matter closely, together with its Greek member organisation that has participated in the campaign since its inception.

- Parnitha National Park

The designation 'National Park' refers to areas which, under the international forest legislation, display special ecological interest due to the rare and variegated indigenous flora and fauna, their geomorphologic formations, subsoil, water and atmosphere. Humans must ensure their preservation and improvement, both in order to allow the conduct of scientific studies and to attract visitors for recreational and educational purposes. Westerly of the modern city of Athens., this wooded area has geological, ecological and historical interest. The biggest mountain of Attica (ca 20.000 hectares) also carries two small lakes, springs and brooks, and it is acknowledged as a Protected region from 1961. It is a wooded area (core zone: 3812 ha. Peripheral zone boundary remains undefined.) noted primarily for its spreads of the endemic Cephallonia fir (*Abies cephalonica*) on relatively poor and dry soil, for temperate coniferous-tree forests (chiefly consisting of *Pinus halepensis*), maquis, mountainous grasslands, rocky hills, springs and streams. The area supports two main vegetation zones: a) the *Abies cephalonica* zone (rising at 600-800 m or above) consisting of *Abies cephalonica* forests, *Quercus ilex* formations, also harbouring *Q. pubescens*, *Fraxinus ornus*, as well as other Mediterranean bushes occurring at high elevations; b) the zone of *Pinus halepensis* and hard-leaved evergreen shrubs which either occur on their own or form a sub-storey in pine forests. The area has been designated as a National Park since 1961. The Parnitha National Park commands particular ecological interest, and can constitute a reserve for the protection and preservation of Southern Greece's flora and fauna (e.g. 120 species of birds, 42 types of mammals out of 116 in Greece). The Parnitha flora is one of the richest in Greece, boasting 818 recorded plant species, certain among which are endemic or listed as critically endangered. The area's fauna includes many species protected under law both at a national and international level. Indicative is the fact that Parnitha is the only area in Southern Greece where the red deer (*Cervus elaphus*) still survives. Parnitha's proximity to the urban sprawl of Athens, coupled with its great aesthetic and ecological value, accentuate its importance.

(3500 ha) has ecological, historical, mineralogical, paleontological and geological interest. It is protected since 1974. This is the smallest of the country's ten national parks. Its core area is only half that required for a national park but an exception was made because it's coastal, extraordinarily scenic, archaeologically unique, and a visitor destination that could do with the additional legal protection. The 750 hectare core is surrounded by another 2750 ha of limited use land. All land within it is state-owned and most of it is covered by the Aleppo pine (*pinus halepensis*) forest typical of coastal southern Greece. The greatest interest for the natural historian lies in its geological history and properties though its main draw is the fifth-century BCE temple of Poseidon (built with local marble, the old quarry lies within the park) and, to a lesser extent, the neighbouring temple of Athena. Avid rock connoisseurs might find odd items like laurionite (which takes its name from the area and is only found there and in Cornwall), phosgenite and a number of minerals unique to the area and often associated with ancient slag. Its plant and animal life are of limited interest compared to the other national parks. Apart from one endemic cornflower species, the flora are generally commonplace. It does serve as a valuable refuge for species long gone in the rest of the densely populated peninsula such as foxes and jackals. Its fossil record is actually more exciting than what currently lives there. Perhaps the most important factor is that it's protected as a forest and thus almost impossible to turn into lots, it being absolutely prime real estate in the eyes of the many greedy property developers that infest Attica (there's an endemic pest we could do without). Archaeologically speaking, it's one of the most interesting and diverse parts of Greece, which says a lot in a country in which you can't dig a hole in your back yard without an archaeologist peering over your shoulder. That part of Attica has been inhabited since Palaeolithic Times and holds an impressive record of successive cultures based on agriculture and mining. The silver mines of nearby Lavrio, operational into the 20th century, yielded much of ancient Athens's wealth as well as zinc, lead and iron, and the many findings have given scientists a lot of insight into the presence of man in prehistoric and ancient Greece, as well as into ancient mining and smelting technology.

- Vouliagmeni Thermal Springs

Characterized as a lagoon with stable high water temperature (>18°C), it covers an area of ten building blocks underneath the modern suburb of Vouliagmeni. There is a probable underwater communication between the lake and the cave at depth of 100 m. The lake at Vouliagmeni has long been billed for its therapeutic waters - allegedly beneficial for a variety of ailments such as rheumatism, skin disorders and aches and pains. Whether you trust this or not, one thing for sure is that it is a uniquely wonderful place to swim. The rock formations surrounding the waters are fascinating - allowing you to swim between jagged pinnacles of granite, marble and quartz. The small Vouliagmeni Lake is about a 45-minute drive from Athens city centre. There is a coffee shop that overlooks the water (its umbrellas allowing a welcome relief from the sun during the intense summers). For those who are serious about seeking therapeutic treatments at the lake - there is a "medical" centre offering advice and treatments. Vouliagmeni lake is included in the list of Greek karstic

2 SPATIO-TEMPORAL DISTRIBUTION OF HAZARDS IN EASTERN'S ATTICA HISTORY

2.1 Hazards' detection in the cultural landscapes

The science of Geography is of the first importance in the study of the history of man, for this discipline is a study not only of the complicated board, upon which the drama of human life is played out, but also of the rules which condition the game. Man like other living things, must adapt himself to his environment or perish. Here he differs only from the beasts in that his adaptation is not merely passive. Increasingly he becomes the master of nature and is able to modify the conditions which she imposes.

The Balkan peninsula consists of a tangled mass of limestone mountains, of which the adjacent islands are merely the continuation. There is but little arable land in the small plains and that little is for the most part stony. It is noteworthy that although deforestation has no doubt diminished the rainfall and assisted the erosion of the soil on the mountain flanks, the farming conditions in antiquity were not so very different from those of modern Greece. The settlements were for the most part cut off from each other by the mountains and the sea. Land communications were difficult, particularly in winter, when the snow lies deep. In consequence the communities developed in independence of their neighbours, and it is due ultimately to this geographical condition of their growth that independence is the key-note of Greek civilisation throughout its political history. For relief the Greeks were driven to sea.

Ancient Athens consisted of the city itself and the large triangular peninsula known as Attica, which juts southward into the Aegean Sea. In antiquity Attica was settled with numerous villages and towns. Running through the plain of Athens, in a NE - SW orientation, is a long limestone ridge. The highest point, a conical peak which reaches 273 meters above sea level, is known as Lykabettos, now a clear reference point rising above the sprawling modern city; beyond, the ridge continues northeast as modern Tourkovouni (ancient Brilessos or Anchesmos). Three rivers pass through the plain, the two biggest being on the limits of the ancient city. To the north, the Kephisos River rises in the foothills of Mount Parnes and makes its way, for 27 kilometers, to the sea at Phaleron. To the south, the Ilissos winds along the foot of Mount Hymettos to the southeast of Athens. Between them, the Eridanos rises on the slopes of Lykabettos Hill and flows north of the Acropolis, passing through the

the Thriasian plain and the important town of Eleusis, with its sanctuary of Demeter. To the north, Mount Parnes separated Athens from Thebes and Boiotia. To the northeast is Mount Pentele, source of the fine white marble used and exported by the Athenians for centuries. And to the southeast, closing Athens off from the rest of Attica, is Mount Hymettos, crowned with a sanctuary to Zeus as weather god and famous in antiquity for fine honey. Beyond Pentele and Hymettos lies the rest of Attica, some of it hill country, part of it a large arable plain. The northeast limit was occupied by the towns of Rhamnous and Marathon, both on the sea, facing the large island of Euboea. The southern tip is Cape Sounion, which was dedicated to the sea god Poseidon.

Plato, writing in the early 4th cent. B.C., describes an earlier time when the ecological equilibrium was better: "But at that epoch the country was unimpaired, and for its mountains it had high arable hills, and in place of the moorlands, as they are now called, it contained plains full of rich soil; and it had much forest land in its mountains, of which there are visible signs even to this day; for there are some mountains which now have nothing but food for bees, but they had trees not very long time ago, and the rafters from the trees felled there to roof the largest buildings are still sound. And in addition there were many lofty trees of cultivated species; and the country produced boundless pasturage for flocks. Moreover, it was enriched by the early rains from Zeus, which were not lost to it, as now, by flowing from the bare land into the sea; but the soil it had was deep and therein it received the water, storing it up in the retentive, loam soil. (Critias 111 C–D).

Consequently, any modern researcher who has to deal with cultural heritage's assessment, should be able to trace past catastrophes, landscapes' changes and ecological oscillations, as well as to recognize and classify the existent / possible hazards that may have impact on patrimony's units, either natural or cultural, before evaluating and analyzing them. These hazards are divided into natural (31) and human-induced (53).

The natural hazards include the following cases: land movements, landslides, avalanches, soil liquefaction, earthquakes, sea-level changes, coastline regression / transgression, tsunami, volcanic eruption, submarine pockmarks of natural gas, gravitational waves, electromagnetic storms, rapid climatic changes, changes in the biochemical synthesis of waters, prolonged drought, floods, hail, unexpected frost or snow, prolonged burning heat, typhoons, tornadoes, stormy winds, soil erosion, desertification, extensive disappearance of plant & animal species, transgression of marshy areas, lethal mutations of pathogens / pandemics, massive movement of populations, meteoritic fall, wild fires, insects, birds, reptiles, carnivores, undesirable plant species within the site.

The human-induced hazards include the following cases: drainage of marshes, lakes & rivers, burying of streams, habitation of sites near volcanoes or faults, changes of river's course, intentional fires, land's deforestation, dams, transmitters of electric power, extended industrial units, mines & quarries,

destruction of wetlands, explosives and other kinds of vibrations, overpopulation, aesthetic alteration of the landscape, ignorance / indifference concerning the cultural heritage, degradation of life's quality, vandalisms, insufficient / non existent enclosure of the site, smuggling, insufficient / problematic cleaning / hygiene of the site, other problems inside the site, destruction of subterranean antiquities due to land's cultivation, building procedures, e.t.c., problems in static balance of monuments, unauthorized removal of architectural elements, cutting of architectural elements, mutilation of the monument, erosion, burying, alteration of site's general profile, alteration of monument's view, disappearance of various elements, items, e.t.c, defective watching of the site, defective conditions of conservation, study or storage concerning the materials found in the site, interventions of bad taste concerning the external spaces of the monument, use of ancient elements in later works, graffiti, existence of high buildings within 500 m. distance from the site, vicinity to dense populated area, various works in progress, e.g. harbour installations, industries, road construction, e.t.c., unsuccessful methods & techniques of conservation, intensive rates of visitors, difficulties in site's accessibility, difficulties in site's touristic exploitation.

Especially the natural phenomena (potential dangers) may be classified into three main groups according to their patterns of appearance: a. Cyclic, meaning the rhythmically repeated (sequence of seasons, day and night, tide), b. Progressive or Inclining, meaning their appearance in a time period longer than the life of an organism that experiences it (glaciers, erosion of coasts) and c. Erratic/chaotic (storms, cyclones, hurricanes, reappearance of illnesses).

On the other hand, both categories (natural & human-induced) can cause human loss and severe economic damage -see the recent case of the archaeological site at Akrotiri in Santorini island during September 2005, with one tourist dead and millions of euros needed for repair -, and jeopardize the integrity, the physiognomy, the functions and the features of patrimony sites as well as the local infrastructures, the character of the natural and human ecosystems of the area and the cultural profile of the whole county.

Natural and man-induced hazards play an active role in the morphology and evolution of past, present and future ecosystems, both natural and human. They happen in periodical or chaotic patterns, varying in frequency, magnitude and functional structure. They may have also several impacts on the evolution of human civilization (biological, ecological, environmental, socio-economic, political, technological, geographical, ideological and cultural results) that are not always clearly defined, even by the victims or the generations following the event. These effects could be hidden in the 'archaeological landscapes', due to diverse parameters. Furthermore, many 'entities', for example the vulnerability of ancient societies to environmental or human-made risks, and their adaptation process to the 'unfamiliar landscapes' formed after natural disasters are not measurable as other proxy data can be (e.g. palaeoclimatic, hydrogeological, palaeoanthropological) .

The cultural heritage of Eastern Attica is prone to the following hazards.

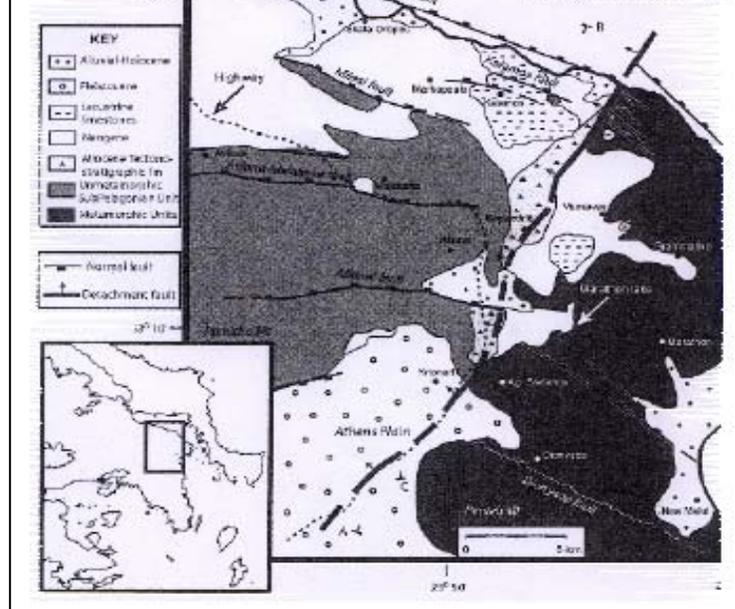
2.2.1 Local or regional geotectonics

a. Active faults

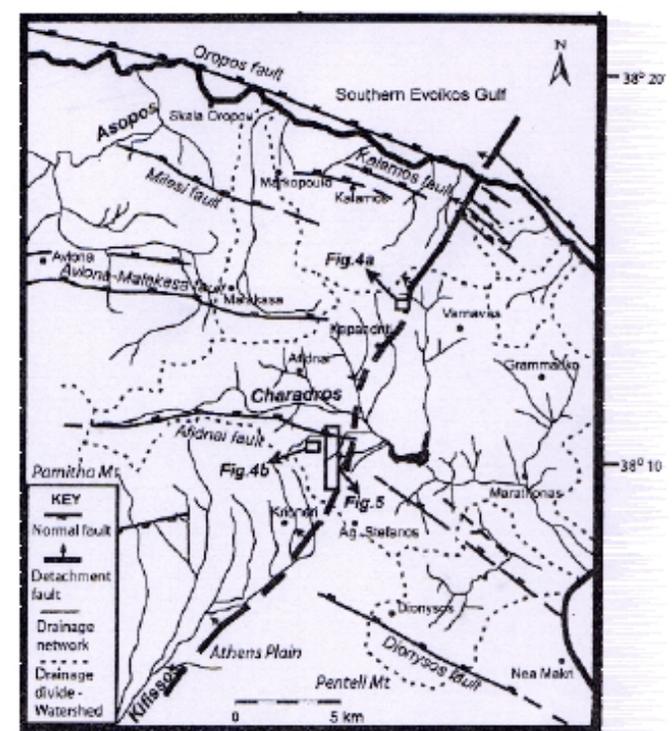
One should always pinpoint the hazard of earthquakes, a frequently repeated natural phenomenon all over Greece. Apart from severe seismic paroxysms like the phenomenon of Seismic Storm in Eastern Mediterranean that lasted from ca. 1.175 to 1.125 (Peiser et al., 1998; Nur & Cline, 2000/1), and triggered the collapse of Bronze Age societies, other isolated significant remote events that cause damage in long distances (i.e. the event of A.D. 365 with an epicenter between Peloponnesus and Crete), or even destructions in neighbouring antiquities (i.e. in the Late Helladic settlement at Agia Irini at Keos island), Eastern Attica is located near the active faults of Central - Southern Evoikos Gulf (i.e. Agios Minas - Chalkida, Lefkadi, Avlida) and the most remote Atalante, which had given strong earthquakes since the ancient times (Rondoyanni et al., 2007).

In addition, the major structural features of the Marathon Basin, an area of approximately 40 km² with very smooth relief but also with abrupt topographic changes in the transition to the highlands, appear to be controlled by a system of NE- SW neotectonic faults cause stepwise NW - SE deepening of the basement and clockwise block rotation. The permeable communication of the bedrock marbles with the sea make local aquifers to experience intense salination, and pollutants due to intense agricultural activity to be transported to the sea and to the nearby natural reserves of Schinias wetland and pine forest (Chailas et al., 2007).

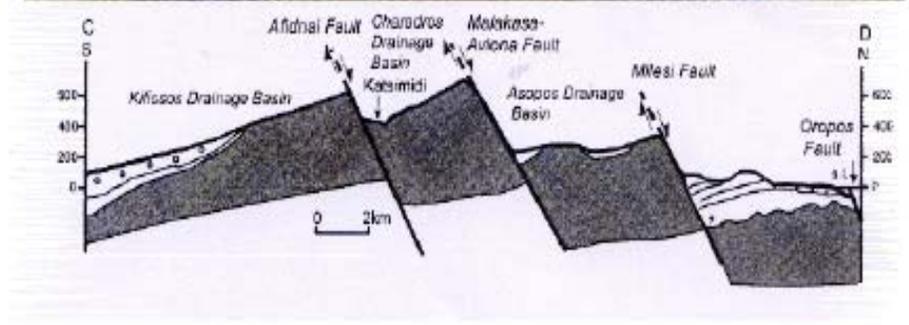
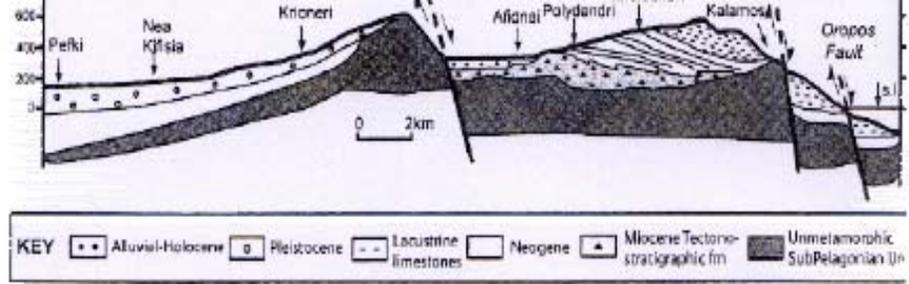
A wider synthesis of geological, geomorphological and tectonic data from NE Attica reveals that the region forms a tilted tectonic block bounded by the Afidnai fault to the south and the Oropos fault to the north that rotates to the S. - SW. The drainage basins of the area are highly asymmetric due to the presence of active normal faults (i.e. Avlona - Malakassa, Dionysos, Kalamos, Milesi). In particular, the Charadros river is clearly deflected into a fault parallel flow direction due to the subsidence within the Afidnai hangingwall. A major detachment fault separates, also, the western from the eastern part of NE Attica. The E -W trending faults are large and known to generate medium to large magnitude earthquakes (1938 Oropos M = 6.0). This is one of two major recorded events in the historical catalogues since 1500 for M > 7.3 for the area, the other happened in A.D. 1705 (Papanikolaou & Papanikolaou, 2007).



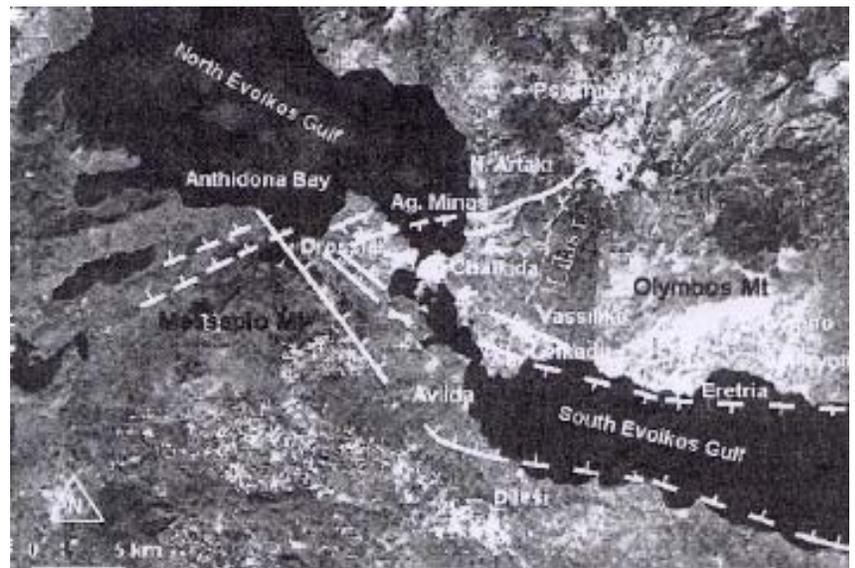
Geological map of NE Attica indicating major faults (Papanikolaou & Papanikolaou, 2007)



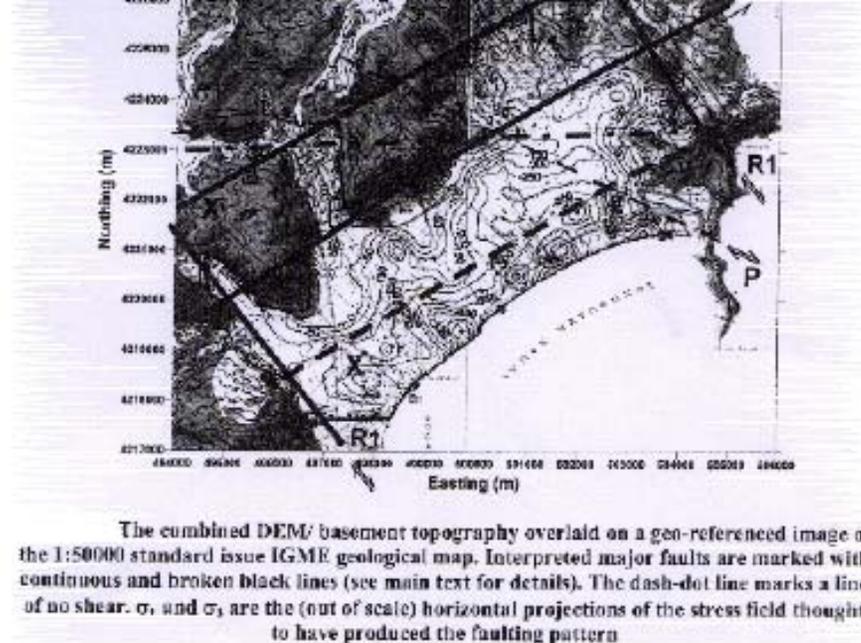
NE Attica drainage network, drainage divide and active faults (Papanikolaou & Papanikolaou, 2007)



Cross-sections A-B & C-D (Papanikolaou & Papanikolaou, 2007)

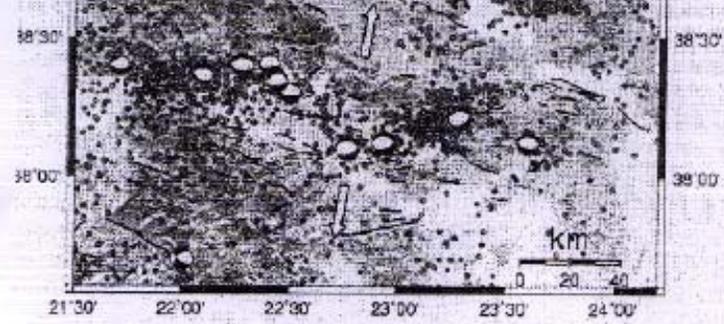


Active and recent faults in the central Euvoikos area (Rhondoyanni et al., 2007)



Major faults , combined DEM/basement topography of Marathon Bay, overlaid on geo-referenced IGME geological map (Chailas et al., 2007)

Another probable source of events lies in the eastern part of the Gulf of Corinth (i.e. Holocene Kaparelli fault), as Central Greece is one of the most tectonically active and rapidly extending regions in the world. In February - March 1981, a sequence of three earthquakes of Alkyonides ($M = 6.7$, $M = 6.4$, $M = 6.3$) with magnitudes greater than 6.3, struck the area and caused damage in the Athenian plain (Ganas et al., 2007). The sequence of September 1999 Athens earthquake with its magnitude of 5.9, originated in the active fault of Fili. The earthquake also affected monuments. Seriously damaged were the Monastery at Dafni (11th century), the Fortress of Fili (5th century BC) and the wall of Elefsina (5th century BC). Also affected, though repairable, were also a large number of buildings hosting cultural activities or objects of cultural value, including the National Theatre, the National Opera and the Archaeological Museum.



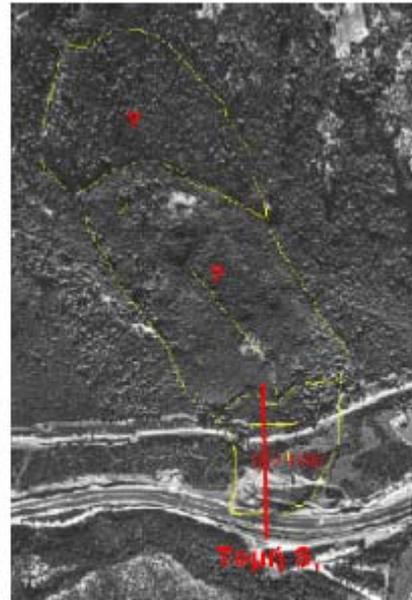
Seismicity and active normal faults of the Gulf of Corinth and surrounding area. The arrows present the extension of the Gulf of Corinth. Focal mechanisms of large events are also presented

Seismicity and active normal faults of the Gulf of Corinth and surrounding area (Kaviris et al., 2007)



b. Landslides

Landslides / rock falls / soil creep and other forms of geomorphological instability are triggered by erosion, earthquakes, faulting, lithological conditions, mining activities, heavy rainfall and other phenomena. The International Geological Correlation Programme (IGCP) was established in 1972 as a cooperative enterprise of the UN educational, scientific and cultural organization (UNESCO) and the International Union of Geological Sciences (IUGS). The IGCP -425 project launched in 1998 with the overall aim of protecting natural and cultural heritage sites from landslide hazard, Delphi & Mount Athos being among them. In Attica, the site of Amphiareion at Oropos is exceptionally prone to this, as the whole area is almost annually damaged by the phenomenon of winter flooding and its geological side effects, as the slope-stability is low.



Σχήμα 1. Γενική κάτοψη της κλιτύς στην Περιοχή της Μαλακάσας, όπου φαίνεται το ίχνος της πρόσφατης κατολίσθησης της 18-02-1995 στον πόδα μιας ευρύτερης διατεταραγμένης ζώνης.

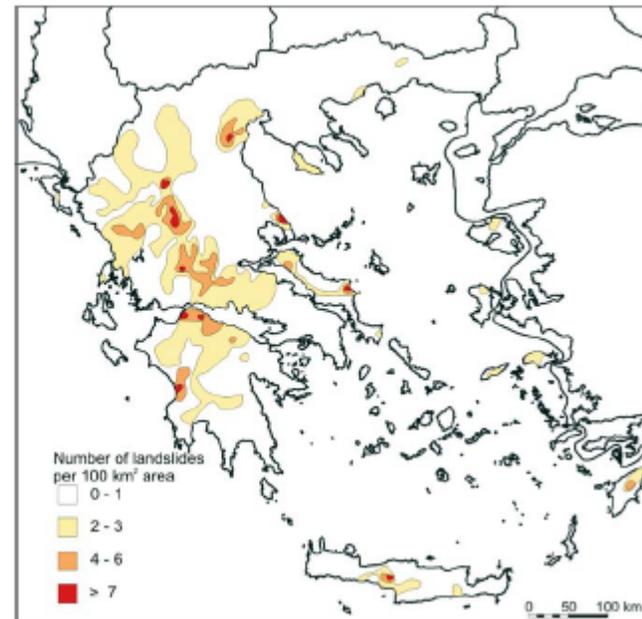
Figure 1. General topography of the Malakasa region, where the trace of the recent landslide in 18-02-1995, in the footing of an extended disturbed zone is given.



Fig.37.6. Malakasa landslide, February 1995. Damages on the new highway from Athens to Thessaloniki. The landslide manifested in the tectonized and weathered zone of schists covered by debris

Malakasa landslide, 18-02-1995 (Georgopoulos, & Vardoulakis, 1996; Koukis, Sabatakakis, Nikolau & Loupasakis, 2005)
 <<http://geolab.mechan.ntua.gr/papers/Malakasa.pdf>>
 <<http://www.springerlink.com/content/j6k14213164110r1/fulltext.pdf>>

Fig.37.9.
 Landslide hazard zonation map
 of Greece



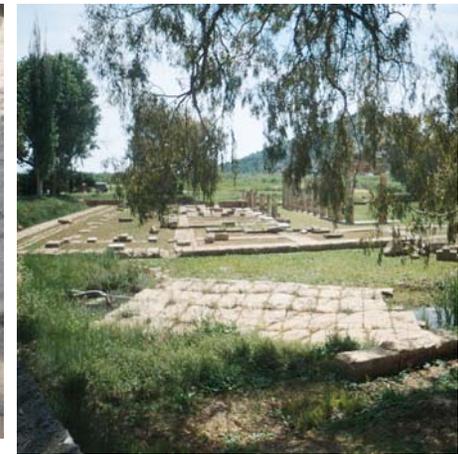
Landslides hazard zonation map
 (Koukis, Sabatakakis, Nikolau & Loupasakis, 2005)

b. Subsidence

Brauron seems to experience the phenomenon of subsidence, which is attributed to local geomorphological reasons. The temple area is located in a shallow depression not far from the river mouth



Stagnant waters in the subsided ground



Sanctuary of Brauron -visible subsidence around the sanctuary - E. precinct (field visit of 24/09/2006)



Sanctuary of Brauron (North corner)



East corner of the sanctuary visibly lowered in relation with the slope (field visit of 3/ 06/2007)

c. Sediment deposition

Pleistocene alluvial fans are observed within the Athens plain along the southern slopes of Parnitha mt and the western slopes of Penteli southwards from the Afidnai and the Agios Stefanos covering the Neogene sediments. Recent alluvial sediments are limited in thickness and are observed only in some small narrow bands along the coastline (Oropos, Kalamos, Marathon, and in the Afidnai Basin (Papanikolaou & Papanikolaou, 2007).

Erasinos, in the area of Brauron, was a notorious river for his destructive action (Strabo VII.5.VII-VIII cap. 371). The oldest, insofar, bridge of Attica was built

deposits, that the whole geomorphology of the area changed dramatically. During its steady action, the river caused the formation of a fan in the Bay of Brauron. Nowadays, Brauron has a rich ecosystem of great environmental importance, a coastal green wetland with lush vegetation, manifold rural landscapes with cultivated fields and mild hills that embrace the serene valley.

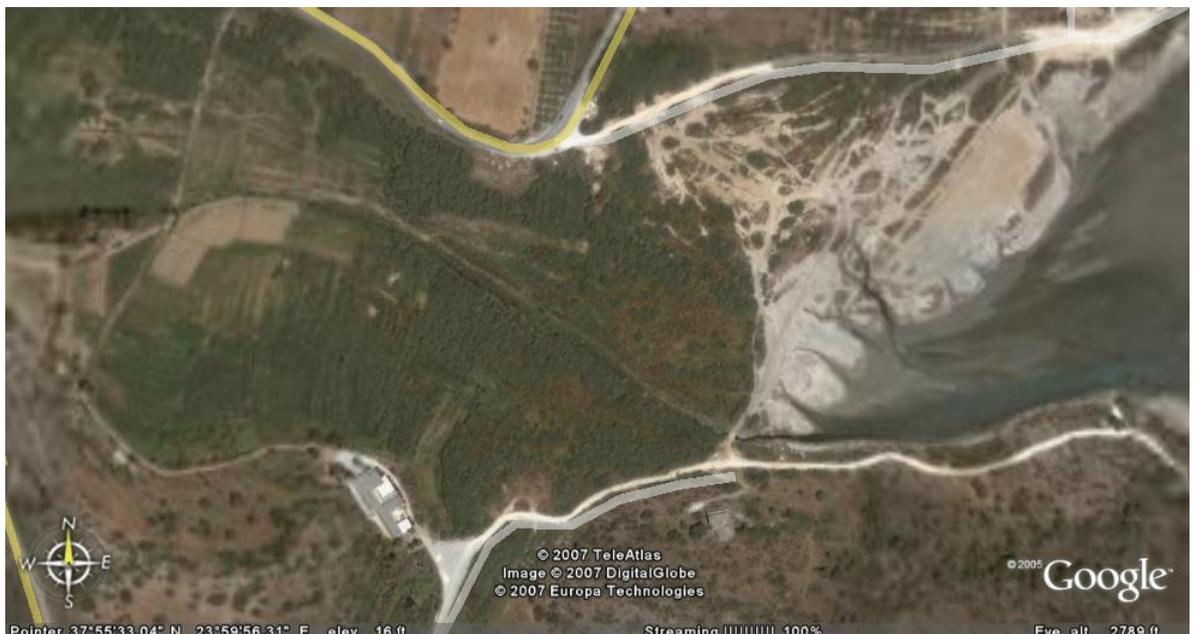
The neighbouring bay intrudes inland formatting islets of salinas and hydrophytes' vegetation. The archaeological site stands on a 'marshy' area, as after an even mild rainfall visitors' steps are sunk into the wet muddy ground covered by lichens and mosses. During severe rainfall and the overflow of Erasinos, the site is flooded as the waters cover the area of the ancient temple.



Erasinos within the sanctuary (Northern boundaries)



Stagnant & running water in the ancient drainage pipeline SW corner of the site (field visit of 3/06/2007)



mentality of human communities, playing a crucial role in the transformation of human civilization. Moreover, environmental changes, whether man-made or natural, contemporary or past, have always involved a complex interplay of physical, chemical and biological processes of the Earth.

On the other hand, cultural landscapes are extremely vulnerable to the disasters related to water. Apart from the fact that these events are increasing, institutions and countries take action after damage has occurred. But rather than financing relief, it is essential to think of risk management as a coherent suite of actions including cultural assessment, prevention, monitoring, preparation, intervention and sustainable reconstruction. Although not all disasters can be avoided, preventive measures should play an important role and have proven to be cost effective. In order to increase the coping capacity of cultural heritage, and decrease its vulnerability to water hazards, policies, either in local, regional, national or international level, should be less dependent on environmental extremes. Detailed analyses of the cultural landscapes and integrated vulnerability assessment of the patrimony can function as a buffer action, in order to absorb natural or human-triggered shocks like floods, tsunami, pollution / contamination, sea-level rise and coastal changes.

Water -related disasters take an enormous bill not only on human lives and economic losses, but also on environmental, social and cultural losses all over the world. The driven forces of water hazards may be generally categorized into three main groups: a) hydro-meteorological phenomena (HM), b) hydro-geological phenomena (HG) and c) anthropogenic causes (A). Their impact may also be assessed either as direct , or as indirect / long-term process. Although there are many methods of evaluation, categorization and analysis of such phenomena, an archaeologist / heritage manager would probably like to know the main factor of risk and its spatio-temporal distribution. Thus, it would be wiser, for practical reasons only, if we could estimate the role of man in the appearance or aggravation of disastrous phenomena, that destroy, degrade, mutilate or alter the cultural landscapes. The list presented below is not exhaustive, but rather explanatory and representative, in order to give various examples of cultural heritage undergone damage related to water phenomena.

a. Inundation / Flooding

Many areas of the world experience periodic inundation or are prone to flooding due to local geomorphological and hydroclimatic conditions. It is also evident that multiple secondary factors increase their vulnerability to flooding, growing population, denser occupancy of flood plains and other flood-prone areas, along with the expansion of unwise forms of watershed land use, being among them. Moreover, massive deforestation and urbanization reduce water storage capacity and amplify flood waves. Noteworthy is the fact that dryness may turn to be a normal state to which humans have adapted, while floods strike unprepared populations suddenly. This category includes heavy rainfall cases and river or lake over flooding. Dam and sea-generated flooding is analyzed as separated category for various methodological reasons.

the area then known as Acte (Akte). The land was called Ogygia in his honour, but was later known as Attica. A great flood in Attica in his days derives its name, the Flood of Ogygia, from him. This flood, according to tradition, is dated to 1796 BC. He survived the flood, but many people perished. After the death of Ogygus, due to the very great destructions of the flood, Attica did not have a king for 189 years, until the time of Cecrops (Cecrops Diphyes).

Later on, perhaps during the 15th cent. B.C., a large influx of waters into the Patras-Corinth-Alkyonides gulf. Some of the waters move over the low lying Corinth isthmus flooding Attica and destroying Athens. Others enter the Amphissa plane and move up the slope of the Parnassus. They probably did not reach Delphi, about 800 m high, but were close providing to Deucalion dramatic evidence of the flood.

In the area of Marathon, Charadros, a torrential river, has his spring on the mountain of Parness (1365 m. height) and casts his waters onto the bay of Marathon, after 31 km of flow, almost 3 km SE of the modern town of Marathon.

Along his flow many tributaries join his course, like the one which flows into the area of Schinias (Kato Souli). In the 190 km² of his basin the modern dam of Marathon has been constructed during the period of 1928 - 1931. The river, notorious from the Classical Period, has a steady annual water runoff, characteristic that triggered the formation of the big marshy lake in the plain of Nea Makri (Pausanias, I.32.7). The transgression of the marshes in the area was the main cause for the spreading of malaria, an endemic disease in the archaeoenvironments of Eastern Mediterranean, disease with hardly recognisable overall impact on the population rates in the ancient world. In fact, the whole area was notorious for its two marshes, the Big where the historic conflict of 490 B.C. took place, and the small, which functioned as the southern boundary limit of ancient Marathon's area. It still exhibits the same 'dual' behavior: the positive being that the area is a very fertile land, extensively cultivated as it is the main provider of vegetable for the city of Athens.

Moreover, it offers the ideal environmental conditions for the formation of wetlands and idyllic sceneries.

Flooding is a constant threat for local people, infrastructures, and, of course, the monuments themselves. It causes repeated problems to their living conditions, as well as to the accessibility and visiting capacity of the sites, and the general profile of the area. More precisely, weather conditions harm the structure of the open-site monuments, such as the Tumulus of Athenians at Marathon. Probably, the myth of Theseus who captured the Marathonian Bull which damaged the area and terrified the local people, is an allegory of organized civil attempt to control the hydrological hazards of the area.

In the area of Brauron, ancient pilgrims and local populations seemed to face similar problems. Although Erasinis is a small river, its water drainage area is large enough to cover locations as Attiki Odos, Venizelos Airport, and Markopoulo city. It is also flooding after strong and intense rainfalls, carrying



Drainage pipeline within the installations of ex-American Base at Nea Makri, 8/11/2006)



Classical bridge leading to the sanctuary next to Brexiza north view (field visit of of Brauron, field visit of 3/06/2007)

b. Tsunami

Tsunamigenic factors (i.e. submarine landslides, volcanic eruptions, meteoritic impacts, activation of submarine faults) trigger this extremely unpredicted and disastrous phenomenon. The majority of visited archaeological sites in many countries of the world are coastal, with highly developed touristic infrastructures. Past natural disasters from the Early Antiquity can teach us the necessity for early warning / monitoring systems, the hazard assessment of the cultural sites and an iterative risk management of the patrimony, according to the constantly changed natural and human environments.

Many areas of the world are tsunami-prone, Greece being among them. Ancient authors (Thucydides, III. 89.1; Strabo, I.3.xx & I.60; Diodorus, XII.59 et al.) describe two major events, one in the N. Aegean basin, which seriously affected Poteidaia (Chalkidiki Peninsula) during spring of 479 B.C. and another in Malliakos Gulf (three seismic sea-waves), which seriously affected Scarfeia during summer of 426 B.C. (Tinti et al., 2001; Ambraseys in Stiros & Jones, 1996; Galanopoulos, 1960). In addition, excavation data from E. Locris reveal that earthquakes and seismic sea-waves frequently hit the area causing destruction. The Homeric town of Kynos, harbour of Opos, at Livanates - Central Greece, was a flourishing center during the LH Period. Storerooms of the LHIIIC settlement (12th cent. B.C.) suffered at least one destruction by earthquake and tsunami, probably related to the reactivation of the nearby Locris or Atalanti fault (Dakoronia in Stiros & Jones, 1996). The notorious Helike case is presented in another category, because the destruction of the Classical city happened as a result of various hydrogeological phenomena.

c. Sea-level rise (SLR) and coastal changes

Global or local event SLR reflects the interaction between various

1989; Christie-Blick, 1986; Butzer, 1983). Coastal evolution after the Last Glaciation Maximum (LGM) and especially during the Late Pleistocene and Holocene, is related to the amelioration of the climatic conditions, the active sedimentary dynamics of marine, tidal, fluvial and lacustrine environments, extensive freshwater runoff, rise of vegetation cover and pedogenetic processes. Coastal flooding is also due to severe windstorms and tsunamis.

On the other hand, coastal erosion, either natural or anthropogenic, which is always accompanied with the shoreward recession of the shoreline and the loss of land area, causes various economic, industrial, agricultural, navigational, recreational, demographic and ecological problems, even if happens in pocket beaches as a local phenomenon.

The circum-Mediterranean area is an interesting case of changing coastal landscapes that are registered in the local geoarchives (i.e. Bintliff, 2002; Rapp & Kraft in Kardulias, 1994; Pirazzoli, 1991 & 1986). Ancient authors (Herodotus, Thucydides, Plato, Aristotle, Theophrast, Strabo, Pausanias, Titus Livius) had realized these coastal changes and their repeated transformative impact on human societies. Coastal regression or transgression affected cities' prosperity and longevity. Well-known are the examples of ancient Mediterranean harbours like Piraeus, Thessaloniki, Ephesos, Myous / Miletus (Mac Kil, 2004). The ancient seaport of Oiniadai (Triardo island, Akarnania, N.W. Greece), once belonged to the Echinades Islands, famous for its spectacular shipsheds of the 5th cent. B.C., has been engulfed by sediments of the Acheloos river. Today, it is surrounded by the alluvial plain, the distance to the open sea being between 9 and 11 km. (Vött et al, 2004).

During ancient times, the sea in the bay of Marathon intruded much further inland, more than a 1km as the subsoil indicates. The big marsh was created in the period before the battle of 490 B.C., partly as the result of the continuous silting up of the Charadros, this large and sometimes destructive river.

- d. Temperature & moisture variations (periodic freezing, ice, heat and rain)/ existence of saline waters near the monuments / erosion of the monuments

Long-term changes affect the cultural sites and monuments in climates that experience interannual variability, in areas that are characterized by intense seismotectonic activity, in cases of uncontrolled human action or total abandonment of the cultural heritage. Temperature / humidity variations, periodic hydrometeorological effects (rain, snow, freeze-thaw cycles, moisturizing winds), apart from air pollutants, UV radiation, salt crystallization and biological weathering (colonization by microflora, i.e. fungi, algae, lichen & bacteria) interrelate each other in a vicious cycle of short- and long-term damage. These phenomena are often disregarded by heritage managers, even if they play crucial role in the overall status of the monuments, or by archaeologists who abandon the sites to their fate without permanent monitoring controls, iterative assessment processes and strategic plans for sustainable touristic development. The sanctuary of Brauron is a rather sad

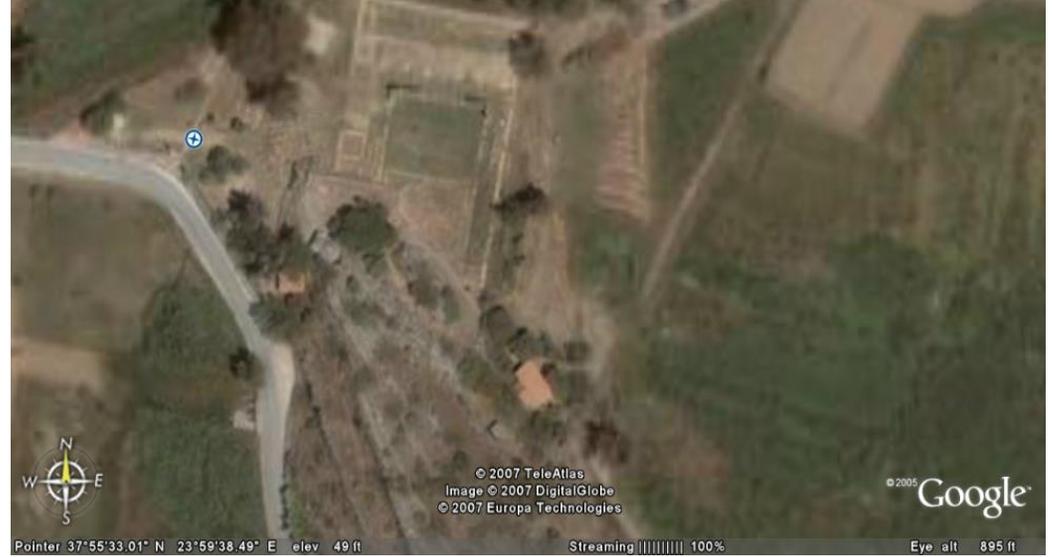
archaeological site of Sounion. One should also emphasize that the progressive decay of monuments make them more vulnerable to seismic / ground movements and other factors which damage their stability or their overall integrity.

The constructions at Brauron took place in two phases. The ancient quarries that provided the sandstone originated from Neogene sedimentary deposits, are located 500 m. away from the monument and traces of quarrying are still visible. After being buried under the mud load carried by Erasinos river for many centuries, the restoration works used not only the material found in situ, but also new material provided by the same formation as well. Thus, the restored parts of the monument display the same intensive deterioration. The decay forms result from intrinsic (endogenic) and environmental factors. The main endogenic factors of decay are: (1) high porosity & pore size distribution, (2) the calcite cement of the stone, and (3) the mineralogical composition, especially the presence of swelling clay minerals. Furthermore, the main environmental factors of decay that result in the calcite and salt crystallization, are: (1) the burial of the monument into the brackish water mud, (2) the frequent floods and the possible pollution of Erasinos river, (3) acid rain & aerosol attacks, and (4) biodeterioration (Tsipoura - Vlachou & Michopoulos, 2007).

Water is an important weathering factor, as water can reach a building material through capillary rise of ground moisture, rain and condensation of air humidity.

Other phenomena, too, like crystallization and hydration of salts, are controlled by water, so building stones of monuments at coastal sites are affected. These procedures are capable of destroying even the most resistant stone. The future durability of Brauron sandstone depends heavily on the anthropogenic factors, such as air pollution, but also on various natural parameters such as humidity levels, marine aerosol rates and local climatic conditions (Tsipoura - Vlachou & Michopoulos, 2007). The wetland that was inside the site drained during the restoration works of the monument, while thirteen columns of the portico had been restored during the decade 1950 - 1960.

The lithotypes of building stones are: I. whitish-grey cohesive, coarse-grained sandstone (calcareous litharenite) used in the construction of the columns and the capitals of the portico (stoa), with water absorption index up to 2%, II. beige semi-cohesive, fine-grained sandstone (calcareous litharenite) used in the construction of the capitals and the rooms connected to the portico with water absorption index up to 3%, and III. beige non-cohesive, medium-grained sandstone (calcareous litharenite) used in the construction of the columns of the temple with water absorption index up to 6%. The more intense decay problems appear on the portico columns and are summarized as following: (1) pitting corrosion to cavitation erosion of graduated degree, presence of vugs & cavities, and (2) strong color alteration, calcareous crust formation. Evenmore, the columns facing NE are affected by marine aerosol, displaying stronger decay degree due to salt crystallization. Finally, Biodeterioration is enhanced by microbial communities, bacterial populations, and fungi existing in cracks or



Brauron sanctuary - satellite photo



Erosion of the protective wall , NE corner (field visit of 3/06/2007)



3rd votive stele (westwards)



6th votive stele (westwards) (field visit of 3/06/2007)







Underwater Archaeology is the study of past human life, behaviours and cultures using the physical remains found in salt or fresh water or buried beneath water-logged sediment. It is considered as a branch of Maritime Archaeology. Changes in sea-level due to local seismic events, or more widespread climatic oscillations or changes on a continental scale, even other geological phenomena, alter the coastal environments, having as a result the submersion of occupational sites, once in dry land. The remains may be within various sedimentary facies: 1. terrestrial (peat formation), 2. fluvial (floodplain / freshwater marsh -H- or levee / crevasse splay sediment -F-), 3. (fluviomarine-) fluvial (river channel), 4. fluviomarine (delta), 5. brackish (coastal swamp), 6. shallow marine, littoral (sand bar / spit), 7. brackish (marsh), 8. brackish - marine (lagoon), 9. littoral, shallow marine (beach, shore face) and 10. marine (sublittoral environment).

Marine and coastal environments (lagoons, river deltas, mangrove landscapes, dunes, fluvial routes, wetlands, islands, shorelines), apart from their natural and cultural significance, are also rich in archaeoenvironmental information, which is vital for a huge spectrum of scientists (e.g. Palaeoceanography, Paleoclimatology, Palaeontology, Palaeoecology, Disaster Archaeology). Another important aspect is that parts of many contemporary seas were dry land during Palaeolithic and Mesolithic times and were then inhabited. Many remains of these habitations are preserved in the sediments of the seabed. These underwater settlement sites are unique in an international context.

Obviously these scientific treasures call for a strong protection. Finally, the conservation conditions of the remains laying on the sea floor of several seas (e.g. Baltic, Black Sea) are extremely good. Low salinity, absence of shipworms and a large portion of oxygen-free bottom layers keep organic material intact.

Underwater archaeological remains (deep water underwater excavations and shallow coastal excavations) are subject to a much wider array of physical, chemical and biological processes than their terrestrial counterparts. To encompass the effects of these processes, data collection, recording, and interpretation must differ slightly from the procedures used on land, although they are no less scientific in their nature (Stanimirov, 2003; Breen and Forsythe, 2001; Porojanov, 1999; Neill and Krohn, 1991; Warren and Gubbay, 1991; Murdin, 1989; Cleere, 1988; Prott and O'Keefe, 1987; Masters and Flemming, 1983; Bass, 1982; Muckelroy, 1980).

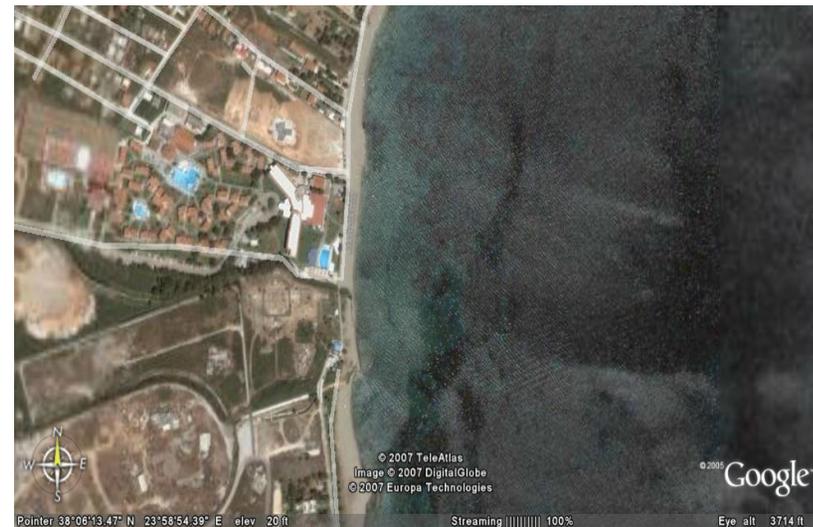
The sites of underwater / maritime interest that are within the boundaries of Eastern Attica's prefecture face many major threats: (1) biochemical structure of waters (i.e. salinity), (2) high rates of sediment deposition, (3) neighbouring port facilities, (3) intensive summer activities, (4) abandonment or unsatisfactory monitoring. and (5) need for more expensive and complex archaeological projects.



Porto Rafti Bay facing SW (field visit 9/11/2006) Porto Rafti facing N. , Kotroni area



Prassia harbour – satellite image



Brexiza harbour – satellite image

indicator for the ecological equilibrium of modern environments, local flora and fauna may cause long-term harm on the monuments. The roots of specific plants or trees (i.e fig-trees) are very destructive even to the more solid ancient walls, and the darnels and other weeds are extremely persistent to herbicides.

The roots of small wild plants within the fissures retain moisture and cause mechanical problems. Some archaeological features, like the mosaics, are extremely vulnerable to them. Frequently, after a rainy season, visitors have problems to access the monuments or to understand the landscape as the vegetation alters the impressions. In addition, places with abandoned wild plants turn easily into damping areas! Finally, future excavation works are getting more problematic and expensive in such places. Another neglected parameter is the presence of irrelevant flora which is alien to the geography and history of the area, for example the eucalypti in the site of Brauron.

Equally, the plant communities may present a dual face, as fire prone flora, like the annual plants (on the mountains or in S. Attica) and lush vegetation (Brauron, Brexiza) are the major threat to cultural sites. Living communities of birds that nestle over the ancient monuments cause also problems because their dung damages the stone.



Koutouki cave on Hymettos Mt. facing NE. Forest landscape around the facilities (field visit of 5/11/2006)



Lush vegetation of Brauron Wetland outside the archaeological site (field visit of 3/06/2007)



Brauron, West precinct wall with weeds, season plants & flowers (field visit of 3/06/2007)



Marshy area on the E. part of Brauron site after clearance works (field visit of 24/09/2006)



Oinoe Tower, NW view - fire danger from garbage & vegetation (field visit of 8/11/2006)



Rural landscape in front of the Monastery of Saint George at Vranas



Vegetation within the archaeological site of Vranas after a hot dry season (field visit of 20/09/2006)



Brauron - Birds nestling on the damaged roof of the stoa (field visit of 3/06/2007)



Panagia Mesosporitissa in the Big Marsh at Schinias (field visit of 20/09/2006)



Archaeological site of Brexiza, facing North– vegetation within the excavation area (field visit of 8/11/2006)

On the other hand, the archaeological sites often include some interesting and beautiful plant species (i.e. *Matthiola sinuata* I.R.Br. or *Lavatera bryoniifolia* Miller in the area around the Temple of Poseidon at Sounion or few unregistered water-loving plants in the wetland of Brauron).



Landscape architecture at the archaeological site of Vranas, Tumulus of Plataeans (field visit of 20/09/2006)



Pond outside the archaeological site of Brauron (field visit of 3/06/2007)

2.2.4 Climatic conditions

a. Semi-arid climate

The climate is typically Mediterranean, with hot dry summers and generally low rainfall totals. Annual precipitation varies from 370 mm to over 1000 mm. Winters are cool and generally mild in the low-lying areas adjacent to the sea, but are harsher in the mountains. It is often the case that snowfalls cause disruptions in parts of Attica, with the latest cases being in January 2002,

extended dry periods through the year along with fire prone flora accelerate wild fires' manifestation. In the southern areas, the Mediterranean climate is much more pronounced, with lower precipitations and higher temperatures (for example, Athens never receives more than 400 mm of precipitation annually; the average July temperature is 27°-28°C, while in January it is 7°-8°C).

The cyclostratigraphy of the areas shows also periodical phases in environmental sedimentation (available online at: <http://unesdoc.unesco.org/images/0010/001036/103637e.pdf>).

Landscape changes in Greece as a result of changing climate during the Quaternary have been investigated by Papae and his collaborators (Papae, 1984). The following are the main results of his work: "R. Paepe and M. E. Hatziotis worked out in the area of Attica (Greece), more specifically in archaeological excavation sites of Academia Platonos in Athens, in the Marathon Plain in coastal sites the Temple of Artemis in Brauron (E. Attica) a lithostratigraphy dated on basis of archaeological elements. C. Baeteman at the same time studied the marine sequences where D. Tsouclidou studied the relationship between marine and continental deposits in Brauron.

"Putting together all evidence after comparative study of all sites combined, the lithostratigraphic record (Fig 9 revealed in the Charadros Complex of Marathon six Holocene Soils of which respectively the earliest one (Marathon Soil, HS1) and the last one (Kallileios Soil, HS6) are the most developed. With regard to the Neolithic finds, the Marathon Soil most probably developed about 7.000 BC (9.000 BP); the Kallikleios Soil instead was very accurately dated (725 BC ~ 5 y.) thanks to the presence of Geometrical tombs in many sites of the Academia Platonos.

"Strikingly HS 3, HS 4 and HS 5 together with relevant fluvial gravel deposits perfectly encompass the three phases of the Helladic period. together with the Kallikleios Soil (H.S. 6) the subdivide the Subboreal Substage into four cycles of approximately 500 y. Soil formations in the fluvial valley system perfectly tally with peat development in the marine sequence of Marathon. Furthermore, in between soil development phases, fluvial sedimentation rates score the highest values. "In Marathon, however, no soils are found within the time span of the geological Atlantic substage coinciding with the Neolithic. Nevertheless H.S. 2 and H.S. 1 close the fluvial cycles of respectively Boreal and Pre-Boreal Substage inferring a 1.000 Y. periodicity.

"This sequence was recently completed with a more detailed profile from Academia Platonos (Kratilou section). It produced at least 6 other soils in between H.S. 2 and H.S. 3 namely: H.S. 2 a, b, c, d, e, f. Some of these soils were more weakly developed: gley and steppe soils. It points to the fact that weaker climatic oscillations interfered. However, the presence of these soils testify once more of the 500 years periodicity.

"By the time of the development of the Kallikleios Soil about 725 y. B.C. all valleys and coastal plains are completely filled up, to the level very near of today's surface.

"As to then sedimentation in general slowed down except for the peaks coinciding with the fluvial phases which point to high sedimentation rates.

"In Marathon as well as in Academia Platonos usually a series of five Holocene

In the Middle and Late Roman Period (2-4 Cent. AD), in the second half of the 12 Cent. AD and today. They reveal a periodicity of 1.000 years.”

There exist many discrepancies between interpretation suggested by Papae and the base-section. The tentative interpretation by the author of this paper would be the following:

Cold wet periods will be characterized by rather small sedimentation due to the fact that the forest expands and there is less soils erosion, while during dry periods higher rates of soil erosion causes higher sedimentation rates.

Correlating the curve of sedimentation rates with the base-section (Fig. 6) one can give the following interpretation: During the Neolithic the Pleistocene forest still dominated the area, protecting the soil cores. Only towards the upper Neolithic do the rates of sedimentation become higher due to the warming. The rates fall again towards the Chalcolithic and Early Bronze, but rise toward the Middle Bronze. The Iron age is again characterized by low sedimentation, i.e. a cold climate.

During the Roman periods the rates are in general high, presumably due to the cutting of the forests, but still one can see fluctuations which correspond to cooling and warming.

Around 700 AD, namely the Moslem warm spell, rates of sedimentation became higher, corresponding to the global warming phase, The grain size median (Fig 6) more or less follows this curve. As mentioned earlier, this is a tentative interpretation which has to be further investigated.

b. Torrential rainfall

The kind of run off is also important, because flash floods in eroded soils or stagnant waters covering already decayed monuments cause extra problems in the cultural landscapes. Torrential rains hit often Attica. At this point we should emphasize the role of the ravines in flood protection. Ravines are a significant environmental heritage and they are addressed as an important element of the city's ecosystem and Attica's landscape. They are not seen just as natural water catchment areas and flood preventing channels. Rafina and Vari are two areas with protected ravines.

2.3 Human - induced problems

2.3.1 Human- induced water -related hazards

a. Acid rain

Acid Rain, or more precisely acid precipitation, is the word used to describe rainfall that has a pH level of less than 5.6. This form of air pollution is currently a subject of great controversy because of it's worldwide environmental damages. For the last ten years. this phenomenon has brought destruction in

One serious anthropogenic threat for the monuments is related to the atmospheric circulation of SO₂, which is released from the combustion of sulphur -contained mineral fuel. Acid rain causes damage on the fluvial and lacustrine waters, on the soil and agriculture, as well as on the surface of the buildings. Acid rain contributes to the corrosion of metals and to the deterioration and soiling of stone and paint on buildings, statues and other structures of cultural significance. Limestone and marble turn to a crumbling substance called gypsum upon contact with acid. The damage inflicted on cultural objects is especially costly, since a loss of detail seriously depreciates the objects' value to society. They say that ancient buildings and sculptures in a number of cities have weathered more during the last 20 years than in the preceding 2.000 (<http://pubs.usgs.gov/gip/acidrain/contents.html>; <http://www.epa.gov/acidrain>).

Many monuments and beautiful historic artifacts of great importance all over the world suffer from air pollution, Parthenon at Acropolis, is a prominent example. Effects of acid deposition on monuments are well known and demonstrated either by natural weathering or by man made pollutants (Bravo et al, 2006; International Workshop, 2005; Bravo et al., 1998; Camuffo, 1992).

b. Water- drilling due to meteorological (lack of precipitation), hydrological (lack of water in streams and aquifers) or agricultural drought (when conditions are unable to sustain agricultural and livestock production)

Water tables are falling fast under East Attica's plains. The periodical phenomenon of meteorological drought was present since ancient times. A dry phase lasted from ca. 1.000 to 850 B.C.. The traveller Pausanias (I.24.3) notes that there was on the Athenian Akropolis a statue of a kneeling woman (Gaia, the Earth) who supplicated Zeus for rain. During Classical Era, an extended period of drought (335 - 325 B.C.) distressed whole Greece. In Attica the majority of city wells had been abandoned, while the number of private cisterns rose significantly. Another registered period of meteorological drought happened between A.D. 1887 - 1889 that gave the initial motive to the later construction of Marathon's dam (1925 - 1929) with 54 m. height and 285 m. length.

Surface and groundwater resources are important assets for the economic and social welfare of local populations. The rapid reduction in the quantity and quality of water reserves is the result of the expansion of industrial and agricultural activities that increase the withdrawal of waters in the aquifers, intensify the use of pesticides and fertilizers, even the disposal of industrial waste. Moreover, the dramatic decrease in subterranean water reserves around Mediterranean, together with the phenomenon of salination, that is also mostly attributed to human activities rather than to physical / environmental conditions, and the increasing deterioration of water quality due to various forms of pollution.

The plane of Kato Souli is bounded by the Schinias wetlands to the south and

the Kato Souli Plain suffers from intense salination (sea water intrusion), as evident in the springs of Agia Marina, Rhamnous and Kato Souli (Sotiropoulos, 2007).

Today, a desperate quest for water is also observed a bit southerly, in Mesogeia Plain (Attica - Greece). But similar activities threat buried antiquities, too, by damaging the stratigraphies (therefore future excavation processes) and the protection of items from unprepared exposure to atmospheric phenomena and from illegal exchange.



Panoramic view of Mesogeia Plain facing SE., taken from Koutouki Cave (field visit of 5/11/ 2006)



Cultivated fields next to the sanctuary of Brauron (photo: D. Damianakos)

plant caus., I.V.II-III. On winds, 13). Finally, Strabon (XIV.6.V cap. 684) refers to an observation made by Eratosthenes on the irreversible results of forest's overexploitation in Cyprus. Often various markers and proxies in the sediments and the stratigraphic layers include valuable indicators for past human activities that had a negative impact on the archaeoenvironments, such as urbanism, deforestation and pollution. In many parts of the world, the development of agriculture accelerated soil erosion processes, so the deposition of erosion products formed alluvial fans at the mouths of dry or temporarily drained valleys (Binford, 1983; van Andel et al., 1990; Peglar, 1993; Hong et al., 1994; Ramrath et al., 2000; Ridgeway and Shiermmield, 2002; Edyta, 2004; Müllenhoff et al., 2004). Interdisciplinary modern research has shown that the Bronze Age landscapes of S. Greece already faced erosion problems. Mountain Hymmetos was severely eroded in the Classical Era, and Aristotle wrote about the phenomenon (Athenaion Politeia, XVI.6).

d. Long-term socio-economic side-effects of water related hazards

Water hazards and water-related disasters cause various damages on the agricultural production, the local infrastructures and the communications network, apart from the bioclimatic changes (i.e. spread of diseases such as malaria), the food crises, the war conflicts and the general societal upheaval. All the above-said results make the cultural landscapes to suffer, because the sites and the monuments are destroyed or severely damaged, the touristic exploitation is stopped, the communication network is chaotic, the scientific research is blocked, the heritage is vulnerable to illegal activities, political / religious / social / commercial restrictions and constraints are imposed and the agenda of the governments / international organisms finds no room for cultural issues. In addition, the displacement of people who are directly or indirectly affected by those hazards break the linkage between local populations and their cultural roots, hurting the plurality of identities, cultures and memories.

2.3.2 Wild fires / Deforestation

The notorious Penteli fire in early July 1995 consumed much of the mountain forest and the eastern half became residential areas of the Athens area. The volume of smoke was tremendous; it nearly covered the entire northeastern part of Athens. All terrestrial television stations covered the fire, with the exception of some times on the weekend. The fire lasted about 5 days; it began on Friday and continued into the next week. It reached east of Penteli about 5:30 p.m. local time and then the Pentelis and Vrilissia, consuming a couple of houses on Friday night (about 9:00 p.m. EET, 7:00 p.m. UTC), the northern range on Saturday morning, then Rhea on Saturday afternoon, Anoixi on Monday, and Dionysus communities on Saturday. It consumed three quarters of the slopes of Penteli. It was the worst forest fire Athens and Greece had seen in the 20th century. Housing development took place in the eastern half of the mountain which removed what's left of nature from the mountain and streets are grid and circular. Lots are luxurious and later built several houses. A mining

1995, three years later in the area of Drafi, mudslides blocked roads as a rock clogged off a residential road. Series of mudslides occurred several years later and devastated a few homes and continued some to this day.

Forest fires also ravaged East Attica on July 28, 2005 from Agia Triada Rafinas to west of Rafina. The fires began at around 8:00 AM GMT consuming 70 km of forests, properties and farmlands. The fire spread quickly after a few hours with winds of up to 55 to 70 km/h and spread near the suburban housings of Athens near Rafina causing dense smoke. The fire reached Kallitechnio and the settlements and devastated homes leaving some people homeless and evacuated people in areas around Agia Triada Rafinas, Agia Kyriaki Rafinas, Kallitechnio, Loutsa, Neos Vourtzas and the Rafina area mostly on the hillside areas. Pine trees were devastated. Firefighters didn't put out the blaze until the winds calmed down. It took hundreds of fire trucks, firefighters, planes, 65 firefighting helicopters from all over the surrounding areas and most of Greece to put out the blaze. A stretch of Marathonos Avenue became closed.

2.3.3 Accessibility to the cultural sites / Level of tourist infrastructures

Oinoe area, presents environmental difficulties and human-induced problems that make it hardly accessible.

Two of the sub-sites (Brexiza & Tumulus of the Athenians) have excellent accessibility, via the main surfaced road and the existing explanatory labels that lead to the places. Vrana / Tsepi and Trophy's area have less qualified and narrower roads that are not well asphalted. Finally, Oinoe area is the most problematic of all.

Preferred transportation means, besides the organized excursions by the travel bureaus at Athens, are the private cars & taxis, the latest being rather expensive for a full touristic guide of the area.

Explanatory panels exist in all the sub-sites, but are the victims of vandalism and graffiti as many of the labels on the roads are, too.



Marathon Avenue leading to the cultural sites



Early Helladic Cemetery at Tsepi (field visit of 20/09/2006)

The Tumulus of the Athenians shows the most appropriate visiting profile with

land-labourers from foreign countries, especially India & Pakistan.

Even more, the Byzantine churches dispersed in the rural landscapes of Oinoe & Trophy area, are not indicated for solitary visits, especially by lonely women, because they are isolated into lush vegetation and a bit far away from inhabited nuclei.



Trophy site at Schinias, label & enclosure (field visit of 20/09/2006)



Tumulus of the Athenians at Marathon.
Parking area facing NW



Skouze estate next to Trophy area at Schinias (field visit of 20/09/2006)



Vranas, rural road leading to the churches of Saint Nikolaos & Athanassios
(field visit of 20/09/2006)

Furthermore, some interventions of bad taste and ambiguous functionality hurt the monuments, for example a huge cement wall in front of the otherwise beautiful construction over the early Helladic Cemetery at Tsepi, which 'loads' the whole construction, hardly can the visitors distinguish the archaeological site.



Tsepi, the NW precinct of the modern construction (field visit of 20/09/2006)

In case of conflict / war there is also another danger for the monuments. The fertile coastal plain of Marathon is bounded to the west by the foothills of mountain Pentelikon, Agrieliki, Kotroni – the ancient form of which has been lost because of a large helicopter pad has been recently constructed on its summit – and Stavrokoraki.

Moreover, a noise pollution derived from the helicopters that make their daily exercise routine flying constantly over our heads, distracts the visitors, destroys the serene sceneries and creates an annoying atmosphere.

heritage, are : a) geopolitical conflicts dominate the humanitarian agenda, pushing aside the problem of cultural sites' vulnerability to natural hazards, b) the responsibilities for mitigating disasters are fragmented, c) risk reduction is not an integral part of cultural heritage management and development, d) risk reduction is often viewed as a technical problem and the underlying factors are ignored, e) donors and states dedicate far fewer resources to risk reduction than to relief, f) cultural 'goods' are not easily or explicitly measurable, their value being far from merely economic, g) institutional / legal constraints block integrated national strategies for long-term management of cultural landscapes, g) commercial reasons prohibit even the governments from having the financial strength required to assume financial responsibilities. Equally, the lack of monitoring or of appropriate periodical maintenance, inefficiency of civil preparedness, abandonment, ignorance or illegal export of antiquities have a significant share in hazard's triggering within cultural landscapes. Finally, inside the museum collections, other factors could also represent serious threat to the exhibits, for example insect populations, mold or unprotected flammable material / exhibits.

Unfortunately, the issue of 24-hour guarding and monitoring of the places remains on the top of the priority list. Loose enclosures with simple wire nettings can be easily violated by any intruder.. Events of intrusion, violation of the archaeological areas and other illegal activities concerning antiquities from Eastern Attica have been recorded repeatedly at Ramnous, Brexiza and Glyka Nera (Paiania), to mention only few severe cases.



Brauron Castle - SE. view



Early Christian Basilica, Brauron. Damaged wire fence (photo: D. Damianakos)

Even if the area of Marathon had been on the centre of publicity due to the recent Olympic Games of 2004, and few restoration programs are running (i.e. in the case of the Archaeological Museum of Brauron), the overall management of the cultural patrimony seems fragmented and money-oriented, lacking a long-term inspired vision for its educational and social upgrade through new

a pleasant ..unexpected surprise, cameras are monitoring the site sending the images to the local museum, 400 m. SE of the sanctuary. Despite the absence of facilities for disabled people, the parking area is quite spacious and the rooms of the museum, as well as the yard are very clean and tidy. The guarding staff is friendly, too. Working interventions onto the museum collections have already been started, as the restoration is officially authorized.

By the next months, it will be closed, in order to accelerate the whole procedure.



Camera on the S. hill within the site of Brauron (field visit of 24/09/2006)



Entrance of the Archaeological Museum. NW view-no disabled people's facilities, before restoration works of 2007

Furthermore, the excavator of the site, Prof. J. Papademetriou, during the decades of 1950 and 1960, first understood the ecological significance of the site. So, he proposed the building of the museum within the archaeological site of Brauron, 400 m. away from the main place, leaving room for further excavational works and the future formation of an 'archaeological park'.

Unfortunately, today the lane which unites the museum with the site, is closed to the public. The whole site offers an excellent opportunity to be transformed into an integrated cultural unit (archaeological park, wetland, rural landscapes) due to its vicinity to communication nodes such as the airport and the harbour of Rafina. In fact, this is the nearest destination for the foreign traveller who comes to Attica.

Moreover, one should underline the environmental difference between the site of Brauron and the area of Marathon. In the later, the whole scenery seems badly injured and aesthetically degraded by various modern interventions, a fact that shows clearly the deficit in: a) the cooperation among several public authorities responsible for the development of the area, b) the technical infrastructures concerning the monitoring and the protection of the cultural sites and c) the awareness of local communities, which may act as 'buffer' zones against national indifference and ignorance of local climatic, environmental &

cultural environments. On the contrary, only the projects which include risk analyses of archaeoenvironmental landscapes are able to fully show the constant changes and the multifarious parameters that are affected in a short-, medium- and long- term basis.

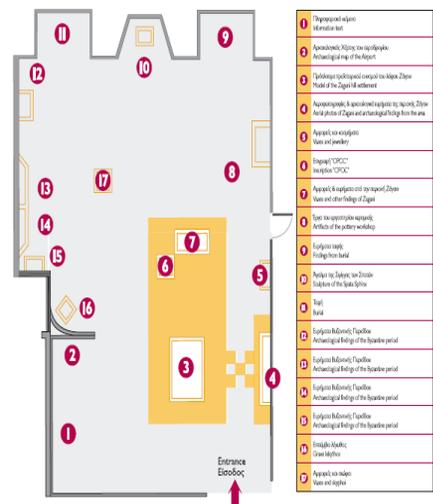
Finally, we should mention a critical parameter in patrimony's protection projects. For various reasons (social, economic, practical & technical) should be preserved and protected also in the form of virtual reality, giving to the worldwide lovers of antiquity the opportunity to visit the sites and admire the exhibits & the modern landscapes via web solutions (virtual tours, internet sites, e.t.c.). We strongly hope that GIS platforms will help scholars and local authorities to move forward this managerial direction.

2.3.5 Fast development rates and human activities

Expanding settlement boundaries make often the cultural sites to 'suffocate'. Marathon antiquities are already within expanding settlements' boundaries, next to big hotel facilities. In parallel, construction works, especially when accelerated due to urgent deadlines (i.e. Attiki Odos, national airport El. Venizelos), push archaeologists to their limits. The case of the International Airport El. Venizelos seems to be rather an exception to the rule.

Athens International Airport "Eleftherios Venizelos" (AIA), in cooperation with the Ministry of Culture (B' Ephorate of Prehistoric & Classical Antiquities & 1st Ephorate of Byzantine Antiquities), created the Exhibition of Archaeological Findings from the Airport Area at a specially designed 200 m² area. The Exhibition, which was inaugurated in 2003, was sponsored by AIA and comprises 172 archaeological findings dating from the Neolithic and Early Helladic through the Post-Byzantine period. AIA received a "Commendation" in the Culture Category, in the framework of the 2003 Corporate Social Responsibility Excellence Awards organised by the Greek Advertisers Association, for its contribution to the promotion of the cultural heritage of our country, with an emphasis on the greater airport area.

Evenmore, the case of the psot-byzantine church of Saint Petros & Pavlos in the area and its removal proved that coordinated actions bring better scientific results (available online at: <<http://www.aia.gr/UserFiles/File/InformativeBrochures/AIA%20museum.pdf>>)



Ο ναός κατά τη διάρκεια της μεταφοράς του
The church in course of its transfer



Ο ναός στη νέα του θέση μετά τη μεταφορά του
The church at its current location after its transfer



Άποψη της περιοχής πριν από την έναρξη των ανασκαφών
View of the site prior to the excavations



Ανασκαφή βόρειου ναού, η επιτύχη του ορθογώνιου συγκροτήματος με τον Πύργο (2. - πρώτο 1/2 του 13ου - αρχές 14ου αι. Άποψη από βόρειο
Excavation NW. of the church. The farmstead excavation and the tower (2nd half of 13th - early 14th cent.). Aerial view



Ανασκαφή βόρειου ναού, ερείπια του συγκροτήματος του Πύλου αι. Ανασκαφή από βόρειο
Excavation west of the church farmstead (18th - early 19th cent.) and remains of a small settlement. (2nd cent.). Aerial view



Λιθοκίβρια αποθήκευσης κηρών του ορθογώνιου συγκροτήματος
Details of the farmstead storage rooms



Κιβωτισμοί και κεραμοσκεπές τάφοι περιτριγυρισμένοι τον ναό
Clay and tile-covered graves around the church



Ο Άγιος Χαράλαμπος (αποκόμματα της αλόφωνης μεσοεικόνας, στο μέγεθος του ΝΑ τοίχου του ναού). Τεχνουργό του Γεωργίου Γεωργίου Πάριου, 18ος αιώνας
St. Charalambos (detail, south-east pillar of the church). Wall painting attributed to the school of the painter Georgios Marinos, 18th cent.



Αποθήκευση κηρών κατά την ανασκαφή και τη μεταφορά τους, πριν από την επανένταξη των αρχαίων
Storage jars in situ and during their transfer before the reburial of the archaeological remains



Αποθήκευση κηρών κατά την ανασκαφή και τη μεταφορά τους, πριν από την επανένταξη των αρχαίων
Storage jars in situ and during their transfer before the reburial of the archaeological remains

Moreover, summer facilities (i.e. organized beaches, taverns on the coast, fast-sailing ships or boats, harbours), illegal transformation of environmentally protected land into building space, extensive agricultural activities (the fertile plain of Marathon is the main vegetable's provider of the city of Athens, while Mesogeia Plain is full of vineyards and fruit-bearing trees) and anarchious diffusion of garbage / litter are included in the list of pollution against cultural attractions. Finally, pasture land often intersects archaeological sites or even worse, cultural units (e.g. caves) are used as dens or winter quarters for sheep.



Cultivated pieces of land next to the Early Christian Basilica, Brauron – warning label for sprayed pesticides (field visit of 24/09/2006)



Marathon Bay looking NE (field visit of 8/11/2006)

More specifically, the landscapes of Marathon area are characterized by wetlands, lush vegetation, full of mud, swamps and lakes and meadows. Just as the ancient times, large parts of the plain are cultivated. All the same, continuous cultivation and ploughing, the silting up of the plain and various drastic changes in recent years due to the transformation of large tracts of arable land into unplanned settlements, inhibit the uncovering of other remains of ancient monuments, probably preserved here. There is also an archaeological parameter added to the list of human-induced hazards. The upper structure of the ancient buildings, either public, private or sacred, was mainly constructed of mud bricks, that had been destroyed without leaving any trace. Marathon, Oinoe, Trikorynthos & Probalinthos comprised a local union, the famous Tetrapolis of Marathon. Marathon, Oinoe & Trikorynthos belonged to the Aiantis Tribe, Probalinthos to the Pandionis. Although the boundaries of these demes have not been established, the district of each can be accurately determined on the basis of inscriptions and literary evidence.

One should not ignore the case of Schinias' wetland, which was seriously affected by the installations for the Olympic Games of 2004. A significant number of Greek and foreign scientist, environmentalist, scholars and local communities & agents, arose an international protest and appealed for the integration of the area into NATURA 2000.. The installations had been finally constructed and abandoned immediately after the Games, creating irreversible problems in the rural landscapes. Nowadays, they stay unexploited and deserted..

2.3.6 Industrial threats

The Pikermi paleontological site is threaten by the future installations for water cleaning facilities planned by the National Water Service (EYDAP) in the nearby area.

The area of Lavrion experienced a severe threat in August 2006, due to malfunctions in the nearby installations of Public Electricity Service Corporation (DEI). This industrial accident, with no fatalities fortunately, caused litteral



Lavrion. Industrial installations – satellite image

3 METHODOLOGY

3.1 The methodological framework in Hazard Analysis of Cultural Landscapes

3.1.1 General description

As cultural heritage can be assigned any kind of evidence related to human action, any 'product' of human creativeness and expression, widely accepted for its scientific, historic, artistic and anthropological value. On the other hand, natural landscapes are also included in the lists of patrimony objects that must be protected. The international meetings can provide all the terms needed for further analysis (e.g. UNESCO General Conference, 17 October - 21 November 1972, Paris -Convention for the Protection of the World Cultural and Natural Heritage, NATURA 2000 network, Directive 92/43/EEC, Rio Convention, 1992 e.t.c.).

Natural features (physical or biological formations), geological and physiographical formations, natural sites and protected natural areas (marine parks, national parks, aesthetic forests, protected monuments of nature, game reserves and hunting reserves, eco-development areas), along with the four types of biodiversity (genetic, species, habitat, landscape), are unified under the umbrella of this category.

On the other hand, cultural landscapes include places, features, objects, memories and perceptions related either to natural or man-made environments, ranging from those that are lost or 'mythical', to those with numerous surviving features. Some are living landscapes, but their usage has altered them considerably, while others are largely unchanged. Sometimes, 'fossil landscapes' (e.g. Pompei, shipwrecks on the sea floor of Black Sea) are unusually well preserved due to various environmental conditions or geological / physical processes.

Monuments, caves of archaeological interest, groups of buildings, archaeological sites (open air areas, subterranean, submarine or coastal), mobile objects, archival material, scientific works, paleontological & paleoanthropological remains, industrial sites and landscapes of memory (e.g. languages, oral traditions, sacred and mythical landscapes), museums and collections, all are prone to diverse water hazards, the impacts of which can

sites under river courses, cultivated lands, estuaries, layers of various sediments, e.t.c.) cry out for their complete protection from all kind of physical disturbance.

The elaboration of a criteria matrix consists of two main axes of methodological steps: a. the assessment of methodologies which are compatible with each of the cultural targets, in order to register any possible detail of vulnerability's status or hazards' impact related to different aspects of patrimony and b. the assessment of the evaluation's criteria.

Each of the cultural subgroups deals with a different methodological approach, evaluation and work procedure. A museum collection presents a different functional and behavioural image from an open space, a group of buildings, a cave, ancient harbour facilities or an underwater site. Other criteria that affect the evaluation, are the age of the patrimony object and its vulnerability to specific natural hazards. Equally, the degree of use concerning the patrimony objects (some areas have more organized touristic infrastructure than others) and the human ecosystems (social, economic and technological levels of development) that include the patrimony objects, may act as restraining or enhancing key-parameters. The existing situation - economic, social, environmental, e.t.c. (facilities, road network, accessibility of cultural targets)- can probably affect each cultural subgroup in a different way, so the cultural category precedes the evaluation damage grid.

Furthermore, the sequential order in priority lists varies considerably according to the factor that makes the choice. Usually, public authorities prefer economic and technical criteria (cost analysis, technical means available), but scientific institutions or private cultural units consider this priority list in a different way, by estimating other values. Likewise, the nature of the environmental and man-made hazards (probability, reversibility, magnitude, duration, frequency, predictability, spectrum of losses) interrelates with the priority criteria. Finally, the number of chosen patrimony objects dictates the methodological issues we are dealing with. In case of examining an adequate number of chosen patrimony objects, the registration and digitization of all possible criteria analysis is impossible within such a limited time span. Then, extensive information input for further elaboration in GIS platform will be considered as preferable. On the contrary, if we deal with specific case studies, the analysis will be detailed. Consequently, the GIS platform should incorporate all the above-mentioned aspects in a flexible scheme, as well as the data / information concerning the cultural targets should be in the most 'digitized' form. criteria matrix.

3.1.2 Main categories of hazards that could affect the patrimony

Any researcher who has to deal with cultural heritage's assessment, should recognize and classify the existent / possible hazards that may have impact on patrimony's units, either natural or cultural, before evaluating and analyzing them. These hazards are divided into natural (31) and human induced (52).

regression / transgression, tsunami, volcanic eruption, submarine pockmarks of natural gas, gravitational waves, electromagnetic storms, rapid climatic changes, changes in the biochemical synthesis of waters, prolonged drought, floods, hail, unexpected frost or snow, prolonged burning heat, typhoons, tornadoes, stormy winds, soil erosion, desertification, extensive disappearance of plant & animal species, transgression of marshy areas, lethal mutations of pathogens / pandemics, massive movement of populations, meteoritic fall, wild fires, insects, birds, reptiles, carnivores, undesirable plant species within the site.

The human-induced hazards include the following cases: drainage of marshes, lakes & rivers, burying of streams, habitation of sites near volcanoes or faults, changes of river's course, intentional fires, land's deforestation, dams, transmitters of electric power, extended industrial units, mines & quarries, overexploitation of natural resources, intensive cultivation of the land, transboundary pollution, non cooperative management of cultural resources among states that share common frontiers, war / conflict, biological war, chemical pollution, nuclear pollution, noise pollution, exhaustion of ground watertables, destruction of wetlands, explosives and other kinds of vibrations, overpopulation, aesthetic alteration of the landscape, ignorance / indifference concerning the cultural heritage, degradation of life's quality, vandalisms, insufficient / non existent enclosure of the site, smuggling, insufficient / problematic cleaning / hygiene of the site, other problems inside the site, destruction of subterranean antiquities due to land's cultivation, building procedures, e.t.c., problems in static balance of monuments, unauthorized removal of architectural elements, cutting of architectural elements, mutilation of the monument, erosion, burying, alteration of site's general profile, alteration of monument's view, disappearance of various elements, items, e.t.c, defective watching of the site, defective conditions of conservation, study or storage concerning the materials found in the site, interventions of bad taste concerning the external spaces of the monument, use of ancient elements in later works, graffiti, existence of high buildings within 500 m. distance from the site, vicinity to dense populated area, various works in progress, e.g. harbour installations, industries, road construction, e.t.c., unsuccessful methods & techniques of conservation, intensive rates of visitors, difficulties in site's accessibility, difficulties in site's touristic exploitation.

Especially the natural phenomena (potential dangers) may be classified into three main groups according to their patterns of appearance: a. Cyclic, meaning the rhythmically repeated (sequence of seasons, day and night, tide), b. Progressive or Inclining, meaning their appearance in a time period longer than the life of an organism that experiences it (glaciers, erosion of coasts) and c. Erratic/chaotic (storms, cyclones, hurricanes, reappearance of illnesses).

On the other hand, both categories (natural & human-induced) can cause human loss & severe economic damage -see the recent case of the archaeological site at Akrotiri in Santorini island during September 2005, with one tourist dead and millions of euros needed for repair -, and jeopardize the integrity, the physiognomy, the functions and the features of patrimony sites as

3.1.3 Main scientific fields contributing to hazard's detection and evaluation

Hazard's detection

Natural and man-induced hazards play an active role in the morphology and evolution of past, present and future ecosystems, both natural and human.

They happen in periodical or chaotic patterns, varying in frequency, magnitude and functional structure. They may have also several impacts on the evolution of human civilization (biological, ecological, environmental, socio-economic, political, technological, geographical, ideological and cultural results) that are not always clearly defined, even by the victims or the generations following the event. These effects could be hidden in the 'archaeological landscapes', due to diverse parameters. Furthermore, many 'entities', for example the vulnerability of ancient societies to environmental or human-made risks, and their adaptation process to the 'unfamiliar landscapes' formed after natural disasters are not measurable as other proxy data can be (e.g. palaeoclimatic, hydrogeological, palaeoanthropological).

The analytical and hermeunetic tools used in the assessment of hazards within the cultural landscapes could be provided by a wide spectrum of disciplines. Four (4) groups are of great importance.

Group A: Volcanology, Seismology, Structural Geology, Hydopedology, Igneous Petrology, Engineering Geology, Mineralogy, Geochemistry, Soil Science, Hydrogeology, Economic Geology, Exploration Geophysics, Paleontology, Palynology, Paleobotany, Geoarchaeology, Paleoclimatology, Paleoceanography, Glaciology, Limnogeology, Planetary Geology

Group B: Archaeozoology, Epidemiology, Palaeoanthropology, Palaeodemography, Palaeopathology, Palaeoecology, Palaeogeography, Palaeomagnetism, Tree-ring Dating, Astronomy, Archaeometry, Study of ancient Technologies, Sociology, Economic Management

Group C: Civil Engineering, Chemical Engineering, Urban & Regional Planning, Topography, Rural Technology & Development, Remote Sensing, Geodesy

Group D: Environmental / Disaster Archaeology, Landscape Archaeology, Cognitive Archaeology & Anthropology, Astroarchaeology / Astromythology, Social / Behavioural Archaeology, Study of communication systems (e.g. languages, commercial routes, alliances & wars, exchange patterns, systems of investment & imposition, religions, economies), Study of ancient sources of information (e.g. analysis of written texts, artistic representations, ceremonies & rites, beliefs & oral traditions).

GIS environment is compatible to the methodological framework of the aforementioned fields, for it is able to visualize and rearrange the data according to user's need, providing the possibility to detect the spacio-temporal pathway of hazards.

Changes, either expressed as periodical phenomena with moderate character or as sudden, violent, and highly dangerous events, transform the natural

The natural ecosystems provide scientists with quite helpful information, not always easily spotted and retrieved, though. The sequences of events, which embrace a huge spectrum of space and time being periodically or chaotically repeated, are imprinted on a series of elements, structures and markers that share a common approach, the main concept of Stratigraphy (Physical Stratigraphy, Lithostratigraphy, Chronostratigraphy, Biostratigraphy / Ecostratigraphy, Chemostratigraphy / Geochemical Stratigraphy, Seismic Stratigraphy, Cyclostratigraphy, Tephrostratigraphy, Bog Stratigraphy, Magnetostratigraphy). This concept, along with Taphonomy, is also the main methodological tool of archaeological investigations referring to the human ecosystems of the past and their 'fingerprint on the archive of the Earth'.

Furthermore, the concept of Accretion, meaning the visible or measurable transformation (in quality, quantity, context or composition) of material due to geological, biochemical and other processes, for example the formation of annual Ice-Layers, various Lacustrine Deposits and Geological Formations (e.g. soil formation / pedogenesis & Loess), Tree-rings, Deep-Sea Sediments / Sapropels, Coral Bands and Algal Stromatolites, has enriched the worldwide scientific efforts with extremely resourceful data banks.

In addition, T-GIS (Temporal Geographic Information System) seems to share some common functional characteristics not only with hazard research, but also with archaeological entities, even the catastrophist mythology itself (Laoupi, 2005). Most information embraced by the myths is spatial and temporal in nature, like the archaeological entities do, therefore, especially suited to the basic principles of GIS. Moreover, this challenging tool provides a complete lineage of elements, layers, sets and features concerning disaster topics, including the evolution of catastrophic phenomena over time and their state at any moment of human history. Modern technologies may be promising enough to provide both the practical framework and the assessment tools and strategies for the re-evaluation of ancient knowledge.

Finally, a very promising tool is the comparative study of destruction layers all over the world, either as archaeological stratigraphic units or as a features of geological sequences. Of course, there is a necessity for undertaking long field seasons, working on laboratory's data evaluation, collecting evidence from memory institutions and communicating with specialists, until we reach high level of synchronized well-explained sequences.

The above-mentioned process of categorization should also include the archaeoenvironmental profiles of the relevant sites. The historical evolution (spatial & temporal distribution) of hazardous physical and man-induced phenomena, this extremely useful but neglected aspect, can be provided through the methodological tools and the existing studies of the scientific fields of Environmental Archaeology and Disaster Archaeology.

Hazard's evaluation

The above-mentioned groups A, B & C may provide the hazard's assessment

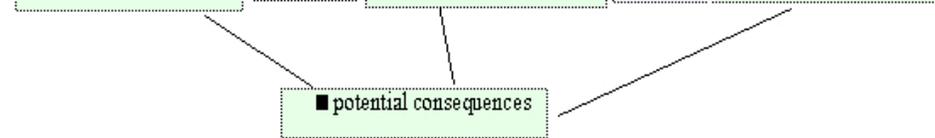
stage should be completely understood by any researcher / user / manager dealing with risk evaluation, including the archaeologists themselves.

The parameters that should be evaluated according to the International Standards and Worldwide measurement methods are:

- i. predictability of the hazard
- ii. certainty of hazard
- iii. intensity / magnitude of hazard
- iv. period of exposure to hazard
- v. periodicity of exposure to hazard (in a 13-grade climax from permanent to chaotic)
- vi. distance from the 'epicentre' of hazard's manifestation
- vii. reversibility of the hazard
- viii. assessment of the whole damage in case of danger
- ix. horizon of tangible impact on the cultural site (from minutes after the disastrous event to decades after its manifestation)
- x. vulnerability of the landscape / community / infrastructures
- xi. determination of risk level =(probability x consequences)

On the other hand, the evaluation of hazard's parameters dealing with the vulnerability of patrimony's assets or the elaboration of a corpus of criteria dealing with lists of priorities in case of danger (what to save first and why) shows a merely regional character, as various geopolitical, geographical, socio-economic, historical, environmental, ecological, functional and aesthetic criteria dictate different approaches & evaluations. Moreover, issues such as the preparedness of cultural units in front of various dangers, the Carrying Capacity of the cultural unit, the severity of consequences on cultural landscapes or even the kind of impact on them, post -shock evaluation & adaptive processes within local communities, are considered as topics which are either vaguely expressed, or regionally analyzed. Worldwide attempts of categorizing these criteria (e.g. 'Descriptors of standard AS/NZS 4360': 1999, World Heritage Convention Criteria, Disaster Management Planning for Archaeological Archives : IFA 2004), should and will be filtered before their entry into a GIS analysis platform.

The methodological framework of cultural landscape's hazard assessment should, therefore, incorporate four (4) interactive boxes of measured parameters (sets of criteria): hazard's dynamics, cultural vulnerability, potential consequences & level of preparedness before the elaboration of risk assessment climaxes on the cultural landscapes.



3.2 The case studies and the retrieval of information

DISMA assesses the areas of Marathon and Brauron, for they experience iterative phenomena of flooding that are aggravated by the lack of sufficient infrastructures, the overpopulation expansion, the extensive agricultural land patterns, and other local environmental factors (e.g. geomorphology and climate conditions that favor the formation of marshy lowlands, the transgression of the sea, high sedimentation rates due to riverine alluvia) that trigger these events since early Antiquity. In the area of Marathon, Charadros river, notorious from the Classical Period, has a steady annual water runoff, characteristic that triggered the formation of the big marshy lake in the plain of Nea Makri (Pausanias, I.32.7). The transgression of the marshes in the area was the main cause for the spreading of malaria, an endemic disease in the archaeoenvironments of Eastern Mediterranean, disease with hardly recognisable overall impact on the population rates in the ancient world.

Equally notorious for his destructive action, was another river, Erasinos, in the area of Brauron (Strabo, VII.5.VII-VIII cap. 371). The life of the famous temple irrevocably stopped during the 3rd cent. B.C., when extended flooding from the river brought so much alluvial deposits, that the whole geomorphology of the area changed dramatically. Insofar, the cultural landscapes of the above-mentioned areas seem to take a high score in each of the vulnerability's assessment groups, proving that societal, economic, geographical and environmental parameters are interrelated to each other.

Additionally, the chosen areas of Marathon and Brauron, both present a multifarious ecological and archaeological profile. They include different landscapes (ecosystems of Mediterranean Type, woodland, cultivated lands, wetlands, protected areas of aesthetic value). Moreover, mild climatic conditions, coasts with easily accessible beaches and organized tourism enterprises act as attraction parameters, implying a dynamic possibility for further touristic development. Finally, the richness and the variety of monuments and sites of cultural heritage within the above-mentioned areas, allow a flexible scientific approach using GIS technologies, in order to group and re-evaluate the cultural targets. Caves with archaeological interest, architectural works, Mycenaean sanctuaries and Byzantine churches, Classical and Roman farms, cemeteries and burial monuments, prehistoric settlements and harbours, museums and open spaces, excavational works and promising areas for future scientific research, all constitute one of the most prominent examples of cultural continuity.

In the chosen areas.

Nevertheless, one should emphasize the zero- basis of information's retrieval and digitization in our country. Even though the Greek institutional framework of patrimony management is well-fixed, it is also quite rigid in terms of information / data management. This framework includes: a. the geopolitical areas of municipalities and local communities, b. the ephorates (Speleology and Palaeoanthropology, Prehistoric and Classical Antiquities, Byzantine Antiquities, Contemporary and Modern Monuments, Underwater Antiquities) and c. other agents (e.g. groups for the protection of the environment, cultural units, private collections, foreign archaeological institutes). Each of them acts as a possible 'info- provider', participating in a concrete level of administrative network. We must pinpoint an exception, that of the Municipality of Markopoulo, which is already working on a GIS platform with the majority of patrimony objects registered.

The collection of data should be grouped into three (3) main categories :

(1). Digitized and non-digitized formats

Satellite images & aerial photos, digitized ground images, two (2) completed GIS projects on these areas, georeferred maps and few studies completed by the local ephorates before the works for the Olympic Games of 2004 are included in the first case. In the second case may be categorized a huge number of 'describing' information (including even the sketch maps of some travellers of past centuries), which is hidden in official reports, case studies, scientific research (e.g. Msc, PhD dissertations, independent work done by the foreign archaeological institutes in Greece), books & papers. A 'medium' stage includes few maps, available through the web or the institutes, which require a mild transformation procedure into the final GIS platform.

The Municipality of Markopoulo has already received a GIS platform with the majority of patrimony objects registered and categorized in a easily accessible form. The study was conducted by the professors Andreas Tsatsaris & Tomas Antoniou et al. (Department of Topography of T.E.I. of Athens), after a request made by Municipal Society for Development of Markopoulo (M.S.D.M.).

Nevertheless, the programme is not running in the computers of Municipality of Markopoulo, for some unexplained reasons. We hope that after personal communication with the directors of the afore-mentioned projects, digitized data will be available for further elaboration.

On the other side, the Ministry of Culture in collaboration with the Technical Office of Lisa Siola & Partners and an authorized scientific committee has prepared an Integrated Masterplan for the Unification of the archaeological sites of Marathon area. The study has been submitted on November 2002, before the Games of 2004. Unfortunately, the Ministry of Culture and the individual scientists (archaeologists) involved in the project don't allow the use of any digitized information, providing only the submitted 2-volume study, which contain a first stage categorization of cultural data (organized in few general categories) and extended topographic maps. Despite this fact the

(2). Information managed by the state, the private sector or individuals
The state as manager of the patrimony is built on a three-basis scheme: a. the geopolitical areas of municipalities and local communities, b. the ephorates (Speleology and Palaeoanthropology, Prehistoric and Classical Antiquities, Byzantine Antiquities, Contemporary and Modern Monuments, Underwater Antiquities) and c. the national scientific groups of educational perspective (e.g. T.E.I., universities) or the authorized archaeological institutes of foreign states working on Greek field. The private sector may embrace for example several groups for the protection of the environment, cultural units or private collections / museums.

(3). Information managed by Greek authorities or foreign sources
Consequently, an overall data classification should be evaluated as following: i. available, ii. non-available even if they are well-known, and iii. hardly retrievable.

Generally speaking, those crucial categorizations, as well as the evaluation of information's retrieval, not only dictate the future methodological framework of our workflow, but also restrict dramatically the possibilities of presenting a rich GIS environment.

3.3 IESO technique for Vulnerability assessment of cultural heritage

The subject of the conservation of cultural heritage management and its corner stone (assessment) was not generally regarded by governments as a high priority till recently, so it will come as no surprise that it has not been subjected to much in-depth study or analysis. Nowadays, both national and regional planning in a significant part of the world, includes the fields of Environmental Impact Assessment, Cultural Heritage Management and Hazard Assessment.

The cultural issues are of high importance as they influence human behaviour, and thus environmental condition and change. But there is still a scarcity of techniques designed to deal with cultural heritage in Hazard Management, a shortage of published data on cultural assets apart from a few famous sites and a shortage of qualified people to address the cultural heritage sub-component of Hazard Management. Privatization of the environmental sector has been around since the 1960's, so there are a myriad of international consulting companies conducting socio-economic and environmental studies all over the world. In general, this has not been the case for cultural resources. While the cultural resources have been recognised as important, they have not been properly taken into account. On the other hand, private sector interdisciplinary companies provide innovative techniques, developed management skills and a skilled cadre of researchers, thus, they have been forced to work among the conflicting viewpoints of regulators, 'clients' and the public.

The terms Vulnerability, Resilience and Adaptive Capacity, are relevant in the biophysical realm as well as in the social realm. In addition, they are widely

subsystem, or to the coupled socio-economic systems (SES), variously referred also as target system, unit exposed, or system of reference. Vulnerability, according to Adger (2006) is most often conceptualized as being constituted by components that include exposure to multi-scaled perturbations or external stresses, sensitivity to perturbation, and the capacity to adapt. Vulnerability is also thought of as a susceptibility to harm, a potential for a change or transformation of the system when confronted with a perturbation, rather than as the outcome of this confrontation (Gallopín, 2006). A system (i.e., a city, a human community, an ecosystem) may be very vulnerable to a certain perturbation, but persists without problems insofar as it is not exposed to it. Respectively, the vulnerability to water related hazards includes three interdependent parameters (exposure to stress, high intensity of hazard and limited coping capacity. Although measuring vulnerability is a difficult task, the need for its assessment is obligatory. In an attempt to propose a simplified procedure, Tsakiris (2006) presented a component approach corresponding to economic, environmental, social and patrimonial damages. For the economic component, a function between 0 and 1 has been proposed.

We accept that cultural landscapes represent systems. So, we define their vulnerability as the degree of susceptibility to damage from hazardous water related phenomena (Tsakiris, 2006). However, in the case of cultural heritage, vulnerability can not be analysed referring to the entire system, but it is necessary to disaggregate the system into a number of components and perform a detailed analysis on each of them. Consequently, the vulnerability of patrimony, based, initially, on various methodological analyses of social indicators for measuring community's vulnerability to natural or technological hazards (i.e. Krumpe 2006; Dwyer *et al.*, 2004; Pelling, 2003; Heijmans, 2001; Buckle, 2000; King and MacGregor, 2000; Crichton, 1999; Morrow, 1999; Buckle, 1998; Cobb and Rixford, 1998; Jasanoff, 1998; Neuman, 1997; Buckle, 1995; Firschhof *et al.*, 1978; Andrews and Withery, 1976), should be studied according to a four-part analysis (IESO): a) Intrinsic parameters (describing the condition of the cultural asset), b) Environmental parameters (describing the natural setting), c) Socio-economic parameters (describing the living community) and d) Organizational / Institutional parameters (describing various structures & functions of the State). Although a further analysis with ranked questionnaires is presented in the relevant reports of the sub-project DISMA, a brief but explicitly-structured presentation is also necessary for further discussion and improvement. A number of elements contribute to the understanding of the conservation requirements of heritage assets. The process is the following:

a. Intrinsic parameters

The general condition of the cultural asset may be extracted from the data that identify the condition and the integrity of heritage assets. These data include indicators for recovery, context within which heritage items function, operability level of the cultural asset, integrity of the asset and carrying capacity of the cultural target: i. coordinates, ii. extended area of the cultural site / dimensions of the monuments, iii. altimeter of the site asl, iv. distance of

technical and other development projects, xiii. previous technical interventions on the site, xiv. accessibility in case of hazard, xv. capacity of receiving visitors, xvi. number of visitors per year, xvii. medical assistance inside or near the site, xviii. vicinity to other cultural sites, xix. vicinity to modern settlements / other touristic destinations, xx. existence of touristic facilities.

b. Environmental parameters

The natural setting should be identified in the best possible way by an interdisciplinary scientific team, in order to describe the pressure experienced by the asset and the living community in which this heritage belongs or exists. The data that may contribute to a better understanding of the spatio-temporal distribution of water hazards within the cultural landscapes, include: i. predictability of the hazard, ii. certainty of the hazard (Descriptors of standard AS/NZS 4360: 1999 + World Heritage Convention Criteria + Disaster Management Planning for Archaeological Archives : IFA 2004), iii. duration of exposure to the hazard, iv. periodicity of exposure to the hazard, v. reversibility of the hazard, vi. other existing hazards or factors of magnification, vii. severity of consequences in case of damage (referring to the cultural unit), viii. destruction level in case of damage, ix. definition of risk level (Model 1 = destruction level + certainty of hazard), x. definition of risk level (Model 2 = magnitude + frequency of hazard), xii. detection of past catastrophes.

c. Socio-economic parameters

The living communities play a significant role, too, in the perception, assessment and management of hazards, either referring to contemporary landscapes or to heritage ones. Information that describes the range & significance of conservation values of heritage assets includes: i. rarity of a heritage asset, ii. originality of a heritage asset (duration of use) iii. existence of legal, economic, national / regional or other response framework in case of hazard, iv. elaboration of economic assessment concerning the damage profile of cultural asset, v. awareness of the social side-effects after a damage on cultural patrimony, vi. awareness of the environmental side-effects after a damage on cultural patrimony, vii. awareness of the technical level (infrastructures, personnel, disaster plan, disaster simulation techniques) for intervention in case of damage on cultural patrimony, viii. awareness of the cultural structure of the community, within which the cultural asset exists, its function / role and significance, ix. awareness of the scientific 'value' of the cultural asset, its role and potentiality in the current or future research, x. awareness of the aesthetic / artistic 'value' of the cultural asset, its role and significance in the modern landscapes, xi. awareness of the economic 'value' of the cultural asset, its role and potentiality in the current or future development planning (i.e. eco-tourism, archaeo-tourism, contemporary cultural happenings), xii. overall prioritization level for rescue in case of hazard / damage (what to save first and why).

d. Organizational / Institutional parameters

possible hazard threatening the cultural landscapes. The estimation of this situation is further analytical and examines: i. whether an asset is on a protective listing, ii. whether an asset is subject to agreed agency standard operating procedures, iii. whether an asset receives recurrent conservation funding, iv. whether an asset is subject to asset management planning guidance, v. whether knowledge of an identified asset is subject to a standard inventory, regularly updated and maintained, vi. whether an asset is subject to an assessment criteria and process consistent with industry standards, and endorsed at senior management level, vii. whether an asset is subject to a risk management strategy addressing the threat to a place by in-house staff, viii. whether an asset undergoing conservation is subject to conservation management planning guidance, tied to the relevant ICOMOS (International Council on Monuments and Sites) charter, ix. whether management of an asset is subject to cyclical maintenance plan works, x. whether an asset is subject to an agreed process of presentation directed by conservation heritage values, xi. whether an asset is subject to a monitoring regime integrated with asset management planning requirements and predetermined performance measures. Consistent with the four-part systematic analysis of the cultural landscapes, an overall assessment of their vulnerability is rather unappropriate and should be avoided. Instead of it, we suggest a four-part vulnerability assessment for each group of the afore-said parameters through a filtering process of the answers, according to which the level of vulnerability profile could be rated as: 1. High, 2. Moderate or 3. Low. In the case of cultural heritage, though, we can not proceed further into a unification of vulnerability's sublevels, because each group of questionnaires present different 'entities' that are equally present but not equally expressed and measured (see ch. 7).

3.4 GIS : a multiple-choice flexible tool - Digitizing data for specific targets (selected examples)

3.4.1 GIS for caves

■ As it is worldwide accepted, “a geographic information system (GIS) is a software system that stores, analyzes, and displays geographic data and related information. GIS is a relatively new science and technology that brings together many different disciplines. It is based on the fact that much of the data and information we need to use has an inherent geographic location and is related spatially. GIS delivers the capabilities to store, manage and query geographic data, and produce maps and reports. More importantly, GIS provides the analytical tools to help understand the spatial distribution of geographic information and model its interactions, in many cases finding patterns and relationships previously unrecognized” (ESRI).

Once used only by a select few organizations and research institutes, today GIS is used by many cities and towns, states and countries all over the world. A

The use of GIS functions also as a tool to explore non-traditional landscapes such as caves. This tool is able to display, visualize and explore various sets of data, as well as to evaluate distances and analyze the data. Cave archaeologists should work together to devise logical, reliable and efficient methods of data collection for the documentation of these unique archaeological resources. The presence of scientifically valuable finds and remains in caves is a common phenomenon throughout the world. Prominent examples are: the Karst feature database of Southeastern Minnesota (University of Minnesota, Department of Geology and Geophysics, Minnesota Geological Survey, and Minnesota Department of Health), the Cave survey data from Lechuguilla Cave (Carlsbad Caverns National Park), the Cave Resources (Sequoia & Kings Canyon National Parks) and the Western Belize Regional Cave Project (director Dr. Jaime Awe).

Despite the fact that many case studies address the importance of GIS and its role in visualizing spatial data today (see http://www.esri.com/industries/cavekarst/graphics/locations_bg.jpg; http://www.esri.com/industries/cavekarst/business/mapping_visualization.html; http://www.esri.com/industries/cavekarst/business/resource_planning.html; http://www.esri.com/industries/cavekarst/business/engineering_hydrology.html), maps of karst were not produced until late in the 20th

Century because detailed, regional geologic maps were not broadly available until that time.

In Greece, researchers usually do not document the material in situ, although the application of GIS in combination with a flexible recording system could provide efficient means of recording the whole context. On the other hand, archaeologists traditionally conceive of units as discrete, horizontal, stratigraphic levels, even though archaeological excavations are conducted in three-dimensional space. Divisions between levels may be arbitrarily assigned or may represent temporal or cultural changes. Unfortunately, this cognitive model is not always appropriate for archaeology in caves. So, we look forward to the continuing evolution and expansion of GIS in the cave and karst domain in our country, with Speleothems, habitats for cave-adapted species and paleontological / archaeological features taken under consideration. The results will be better understanding, management, and conservation of these unique resources.

Rock shelters and caves, apart from their ecological and environmental value, have played a prominent role in the study of man's adventure on Earth. From Palaeolithic Times onward, humans used, worldwide, these geological formations for a variety of reasons categorized and listed below: 1. residence, 2. animal pen / shelter, 3. work / production place, 4. water source, 5. storage place, 6. mine / quarry, 7. dump, 8. burial place, 9. sacred place, 10. ceremonial place, 11. tourist site, 12. place of execution / disposal of bodies, 13. refuge for danger, 14. refuge for outlaw / resistance fighters, 15. refuge for castout / victims of epidemics and 16. scientific destination.

with a plethora of artefacts / menhiracts of our ancestors (e.g. the famous rock art, the palaeolithic tool industries, the first fire hearths, burials), along with palaeoanthropological remains of tremendous scientific value, creating thus, unique archaeoenvironments which require autonomous investigating methodologies.

According to a brief summary of bedrock Geology of Attica, southern and eastern Attica, structurally, is part of the metamorphic / crystalline Attic - Cycladic massif, the southernmost of the three massifs forming the Pelagonian ridge or zone of the Hellenides mountain chain. Attica is also water-poor, due to both its structure and climate. Karst formation is strongly related to the largely carbonate rock formation and the mainly subterranean drainage systems.

The Greek Speleological Society (ESE) has catalogued about 300 karst forms in Attica, of which nearly half are caves or shelters and about 75 are varathra or caves with varathra. After 1986, about 50 additional caves and shelters were found by individual researchers / scholars. Roughly half of those 350 features are found on Hymettos (ca. 100) and in the area of mount Parnis (ca. 75), because these two regions show the greatest karst development.

■ The analysis of caves as cultural sub-group combine the criteria /needs of three (3) scientific fields (Environmental Archaeology, Disaster Archaeology and Hazard Management), and consists of four (4) main categories of parameters, which function as questionnaires. These data, through GIS possibilities, can be further used in various risk scenarios, layered risk maps of the area or restoration plans in a monitoring framework.

The first category comprises of general data that give the general profile of the site. The second category spots the data that give the general profile of site's geographical & ecological setting, as they can influence, directly or indirectly, upon many parameters of patrimony's viability, accessibility and visiting capacity, as well as the proactive planning of any risk preparedness. The third category includes the data that reflect the local community's level of preparedness. The fourth category provides various archaeoenvironmental & excavational parameters which will be further elaborated in an interdependent scheme of hazard and cultural assessment.

I. General profile

A. Questionnaire

1. name of the site
2. country
3. county
4. prefecture
5. community
6. "manager" of the site
7. number of the site on the map
8. running programmes (restoration, excavation, etc.)
9. participation in technical and other development projects
10. previous interventions on the site
11. detection of past catastrophes
12. reappearance / existence of the hazard in the area

B. Accompanying information

1. photos of the site
2. aerial photos, satellite images, etc.
3. topographic sketch
4. brief general info
5. bibliographic references
6. hyperlinks
7. information about ancient catastrophes (archaeological, palaeoenvironmental & historical data)

II. Cultural Landscape analysis

Questionnaire

1. latitude (coordinate x)
2. longitude (coordinate y)
3. extended area of the cultural site
4. accessibility in case of hazard
5. kind of intervention in case of hazard
6. categorization of roads' network on the map
7. general hydrological profile of the site
8. orientation of the site
9. altimeter of the site above mean sea-level
10. distance of the site from the nearest coast
11. slope 'bending around the site
12. capacity of receiving visitors
13. number of visitors per year
14. medical assistance inside or near the site
15. vicinity to other cultural sites
16. vicinity to modern settlements/ other touristic destinations
17. parking area
18. the site is open to visitors
19. total number of 'visiting days'

IV. Archaeoenvironmental & excavation parameters

A. Questionnaire (1)

1. length of the cave
2. width of the cave
3. height of cave's tallest chamber
4. depth of cave's deepest chamber
5. kind of cave
6. use of cave as habitation site
7. use of the cave as temporary transit / camping site / seasonal site
8. potential living space within the cave
9. population density within the cave
10. proximity to potable water
11. proximity to suitable pasture / open forest vegetation
12. proximity to arable land
13. frequency of occupation
14. duration of occupation
15. use of the cave as residence
16. use of the cave as animal pen / shelter
17. use of the cave as work / production place
18. use of the cave as water source
19. use of the cave as storage place
20. use of the cave as mine / quarry
21. use of the cave as dump
22. use of the cave as burial place
23. use of the cave as sacred place
24. use of the cave as ceremonial place
25. use of the cave as tourist site
26. use of the cave as place of execution / disposal of bodies
27. use of the cave as refuge for danger
28. use of the cave as refuge for outlaw / resistance fighters
29. use of the cave as refuge for castout / victims of epidemics
30. use of the cave as scientific destination

32. phase of cave use
33. maximum observed depth of occupational layers
34. earliest evidence of human occupation within the cave
35. karst phenomena (stalagmite / stalactite formation)
36. dating of the geological formation
37. need for further excavation
38. kind of finds within the cave: unsorted palaeontological material
39. unsorted palaeoanthropological material
40. primary / secondary burials
41. constructions (hearths, floors, wells, latrines)
42. archaeozoological finds
43. archaeobotanical finds
44. bone / stone / wooden tools
45. ceramics
46. metallic artifacts
47. mosaic, remains of dyes, rock / mural painting
48. leather items
49. other material

B. Accompanying information

1. name of excavation's director
 2. excavational periods
 3. photos of the finds
 4. exhibition / keeping area of finds from the cave
 5. brief bibliography
-

TABLE 1: DATING OF GEOLOGICAL FORMATION

0. Cambrian	570 - 500 myr B.P.
1. Ordovician	500 - 435 myr B.P.
2. Silurian	435 - 395 myr B.P.
3. Devonian	395 - 345 myr B.P.
4. Carboniferous	345 - 280 myr B.P.
5. Permian	280 - 230 myr B.P.
6. Triassic	230 - 195 myr B.P.
7. Jurassic	195 - 141 myr B.P.
8. Cretaceous	141 - 65 myr B.P.
9. Paleocene	65 - 55 myr B.P.
10. Eocene	55 - 37.5 myr B.P.
11. Oligocene	37.5 - 22.5 myr B.P.
12. Miocene	22.5 - 5 myr B.P.
13. Pliocene	5 - 1.8 myr B.P.
14. Pleistocene	1.8 myr - 10 kyr
15. Holocene	10 kyr - ...

TABLE 2: PALAEOCLIMATIC PERIODS - Oxygen isotope Stages

Lowe & Walker, 1997:

0. OIS 1	10.000 B.P. - ...
1. OIS 1/2	13.000 - 10.000
2. OIS 2	23.000 - 13.000
3. OIS 3	58.000 - 23.000
4. OIS 4	75.000 - 58.000
5. OIS 5	130.000 - 75.000
6. OIS 6	>130.000

TABLE 3: ARCHAEOLOGICAL DATING

Runnels, 2001:

0. Lower Palaeolithic	300.000 - 100.000 B.P.
1. Middle Palaeolithic	100.000 - 30.000
2. Upper Palaeolithic	30.000 - 10.000
3. Lower Mesolithic	10.000 - 9.500
4. Upper Mesolithic	9.500 - 9.000

Demoule & Perlis, 1993:

5. Aceramic Neolithic	ca. 9.000 - 8.500
6. Early Neolithic	ca. 8.500 - 7.800
7. Middle Neolithic	ca. 7.800 - 7.300
8. Late Neolithic	ca. 7.300 - 6.500
9. Final Neolithic	ca. 6.500 - 5.200
10. Early Bronze Age	ca. 5.200 - 4.200
11. Middle Bronze Age	ca. 4.200 - 3.700
12. Late Bronze Age	ca. 3.700 - 3.200
13. Submycenaean period	ca. 3.200 - 3.000
14. Early Geometric	ca. 3.000 - 2.900
15. Geometric	ca. 2.900 - 2.700
16. Archaic	ca. 2.700 - 2.600
17. Classical	ca. 2.500 - 2.300
18. Hellenistic	ca. 2.300 - 2.000
19. Roman	ca. 2.000 - 1.600
20. Byzantine	ca. 1.600 - 500
21. Post-byzantine	ca. 500 - 0
22. Modern era	A.D. 1950 - ..

Generally speaking, the cultural heritage, apart from the natural landscapes, comprises : a) the cultural resources of living populations (e.g. their mode of subsistence, their social & political organization, their religion, ideology & language, as well as the material expression of their ideas and practices, which range from sacred elements of the natural landscape to artifacts & buildings), b) the cultural landscapes (they consist of landforms and biotic & non-biotic features of the land, resulting from cultural practices over historical or prehistoric times, by generations of peoples of one or more cultural traditions) and c) the archaeological resources (e.g. occurrences & sites which may include artifacts, archaeobotanical & archaeozoological remains associated with human activities, burials & architectural elements). Especially the archaeological resources may not be an integral part of the cultural heritage of the local inhabitants.

The famous case of the construction of the Aswan High Dam (1953 ff.) which radically changed our knowledge of Egyptian archaeology with the Nubia campaign, was vital for safeguarding Egypt against increasing water, energy and land demands. Similarly, the dam at Akosombo on the Volta River, which created the largest man-made lake in Africa (officially opened in 1966), was a catalyst for Ghanaian archaeology. On the other hand, over the last forty years the lands impacted by the Siberian hydroelectric projects (Ob, Yenisey, Lena, Amur and of the rivers & tributaries) have witnessed a tremendous amount of cultural protection and conservation, for all the kinds of monuments have been united into a single 'cultural and historical heritage' protected by the state.

Another often neglected parameter is the detailed identification, registration and protection of the excavational sites (present and future). The prioritization of graded groups (for example, A-grade : large-scale excavations of most important sites, B-grade: moderate-scale excavation of relatively important sites, C-grade: small-scale excavation of less important sites and D-grade: test-excavation of general sites) and their georeferencing within GIS environment would be an extremely helpful tool for all the managerial policies concerning various environmental and cultural issues.

But how many monuments and open archaeological sites all over the world have the same destiny against fierce environmental or man-made disasters / hazards? Frequently, authorities choose the present well-being of people over the heritage or there is not an efficient cooperation among governments, institutions, private foundations and local people to prevent damage. Moreover, there may be a lack of managerial co-ordination between various specialists or regional authorities, even lack of money, expertise or time. Lack of long-term monitoring & of trained personnel locally available, ignorance of Cultural Heritage values and deficiency in sustainable development may also be added in the catalogue of monuments' worst enemies.

■ As cultural heritage consists of different types of properties which relate to a variety of settings, and include important works of art, monuments, sites, large historic areas and landscapes, the development of a framework for establishing

2. methodological inspection, survey & documentation of the resource's historical setting
 3. methodological inspection, survey & documentation of the resource's social, cultural and economic functions
 4. methodological inspection, survey & documentation of the resource's physical environment
- b) Definition:
1. critical / historical definition and assessment of the heritage resource & its settings
 2. identification of relevant qualities and values
 3. statement of character and significance
- c) Analysis:
1. scientific analysis and diagnosis of the resource
 2. scientific analysis and diagnosis of the resource's design
 3. scientific analysis and diagnosis of the resource's workmanship
 4. scientific analysis and diagnosis of the resource's materials
 5. scientific analysis and diagnosis of the resource's associated structural system in relation to appropriate cultural and functional context
- d) Strategy:
1. long- & short-terms programmes for regular inspections
 2. long- & short-terms programmes for cyclic maintenance
 3. long- & short-terms programmes for environmental control.

Furthermore, the rapid environmental changes and the urban development due to various international or regional reasons show a more and more complex profile requiring multiple scenarios and solutions, along with numerous detailed surveys or monitoring. In the case of 'ruined' monuments /sites, the delicate problems, both from the technical and philosophical points of view, enhance the use of GIS platforms, which show a non-destructive and reversible profile and facilitate their preventive maintenance.

■

Digital archaeological spatial database can contribute significantly to the management and protection of archaeological resources. Although GIS has been used in the field since the 1980s, and aerial photography has had a long history of use, it has only been within the past decade that these two technologies have matured substantially in archaeology. Remotely sensed data are currently used for exploration and discovery, and there have been numerous successful attempts to use them to identify landscape or cultural features, such as stone quarries, structural remains, and ancient river courses. Remotely sensed data are increasingly valuable as basic components of predictive models, which seek to classify landscape or other features as to their probabilities of possessing archaeological sites of particular ages or cultural affiliations. Furthermore, over the past decade universities and colleges in the United States are more frequently indicating that knowledge of GIS and related technologies is a desirable quality for any candidate for academic career in Archaeology.

GIS solutions for intrasite analysis, for example the OpenArcheo since 1996 (LIAAM, Siena - Italy), the British Columbia Archaeological Site Inventory Form

Archaeological Sites with GIS worldwide, Documentation and Evaluation analyses on deterioration and conservation of stone damage on monuments (10th International Congress on deterioration and conservation of stone - Stockholm, 2004) and search engines to retrieve archaeological information on the web, provide solutions suitable for a large number of users within the scientific community.

In addition, terms as integrated conservation and protection management, preservation, consolidation, anastylosis, reconstruction and restoration reflect the repeated human attempts, since Antiquity, to protect and exploit the cultural landscapes of the past. Salvage / Rescue / Conservation Archaeology, Management Archaeology, Crisis Archaeology, Public & Virtual Archaeology deal with these major issues.

In Greece, the case of anastylosis' works for the monuments of Athenian Acropolis (1975 - 2005) is rather an exception to the rule. The bureaucratic mechanism that controls all archaeological activity in the country is backward, conservative and not at all designed to fit present demands. Preventive and not curative policies are not widely accepted. So, GIS solutions for monuments' / sites' monitoring are not in the agenda of the current socio-economic orientation.

However, research projects, for example the Web-based Digital Archaeological Map of Lasithi, E. Crete (Laboratory of Geophysical - Satellite Remote Sensing & Archaeoenvironment. Institute of Mediterranean Studies, Rethymno, Crete), the Municipal Map of Markopoulo - Eastern Attica (Municipality of markopoulo and Department of Topography, T.E.I. of Athens), the GIS map of ancient Messene - Peloponnesus (Laboratory of Geophysical - Satellite Remote Sensing & Archaeoenvironment. Institute of Mediterranean Studies, Rethymno, Crete) and the Photogrammetric Survey of the prehistoric site of Zagani - International Airport of El. Venizelos (NTUA) open new doorways toward GIS use by Archaeologists.

In the present case of DISMA project, in order to obtain as comprehensive a report as possible within the very limited time and data available, the questionnaire is built over the four-part categories of analysis.

CATEGORIES OF INFORMATION

I. General profile

DIGITIZED PARAMETERS OF ANALYSIS

A. Questionnaire

1. name of the site
2. country
3. county
4. prefecture
5. community
6. "manager" of the site
7. number of the site on the map
8. running programmes (restoration, excavation, etc.)
9. participation in technical and other development projects

B. Accompanying information

1. photos of the site
2. aerial photos, satellite images, etc.
3. topographic sketch
4. brief general info
5. bibliographic references
6. hyperlinks
7. information about ancient catastrophes (archaeological, palaeoenvironmental & historical data)

II. Cultural Landscape analysis

Questionnaire

1. latitude (coordinate x)
2. longitude (coordinate y)
3. extended area of the cultural site
4. accessibility in case of hazard
5. kind of intervention in case of hazard
6. categorization of roads' network on the map
7. general hydrological profile of the site
8. orientation of the site
9. altimeter of the site above mean sea-level
10. distance of the site from the nearest coast
11. slope 'bending around the site
12. capacity of receiving visitors
13. number of visitors per year
14. medical assistance inside or near the site
15. vicinity to other cultural sites
16. vicinity to modern settlements/ other touristic destinations
17. parking area
18. the site is open to visitors
19. total number of 'visiting days'

III Community's preparedness

1. the site is near - in 5 km. distance - a town
2. the site is near - in 5 km. distance - a inhabited area
3. the site is near - in 5 km. distance - a fuel station
4. the site is near - in 5 km. distance - the sea / stored water
5. the site is near - in 5 km. distance - an open space
6. the site is near - in 5 km. distance - an accessible road
7. the site is near - in 5 km. distance - a port
8. the site is near - in 5 km. distance - an airport
9. the site is near - in 5 km. distance - a mountain refuge
10. the site is near - in 5 km. distance - a fire guard station
11. Existence of Emergency Manual
12. Alternative storage area in case of removal of 'objects'
13. Emergency Equipment
14. Assurance
15. Emergency Personnel: Disaster reaction Manager
16. Emergency Personnel: Disaster reaction team
17. Disaster Notification
18. Disaster Information
19. Recovery Priorities
20. Need for monitoring
21. Monitoring
22. Existence of warning levels

Questionnaire

23. Present situation of the monument
24. Previous Interventions
25. Problems in construction
26. Problems in statics
27. Problems in aesthetic issues
28. Problems in integrity
29. Problems in functional coherence
30. Problems in accessibility
31. Problems in visiting capacity
32. Problems in environmental surroundings
33. Previous problems concerning the visitors
34. Problems in identification (is it well-known?)
35. Problems in human-induced hazards
36. Reappearance / existence of the hazard in the area
37. Overall level of monument's / site's vulnerability

IV. Archaeoenvironmental & excavational parameters

A. Questionnaire

1. length of the monument
2. width of the monument
3. height of the monument
4. kind of the open-air cultural unit
5. dating of first use
6. frequency of use since Antiquity
7. duration of use since Antiquity
8. future excavation / other intervening activities
9. components of structures & features
10. intact or fragmentary artifacts
11. by-products / waste products / debris
12. organic material
13. artistic / symbolic representations
14. environmental & chronometric specimen
15. paleontological specimen

B. Accompanying information

1. name of excavation's director
2. excavational periods
3. photos of the finds
4. exhibition / keeping area of finds from the site
5. brief bibliography

Although “the right to a cultural heritage is an integral element of humanity ” (Article 27 of the United Nations’ Universal Declaration of Human Rights) and “the diversity of such resources is essential for sustaining the ability to cope with the past, present and future”, the colossal magnitude of the loss and damage of cultural heritage due to various worldwide natural phenomena and human-induced hazards diminishes the pool of knowledge and wisdom from which we draw our strength and resilience. Unfortunately, in the majority of cases, we cannot rehabilitate or restore what has been lost, but we can prevent a further loss of cultural heritage by : a) the integration Cultural Heritage Management (CHM) assessment with environmental assessment to elucidate long-term interactions between living and past populations and their environments, b) the elaboration of a more synergetic, effective, satisfactory and internationally accepted legislation and policy, c) the incorporation of costs for CHM into national budgets, d) the involvement of direct and active participation of local communities in all stages of CHM, e) the enforcement of public education, f) the coordination of international efforts to secure funding and ensure compliance with international legislation and guidelines, as well as compliance with professional standards.

The arena of human rights concerning the local cultures is perhaps the least developed in the human rights field. It is widely acknowledged among Anthropologists that social, economic and cultural rights have not been a primary focus in the human rights community. Moreover, Archaeologists are rarely on the front lines to help mitigate and stop abuses of cultural rights, despite that they should “consult actively with affected group(s), with the goal of establishing a working relationship that can be beneficial to the discipline and to all parties involved” (Principle #2, Society for American Archaeology, Principles of Archaeological Ethics, 1995). On the other hand, our human cultural resources are finite and non-replenishable.

'A museum is an institution which collects, documents, preserves, exhibits and interprets material evidence and associated information for the public benefit'. (Museums Association 1984). Memory institutions seem to ensure in the most tangible way among all the other groups of cultural heritage, the sense of continuity, security and integrity of living communities, fighting against the destabilisation, alienation and disorientation of the citizens and providing proper care and socialization of the younger generations, via the exhibition of the 'cultural property'.

Furthermore, museums as forms of Memory Institutions could provide a hospitable shelter for the 'virtual presentation' (e.g. visualization) of the whole cultural heritage of a local community, by hosting : 1. surveys that locate and document the cultural targets of the area, 2. records of sites' evaluation, 3. assessment of facilities and features, 4. formulas for mitigation, 5. cultural chronological framework based on actual sites located and evaluated and 6. open communication network with the visitors . Consequently, the museums are the nearest locations within the boundaries of cultural landscapes, so they should also function as local operational centres in cases of hazards. Finally,

adequate and justifiable research designs and procedure manuals, b) justify methods and evaluate the results, c) undertake strict quality control and assurance, d) manage funding and personnel within the probability of hazardous phenomena, e) work efficiently with a variety of other project personnel in an interdisciplinary concept, f) understand and comply with appropriate regulations and guidelines, g) prepare integrated reports, h) develop plans for curating collections and supporting documentation and i) work with local communities and public. GIS platforms are able to incorporate and elaborate all the above-mentioned fields in a 24-hour flexible working system installed both on central offices, as well as on local units (e.g. museums).

■

During the International Decade for Natural Disaster Reduction (IDNDR) of 1990's, not only are management strategies evolving at international, national and regional levels, but they also include targets such as the museums, the libraries, and the archives. Archives, libraries and museums are Memory Institutions, as they organise the cultural and intellectual record, and their contents are treated as 'collections', "which contain the memory of peoples, communities, institutions and individuals, the scientific and cultural heritage and the products throughout time of our imagination, craft and learning" (Information Society Technologies Programme within the EU's Framework Fifth Programme: FP5). They join us to our ancestors and are our legacy to future generations, they function as social assembly places, physical knowledge exchanges and hospitable localities open to all..

The communities of Memory Institutions all over the world are working on the expansion of learning, research and cultural opportunities, as well as the growing of users's groups. The digital medium is radically new. The 'information landscape' has to deal both with the constraints of particular media or systems, and the needs of users. Documents, publications and exhibits can interact with the provider / user, because fluidity replaces fixity. Data flows, it can be shared reused, analysed, adapted, reconfigured and newly combined in ways which were not possible before. On the other hand, accessibility of resources is potentially enhanced in a digital environment, so the transforming influence is unpredictable.

The resources are now approached via the concept of the 'life-cycle'. A choice made at any stage may ramify throughout the life of a resource, through the scheme: 1. collection development, 2. collection management, 3. access (including discovery & retrieval), 4. use and 5. creation. Special attention is given to questions of access to cultural resources and network services. First and foremost, libraries, archives and museums disclose and deliver cultural content via various network services (disclosure services, content delivery, rights management, resource discovery, terminology & knowledge representation, ratings, authentication, e-commerce, catching & mirroring, schema registering, location, user profile, search, request / order, user interface services). In addition, they develop their collections in line with specific missions and according to different curatorial traditions, local needs and socio-economic features. All of them move to 'hybrid' collections, which contain

digital space and the hazard management of hybrid collections are the five pivotal axes of the actions made by the Memory Institutions worldwide. But we must keep in mind that the digital information environment is still 'under construction'.

Similarly, Emergency Planning is now a compulsory requirement for museums. It is a quite complicated process based on the Risk Assessment, being the result of a wide range of preliminary activities. Albeit the fact that catastrophes of a great magnitude are rare, disaster can strike in many ways. So, the Risk Assessment involves five stages:

- * identify the risks
- * evaluate the risks
- * control of risks occurrence and effects
- * liaise with those who are or will be involved
- * feedback and review.

In identifying the risks, three key vulnerabilities must be kept in mind (environment / location, archival medium & storage type). These will allow risk evaluation (assessment) and control (reduction). Firstly, we should examine if the building is vulnerable (past cases of flooding, fire, earthquake, vandalism, dirt, human-induced accidents) and if the building is water tight and weather proof (gutters & drains regularly inspected and maintained, existence of security alarms, weather tight windows, quality of electrical wiring, attacks by animals, leaking pipes or water using machines near collections, position & leaking of water tanks).

Secondly, we should examine the materials of archives / exhibits because they represent different levels of vulnerability towards various hazards. Collections may include: archives (manuscripts, books, documents, photographs / slides, negatives, motion picture films, CDs, framed items, coated papers, archival box files), social history items, fine and decorative art (e.g. easel paintings, frescoes, mosaics), geological collections, biological collections made of plants (wood samples, tree rings, large seeds or fruits, exsiccata, economic botany samples, pollen, very small seeds, dissected parts), invertebrates & vertebrates (fish, amphibian & reptiles, birds & mammals) in the forms of models in wax and glass, synthetic polymers, molds, skeletons or mummified specimen and archaeological collections.

Especially the archaeological objects are the result or product of an activity in the past that has been recovered from an archaeological site. Archaeological objects may have originated in the ancient past or quite recently. Depending upon the soil and climate of the site, a wide variety of materials may be excavated. So, archaeological collections include inorganic artifacts (metal, ceramics, glass, stone) and organic artifacts (leather, basketry, textiles, modern plastics and other synthetics, bone, teeth). Archaeological collections may also contain non-artifactual samples, such as botanical material, soils, pollen, phytoliths, oxalate crystals, snails, insect remains, and parasites. An important part of archaeological collections are the associated archival records (for example, field notes, photographs, maps, digital documentation).

environment, storage, staff routines & transportation), as well as the risk factors (security, fire, flood, building works & maintenance, vandalism, electronic sabotage, terrorist attack, earthquake / subsidence, extreme weather conditions).

In evaluating the risks, the key factors to be considered are the likelihood of a disaster occurring and the effect of loss ranging from light to total. Similarly, the severity of the consequences can be assessed numerically or simply categorised into low, medium or high severity (detailed analysis will be found in the final Risk Assessment of Cultural Landscapes).

Then, the control or reduction of risks falls into one of four categories: avoiding the risk, transferring the risk, controlling the risk or accepting the risk.

Moreover, beyond the preparation of risk reduction measures, preparation should also be made for procedures in terms of personnel, training, disaster notification, salvage prioritisation, maintenance of equipment, insurance issues, monitoring and temporary accommodation in case of hazard. All the aforementioned parameters are converted into questionnaires which reflect the level of community's preparedness against various natural or human-induced hazards.

It is noteworthy that damage can be limited even in the face of a large-scale disaster, when institutions are able to put their early warning procedures into operation (e.g. the case of the cultural institutions in Charleston, South Carolina before the hurricane Hugo in 1989).

In case of disaster five main staff members should be in alert: (1). Chief Administrator, (2). Disaster Recovery Team Leader, (3). Person in charge of building maintenance, (4). Cataloguer / Registrar and (5). Preservation Administrator / Conservator. All of them should be registered by name, home phone & specific responsibility in case of disaster.

The main services needed in an emergency are: (1). Fire Department, (2). Police, (3) Utility Companies (Electric, gas, Telephone, Water), (4). Architect or Builder, (5). Insurance Company, (6). Ambulance, (7). Janitorial Service, (8). Professional Advice / Conservator, (9). Computer records recovery salvage, (10). Computer Emergency, (11). Legal Advisor, (12). Electrician, (13). Plumber, (14). Locksmith, (15). Photographer, (16). Other. All of them should be registered by Company and / or name of contact, and phone number.

The Emergency Equipment includes: (1). Keys, (2). Main Utilities (electrical cut-off switch, water shut-off valve, gas shut-off), (3). Sprinkler system, (4). Heating /cooling system, (5). Fire extinguishers (Wood, paper, combustible = Type A, Gasoline and flammable liquid = Type B, Electrical = Type C, All routine types of fire = Type ABC), (6). Master fire alarm (pull box), (7). Smoke and heat detectors, (8). Cellular telephone, (9). Portable pump, (10). Extension cords (50 ft., grounded), (11). Flashlights, (12). Camera with film, (13). Battery operated radio. (14). Tool kit (crowbar, hammer, pliers, screwdriver).

(for removing soot), (26). Portable dehumidifiers, (27). Portable electric fans, (28). Portable generator, (29). CB radio, (30). Photographic equipment/supplies, (31). Portable toilets, (32). Construction materials, (33). Ladders, (34). Extra security personnel (35). Other.

■

Apart from the GIS platforms which are increasingly used in field data recording (excavational processes, see http://www.esri.com/industries/archaeology/business/survey_excavation.html), but they are beyond the scope of this project due to the functional system of Greek archaeological services, GIS opens up new possibilities for museums, libraries and heritage management organizations (<http://www.esri.com/industries/libraries/education/collections.html>).

Although museums are concerned with the care and interpretation of natural and man-made objects / elements of social history from the geological past to the present-day, and many of these objects / elements have a geographical association, GIS facilities for the registration, visualization and protection of the various collections is still a rare tool in Greece. There is not elaborated yet a basic coordination level among institutions, services and local / regional authorities, in order to keep accurate records about the collected items, build up accessible and flexible information easily retrieved by the user (being either the general public, or specialist researchers), and what's the most important, to work on a proactive planning concerning the natural and human-induced hazards.

The general remark, internationally, is that the adoption of GIS by museums has been a much slower process than the use of computerised databases, probably due to four main factors: α ignorance of the possibilities of GIS, α GIS seen by some museums as desirable but not essential, α a perception that GIS software is very complex and user-unfriendly compared with other 'office' software and α the high cost of GIS software and required datasets is added to the cost of standard database software.

Consequently, we tried to remain very focused on a simple questionnaire, which would be able to turn any relevant information (spatial, temporal or descriptive) into coherent elements for a further analysis (hazard assessment within the cultural landscapes), because knowing where museum objects are located in collections' buildings is just as important as knowing where they originated.

I. General profile

A. Questionnaire

1. name of the site
2. country
3. county
4. prefecture
5. community
6. "manager" of the site
7. number of the site on the map
8. running programmes (restoration, excavation, etc.)
9. participation in technical and other development projects
10. previous interventions on the site
11. detection of past catastrophes
12. reappearance / existence of the hazard in the area

B. Accompanying information

1. photo of the site
2. aerial photos, satellite images, etc.
3. topographic sketch
4. brief general info
5. bibliographic references
6. hyperlinks
7. information about ancient catastrophes (archaeological, palaeoenvironmental & historical data)

1. latitude (coordinate x)
2. longitude (coordinate y)
3. extended area of the cultural site
4. accessibility in case of hazard
5. kind of intervention in case of hazard
6. categorization of roads' network on the map
7. general hydrological profile of the site
8. orientation of the site
9. altitude of the site above mean sea-level
10. distance of the site from the nearest coast
11. slope 'bending around the site
12. capacity of receiving visitors
13. number of visitors per year
14. medical assistance inside or near the site
15. vicinity to other cultural sites
16. vicinity to modern settlements/ other touristic destinations
17. parking area
18. the site is open to visitors
19. total number of 'visiting days'

1. the site is near - in 5 km. distance - a town
2. the site is near - in 5 km. distance - a inhabited area
3. the site is near - in 5 km. distance - a fuel station
4. the site is near - in 5 km. distance - the sea / stored water
5. the site is near - in 5 km. distance - an open space
6. the site is near - in 5 km. distance - an accessible road
7. the site is near - in 5 km. distance - a port
8. the site is near - in 5 km. distance - an airport
9. the site is near - in 5 km. distance - a mountain refuge
10. the site is near - in 5 km. distance - a fire guard station
11. Existence of Emergency Manual
12. Alternative storage area in case of removal of "objects"
13. Emergency Equipment
14. Assurance
15. Emergency Personnel: Disaster reaction Manager
16. Emergency Personnel: Disaster reaction team
17. Disaster Notification
18. Disaster Information
19. Recovery Priorities
20. Need for monitoring
21. Monitoring
22. Existence of warning levels
23. dimensions of exhibits

B. Accompanying information

1. Staff members in case of disaster
2. Service needed in an Emergency
3. Emergency Equipment
4. Checklist

IV. Archaeoenvironmental & excavation parameters

A. Que stormare (1)

1. length of the building
2. width of the building
3. height of building
4. kind of exhibit: palaeontological material
5. palaeoanthropological material
6. burials, hearths, floors
7. archaeozoological finds
8. archaeobotanical finds
9. stone artifacts
10. bone artefacts
11. ceramics
12. metallic artifacts
13. mosaics
14. wooden artifacts
15. leather artifacts
16. remains of dyes
17. rock / mural painting
19. modern materials
18. other material

B. Accompanying information

1. photo of the finds
2. brief bibliography

cultural landscape. The transit points or transport / communication corridors fundamentally consist of seven different zones : 1. trans-isthmian cross-ridge/ cross-watershed) land transport zones, 2. "ferry" corridors or routes of regular transportation across waters, 3. zones based on river valleys or other far-reaching water courses, 4. coastal transport zones, 5. estuary lagoon zones, 6. lake zones and 7. zones of the open sea.

Underwater Archaeology is the study of past human life, behaviours and cultures using the physical remains found in salt or fresh water or buried beneath water-logged sediment. It is considered as a branch of Maritime Archaeology. Changes in sea-level due to local seismic events, or more widespread climatic oscillations or changes on a continental scale, even other geological phenomena, alter the coastal environments, having as a result the submersion of occupational sites, once in dry land. The remains may be within various sedimentary facies: 1. terrestrial (peat formation), 2. fluvial (floodplain / freshwater marsh -H- or levee / crevasse splay sediment -F-), 3. (fluviomarine-) fluvial (river channel), 4. fluviomarine (delta), 5. brackish (coastal swamp), 6. shallow marine, littoral (sand bar / spit), 7. brackish (marsh), 8. brackish - marine (lagoon), 9. littoral, shallow marine (beach, shore face) and 10. marine (sublittoral environment).

According to the CHAPTER ON THE PROTECTION AND MANAGEMENT OF UNDERWATER CULTURAL HERITAGE (1996), ratified by the 11th ICOMOS General Assembly in Sofia, Bulgaria, October 1996, the protection and management of underwater cultural heritage in inland and inshore waters, in shallow seas and in the deep oceans, are encouraged. For the purposes of this Charter underwater cultural heritage is understood to mean the archaeological heritage which is in, or has been removed from, an underwater environment. By its very character this category of cultural heritage is an international resource.

A large part of the underwater cultural heritage is located in an international setting and derives from international trade and communication in which ships and their contents are lost at a distance from their origin or destination.

Underwater and coastal cultural heritage is both finite and non-renewable and contributes to the formation of identity being important to people's sense of community. In addition, if managed sensitively, it can play a positive role in the promotion of recreation and tourism. Many marine activities, which are themselves beneficial and desirable, can have unfortunate consequences for underwater cultural heritage if their effects are not foreseen. Underwater and coastal cultural heritage may be threatened by construction work that alters the shore and seabed or alters the flow of current, sediment and pollutants and it may also be threatened by insensitive exploitation of living and non-living resources. Furthermore, inappropriate forms of access and the incremental impact of removing "souvenirs" can have a deleterious effect.

The General Conference (Unesco) Paris 2001, elaborated the DRAFT CONVENTION ON THE PROTECTION OF THE UNDERWATER CULTURAL

periodically or continuously, for at least 100 years such as: (i) sites, structures, buildings, artefacts and human remains, together with their archaeological and natural context; (ii) vessels, aircraft, other vehicles or any part thereof, their cargo or other contents, together with their archaeological and natural context; and (iii) objects of prehistoric character (b) Pipelines and cables placed on the seabed shall not be considered as underwater cultural heritage. (c) Installations other than pipelines and cables, placed on the seabed and still in use, shall not be considered as underwater cultural heritage.

Marine and coastal environments (lagoons, river deltas, mangrove landscapes, dunes, fluvial routes, wetlands, islands, shorelines), apart from their natural and cultural significance, are also rich in archaeoenvironmental information, which is vital for a huge spectrum of scientists (e.g. Palaeoceanography, Paleoclimatology, Palaeontology, Palaeoecology, Disaster Archaeology).

Another important aspect is that parts of many contemporary seas were dry land during Palaeolithic and Mesolithic times (until LGM) and were then inhabited. Many remains of these habitations are preserved in the sediments of the seabed. These underwater settlement sites are unique in an international context. Obviously these scientific treasures call for a strong protection. Finally, the conservation conditions of the remains laying on the seafloor of several seas (e.g. Baltic, Black) are extremely good. Low salinity, absence of shipworms and a large portion of oxygen-free bottom layers keep organic material intact.

■

The controversial Three Gorges Projects (China), the largest reservoir project in the world, due to be completed by 2009, experienced lack of funding, shortage of trained personnel and serious problems related to administrative organization, logistical requirements and political constraints. The lack of an overall research design and the failure to incorporate a sampling scheme based on issues of significance resulted in the damage and destruction of archaeological and historical sites, along with the total disfiguration of past cultural landscapes. Although the overall number of the reports and the identification of the sources made by Chen Shen (Royal Ontario Museum & University of Toronto, Canada) and his salvage team, are not available, this effort focused on the assessment of the degree to which the cultural heritage of the region is being properly protected.

On the other hand, the cultural itinerary of Portugal is noteworthy. Prior to the 1970's Portugal lacked safeguards for archaeological heritage with projects such as dams and changes of the shorelines. The Sines Project conducted in the SW Atlantic shoreline between 1972 and 1977 comprised Survey and Salvage Archaeology in the face of a state-promoted industrial development project. Between 1971 and 1973, a rescue survey promoted by Archaeology students with minimal government involvement, during the construction of a dam at Fratel on the Tejo river, discovered and registered rock engravings. A 1985 new law in Cultural Heritage recognized archaeological heritage specialty and the need for archaeological surveys on projects that impact the landscape. In the 1990's, Archaeology at the Alqueva and the Côa dams contributed to

indices or spatial analysis should be referred to : a) the settlements and their patterns, b) the producing processes (e.g. agriculture, cattle-raising, forestry, tourism, commercial activities), c) the technical and social infrastructures (e.g. transportation, water supplying, drainage, telecommunications, education, social care & health) and d) special infrastructures for the environmental protection. On the other hand, coastal man-made constructions (e.g. houses, hotels, ports, campings) usually do not take under consideration the Carrying Capacity of the coastal environments (e.g. soil & subsoil qualities, climatic conditions, marine surroundings, biotic systems).

Greece has an enormous coastline contour with 15.021 km of coasts. The 2/3 of the modern state is sea. Considering that the coastal zones include the areas that extend as far as 50 km from the coastline, the 80% of the Greek settlements exist within these boundaries. The nature of the Greek environments favours the development of local geocultural units with show different environmental and socio-cultural profiles. Greek civilization has started from the coastlines of this country, as evidence for open sea journeys in the Aegean date back at least to the 11th millennium B.C.. Maritime civilizations (e.g. Minoan, Mycenaean, Archaic & Classical Greece, island communities even before A.D. 1821) forged the Greek identity and its expressions through time. The current perception of the coastal management wants to integrate all the seven categories of the waterfronts into a cooperative and sustainable development. The afore-mentioned categories are the following: (1). working waterfront (areas in which working procedures take place, for example shipyards, ports and fishing industries), (2). residential waterfront (areas with houses), (3). environmental waterfront (areas which need protection, such as beaches and wetlands), (4). cultural waterfront (areas with educational and cultural infrastructures and uses, for example aquaria), (5). historic waterfront (conservation and reuse of nautical installations, lighthouses, ships and storehouses), (6). recreational waterfront (parks, network of pavements for walkers) and (7). mixed-use waterfront (areas with multiple uses).

■ Crucial parameters of the modern life are the violation of the coastal zones, the considerable enrichment of the local populations by tourists, the rapidly increasing urbanization, along with the continuous environmental stress and the existent inter-annual variability in the majority of coastal and littoral ecosystems.

Especially, marine litter poses a vast and growing threat to the marine and coastal environments. It originates from many sources, it has a very slow rate of degradation and causes a wide spectrum of environmental, economic, safety, health and cultural impacts. The need for monitoring, assessment and sustainable management of submarine and coastal cultural landscapes urges to the use of GIS platforms in them.

The coastal zones are home to the majority of our global population, and the oceans and seas provide some of the Earth's most important and dynamic elements. From oceanography to Hydrography, navigation to defense, from the coastal shoreline to the bathymetric bottom, marine GIS has been adapted and utilized to assist researchers and organizations in achieving their goals

California, a region that has witnessed extensive research on the interrelationship between cultural developments and a dynamic physical landscape, have been put in GIS environment, in order to examine key organization trends in relationship to specific aspects of the cultural and physical landscape. The study of the site of Tel Shiqmona, a coastal site where human activity dated from the Late Bronze Age, ca. 1500–1200 B.C. to the Arab Period, ca. 636–640 C.E., 1.3 km southwest of the Carmel Cape at the southern tip of Haifa Bay, Israel, focused specifically on the potential for maritime activity at Tel Shiqmona during the Persian Period by using a GIS as the primary tool. On the other hand, field works for risk maps are also helpful for they embrace all the categories of targets within their GIS layers (e.g. the liquefaction potential of the city of Aqaba, in southwestern Jordan, about 320 km south of the capital Amman, by using the GIS).

Larger projects contribute equally to the regional assessment of underwater and coastal / maritime heritage. The Final Report of the Working Group on Heritage Cooperation, agreed upon in Gdansk, May 27-29, 1999, concerning the Safeguard and Development of the Common Cultural Heritage in the Baltic Sea Region, was found its mandate in the Presidency Declaration of the Baltic Sea States Summit in Visby on May 3-4, 1996, and the Declaration of Ministers of Culture, meeting in Lübeck on September 21-23, 1997. The purpose of the working group is to prepare a report on possible actions for safeguarding and developing the regional cultural patterns which are manifest in landscapes, settlements, buildings, archaeological remains, ships, artefacts, and traditions, whether material or spiritual. This project identified the need for the creation and establishment of a network for culture heritage information, and the elaboration of a system, which has to meet with various demands including facilities as: a) Databases of inventories, excavations and artefacts, b) Networks and linking between museums, archives and research institutes on international, national and local level for experts, c) Web-sites for the general public and d) Links to culture tourist organisations.

Moreover, the research on the relationship between coastal evolution and basin management in South Italy - Basilicata Region (between Bradano and Basento river mouths) is conducted in an area with the highest coastal erosion rates in Italy and based on an Institutional agreement between ENEA (the National Agency for New Technologies) & the Italian Ministry of Environment. In addition, the program of mapping underwater archaeological sites around the island of Ireland, run by the Irish Government in partnership with a number of Irish universities, helped new technologies and marine survey techniques to be enlisted in order to develop integrated management plans. Furthermore, the National Heritage Act of England (2002) includes archaeological sites of all types from the low-water-line out to the 12-mile limit around England. This Act and the works based on it discuss the broad characteristics of the maritime archaeological resource in English territorial waters, the character of inventories of marine archaeological sites and the role and relationships of professional maritime Archaeologists, amateur Maritime Archaeologists and recreational divers. They also discuss the legislative framework pertaining to maritime archaeology and the future role of English Heritage and Local

at Patras University (G. Ferentinos, G. Papatheodorou, Athena Chaiari, Maria Geraga, A. Stefatos & D. Christodoulou), H. Tzalas & the Hellenic Institute for the Preservation of Nautical Tradition (an Athens-based scientific institution specializing in Marine Archaeology and Nautical Experimental Archaeology) and J. Y. Empeur & the French Center for Alexandrian Studies in Alexandria, are listed among the pioneering efforts of GIS use in the field of maritime heritage.

Underwater archaeological remains (deep water underwater excavations & shallow coastal excavations) are subject to a much wider array of physical, chemical and biological processes than their terrestrial counterparts. To encompass the effects of these processes, data collection, recording, and interpretation must differ slightly from the procedures used on land, although they are no less scientific in their nature. The excavation results and the surrounding sites should be also able to be interpreted and used by future researchers.

Archaeologists, other scientists and future visitors must deal with an often hostile environment, where wave surge, underwater currents, and topical wave patterns interfere with working procedures and sometimes threaten personal safety. Moreover, the underwater environment may affect sediments, artifacts and structures so that they are preserved differently. On the other hand, these environments are of high energy status. Consequently, careful visual observation, sediment sampling and careful recording of depths and location are needed, so that future environmental reconstruction can be achieved based on as much scientific information as possible. In addition, there is a need for permanent monitoring, assessment and intervening. For example, high seas may transport sediment to infill sites.

The case of the Diolkos of Corinth is a sad example of human negligence and environmental degradation. The Diolkos was an 8-km long paved trackway across the Isthmus of Corinth, over which ships could be hauled overland between the Gulf of Corinth and the Saronic Gulf, to save them sailing around the Peloponnese. It has ruts with a gauge of 1.52 m cut for the trolleys onto which the ships were loaded, and has been called the world's first railway. First built probably by Periander (625-585 B.C.) , it is mentioned by Thucydides as something ancient. Nowadays it has been superseded by the modern Corinth Canal. It is a monument of first-class importance for the history of technology, and for the Greek achievement, generally. The western end of the Diolkos, excavated between 1956-1962, lies today in a serious state of degradation. In 1985, the monument was already heavily eroded.

Since natural processes and archaeologists destroy their evidence, we must record everything as precisely as possible. GIS solutions enhance the preservation / disclosure , evaluation and re-use of various information. there are international scientific teams, like the American one which searches for prehistoric Aegean harbors with GIS, Geomorphology and Archaeology (Th. F. Tartaron - Yale University, R. M. Rothaus - St. Cloud State University & D. J. Pullen - Florida State University. source <http://www.athenapub.com/>) and

Salamina Island and W. Attica. In addition, the Greek Ephorate for the Submarine Antiquities has succeeded a cooperation with the Hellenic Center for Marine Research, the MIT and the Institute of Oceanography Woods Hole, in order to detect, scan and manage at least 30 shipwrecks which are laying on the Greek sea-floor, by using the latest technological equipment worldwide. 300 shipwrecks are already spotted on maps, while the Greek Ephorate is informed for more of 1.000.

Furthermore, apart from the biological degradation and the hydrological or thermal dilatation, weathering mechanisms due to salt accumulation and the repeated climatic cycles (humidity / dryness) in the marine environments, alterate the surface and the structure of coastal monuments. Another often neglected hazard of coastal landscapes is the provocation of tsunami due to various reasons (meteoritic impact, submarine volcanic explosion, submarine landslide, activation of submarine tectonic fault). Both the neighbouring tsunamigenic areas of Korinthiakos Gulf which gave repeated epicenters of strong earthquakes since Antiquity (see the famous Eliki case), and phenomena of submarine landslides and hazardous pockmark fields, as well as the tectonically active area of N. & S. Euboikos Gulf, highlight the importance of an integrated hazard report concerning the cultural landscapes of Eastern Attica.

On the other hand, the eastern coastal peninsula of Attica has undergone major changes during the last decades, which have modified completely the coastal environment in lowland areas. The coastal geomorphology is characterized by medium to steep slopes with several pocket beaches, which are sandy at wind-protected bays. In most cases these environments are of high energy level, as erosion denotes the retreat of the coastline, while terrestrial and fluvial / torrent deposits activated in recent years following heavy rains, trigger the reverse process. In the lowland areas, human intervention in the coastal environment is particularly intense in recent decades. The construction of all kinds of coastal structures (wharfs, jetties, piers, marinas, breakwaters, landfills & sewers) has altered significantly the natural and cultural coastal environments, which have become stagnant and artificial.

Despite the human-induced changes which have left their imprint on the cultural landscapes of Eastern Attica, the coastal and marine environments of this region is still of high quality. The private sector has already started to invest on environmental tourism. The company of 'Greek Diving Parks' in cooperation with the 'Municipal Enterprise for the Development of Keos' are elaborating the creation of a marine park in the S.E. littoral zone of the island of Makronissos.

The Petalioi Gulf (opposite of Marathon Bay, in the coasts of S. Euboiia) is an example of a rather unpolluted area, which receives domestic and agricultural inputs, but it preserves the character of an open-sea area with very low nutrient concentrations. This area behaves like a natural filtering laboratory, which biodegrades the relatively higher phosphate and nitrate finds measured in the warm period near the eastern coast of Attiki.

management with satisfactory efficacy. Furthermore, mild forms of intervention and a development based on sustainable perspectives (e.g. saltworks, marine park, eco-region) may offer an integrated model of cooperation between the modern socio-economic values and the cultural assets.

CATEGORIES OF INFORMATION

DIGITIZED PARAMETERS OF ANALYSIS

I. General profile

A. Questionnaire

1. name of the site
2. country
3. county
4. prefecture
5. community
6. "manager" of the site
7. number of the site on the map
8. running programmes for protection
9. running programmes for eco-tourism
9. participation in technical and other development projects
10. previous interventions on the site
11. detection of past catastrophes
12. reappearance / existence of the hazard in the area

B. Accompanying information

1. photo of the site
2. aerial photos, satellite images, etc.
3. topographic sketch
4. brief general info
5. bibliographic references
6. hyperlinks
7. information about ancient catastrophes (archaeological, palaeoenvironmental & historical data)

1. latitude (coordinate x)
2. longitude (coordinate y)
3. extended area of the cultural site
4. altimeter of the site above mean sea-level / bathymetry
5. distance of the site from the nearest coast
6. slope bending around the site
7. accessibility in case of hazard
8. kind of intervention in case of hazard
9. capacity of receiving visitors
10. number of visitors per years
11. vicinity to other cultural sites
12. vicinity to modern settlements / other touristic destinations
13. parking area for visitors
14. the site is open to visitors

15. existence of rich ground-water tables
16. wildlife diversity / abundance
17. aquatic diversity / abundance
18. recreation purposes
19. uniqueness / heritage
20. salinity of waters
21. developed land in the surrounding upland
22. annual duration of wetland existence
23. range of water level fluctuations
24. sedimentation rates
25. tidal action

1. the site is near - in 5 km. distance - a town
2. the site is near - in 5 km. distance - a inhabited area
3. the site is near - in 5 km. distance - an open space
4. the site is near - in 5 km. distance - an accessible road
5. the site is near - in 5 km. distance - a port
6. the site is near - in 5 km. distance - an airport
7. Existence of Emergency Manual
8. Assurance
9. Emergency Personnel: Disaster reaction Manager
10. Emergency Personnel: Disaster reaction team
11. Disaster Notification
12. Disaster Information
13. Recovery Priorities
14. Need for monitoring
15. Monitoring
16. Existence of warning's levels

1. length of the site
2. width of the site
3. reasons of sea-level fluctuations
4. trends of sea-level changes
5. kind of underwater unit
6. terminus post quem for site's formation
7. future excavation / other intervening activities
8. components of structures & features
9. intact or fragmentary artifacts
10. by-products / waste products / debris
11. organic material
12. human remains
13. artistic / symbolic representations
14. components of shipwrecks
15. environmental & chronometric specimen
16. paleontological specimen

B. Accompanying information

1. name of excavation's director
2. excavational periods
3. photos of the finds
4. exhibition / keeping area of finds from the area
5. brief bibliography

■ The definition of a natural heritage site is slightly less tangible than the definition of cultural sites, as it ranges from the outstanding representation of major stages in Earth's history to the significant examples of on-going ecological or biological evolution of ecosystems, from superlative natural phenomena of exceptional beauty to significant natural habitats.

All the same, the natural landscapes as forms of the cultural heritage, are a fragile and usually non-renewable and irreplaceable resource. The aim of safeguarding such sites is to maintain their longevity, their authenticity and the environmental surroundings in which they belong. A significant number of categories build the group of the natural heritage, which is nowadays considered as a part of the cultural heritage:

(1). natural features , (2). geological & physiographical formations, (3). natural sites, (4). protected natural areas (formations, landscapes & elements of the landscapes):

a. marine parks, b. national parks, c. aesthetic forests, d. protected monuments of nature, e. game reserves & hunting reserves, f. eco-development areas.

Furthermore, the concept of Biodiversity and its protection, terms firstly used during the famous Rio Conference (1992), is included in the natural heritage and is built on a four - level schema: a. genetic diversity (natural / artificial & genetically improved species), b. species biodiversity (number of species, species population, size of individuals, their biomass, dominance of certain species, number of niches, ecological balance & stability, feedback mechanisms), c. habitat diversity (number of links between animal & plant species found in a particular area, spatial distribution to form mosaic of habitat types), d. landscape diversity (number of landscape types in an area, natural habitats, man-made ecosystems or human ecosystems, their geographical distribution, their relative frequency, general character of the landscape).

More specifically, agriculture has formed our physical surroundings more than any other human activity. Being an industry, has a tremendous impact on the development and forming of the cultural landscape. This landscape is the product of thousands of years of farming activities and the utilization of natural resources, that left behind an enormous amount of physical traces.

Monuments, installations and natural features (e.g. meadows, forests, valleys, wetlands, coasts and mountains) are the diverse aspects of the cultural heritage in agro-ecosystems. However, this cultural heritage is not limited to the cultivated land areas, but it includes vast expanses of outlying lands, which are utilized for hunting, trapping, fishing, mountain dairy farming, as grazing land, as a source of livestock forage and forestry.

In addition, the traditional knowledge of rural populations (immaterial culture) with its financial and functional potentials, along with the extensive knowledge of historical events, beliefs and traditions associated with the landscape, can be used as a source of historical information or can be directly experienced. Via the physical traces of our ancestors, the cultural heritage also allows the visualization of History. Sites, monuments and landscapes, either being cultural

Finally, the category of the archaeological remnants underneath the surface of earth or water, usually being transformed into geological features (e.g. buried sites under river courses, cultivated lands, estuaries, layers of various sediments, e.t.c.) cry out for their complete protection from all kind of physical disturbance.

Consequently, cultural landscapes include places, features, objects, memories and perceptions related either to natural or man-made environments, ranging from those that are lost or 'mythical' , to those with numerous surviving features. Some are living landscapes, but their usage has altered them considerably, while others are largely unchanged. Sometimes, 'fossil landscapes' (e.g. Pompei, shipwrecks on the sea floor of Black Sea) are unusually well preserved due to various environmental conditions or geological / physical processes.

■ Humans, during their long history on the planet, have transformed the landscapes and the ecosystems in which they live. But often natural sites escaped degradation because they served purposes which are greatly appreciated and which contributed to the life of the community. Certain creatures have power over nature, so humans should court, venerate or befriend them in order to enjoy powers that they are able to confer. On the other hand, supernatural powers, deities, heroes or other anthropomorphic creatures dominate over the landscapes, by representing the untamed powers of nature or the manifestation of environmental phenomena , and by projecting the cosmic order into the daily life of human societies.

In many parts of the world the sacred sites (e.g. the sacred forests of Central Africa, the desert landscapes of the Aborigines in Australia) are incorporated in the environmental assessment of policymakers, because it is widely observed that when people is deprived of their lands in any form (abandonment, removal, degradation of environmental quality, alienation from the ancestral home), they suffer from psychological trauma and other mental health problems.

A noteworthy case is this of National Museums and Monuments of Zimbabwe Act, according to which country's policy is set out on the preservation and recording of archaeological remains during rural or urban development. Guidelines concerning the need for archaeological / environmental impact assessment, are elaborated and scientists must assess the cultural potential of each area.

The Convention concerning the Protection of the World Cultural and Natural Heritage, which was adopted by the General Conference of Unesco in 1972 and ratified to date by 178 countries, it has become the most important international legal instrument for the protection of heritage. Its primary mission is to define and conserve the world's cultural and natural heritage.

Moreover, since the 1992 Rio Earth Summit, an increasing number of initiatives aiming at achieving sustainability were introduced in all kinds of human

as the viability of landscapes for the future.

In Greece, wildlife biodiversity is exposed to serious threats and negative impacts. Forest degradation through tree cutting, fires, encroachment of agricultural lands, overgrazing, soil degradation through pollution and erosion, lack of management in recreational areas and daily destruction of natural habitats do not coincide with Natura 2000 policies. Furthermore, the absence of systematic and comprehensive field surveys and recording of cultural sites in the landscapes, as well as the absence of cultural heritage data bases, do not allow for the integration of this heritage with the overall developmental policies in the country.

Most of the investigated sites all over Greece have been identified as important to nature conservation by the Hellenic Authorities and accordingly statutorily protected. However, a number of sites are insufficiently known and therefore unprotected at national, regional and international level. In addition, although certain sites have been designated as protected areas, management measures are not properly implemented.

National Parks comprise the main category of nationally protected areas which are declared and managed in the context of Forestry legislation. They usually comprise an area of absolute protection, the core, and a protected peripheral zone. Within the core of National Parks several activities such as grazing, logging, hunting, uprooting of plants, collection of flowers and lighting of fire are strictly forbidden. In the peripheral zones only certain traditional activities are permitted.

Another category refers to Monuments of Nature (e.g Lesvos' fossilized forest), which include isolated trees or tree stands with special botanical, ecological, aesthetic or historical and cultural value.

A third category contains the Aesthetic Forests, that is, sites with special aesthetic and ecological interest which, apart from nature conservation, are used for recreation. In addition, a Marine Park has recently been declared in Hellas, in the North Aegean (Voreies Sporades) which is a refuge of the last population of the monk seal (*Monachus monachus*) in the Mediterranean. The declaration of a second Marine Park is underway in the Ionian Sea, in the island of Zakynthos which is an important breeding and nesting area of the sea turtle *Caretta caretta*.

Finally, the legislation on hunting has led to the designation of areas as Game breeding stations, Game refuges and Controlled hunting areas. The above areas are managed by peripheral Services of the Ministry of Agriculture, i.e., the local Forestry Departments. In the context of the present project, statutory protection and international designation were taken into consideration, so that almost all designated areas were included in the sites under investigation.

Game refuges (GR22), 9as Controlled hunting areas (GR23) and 1 as Marine Park - multiple use management zone (GR26). Regarding the designation of sites in international level, it should be noted that all sites designated under the Ramsar and Barcelona Conventions, or characterised as Biogenetic Reserve, Biosphere Reserve and World Heritage Site, and having been awarded the European Diploma, have been considered for their great ecological value and therefore included within site boundaries during the site selection process. In addition, almost all sites characterised as Important Bird Areas have been considered for their great ecological value and ornithological importance and accordingly included in the list of investigated sites.

To sum up, one can say that Hellas possesses a high degree of biodiversity at all levels-genetic, species, habitat and landscape. Regardless of the distinctions between the different levels, biodiversity must be conserved as a continuum, as one entity. The conservation of each level depends on the conservation of the levels above and below.

In the 1970's, scientists, ecologists, and conservationists began to articulate the values of wetlands. Wetland assessment methods have been or are being developed that assign numerical values to wetland functions. Some methods assign values on the basis of the benefits to the wetland itself. The development of a single method for assessing the functions of wetlands or for assigning values to the functions of wetlands is not a simple task. Indeed, probably no one method will satisfy all needs. However, assessing each function of a wetland and then assigning a value to each function is a step toward the protection of sensitive wetlands. Furthermore, an evaluation system that provides the basis for comparing wetlands would facilitate mitigation for unavoidable wetland losses, would provide a tool for determining the success (or failure) of programs and policies intended to protect or manage wetland resources, and would assist in identifying long-term trends in the condition of wetland resources.

The Wetland Evaluation Technique was developed for the Federal Highway Administration and has been used widely. It assigns values to specific functions of individual wetlands. The Environmental Monitoring Assessment Program--Wetlands was developed by the Environmental Protection Agency. The Hydrogeomorphic approach is being developed by the U.S. Army Corps of Engineers for assessing wetland functions. It combines features of the other two methods by measuring the functions of individual wetlands and also by comparing them to functions performed by other wetlands.

The WET considers wetland functions to be the physical, chemical, and biological characteristics of a wetland. It assigns wetland values to the characteristics that are valuable to society. The following functions are assigned values by WET:

- * Ground-water recharge
- * Ground-water discharge

- * Production export
- * Wildlife diversity/abundance
- * Aquatic diversity/abundance
- * Recreation
- * Uniqueness/heritage.

The EMAP-Wetlands program was intended to have three phases. First, pilot studies were to be conducted to evaluate the ability of selected indicators to make a distinction between healthy and degraded wetlands. Next, regional demonstrations were to be conducted by using some of the best indicators from the pilot studies. In the salt marshes, the indicators that seem to hold the greatest promise are as follows:

- * Ratio of vegetated areas to open water
- * Number of plant species (or the diversity of plant species)
- * Biomass (production of plant material per unit area)
- * Amount of organic matter in soil
- * Salinity

In prairie pothole wetlands, indicators of the health of a wetland that seem to hold the greatest promise at the local level are:

- * Amount of developed land in the surrounding upland
- * Rates of increase and decrease in the number of water-filled basins or in the area of water surface between April (spring thaw) and August (end of summer)
- * Ratio of temporary to seasonal to semipermanent wetlands.

At the level of the individual wetland ecosystem, other promising indicators are:

- * Diversity of plant species
- * Number and types of species of large invertebrates
- * Range of water-level fluctuation
- * Sedimentation rate.

A wetland assessment provided by the HGM approach will likely be a "site profile" that lists the site characteristics that are related to identified wetland functions. This profile then will be compared with characteristics of the reference wetlands (all wetlands in the region in the same geomorphic class) in order to rank the site. A data base that contains profiles of wetland characteristics (indicators of wetland functions) for each wetland type (hydrogeomorphic class) will be established for each region. These data will define the range of characteristics found in the wetlands.

■ The opportunities created by Internet based spatial applications are immense and are being universally accepted. GIS has emerged as a very important tool for effective planning, communication and training in the various stages of the disaster management cycle. On the other hand, GIS provides the analytical tools to help understand the spatial distribution of geographical information and model its interactions. In many cases finding patterns and

units (e.g. a local museum). Finally, these landscapes incorporate all the other cultural categories, as they have a complex profile and they echo more clearly the environmental processes and the interactive schema of ecosystems, both natural and human.

“Environmental GIS describes the use of location based data management tools to assist in the decision making processes that together form an Environmental Management strategy. The application areas of GIS are varied not only in potential users, but also in environmental sphere and specific environmental issue. Which layers of information are combined depends on the project theme (e.g., tracing a point source pollution event in a stream), planning a wildlife reserve buffer zone, or detecting a relationship between environmental factors and human health trends” (http://www.esri.com/industries/environment/business/what_is.html).

Environmental management integrates a broad spectrum of data with the analysis tools of GIS to provide a better understanding of how elements of natural communities interact across a landscape. GIS is used worldwide in ecology labs, planning departments, parks, agencies, and nonprofit organizations to promote sustainable growth.

Nevertheless, quite a few World heritage landscapes and objects are already documented and managed using GIS techniques. For example, Wolves were studied at Bolivia's Muse de Historia Natural, Dolphins in Florida Bay are being studied by the Dolphin Ecology Project, Sea turtle journeys are tracked from space using GIS, transmitters, and the ARGOS satellites, the Oceanic Resource Foundation found GIS helpful in determining the migratory corridors and habitat usage patterns of green sea turtles that nest on the beaches of Lechuguillas Veracruz, Mexico, the South Florida Ecosystem Restoration Program uses GIS to establish baseline information about bottle-nosed dolphins in Florida Bay and the Indonesian government and the Wildlife Conservation Society Indonesia Program in Sulawesi use GIS to understand the biohabitat of Indonesia's preserve (<http://www.gis.com/showcase/environmental.html>).

Conservation and understanding of the Earth's biological diversity is a multi-disciplinary, multi-sector and multi-national activity. Museums around the world have been surveying and cataloging life for the last 250 years, primarily for the purposes of species discovery and description. Non-scientists are largely unaware of vast amount of information represented by an estimated 3 billion museum specimens worldwide, and the geospatial information from the collections themselves have been underutilized beyond the primary cataloging needs of the original collectors. Lifemapper is a digital library that serves species distribution data on a global scale (<http://Lifemapper.org>).

Unfortunately, in Greece, environmental problems are often underestimated, hardly detectable or not interrelated with other physical features existing already in GIS works. For example, according to studies undertaken by the I.G.M.E. & NTUA, Eastern Attica (especially the areas of Marathon, Markopoulo

accelerate the water exploitation rates via new wells and triggers long-term changes for the monuments and the cultural sites of the area. On the other hand, due to lack of time and means during the present phase of work, extensive and detailed studies of assessment of various habitats and ecosystems within the areas of wetlands (Schinias & Vrauron) are not included. Instead, a three-grouped questionnaire is elaborated. This specific category of cultural heritage is included in the project in order to sensitize the authorities to conserve and manage endemic & relict species and their habitats, rehabilitate endangered species, conserve certain types of highly threatened ecosystems such as the wetlands, control industrial or generally human-induced wastewater discharge and pollutants, minimize negative impacts of local populations and tourists on the biodiversity of tourism attraction sites, induce new management styles to include management of tourist activities in natural resources and continue the efforts in the management and conservation of protected areas.

Consequently, this project has also the character of awareness, in order to safeguard cultural & natural resources to ensure sustainable development that maintains both economic growth and the fullness of cultural and natural diversity for present and future generations.

The study areas of Marathon and Brauron include two wetlands and one area of ancient saline landscape. Concerns have been strongly raised about the impacts of human activities on these geologically and ecologically important formations.

I General profile

A. Que stormare

1. name of the site
2. country
3. county
4. prefecture
5. community
6. 'manager' of the site
7. number of the site on the map
8. running programmes for protection
9. running programmes for eco-tourism
9. participation in technical and other development projects
10. previous interventions on the site
11. detection of past catastrophes
12. reappearance / existence of the hazard in the area

B. Accompanying information

1. photo of the site
2. aerial photos, satellite images, etc.
3. topographic sketch
4. brief general info
5. bibliographic references
6. hyperlinks
7. information about ancient catastrophes (archaeological, palaeoenvironmental & historical data)

1. latitude (coordinate x)
2. longitude (coordinate y)
3. extended area of the natural site
4. altimeter of the site above mean sea-level / bathymetry
5. distance of the site from the nearest coast
6. slope bending around the site
7. kind of geological/physical formation
8. main types of habitats within site
9. altimeter of the site above mean sea-level
10. accessibility in case of hazard
11. kind of intervention in case of hazard
12. categorization of roads network on the map
13. general hydrological profile of the site
14. capacity of receiving visitors
15. number of visitors per years
16. medical assistance inside or near the site
17. vicinity to other cultural sites
18. vicinity to modern settlements/ other touristic destinations
19. parking area for visitors

20. existence of rich ground-water tables
21. existence of floodwater alterations
22. existence of sediment stabilization
23. sediment toxic retention
24. wildlife diversity /abundance
25. aquatic diversity /abundance
26. recreation purposes
27. uniqueness/heritage
28. salinity of waters
29. developed land in the surrounding upland
30. annual duration of wetland existence
31. range of water level fluctuations
32. sedimentation rates
33. hydrogeomorphological type of site
34. tidal action
35. coexistence with cultural sites within

1. the site is near - in 5 km. distance - a town
2. the site is near - in 5 km. distance - a inhabited area
3. the site is near - in 5 km. distance - a fuel station
4. the site is near - in 5 km. distance - the sea / stored water
5. the site is near - in 5 km. distance - an open space
6. the site is near - in 5 km. distance - an accessible road
7. the site is near - in 5 km. distance - a port
8. the site is near - in 5 km. distance - an airport
9. the site is near - in 5 km. distance - a mountain refuge
10. the site is near - in 5 km. distance - a fire guard station
11. Existence of Emergency Manual
12. Assurance
13. Emergency Personnel: Disaster reaction Manager
14. Emergency Personnel: Disaster reaction team
15. Disaster Notification
16. Disaster Information
17. Recovery Priorities
18. Need for monitoring
19. Monitoring
20. Existence of warning's levels

4 TECHNICAL REPORT OF THE PROPOSED GIS PRODUCT

The GIS application concerning the archaeological data of East Attica was implemented by Professor K. Koutsopoulos, A. Zervakou, Geologist, PhD student and P. Kordopatis, Forester-Environmentalist, PhD student, members of the Geography and Spatial Analysis Laboratory, School of Rural and Surveying Engineering of the National Technical University of Athens.

The software used for the development of the specific GIS application were:

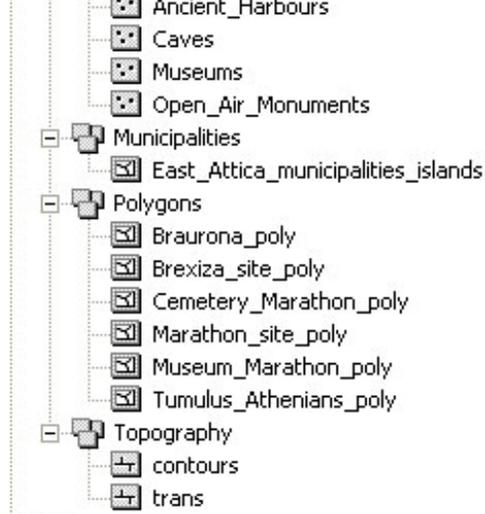
- ArcGIS 9.2, ArcInfo version
- Microsoft Office Access 2003
- Google Earth

The project comprised the following stages.

- **Designing and creating of the geographic database**
- **Editing and data digitizing**
- **Input of vector data**
- **Descriptive information and hyperlink input to the geographic database**

4.1 Personal Geodatabase

The Geodatabase is a native data structure for ArcGIS and the primary data format used for editing and data management. It is a collection of geographic datasets of various types held in a common file system folder, a Microsoft Access database, or a multiuser relational database (such as Oracle, Microsoft SQL Server, or IBM DB2). In this specific GIS application a Microsoft Access database was used. The geodatabase contains all the initial and final (corrected) data layers classified in Feature Datasets and single tables containing additional information. Picture 1 shows the East_Attica_Archaeology geotadabase structure, while Table 1 shows its contents.



Personal Geodatabase

Table 1 Personal Geodatabase contents

Feature Datasets	Feature classes	Object Type
Cultural heritage	ancient harbours	Point
	caves	Point
	museums	Point
	open air monuments	Point
Municipalities	east attica municipalities	Polygon
Polygons	archaeological sites, buildings, open air monuments	Polygon
Topography	contours	Polyline
	transportation	Polyline

4.2 Projection System and Coordinates

Projected coordinate systems are any coordinate system designed for a flat surface, such as a printed map or a computer screen. For this specific GIS application the Greek Grid Projected Coordinate System (Datum: D_GGRS_1987, Spheroid: GRS_1980) – or EGSA87 as is most commonly referred – was used.

4.3.1 Descriptive information of the Cultural Heritage feature dataset.

Each feature class of the Cultural Heritage dataset contains information to every discrete object. The information was derived from questionnaires and imported into the GIS application. The tables below show details of the attribute tables of the feature classes mentioned.

Table 2. Ancient Harbours attribute table

Field Name	DESCRIPTION	FIELD TYPE	VALUES
Object ID	Primary key	number	
SHAPE	Geometry	OLE object	
NAME_SITE	Name of the asset	text	
LONGITUDE	The distance east or west of the prime meridian of a point on the earth's surface	number	
LATITUDE	The distance north or south of the equator of a point on the earth's surface	number	
NEAR_DIST	Distance to the nearest coast	number	
AREA	Extended area of the museum	text	<ul style="list-style-type: none"> • < 1000 m² • > 1000 m² - < 10.000 m² • > 10.000 m² - < 40.000 m² • > 40.000 m²
SEAFLOOR_RELIEF	Sea floor relief around the site	text	<ul style="list-style-type: none"> • < 10i • 10i - < 20i • < 20i - < 30i • < 30i - < 40i • 40i
PRECISE_DETECTION	Precise detection of the site	text	<ul style="list-style-type: none"> • map registered • well-known in the authorities • vaguely known • known only theoretically
RUN_PROGRAMMES	Running programmes (restoration, excavation, e.t.c.)	text	<ul style="list-style-type: none"> • No • Yes
ACCESS	Accessibility	text	<ul style="list-style-type: none"> • excellent • good • mediocre • bad

	receiving visitors		<ul style="list-style-type: none"> • yes
VICINITY_CULT_SITES	Vicinity to other cultural sites	text	<ul style="list-style-type: none"> • no (isolated asset) • yes (complex cultural context) • indirect cultural context
INTEGRITY	Integrity of the asset (function, aesthetic value, overall, impression, e.t.c)	text	<ul style="list-style-type: none"> • full • significant • moderate • poor
ELEMENT_MARITIME_LANDSCAPE	Element of maritime landscape	text	<ul style="list-style-type: none"> • salinas • sites, structures, buildings, artefacts and human remains, together with their archaeological and natural context • vessels, aircraft, other vehicles or any part thereof, their cargo or other contents, together with their archaeological and natural context • objects of prehistoric character • pipelines and cables placed on the seabed shall not be considered as underwater cultural heritage • installations other than pipelines and cables, placed on the seabed and still in use • other • combination of the above
DATING	Age	text	<ul style="list-style-type: none"> • palaeolithic • mesolithic / neolithic • bronze age • protohistoric • archaic/classical • hellenistic / roman • byzantine • post-byzantine • contemporary
FUTURE_EXCAV	Future excavation / other intervening activities	text	<ul style="list-style-type: none"> • No • Yes
IMPORTANCE	Importance of the monument	text	<ul style="list-style-type: none"> • high • moderate • low

DURATION_EXPOS_HAZARD	Duration of exposure to the hazard / threat	text	<ul style="list-style-type: none"> • perpetual • big (months) • moderate (weeks) • small (days) • 4. minimal (hours)
OTHER_HAZARDS	Other existing hazards or factors of magnification	text	<ul style="list-style-type: none"> • No • Yes
PAST_CATASTROPHES	Detection of past catastrophes	text	<ul style="list-style-type: none"> • high • moderate • low
PROTECTIVE_LISTING	Whether an asset is on a protective listing	text	<ul style="list-style-type: none"> • No • Yes

Table 3. Caves Attribute Table

Field Name	DESCRIPTION	ATTRIBUTES TYPE	RANGE – DETAILS OF THE FIELD
Object ID	Primary key	number	
SHAPE	Discrete objects	OLE object	
NAME_SITE	Name of the asset	text	
LONGITUDE	The distance east or west of the prime meridian of a point on the earth's surface	number	
LATITUDE	The distance north or south of the equator of a point on the earth's surface	number	
AREA	Extended area of the museum	text	<ul style="list-style-type: none"> • < 1000 m² • 1000 m² - < 10.000 m² • 10.000 m² - < 40.000 m² • > 40.000 m²
RARITY	Rarity of a heritage asset	text	<ul style="list-style-type: none"> • Significant • Moderate • Plentifullness of similar evidence
SLOPE_INCLINATION	Slope's inclination (terrain model) around the site	text	<ul style="list-style-type: none"> • < 10i • 10i - < 20i • < 20i - < 30i • < 30i - < 40i • 40i
ACCESS_HAZARD	Accessibility in case of hazard	text	<ul style="list-style-type: none"> • excellent • good • mediocre • bad
CAPACITY_VISIT	Capacity of receiving visitors	text	<ul style="list-style-type: none"> • no • yes

VICINITY_CULT_SITES	Vicinity to other cultural sites	text	<ul style="list-style-type: none"> • no (isolated asset) • yes (complex cultural context) • indirect cultural context
KIND	Kind of cave	text	<ul style="list-style-type: none"> • rock shelter • terrestrial cave • underwater cave
KARST	Karst phenomena (stalagmite / stalactite formation)	text	<ul style="list-style-type: none"> • No • Yes
FIRST_HUMAN_EVID	First human evidence	text	<ul style="list-style-type: none"> • palaeolithic • mesolithic / neolithic • bronze age • protohistoric • archaic/classical • hellenistic / roman • byzantine • post-byzantine • contemporary
DURATION_OCCUPATION	Duration of occupation	text	<ul style="list-style-type: none"> • temporary (for hours / days) • temporary (for weeks = base camp) • seasonal / nomadic (for months) • perennial
PHASES_CAVE_USE	Phases of cave use	text	<ul style="list-style-type: none"> • 1 • 2 - 5 • 5
PROTECTIVE_LISTING	Whether an asset is on a protective listing	text	<ul style="list-style-type: none"> • No • Yes
NEAR_DIST	Distance to the nearest coast	number	
ELEVATION	Elevation of the asset (apr.)	number	

Table 4. Museums Attribute Table

Field Name	DESCRIPTION	ATTRIBUTES TYPE	RANGE – DETAILS OF THE FIELD
Object ID	Primary key	number	
SHAPE	Discrete objects	OLE object	
NAME_SITE	Name of the asset	text	
LONGITUDE	The distance east or west of the prime meridian of a point on the earth's surface	number	
LATITUDE	The distance north or south of the equator of a point on the earth's surface	number	
ELEVATION	Elevation of the site (apr.)	number	
PROTECTIVE_LISTING	Whether an asset is on a protective listing	text	<ul style="list-style-type: none"> • No • Yes

RUN_PROGRAMMES	(restoration, excavation, e.t.c.)	text	<ul style="list-style-type: none"> • Yes
ACCESS_HAZARD	Accessibility in case of hazard	text	<ul style="list-style-type: none"> • excellent • good • mediocre • bad
CAPACITY_VISIT	Capacity of receiving visitors	text	<ul style="list-style-type: none"> • No • Yes
VICINITY_CULT_SITES	Vicinity to other cultural sites	text	<ul style="list-style-type: none"> • no (isolated asset) • yes (complex cultural context) • indirect cultural context
EXIST_FLOORS	Existence of floors	text	<ul style="list-style-type: none"> • basement • ground floor • two-floor building • three-floor building • building of many stories
PERIOD_EXPOS_HAZARD	Duration of exposure to the hazard/ threat	text	<ul style="list-style-type: none"> • perpetual • big (months) • moderate (weeks) • small (days) • minimal (hours)
EXIST_HAZARDS_MAGNIF	Other existing hazards or factors of magnification	text	<ul style="list-style-type: none"> • No • Yes
PAST_CATASTROPHES	Detection of past catastrophes	text	<ul style="list-style-type: none"> • No • Yes
RARITY	Rarity of a heritage asset	text	<ul style="list-style-type: none"> • Significant • Moderate • Plentifullness of similar evidence
NEAR_DIST	Distance to the from the nearest coast	number	
AREA	Extended area of the museum	text	<ul style="list-style-type: none"> • < 1000 m² • 1000 m² - < 10.000 m² • 10.000 m² - < 40.000 m² • > 40.000 m²

Object ID	Primary key	number	
Shape	Discrete objects	OLE object	
NAME_SITE	Name of the asset	text	
LONGITUDE	The distance east or west of the prime meridian of a point on the earth's surface	number	
LATITUDE	The distance north or south of the equator of a point on the earth's surface	number	
NEAR_DIST	Distance to the from the nearest coast	number	
AREA	Extended area of the museum	text	<ul style="list-style-type: none"> • < 1000 m² • 1000 m² - < 10.000 m² • 10.000 m² - < 40.000 m² • > 40.000 m²
ELEVATION	Elevation of the site (apr.)	number	
RUN_PROGRAMMES	Running programmes (restoration, excavation, e.t.c.)	text	<ul style="list-style-type: none"> • No • Yes
ACCESS_HAZARD	Accessibility in case of hazard	text	<ul style="list-style-type: none"> • excellent • good • mediocre • bad
CAPACITY_VISITORS	Capacity of receiving visitors	text	<ul style="list-style-type: none"> • No • Yes
VICINITY_CULT_SITES	Vicinity to other cultural sites	text	<ul style="list-style-type: none"> • no (isolated asset) • yes (complex cultural context) • indirect cultural context
INTEGRITY_ASSET	Integrity of the asset (function, aesthetic value, overall, impression, e.t.c)	text	<ul style="list-style-type: none"> • full • significant • moderate • poor

KIND	Kind of the open-air cultural unit	Text	<ul style="list-style-type: none"> • camp / settlement • burial monument / cemetery • group of buildings • farming facilities • industrial facilities • sanctuary / temple / church / other religious • quarry / mine • harbour • communication network (e.g. bridge, road) • construction works (e.g. . drainage system, dam, wells, walls) • unexcavated area with antiquities • combination of the above
DATING	Dating	text	<ul style="list-style-type: none"> • palaeolithic • mesolithic / neolithic • bronze age • protohistoric • archaic/classical • hellenistic / roman • byzantine • post-byzantine • contemporary
FUTURE_EXCAV	Future excavation / other intervening activities	text	<ul style="list-style-type: none"> • No • Yes
IMPORTANCE	Importance of the monument	text	<ul style="list-style-type: none"> • high • moderate • low
PAST_CATASTROPHES	Detection of past catastrophes	text	<ul style="list-style-type: none"> • No • Yes
PROTECTIVE_LISTING	Whether an asset is on a protective listing	text	<ul style="list-style-type: none"> • No • Yes

4.3.2 Hyperlinks

Hyperlinks provide additional information about the features to anyone using this GIS application with ArcMap. Five hyperlinks are assigned to each discrete feature of the Cultural Heritage dataset. They are:

1. A questionnaire document that contains detailed information for every object of the feature class. Microsoft or Open Office software required (Open Office is freeware).
2. An Adobe Acrobat Reader file (.pdf) containig photos for each object. Adobe Acrobat Reader (freeware) required.
3. A Google Earth file (kml, Keyhole Markup Language) containing the objects location.
4. An Emergency Contact Info file (.doc). Microsoft or Open Office software required (Open Office is freeware).
5. A url that directs to a website containing information about the site. A web browser and internet access are required.

4.4 Usage of the GIS Application

4.4.1. *Indicative usage*

As mentioned above, this specific GIS application has been developed with the ESRI ArcMap software and is recommended to be used with it. ArcMap is the main application in ArcGIS, which is used for all mapping and editing tasks as well as for map-based queries and analysis. A map is the most common view for users to work with geographic information and the primary application in any GIS. All maps created in ArcMap are saved to an ArcMap document file with a .mxd extension.

The .mxd document provided for this project, contains a map of the feature datasets mentioned in section 2.1 in layers in the Table of Contents, as shown in picture 2.

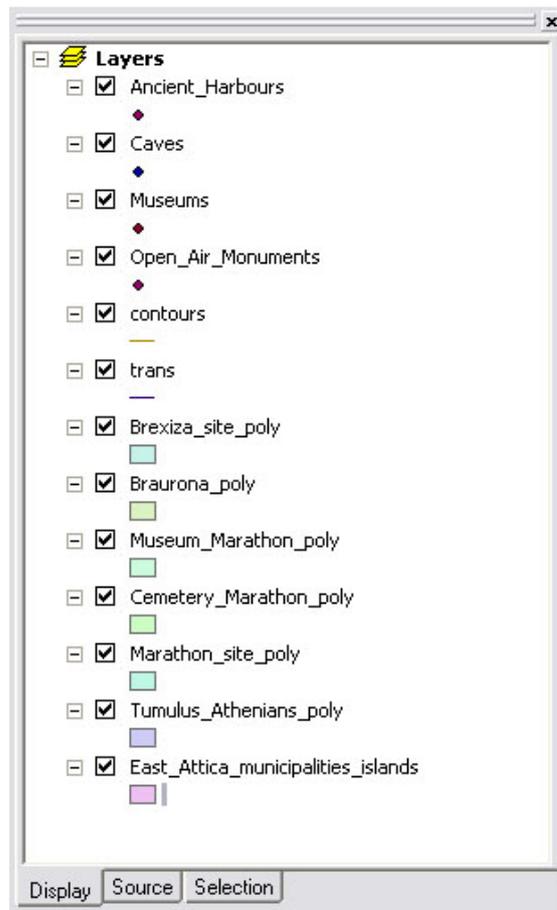


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The symbology for each layer can be altered according to user preferences. Also the layers can become inactive (not visible in the map) by unchecking them.

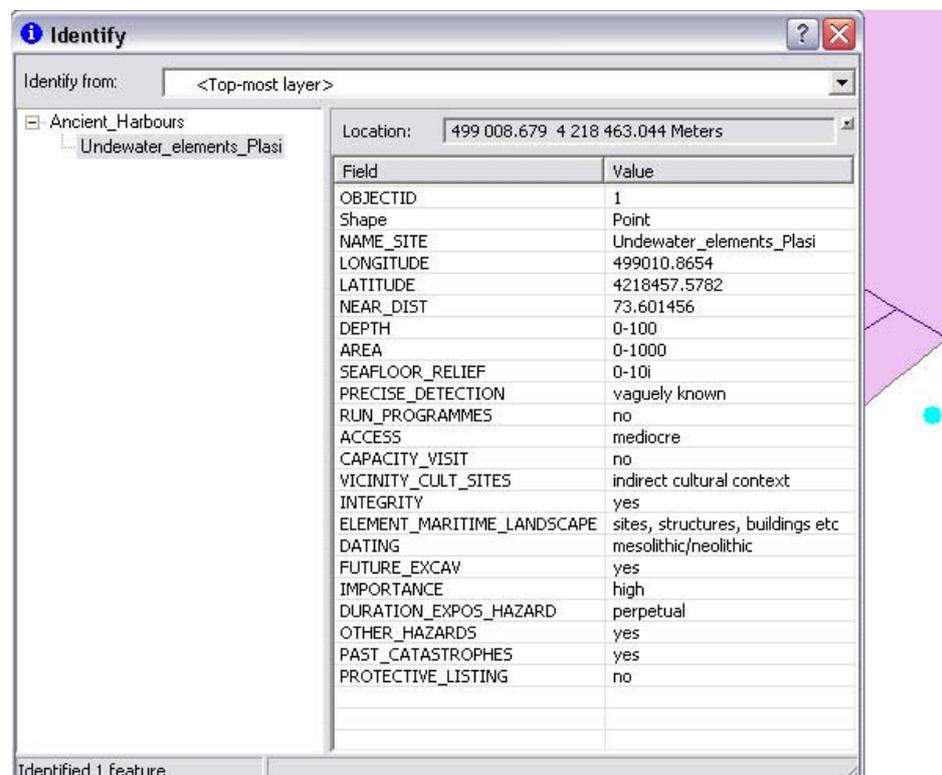
4.4.1 Getting Information for each cultural object

The descriptive information related to Tables 2-5 can be easily accessed through the ArcMap interface. The user can get all the information contained in the attribute table by just selecting (click) the **identify** tool (Picture 3) on the **Tools** bar.



Identify Tool

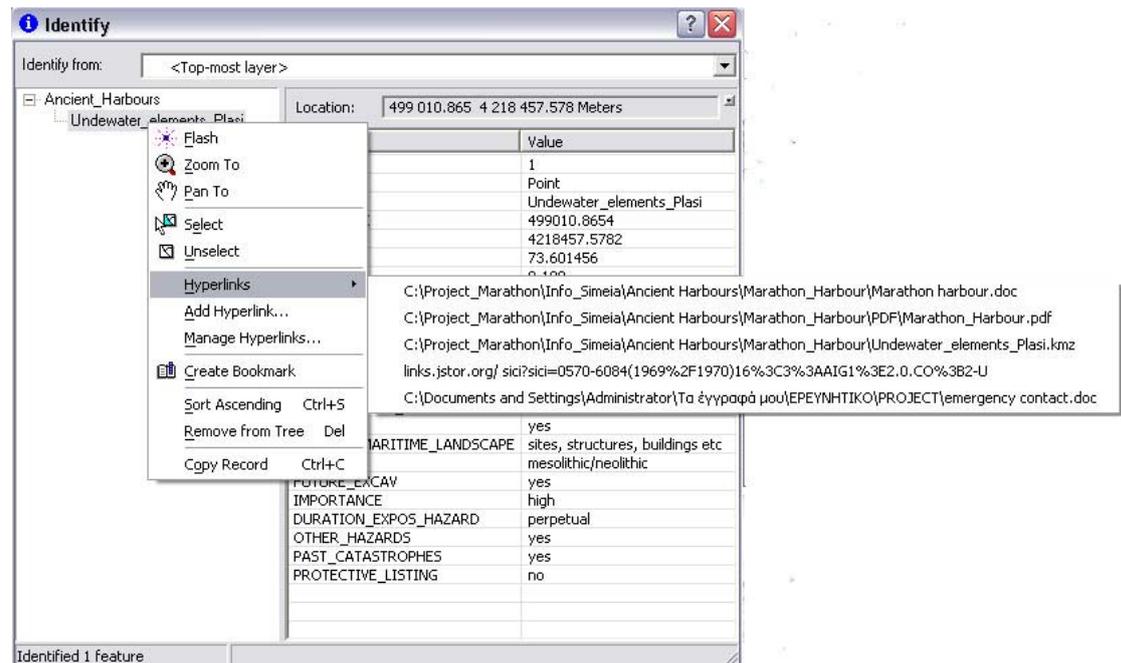
Once the identify tool is chosen, the user can click on a point object on the map of the Cultural Heritage Dataset. The identification results are displayed in a new window showing three categories of information: a list of features that have been identified, the attributes belonging to each identified feature, and location coordinates. The descriptive information about this object will appear, as shown below.



Identify window

4.5 Using Hyperlinks

Each object is assigned to 5 hyperlinks that can also be accessed through the Identify Table or by using the **Hyperlink** tool of the Tools Bar. When the user right-clicks a feature in the left side of the window (Picture 5), a menu appears that has several commands that make it easy to work with the features identified. As shown in **Picture 5** below shows, when the user places the mouse upon the hyperlink option, the hyperlinks of the object identified are displayed. By clicking any of them a new window will open depending on the format of the hyperlink (see Hyperlinks).



Accessing hyperlinks

It should be noted that the documents of the hyperlinks must not be moved from the folder they are stored on the hard drive. If the storage path is changed the hyperlink will not work properly in ArcMap, unless updated.

5 Assessing vulnerability of Cultural Heritage

MULTICRITERIA EVALUATION FORMULA (Va-Vu) FOR HAZARD ASSESSMENT OF CULTURAL LANDSCAPES - LEVEL 2 -

The study areas of Marathon and Markopoulo are characterised as group A & B respectively. So, each entry will show a code that will represent the area which it belongs in, and a number. The list of the most significant cultural targets are:

A	B
1. Wetland of Schinias	1. Wetland of Brauron
2. Oinoe cave of Pan	2. Cave Koutouki
3. Arch. Museum of Marathon	3. Arch. Museum of Brauron
4. Tower of Oinoe	4. Tower of Vraona
5. Panagia Mesosporitissa	5. Early Byzantine Basilica
6. Brexiza	6. Arch. site of Brauron
7. Tumulus of Athenians	
8. Tumulus of Plataeans	
9. Arnos tholos Tomb	
10. EH cemetery (Tsepi)	
11. MH cemetery (Vranas)	
12. Monastery of Agios Georgios	
13. Church of Agios Nikolaos	
14. Church of Agios Athanassios	
15. Estate of Herodes of Attica (Mandra Grias)	
16. Pythion of Oinoe	
17. Makaria spring	
18. Trophy	

Total number of chosen targets (24) as following:

- A1. Wetland of Schinias
- A2. Oinoe cave of Pan
- A3. Arch. Museum of Marathon
- A4. Tower of Oinoe
- A5. Panagia Mesosporitissa
- A6. Brexiza
- A7. Tumulus of Athenians
- A8. Tumulus of Plataeans
- A9. Arnos tholos Tomb
- A10. EH cemetery (Tsepi)
- A11. MH cemetery (Vranas)
- A12. Monastery of Agios Georgios
- A13. Church of Agios Nikolaos
- A14. Church of Agios Athanassios
- A15. Estate of Herodes of Attica (Mandra Grias)
- A16. Pythion of Oinoe
- A17. Makaria spring
- A18. Trophy
- B1. Wetland of Brauron
- B2. Cave Koutouki
- B3. Arch. Museum of Brauron
- B4. Tower of Vraona
- B5. Early Byzantine Basilica
- B6. Arch. site of Brauron

MULTICRITERIA EVALUATION FOR THE ASSESSMENT OF THE 'VALUE' OF CHOSEN CULTURAL TARGETS

The 'value' of each cultural target should be analyzed into six (6) main criteria:

1. Criterion of economic value (Va1)

This parameter assesses the probable sum for repair works in case of severe damage. In case of natural monuments, when human intervention for 'repair' is very difficult, complex or costly, the target receives low score (e.g. the caves). According to this, the 24 aforementioned targets are prioritised as following:

1. A3. Arch. Museum of Marathon
2. B3. Arch. Museum of Brauron
3. B6. Arch. site of Brauron
4. A6. Brexiza
5. A12. Monastery of Agios Georgios
6. A7. Tumulus of Athenians
7. A8. Tumulus of Plataeans
8. A9. Arnos tholos Tomb
9. A10. EH cemetary (Tsepi)
10. A11. MH cemetary (Vranas)
11. A13. Church of Agios Nikolaos
12. A14. Church of Agios Athanassios
13. A18. Trophy
14. A2. Oinoe cave of Pan
15. B1. Wetland of Brauron
16. A1. Wetland of Schinias
17. A16. Pythion of Oinoe
19. A5. Panagia Mesosporitissa
20. B5. Early Byzantine Basilica
21. B2. Cave Koutouki
22. B4. Tower of Vraona
23. A17. Makaria spring
24. A15. Estate of Herodes of Attica (Mandra Grias)

2. Criterion of uniqueness (Va2)

This parameter assesses the uniqueness of the cultural target in case of total loss. According to this, the 24 aforementioned targets are prioritised as following:

1. A7. Tumulus of Athenians
2. B6. Arch. site of Brauron
3. B1. Wetland of Brauron
4. B3. Arch. Museum of Brauron
5. A1. Wetland of Schinias
6. A3. Arch. Museum of Marathon
7. A9. Arnos tholos Tomb
8. A10. EH cemetery (Tsepi)
9. A11. MH cemetery (Vranas)
10. A8. Tumulus of Plataeans
11. A6. Brexiza
12. A18. Trophy
13. B2. Cave Koutouki
14. B5. Early Byzantine Basilica
15. A15. Estate of Herodes of Attica (Mandra Grias)
16. A12. Monastery of Agios Georgios
17. A13. Church of Agios Nikolaos
18. A14. Church of Agios Athanassios
19. A2. Oinoe cave of Pan
20. A4. Tower of Oinoe
21. A16. Pythion of Oinoe
22. A5. Panagia Mesosporitissa
23. A17. Makaria spring
24. B4. Tower of Vraona

3. Criterion of aesthetic/ environmental value (Va3)

This parameter assesses the uniqueness of the cultural target referring to its environmental / aesthetic value. According to this, the 24 aforementioned targets are prioritised as following:

1. B1. Wetland of Brauron
2. B2. Cave Koutouki
3. B6. Arch. site of Brauron
4. A1. Wetland of Schinias
5. A15. Estate of Herodes of Attica (Mandra Grias)
6. B3. Arch. Museum of Brauron
7. A6. Brexiza
8. A18. Trophy
9. A5. Panagia Mesosporitissa
10. A17. Makaria spring
11. B4. Tower of Vraona
12. A2. Oinoe cave of Pan
13. A4. Tower of Oinoe
14. A16. Pythion of Oinoe
15. A7. Tumulus of Athenians
16. A3. Arch. Museum of Marathon
17. A9. Arnos tholos Tomb
18. A11. MH cemetary (Vranas)
19. A8. Tumulus of Plataeans
20. A12. Monastery of Agios Georgios
21. A13. Church of Agios Nikolaos
22. A14. Church of Agios Athanassios
23. A10. EH cemetary (Tsepi)
24. B5. Early Byzantine Basilica

4. Criterion of touristic value (Va4)

This parameter assesses if the cultural target is included in a well-organized touristic framework with high standards for its infrastructures. According to this, the 24 aforementioned targets are prioritised as following:

1. A7. Tumulus of Athenians
2. B2. Cave Koutouki
3. A3. Arch. Museum of Marathon
4. A8. Tumulus of Plataeans
5. A11. MH cemetery (Vranas)
6. A10. EH cemetery (Tsepi)
7. B6. Arch. site of Brauron
8. B3. Arch. Museum of Brauron
9. A12. Monastery of Agios Georgios
10. A5. Panagia Mesosporitissa
11. A18. Trophy
12. A6. Brexiza
13. A1. Wetland of Schinias
14. B5. Early Byzantine Basilica
15. B1. Wetland of Brauron
16. A13. Church of Agios Nikolaos
17. A14. Church of Agios Athanassios
18. A4. Tower of Oinoe
19. A17. Makaria spring
20. B4. Tower of Vraona
21. A9. Arnos tholos Tomb
22. A16. Pythion of Oinoe
23. A15. Estate of Herodes of Attica (Mandra Grias)
24. A2. Oinoe cave of Pan

5. Criterion of archaeological / environmental / scientific perspectives(Va5)

This parameter assesses if the cultural target presents a complex profile that reinforces further investigation (e.g. excavations) /scientific research, touristic exploitation or environmental perspectives (e.g. ecotourism). According to this, the 24 aforementioned targets are prioritised as following:

1. B6. Arch. site of Brauron
2. A6. Brexiza
3. B3. Arch. Museum of Brauron
4. B1. Wetland of Brauron
5. A1. Wetland of Schinias
6. B2. Cave Koutouki
7. A12. Monastery of Agios Georgios
8. A15. Estate of Herodes of Attica (Mandra Grias)
9. A4. Tower of Oinoe
10. A16. Pythion of Oinoe
11. A2. Oinoe cave of Pan
12. A3. Arch. Museum of Marathon
13. A9. Arnos tholos Tomb
14. A5. Panagia Mesosporitissa
15. A18. Trophy
16. A17. Makaria spring
17. A10. EH cemetary (Tsepi)
18. A11. MH cemetary (Vranas)
19. A8. Tumulus of Plataeans
20. A7. Tumulus of Athenians
21. B5. Early Byzantine Basilica
22. A13. Church of Agios Nikolaos
23. A14. Church of Agios Athanassios
24. B4. Tower of Vraona

6. Criterion of social awareness (Va6)

This parameter assesses if the cultural target is fully recognisable by modern society and if the local communities are aware of its value, accepting it as a 'symbol' for their identity. According to this, the 24 aforementioned targets are prioritised as following:

1. A7. Tumulus of Athenians
2. A18. Trophy
3. A3. Arch. Museum of Marathon
4. B6. Arch. site of Brauron
5. A1. Wetland of Schinias
6. B2. Cave Koutouki
7. A12. Monastery of Agios Georgios
8. B3. Arch. Museum of Brauron
9. A8. Tumulus of Plataeans
10. A11. MH cemetery (Vranas)
11. A10. EH cemetery (Tsepi)
12. A5. Panagia Mesosporitissa
13. B1. Wetland of Brauron
14. A6. Brexiza
15. A9. Arnos tholos Tomb
16. B5. Early Byzantine Basilica
17. A13. Church of Agios Nikolaos
18. A14. Church of Agios Athanassios
19. A4. Tower of Oinoe
20. A17. Makaria spring
21. B4. Tower of Vraona
22. A16. Pythion of Oinoe
23. A15. Estate of Herodes of Attica (Mandra Grias)
24. A2. Oinoe cave of Pan

MULTICRITERIA EVALUATION FOR THE ASSESSMENT OF THE 'VULNERABILITY' OF CHOSEN CULTURAL TARGETS

The 'vulnerability' of each cultural target should be analyzed into four (4) main criteria:

1. Criterion of exposure to hazard (Vu1)

This parameter assesses the geographical, geomorphological and hydroclimatic settings (e.g.) within which the cultural target exists . Consequently, targets that are situated within floodplains, near bodies of water (e.g. dams, rivers, lakes, torrents, coasts or wetlands), within landscapes with prolonged wet season or torrential rainfall, receive higher score. According to this, the 24 aforementioned targets are prioritised as following:

1. B6. Arch. site of Brauron
2. A6. Brexiza
3. A7. Tumulus of Athenians
4. B1. Wetland of Brauron
5. A1. Wetland of Schinias
6. A18. Trophy
7. A5. Panagia Mesosporitissa
8. A16. Pythion of Oinoe
9. A17. Makaria spring
10. B3. Arch. Museum of Brauron
11. A10. EH cemetary (Tsepi)
12. A8. Tumulus of Plataeans
13. A9. Arnos tholos Tomb
14. A3. Arch. Museum of Marathon
15. A11. MH cemetary (Vranas)
16. A12. Monastery of Agios Georgios
17. A14. Church of Agios Athanassios
18. A13. Church of Agios Nikolaos
19. B5. Early Byzantine Basilica
20. A15. Estate of Herodes of Attica (Mandra Grias)
21. A4. Tower of Oinoe
22. B4. Tower of Vraona
23. A2. Oinoe cave of Pan
24. B2. Cave Koutouki

2. Criterion of repeated occurrence of damage in the past (Vu2)

This parameter assesses the functional integrity of each cultural target affected by hazardous environmental phenomena in the past (e.g. if a monument is already 'hurt' by flood and sedimentation). According to this, the 24 aforementioned targets are prioritised as following:

1. B6. Arch. site of Brauron
2. A6. Brexiza
3. A7. Tumulus of Athenians
4. B1. Wetland of Brauron
5. A1. Wetland of Schinias
6. A18. Trophy
7. A5. Panagia Mesosporitissa
8. A16. Pythion of Oinoe
9. A9. Arnos tholos Tomb
10. A10. EH cemetery (Tsepi)
11. A8. Tumulus of Plataeans
12. A17. Makaria spring
13. A15. Estate of Herodes of Attica (Mandra Grias)
14. A4. Tower of Oinoe
15. B4. Tower of Vraona
16. A2. Oinoe cave of Pan
17. A11. MH cemetery (Vranas)
18. B3. Arch. Museum of Brauron
19. A3. Arch. Museum of Marathon
20. B5. Early Byzantine Basilica
21. A13. Church of Agios Nikolaos
22. A14. Church of Agios Athanassios
23. A12. Monastery of Agios Georgios
24. B2. Cave Koutouki

3. Criterion of unsatisfactory monitoring (Vu3)

This parameter assesses if a cultural target is not under the regime of permanent or periodic monitoring. According to this, the 24 aforementioned targets are prioritised as following:

1. A2. Oinoe cave of Pan
2. A15. Estate of Herodes of Attica (Mandra Grias)
3. B4. Tower of Vraona
4. A4. Tower of Oinoe
5. A16. Pythion of Oinoe
6. A9. Arnos tholos Tomb
7. A14. Church of Agios Athanassios
8. A13. Church of Agios Nikolaos
9. B5. Early Byzantine Basilica
10. A17. Makaria spring
11. A5. Panagia Mesosporitissa
12. A12. Monastery of Agios Georgios
13. A18. Trophy
14. A1. Wetland of Schinias
15. B1. Wetland of Brauron
16. A6. Brexiza
17. A10. EH cemetery (Tsepi)
18. A8. Tumulus of Plataeans
19. A11. MH cemetery (Vranas)
20. A3. Arch. Museum of Marathon
21. B2. Cave Koutouki
22. A7. Tumulus of Athenians
23. B3. Arch. Museum of Brauron
24. B6. Arch. site of Brauron

4. Criterion of Protection List (Vu4)

This parameter assesses if a cultural target is not registered in Protection Lists or is not worldwide acknowledged as a unique monument . According to this, the 24 aforementioned targets are prioritised as following:

1. B4. Tower of Vraona
2. A4. Tower of Oinoe
3. A16. Pythion of Oinoe
4. A14. Church of Agios Athanassios
5. A13. Church of Agios Nikolaos
6. A17. Makaria spring
7. A5. Panagia Mesosporitissa
8. A12. Monastery of Agios Georgios
9. A2. Oinoe cave of Pan
10. A15. Estate of Herodes of Attica (Mandra Grias)
11. B5. Early Byzantine Basilica
12. A18. Trophy
13. A6. Brexiza
14. A8. Tumulus of Plataeans
15. A11. MH cemetary (Vranas)
16. A3. Arch. Museum of Marathon
17. A10. EH cemetary (Tsepi)
18. B3. Arch. Museum of Brauron
19. B6. Arch. site of Brauron
20. A9. Arnos tholos Tomb
21. B2. Cave Koutouki
22. A7. Tumulus of Athenians
23. B1. Wetland of Brauron
24. A1. Wetland of Schinias

SYNTHESIS OF SCORE FROM VA -VU CRITERIA EVALUATION

Each entry (cultural target) represents a row, while the score it receives in each criterion, represents a column. This score represents the number that shows the rank of the cultural target among the other 23 targets in the list of each criterion. The total score represents the sum of the target's rank in the 10 chosen criteria. The lowest the score, the highest its vulnerability to the hazard (value + vulnerability). Finally, the Vulnerability Index is hierarchical from the target that reserves the top priority backward

Target Vuln. Index	Va1	Va2	Va3	Va4	Va5	Va6	Vu1	Vu2	Vu3	Vu4	Total Score	
A1 16	5	4	13	5	5	5	5	14	24		96	4
A2 14	19	12	24	11	24	23	16	1	9		163	22
A3 1	6	16	3	12	3	14	19	20	16		110	9
A4 17	20	13	18	9	19	21	14	4	2		127	12
A5 19	22	9	10	14	12	7	7	11	7		118	10
A6 4	11	7	12	2	14	2	2	16	13		83	2
A7 6	1	15	1	20	1	3	3	22	22		94	3
A8 7	10	19	4	19	9	12	11	18	14		123	11
A9 8	7	17	21	13	15	13	9	6	20		129	13
A10 9	8	23	6	17	11	11	10	17	17		139	15
A11 10	9	18	5	18	10	15	17	19	15		136	14
A12 5	16	20	9	7	7	16	23	12	8		103	8
A13 11	17	21	16	22	17	18	21	8	5		158	20
A14 12	18	22	17	23	18	17	22	7	4		160	21
A15 24	15	5	23	8	23	20	13	2	10		143	18
A16 18	21	14	22	10	22	8	8	5	3		141	17
A17 23	23	10	19	16	20	9	12	10	6		148	19
A18 13	12	8	11	15	2	6	11	13	12		103	7
B1 15	3	1	15	4	13	4	4	15	23		97	5
B2 21	13	2	2	6	6	24	24	21	21		140	16
B3 2	4	6	8	3	8	10	18	23	18		100	6
B4 22	24	11	20	24	21	22	15	3	1		163	23
B5 20	14	24	14	21	16	19	20	9	11		178	24
B6 3	2	3	7	1	4	1	1	24	19		65	1

Cultural Target	Total Score	Vulnerability Index
B6	65	1
A6	83	2
A7	94	3
A1	96	4
B1	97	5
B3	100	6
A18	103	7
A12	103	8
A3	110	9
A5	118	10
A8	123	11
A4	127	12
A9	129	13
A11	136	14
A10	139	15
B2	140	16
A16	141	17
A15	143	18
A17	148	19
A13	158	20
A14	160	21
A2	163	22
B4	163	23
B5	178	24

6 EVALUATION REPORT

6.1 Overall estimation

The multi-level understanding of change within the cultural landscapes, either faced as normal situation of time passing by, or as a result of hazardous events throughout human history, requires an extremely profound and complicated evaluation technique, which would be able to register all the possible factors that impact on the existence, function and appearance of cultural heritage units. Assessing the risk profile of different patrimony assets (i.e. caves do not require the same technique as a memory institution or an underwater archaeological site) means a strong cross-thematic approach capable of structural analysis and thorough assessment.

The DISMA project had to deal with a variety of adversities and problems that are further evaluated below, after being grouped into coherent methodological categories. In addition, the results are also evaluated in a similar framework in order to detect the national / regional / local peculiarities , and to facilitate future attempts.

The symbol *s* indicates a positive trait while the symbol *t* indicates a negative one.

6.1.1 Archaeological / historic features

■ Archaeology is the study of the past using physical evidence: buildings, monuments, gravesites. When we study Attica we are especially fortunate, however, because the abundant archaeological record can be supplemented by an equally rich written tradition. Much of ancient Greek literature is, in fact, Athenian or concerns Athens. The historians Herodotus, Thucydides & Xenophon provide a narrative account of the 5th and 4th centuries B.C., which can be supplemented by the extant speeches of orators such as Demosthenes, Lysias, and Lycourgos. In the years around .D. 100 the philosopher Plutarch studied in Athens and later wrote a series of biographies which include considerable information on the monuments and topography of the city-state. About A.D. 150 the traveller Pausanias visited Greece and wrote a detailed guide book , describing buildings while they were still in use.

His tour of Attica is the single most important source we possess for a study of the ancient monuments. Numerous other authors provide passing references to many of the buildings in the city. In addition, the Athenians had a tradition of recording tremendous amounts of information on stone: laws, treaties, public honours, dedications, epitaphs, financial transactions and inventories of all sorts. Well over twenty thousand inscriptions survive from Attica, a source of information unparalleled anywhere else in the Greek world. All these voices from the past supplement the archaeological record and help us determine who built a given structure, when, and why. Thus, the archaeoenvironmental

researcher finds easy access to the variety and richness of the documentary and literary evidence. Finally, the historical evolution (spatial & temporal distribution) of hazardous physical and man-induced phenomena, this extremely useful but neglected aspect, can be provided through the methodological tools and the existing studies of the scientific fields of Environmental Archaeology and Disaster Archaeology.

On the other hand, archaeological features within the modern landscapes / seascapes are fragmented by nature. Finds, indirect testimonies, materials and objects are usually mixed up, scattered, removed apart or vanished forever due to various natural phenomena or human-induced actions. Respectively, hazards may coexist and act synergetically, having as a result the complex profile of natural and environments that intersect each other dynamically. Finally, cultural projects usually have to balance contradictory situations, decisions and interests, while often the methodological and technical framework for one monument/site may be proven competitive for another.

- Furthermore, landscapes represent multiple coexisting cultures, simultaneously expressed or overlaid historically. So, the same afore-described situation may bring one cultural feature/monument/site 'against' another. Of course, new digital technologies overpass similar problems, by offering a wide range of choices that register any possible attribute /characteristic/feature of the cultural landscapes.

- Additionally, the cultural heritage may also embrace 'intangible culture', mentifacts, memories and various forms of expression (i.e. language, local traditions), fact that should not be taken seriously under consideration, because it is the most vulnerable and easily affected part of human civilization. The areas of Marathon and Brauron were inhabited systematically since the Neolithic Period, fact that aggravates searching, rescue and enhancing procedures. The relics of past human activities are present in the modern landscapes either intact, fragmented or scattered, and include a wide spectrum of patrimony assets ranging from wetlands and karstic forms to complex cultural targets such as memory institutions, features of maritime heritage, open-air monuments dated from Prehistory to modern Era, industrial archaeological forms, and a vivid tradition of linguistic, mythical, symbolic and folklore identity that lives on.

- Another parameter of preservation and resistance against deterioration's phenomena is the material which the monuments / cultural units are made of. Sandy stones, bricks, building materials of high porosity, loose conjunctions between static parts, are damaged faster and more irreversibly than the more stable materials (i.e. high quality marble), especially when they are exposed to repeated, coexisting hazards, such as earthquakes, interannual temperature & humidity variations and subsidence.

- Finally, the status of archaeological services do not allow GIS registration of active excavational areas or diffusion of any official information concerning underwater sites, protection level of the cultural units and other archaeological data that are under a very strict regime.

6.1.2 Environmental features

■ Natural processes (anaerobic environments, underwater preservation, dry conditions), local geological features (i.e. inaccessible karstic formations) and even disastrous phenomena such as flooding and deposition of rapidly accumulated sediments may preserve valuable geoarchaeological and archaeological information, as well as the cultural sites from overexploitation, degradation, pollution, and destruction.

■ Mediterranean landscapes / seascapes are constantly changed through geological, hydrological, climatic , biological and biochemical processes. The geographical position of Eastern Attica and its geomorphological features are characterized by:

- (1) Extremes of temperature and humidity
- (2) Torrential rainfalls & flash floods
- (3) Lush vegetation and plant communities either fire-prone or harmful to the monuments
- (4) Interannual marshy conditions
- (5) Streams, ravines, and hazardous local rivers
- (6) Active faults and seismotectonic phenomena
- (7) A variety of soiltypes prone to landslides, soil liquefaction, soil erosion
- (8) A prolonged coastal front
- (9) Cultural sites that are by the coast or close to the sea
- (10) High sedimentation rates
- (11) Subsidence
- (12) Coastal changes

6.1.3 Anthropogenic features

■ The majority of cultural landscapes in the areas of Marathon and Markopoulo are highly advantaged for the following reasons:

- (1). Existing level of infrastructures
- (2). Visiting facilities
- (3). Monitoring experience after 2004
- (4). Accessibility
- (5). Vicinity to other cultural sites
- (6). International fame
- (7). High environmental Value
- (8). High archaeological Value
- (9). High economic Value
- (10). High scientific Value (active reconstruction works or future excavations)

■ But the cultural landscapes of Eastern Attica face serious problems, because they are :

- (1) Areas with fast development rates, which neighbour important facilities, the International Airport El. Venizelos, Attiki Odos and the harbours of Rafina & Lavrion
- (2) Areas that function as summer refuge for the millions of Athenians
- (3) Areas that include urban and peri-urban landscapes
- (4) Areas that include rural activities (pastoralism/grazing, agriculture, fishery, deforestation, water drilling)
- (5) Areas that host industrial installations & activities

(6) Areas with high rates of hazard manifestation due to local environmental and anthropogenic features that resulted frequently in disasters during the remote and recent past

(7) Areas with intense technical works (dams, drainage system, roads, burying of streams & ravines, mining/quarrying activities).

t Moreover, sites and monuments may be extremely prone to other human-induced hazards such as:

(1) Abandonment

(2) Lack of tourist infrastructures

(3) Lack of monitoring

(4) Lack of personnel

(5) Lack of disaster plan/team

(6) Lack of stable financial support and management-oriented funding

(7) Long-term pollution (i.e. acid rain, aesthetic degradation)

(8) Illegal activities

6.1.4 Local / regional / national features

■ The excavations to build the new Athenian Metro throughout the 1990' s have brought to light several thousand objects, monuments and ancient constructions. To these new discoveries can be added fresh insights on old monuments, continually being subjected to investigation by an array of scholars devoted to the antiquities of Attica. Furthermore, interdisciplinary groups of restoration teams have been working together in order to restore, refurbish, remodel and enhance archaeological sites and important monuments.

■ The Olympic Games of 2004 forced the authorities to reconsider the cultural profile of Attica as the main reception area of international visitors. Many tourist facilities were rebuilt, restored or even established, along with a campaign of enhancement concerning the most important archaeological destinations within Attica, Marathon and Brauron being among them.

Generally speaking, the national awareness concerning the protection of Patrimony in Greece may be epitomized in the following remarks:

(1). The protection of cultural heritage aims at preserving historical memory for present and future generations and enhancing the cultural environment

(2). The protection of the cultural landscapes shall be included among the objectives at all stages of town and country planning, environmental and development plans

(3). Within the framework of international law, the Greek State shall care for the protection of cultural heritage through the Law No 3028/2002«On the protection of Antiquities and Cultural Heritage in General»(FEK 153/A/28.6.2002)of Hellenic Ministry of Culture.

6.2 Technical level

DISMA project is based on modern high-precision digital technologies, therefore the technical level of parts involved is of high importance.

■ New technologies are emerged a and they are characterized by the global vision of hazard information’s sharing, such as the Google Earth Enterprise version and other worldwide monitoring techniques. The future users will be able to have 3-D animations, and a huge variety of geographical information in an open 24-hour based system. Cultural targets will be extremely benefited from these techniques, because they offer most reliable, cost-effective and socially active solutions, especially for countries like Greece with its fragmented often inaccessible local environments, its coastlines and small islands, as well as its historical / archaeological reality and the complex geomorphological and climatic setting.

■ We should also mention another critical parameter in patrimony’s protection projects. For various reasons (social, economic, practical & technical) new techniques are preferred in Virtual Archaeology which gains soil more and more in order to give people the opportunity to visit the sites and admire the exhibits and the modern landscapes via web solutions (virtual tours, internet sites, e.t.c.). We strongly hope that GIS platforms will help scholars and local authorities to move forward this managerial direction.

Future technical possibilities	High	X
	Moderate	
	Low	

■ In Greece there is a scarcity of experienced personnel on disaster technologies, especially in the area of cultural heritage, apart from being fragmented and scattered into many different institutions without satisfactory communication channels. Thus, this sector is not represented in Universities or private companies, either. Thus, exchange of experience, technical evaluation and validation of results are blocked .

Existing personnel for cultural disaster	High	
	Moderate	
	Low	X

■ In Greece there is a scarcity of GIS technicians & office installations (computers equipped with relevant programs) in authorities that manage cultural heritage, such as municipalities, prefectures, and ephorates of antiquities. Even more, the central offices of the Greek Ministry of Culture do not have incorporate such a department under its jurisdiction. Consequently, this sector is not represented in Universities , either, with few exceptions in the private companies.

Existing personnel for GIS & culture	High	
	Moderate	
	Low	X

■ Another difficulty arises when we deal with the available information. Either digitized or non-digitized formats, they both require time and money :

- (1) for the high sensitive analysis of satellite images & aerial photos
- (2) for the digitization of a huge number of ‘descriptive’ information (e.g. scientific research, independent work done by the foreign archaeological institutes in Greece)

Available time & money	High	
------------------------	------	--

Moderate
Low

X

6.3 Administrative level

■ The Greek state as manager of the patrimony is built on a three-basis scheme: a. the geopolitical areas of municipalities and local communities, b. the ephorates (Speleology and Palaeoanthropology, Prehistoric and Classical Antiquities, Byzantine Antiquities, Contemporary and Modern Monuments, Underwater Antiquities) and c. the national scientific groups of educational purposes (e.g. T.E.I., universities) or the authorized archaeological institutes of foreign states working on Greek field. The private sector may embrace for example several groups for the protection of the environment, cultural units or private collections / museums.

Each of them acts as a possible 'info- provider', participating in a concrete level of administrative network. The public services (Ministry of Culture, local Ephorates) that 'manage' the cultural heritage in Greece, are negative to the idea of providing any kind and form of information (even simple catalogues of the main sites) without an extremely time-consuming bureaucratic procedure. On the other hand, the twelve (12) local authorities (municipalities and communities which are included in the geopolitical boundaries of the chosen areas) are clearly less reluctant to collaborate with such projects, but, unfortunately, they are not mature - both technically and functionally - for a permanent collaborative basis. Moreover, the private sector (very restricted in Greece in matters of cultural patrimony) is more active provider of information, but in the specific study it can't play any role, because the chosen areas don't include targets which function under the umbrella of private structures. Finally, various institutions (universities, foreign archaeological schools, groups or persons by their own initiative) are the more reliable and cooperative partners in the case of information's providing and assessing.

■ The Municipality of Markopoulo has already received a GIS platform with the majority of patrimony objects registered and categorized in a easily accessible form. The study was conducted by the professors Andreas Tsatsaris & Tomas Antoniou et al. (Department of Topography of T.E.I. of Athens), after a request made by Muncipal Society for Development of Markopoulo (M.S.D.M.). Nevertheless, the programme is not running in the computers of Municipality of Markopoulo, for some unexplained reasons. Unfortunately, these data never reached the team of DISMA, so they remain unavailable. On the other side, the Ministry of Culture in collaboration with the Technical Office of Lisa Siola & Partners and an authorized scientific committee has prepared an Integrated Masterplan for the Unification and Enhancement of the archaeological sites of Marathon area. The study has been submitted on November 2002, before the Games of 2004. Unfortunately, the Ministry of Culture and the individual scientists (archaeologists) involved in the project don't allow the use of any digitized information, providing only the submitted 2-volume study, which contain a first stage categorization of cultural data (organized in few general categories) and extended topographic maps. Despite

this fact, CANAH has acquired limited access into the study, but the crucial part of digitized data also remained inaccessible to our team.

In conclusion, information management in Greece is a very serious topic as the main corpus of data was hardly retrievable, while information remained ‘hidden’ or ‘masked’ due to technical, bureaucratic or economic reasons.

Data access	High Moderate Low	X
Data sharing	High Moderate Low	X
Data quality	High Moderate Low	X

6.4 Scientific level

■ The main scientific difficulties encountered (Low) were:

- (1). Lack of a widely acceptable method of hazard assessment for the cultural heritage
- (2). Lack of cross- referencing of information derived from different scientific fields in a uniform GIS platform
- (3). Lack of concrete environmental / archaeological evaluation methods
- (4). Difficulties in photogrammetric / photointerpretation data processing.

On the other hand, this fact acted an intriguing parameter of scientific stimulation, for the research was pioneering in the field of Disaster Archaeology in Greece. Thus, the final product may be characterized by its high originality and operability (High). Consequently, the overall estimation for the scientific level is Moderate.

Scientific level	High Moderate Low	X
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6.5 Co-operative level

■ Difficulties in achieving the expected level of collaboration among the partners within Greece or outside our country, along with difficulties in elaborating firm economic budgets and following the deadlines were strongly present. Various social factors that characterize the modern Greek way of life had also negative effect on the deadlines of DISMA, along with its operability.

The workflow was fragmented due to the long upheaval in the universities of the country. Thus, the final level of expected process is characterized by a sever lack of coordination / cooperation, both internal (among laboratories and Greek colleagues) and external (we couldn't be synchronized with our european partners). Furthermore, monitoring process was fragmented, too, concerning either the progress of the work, or the cost estimation.

Coordination / cooperation	High Moderate Low	X
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6.6 Socio-educational level

■ The internal system's accessibility is rather moderate, because of the aforementioned technical evaluation. A network of experts (technicians, informatics, environmental archaeologists, employees in the offices of local municipalities) is permanently needed for the support, function and upgrade of the system.

Internal system's accessibility	High Moderate Low	X
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■ The existing strategies for sharing our findings were :

- (1) publications
- (2) brochures
- (3) media
- (4) electronic access
- (5) workshops

Due to the afore-mentioned administrative reasons, the diffusion of results was not sufficient and broad. Nos 2,3 and 4 were not represented.

Level of diffusion's strategies	High Moderate Low	X
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■ The beneficiaries of our work would be:

- (1) fellow scientists
- (2) laboratories / universities / institutions
- (3) municipalities / prefectures
- (4) ephorates of antiquities
- (5) local communities
- (6) private sector

The final level of products' availability within Greece (locally, regionally or nationally) is characterized as low and the 'audience' as inadequate, due to the afore-mentioned technical and administrative reasons.

Level of products' availability	High Moderate Low	X
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■ On the other hand, the socio-educational gain made out of this project is high because:

(1) it visualizes the spatio-temporal distribution of hazards within the cultural landscapes

(2) it enhances the public awareness on the existing hazards within local communities in an indirect and a more easily acceptable psychological way, as the environmental issue is projected into cultural targets and not into living populations

(2) it familiarizes the user with the concept of change instead of the static view for the patrimony (fossilized landscapes, deserted archaeological sites, fragmented damaged monuments)

(3) it familiarize the user with the managerial perspective, according to which hazards need cyclic evaluation (assessment - preparedness - mitigation - avoidance)

(4) it elaborates the base for future interactive technologies, where info-providers, users and visitors will have their share in the building of open flexible cultural systems

Level of socio-educational results	High Moderate Low	X
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■ Finally, there is a growing worldwide demand for similar hazard assessment technologies in the field of cultural heritage.

Future demand on similar products	High Moderate Low	X
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7 ANASYNTHESIS

7.1 Conclusive remarks

Vulnerability assessment techniques can be used to determine the vulnerability of infrastructure networks, individual structures, and the economic, environmental, and societal factors related to the risks posed by hazards. DISMA focused on the hazard assessment (damages & threats) of cultural targets within the geopolitical boundaries of Eastern Attica Prefecture (Greece).

7.1.1 Objectives

Main objectives of DISMA were : (1) Elaboration of an integrated cultural schema (archaeological + ethnographic + ecological + scientific + industrial) that would be consistent with UNESCO declaration's framework on Natural and Cultural Heritage of Humanity, and (2) Development of a methodological framework for risk assessment of the patrimony (complex cultural landscapes) in a GIS environment.

7.1.2 Methodology

■ Workflow

- (1) Grouping of cultural targets in two steps process
- (2) Evaluation of the environmental & cultural criteria for the geographical selection of case studies
- (3) Retrieval and evaluation of information concerning the pilot areas (digital & not digital formats)
- (4) Field visits
- (5) Elaboration of methodological framework for the hazard assessment of cultural targets
- (6) Development of GIS platform for the patrimony of Eastern Attica
- (7) Internal evaluation of the system - Technical report

■ Grouping of cultural targets in two steps process

For methodological reasons, we adopted UNESCO's categorization of heritage as following:

i. Natural Landscapes

- (1). natural features (physical or biological formations)
- (2). geological and physiographical formations
- (3). natural sites and protected natural areas
- (4). four types of biodiversity (genetic, species, habitat, landscape)

ii. Cultural Landscapes

- (1). monuments
- (2). caves of archaeological interest
- (3). groups of buildings
- (4). archaeological sites (open air areas, subterranean, submarine or coastal)
- (5). mobile objects, archival material, scientific works
- (6). palaeontological & palaeoanthropological remains
- (7). industrial sites
- (8). landscapes of memory (e.g. languages, oral traditions, sacred and mythical landscapes)
- (9). museums and collections

After evaluation, we transformed the afore-said scheme into the following groups:

- A. (1). living landscapes
 - (2). landscapes of memory
 - (3). archival material & scientific works
 - (4). excavational places and features (open excavations or future field works)
- B. (1). caves with archaeological / palaeoanthropological interest
 - (2). museums
 - (3). open-air monuments
 - (4). ecosystems (natural landscapes)
 - (5). maritime heritage (coastal and underwater features)

DISMA elaborated only group B, for various reasons, such as lack of time, lack of available data and also lack of effective cooperation between the ‘managers’ of cultural assets in Greece (Ministry of Culture, local Ephorates, prefectures and municipalities, local communities).

■ The cultural criteria of geographical selection

Apart from the environmental factors (flooding history of both areas since antiquity & catastrophic wildfires in recent years), the regions of Marathon & Markopoulo are ideal for GIS applications:

- (1). They function as ‘archaeological parks’
- (2). They are two of the most prominent examples of cultural continuity dating from Palaeolithic Era onwards
- (3). They provide an ample spectrum of cultural targets, ideal for GIS registration, categorization, analysis & evaluation: caves with archaeological interest, architectural works, Mycenaean sanctuaries, Byzantine churches, Classical and Roman farms, cemeteries and burial monuments, Prehistoric settlements, elements of Underwater Archaeology (Harbours), museums and open-air monuments, excavational works and promising areas for future scientific research, wetlands and landscapes of natural beauty.

Archaeological research has proven that Eastern Attica has played a very important role since Neolithic Times (at least from the 6th millennium B.C.). Its coastline was the main portal of communication with the flourishing cultural centres of Eastern and Western Mediterranean, the Balkans and other circum-Mediterranean areas. Mainland caves (e.g. Oinoe, Kitsos, Leontari), settlements and cemeteries, and a cultural nucleus that survived through Historic Times onwards, formed dynamic cultural landscapes enriched by environmental beauty and a continuous economic growth, detected today in the high development rates of the area. In fact, the ancient boundaries of

the demes do not differ considerably from the modern ones. Therefore, strong geographical, environmental, geopolitical and socio-economic parameters still transform the modern landscapes of Eastern Attica.

■ Vulnerability assessment of cultural heritage

The topic of the cultural heritage management was not generally regarded by governments as a high priority till recently, so it will come as no surprise that it has not been subjected to much in-depth study or analysis. Nowadays, both national and regional planning in a significant part of the world, includes the fields of Environmental Impact Assessment, Cultural Heritage Management and Hazard Assessment. DISMA focused on the elaboration of an integrated methodological framework that could assess vulnerability's parameters / structures concerning various categories of cultural heritage. Case studies have shown that the evaluation and analysis of cultural landscapes may be significantly improved, when different socio-economic, environmental and technical patterns are explicitly organized into grouped questionnaires.

The four-part analysis (IESO) provides flexible criteria for hazard assessment of cultural targets (memory institutions, open-air sites & monuments, elements of maritime heritage, caves with palaeontological/ archaeological interest), and is built on the following scheme:

- (1) Intrinsic parameters (describing the condition of the cultural asset),
- (2) Environmental parameters (describing the natural setting),
- (3) Socio-economic parameters (describing the living community) and
- (4) Organizational / Institutional parameters (describing various structures & functions of the State).

The cultural issues are of high importance as they influence human behaviour, and thus environmental condition and change. But there is still a scarcity of techniques designed to deal with cultural heritage in Hazard Management, a shortage of published data on cultural assets apart from a few famous sites and a shortage of qualified people to address the cultural heritage sub-component of Hazard Management. Privatization of the environmental sector has been around since the 1960's, so there are a myriad of international consulting companies conducting socio-economic and environmental studies all over the world. In general, this has not been the case for cultural resources. While the cultural resources have been recognised as important, they have not been properly taken into account.

■ GIS product

The final product consists of two main corpi of data (Tables 1 and 2):

(1) Part I

General map of Eastern Attica with various cultural targets (Cave of Pan at Oinoe, Lion Cave, Koutouki Cave, Kitsos Cave, Cave of Pan at Phylli, Cave of Pan at Vari, Underwater elements at Plasi, Underwater elements at Brexiza, Prasiai Harbour, Kamaraki at Oropos, Ramnous Port, Sounion Port, Archaeological Museum of Brauron, Archaeological Museum of Marathon, Vores Museum, Archaeological Museum of Lavrion Mineralogical Museum of Lavrion, Vouliagmeni Thermal Springs, Parnitha National Park, Schinias Wetland, Sounion National Park, Brauron Wetland, Arnos tholos tomb, Archaeological site of Brauron, Archaeological site of Brexiza, Trophy of Marathon, Early Helladic Cemetery at Tsepi, Tumulus of Athenians, Tumulus of Plataeans, Middle

Helladic Cemetery at Vranas, Rhamnous, Amphiareions at Oropos, Church of Saint Petros & Paulos, Thorikos, Kamariza Mining Complex, Archaeological site of Sounion, Brauron Basilica, Brauron Tower, Herodes farm, Settlement at Plasi, Pythion, Oinoie Tower, Agios Nikolaos, Agios Athanasios, Agios Georgios, Skouze estate, Makaria Pigi, Castle at Phyli, Moni Ntaou Pentelis, Pikermi paleontological site) and an associated attribute table with natural (faults, flooding, landslides / rockfalls / mudflow, sedimentation, tsunami, SLR, coastal changes, temperature variations, salination, soil erosion, monuments' erosion, weed, fire prone flora, lush vegetation, insect population, birds, mold, wild fires) & human-induced (abandonment, no monitoring, expensive projects, lack of coordination, summer activities, neighbouring harbours, dams, acid rain, water drilling, deforestation, pollution, flammable material, accessibility, lack of infrastructures, industrial threats, cultivation, grazing, tourist facilities, beaches, neighbouring settlements, lack of disaster plan / team, level of legal protection) hazards as columns rated in a 4-class climax (0= null, 1= low, 2= moderate, 3=high), and many layers of geographical and other information (i.e. road network, relief, hydrology, geopolitical boundaries of municipalities, fire spots, zones of flood risk)

(2) Part II

Specialized categories of analysis (caves, maritime features, open-air monuments, museums) with hyperlinks (general info, emergency contact, evaluation questionnaire), photo gallery and many layers of geographical and other information (i.e. road network, relief, hydrology, geopolitical boundaries of municipalities, fire spots, zones of flood risk).

7.1.3 Difficulties encountered

I. Technical (for GIS elaboration)

- (1) Lack of unified source of information (fragmented data providers)
- (2) Lack of a widely acceptable method for hazard assessment of cultural heritage
- (3) Lack of digitized data concerning the patrimony
- (4) Shortage of published data for cultural assets apart from few famous sites
- (5) Shortage of qualified people to address the topics of hazard management of cultural heritage
- (6) Difficulties in photogrammetric / photo interpretation data processing
- (7) Difficulties in achieving the expected level of collaboration among the partners within Greece

II. Socio-environmental (for heritage management)

- (1) Problems of accessibility, especially in case of hazards (e.g. intense rainfall)
- (2) Problems of constant curation, protection and promotion of the site / monument
- (3) High development rates, summer areas with second house settlements, intense summer activities
- (4). Restricted areas where any scientific intervention is prohibited or under strict regulations or time-consuming negotiations with the local ephorates

- (5) Existence of Monuments fully inaccessible at the present due to various reasons
- (6) Blocked national programs of restoration / enhancement
- (7) Natural / environmental key-parameters maximizing the threats
- (9) Anthropogenic key-parameters maximizing the threats

7.1.4 Overall evaluation of DISMA

The DISMA project had to deal with a variety of adversities and problems that have been evaluated in a separated chapter of the final report, after being grouped into coherent methodological categories. In addition, the results are also evaluated in a similar framework in order to detect the national / regional / local peculiarities , and to facilitate future projects. The symbol ▲ indicates a positive trait while the symbol ▼ indicates a negative one.

7.1.5 Positive trends

- ▲ Attica offers a variety and richness of the documentary and literary evidence
- ▲ Attica offers a variety and richness of archaeological evidence from the Neolithic Period onwards, and its is also characterized by historic continuity.
- ▲ Natural processes (anaerobic environments, underwater preservation, dry conditions), local geological features (i.e. inaccessible karstic formations) and even disastrous phenomena such as flooding and deposition of rapidly accumulated sediments may preserve valuable geoarchaeological and archaeological information, as well as the cultural sites from overexploitation, degradation, pollution, and destruction
- ▲The majority of cultural landscapes in the areas of Marathon and Markopoulo are highly advantaged for their existing level of infrastructures, their visiting facilities and monitoring experience after 2004, their accessibility and vicinity to other important cultural sites, as well as their environmental, aesthetic, scientific and cultural value
- ▲The excavations to build the new Athenian Metro throughout the 1990' s have brought to light several thousand objects, monuments and ancient constructions. To these new discoveries can be added fresh insights on old monuments, continually being subjected to investigation by an array of scholars devoted to the antiquities of Attica. Furthermore, interdisciplinary groups of restoration teams have been working together in order to restore, refurbish, remodel and enhance archaeological sites and important monuments
- ▲ The Olympic Games of 2004 forced the authorities to reconsider the cultural profile of Attica as the main reception area of international visitors. Many tourist facilities were rebuilt, restored or even established, along with a campaign of enhancement concerning the most important archaeological destinations within Attica, Marathon and Brauron being among them
- ▲ Within the framework of international law, the Greek State shall care for the protection of cultural heritage through the Law No 3028/2002«On the protection of Antiquities and Cultural Heritage in General»(FEK 153/A/28.6.2002)of Hellenic Ministry of Culture
- ▲New technologies are emerged a and they are characterized by the global vision of hazard information's sharing, such as the Google Earth Enterprise version and other worldwide monitoring techniques. Cultural targets will be extremely benefited from these techniques, because they offer most reliable,

cost-effective and socially active solutions, especially for countries like Greece with its fragmented often inaccessible local environments, its coastlines and small islands, as well as its historical / archaeological reality and the complex geomorphological and climatic setting

▲ High future technical possibilities for GIS use

▲ High level of socio-educational results for DISMA

▲ High future demand on similar products

▲ Innovative methodology for risk analysis of cultural landscapes proposed by DISMA

7.1.6 Negative trends

▼ Archaeological features within the modern landscapes / seascapes are fragmented by nature. Finds, indirect testimonies, materials and objects are usually mixed up, scattered, removed apart or vanished forever due to various natural phenomena or human-induced actions.

▼ Hazards may coexist and act synergistically, having as a result the complex profile of natural and environments that intersect each other dynamically.

▼ Cultural projects usually have to balance contradictory situations, decisions and interests, while often the methodological and technical framework for one monument/site may be proven competitive for another.

▼ Landscapes represent multiple coexisting cultures, simultaneously expressed or overlaid historically.

▼ The cultural heritage may also embrace 'intangible culture', mentifacts, memories and various forms of expression (i.e. language, local traditions)

▼ The materials which the monuments / cultural units are made of are often either vulnerable by nature, or repeatedly damaged by past catastrophes and human actions

▼ Greek Archaeological services are not aware of GIS potential

▼ Mediterranean landscapes / seascapes are constantly changed through geological, hydrological, climatic, biological and biochemical processes

▼ The cultural landscapes of Eastern Attica face serious problems, because they are areas with fast development rates, which neighbour important facilities, areas that function as summer refuge for the millions of Athenians including urban and peri-urban landscapes along with rural activities, industrial installations & activities, areas with high rates of hazard manifestation due to local environmental and anthropogenic features that resulted frequently in disasters during the remote and recent past, areas with intense technical works

▼ Sites and monuments are extremely prone to other human-induced hazards such as abandonment, lack of tourist infrastructures, monitoring, disaster personnel/plan/team, stable financial support and management-oriented funding, as well as long-term pollution and illegal activities

▼ Low level of existing personnel for disaster management concerning cultural heritage

▼ Low level of existing personnel for the use of GIS in cultural matters

▼ Not sufficient available time and money for the completion of the project

▼ Extremely time-consuming bureaucratic procedure when dealing with Greek Ephorates of Antiquity

- ▼ Disuse of existing GIS products made for the areas of Marathon and Markopoulo
- ▼ Low level of data access
- ▼ Low level of data sharing
- ▼ Low level of data quality
- ▼ Lack of a widely acceptable method of hazard assessment for the cultural heritage
- ▼ Lack of cross-referencing of information derived from different scientific fields in a uniform GIS platform
- ▼ Scarcity of concrete environmental / archaeological evaluation methods
- ▼ Difficulties in photogrammetric / photo interpretation data processing.
- ▼ Low level of coordination / cooperation concerning the research teams
- ▼ Socio-economic conditions in Greece repeatedly block the unhindered workflow of research projects
- ▼ Confusion between different departments (i.e. civil defence, fire, police station, ephorates of Antiquities) about the emergence decision-making process

7.2 Perspectives

7.2.1 Perspectives of GIS use in Archaeology and Cultural Management

The Geographic Information Systems could be used by any Archaeological Service / local authorities for the :

- (1) detection and registration (recording & documentation) of the patrimony
- (2) easiest collaboration of the Archaeological Service with other services and organizations
- (3) monitoring and damage prevention concerning the patrimony
- (4) prevention of illegal excavations, theft and illegal export of antiquities
- (5) facilitation of access to cultural data by the public
- (6) enhancement and integration of patrimony into contemporary social life
- (7) education, aesthetic enjoyment and hazard awareness of the public in terms of cultural heritage
- (8) registration and monitoring of active archaeological excavations
- (9) promotion of archaeological research
- (10) carrying out of statistical analyses and map-making of archaeological sites

7.2.2 Other perspectives for the GIS use in the development plans of the study areas

- (1). Elaboration of a Network of Eco-tourism
- (2) Creation of Sub-marine parks
- (3) Protection of environmental nuclei for future scientific research (natural laboratories)
- (4) Promotion of Environmental Education

7.3 Proposals

The loss or irreparable damage of the cultural resources constitutes a violation of the human rights among the living communities, as implied in Article 27 of the United Nations' Universal Declaration of Human Rights, but still in need of more explicit legislation and codification. On the other hand, the colossal magnitude of several natural phenomena (geological, hydroclimatic, biological & bioclimatic), the rapid environmental oscillations or changes, the unexpected socio-economic fluctuations along with the modern geographical and geopolitical perturbations, as well as the inner character of the cultural heritage which loses its initial coherence through time, make it extremely vulnerable to many spatio-temporal variations.

I. On a global scale, vulnerability of the patrimony could be reversed by :

- (1) more sufficient numbers of skilled and qualified cultural heritage personnel
- (2) more appropriate heritage management infrastructures
- (3) more adequate facilities for curation, preservation and display of cultural resources
- (4). adequate cultural heritage legislation
- (5) availability of funding for capacity building
- (6) enforcement of international cultural heritage preservation agreements
- (7) active civic pressure in order to mobilise actions to preserve and sustain cultural heritage resources.

II. In terms of the existing situation in Greece , a scheme for hazard management of the patrimony should include the following steps:

- (1) monuments & sites, landscapes, places & features, objects, archival material & recorded memories are stored in a stable environment, and periodically monitored for their condition
- (2) outdoors steps are taken to minimise damage from the degradation of elements, the vandals, and tourism
- (3) objects and features are photographed, records are microfilmed, and memories recorded according to a professional standards
- (4) items are catalogued, with backup copies in another building
- (5) cultural heritage management strategies are enhanced for conservation and rehabilitation of all the cultural features and sustainable management practices are implemented
- (6) the new technologies are used for a 24-hour monitoring and assessment of cultural heritage (scientific & technical support for monitoring actions)
- (7) economic incentives for damage preparedness are investigated and applied
- (8) information, environmental /cultural education, updating training and awareness are objectives of high priority
- (9) international cooperation in topics of heritage management is enhanced
- (10) special evaluation criteria for patrimony assets are determined
- (11) disaster personnel is increased in number and technical infrastructures are built
- (12) national action plans for threatened patrimony are elaborated
- (13) coordination bodies for the management of patrimony are created, staffed and equipped

(14) mechanisms to facilitate communication between those involved in cultural management (management coordination bodies, local bodies, interested social groups) and the public are established

(15) pilot application projects are elaborated and innovative methodologies are enhanced

(16) groups of cultural heritage that are hardly accessible or require expensive projects of restoration and enhancement, such as caves, underwater sites and features intangible culture are also incorporated in national programs of heritage management

(17) integrated and intersectoral approaches to managing coastal problems are enhanced due to the biophysical and socio-cultural complexity of Mediterranean coastal environments

(18) the topics of Disaster Archaeology and Heritage Management enter into the curricula of Universities and Colleges in Greece

(19) local people understands and accepts the fact that cultural heritage is both finite and non-renewable

(20) many human activities, which are themselves beneficial and desirable, are balanced with the protection of archaeological sites and monuments, as well as other features of the cultural landscapes

(21) many undesirable anthropogenic threats that damage or exploit illegally the patrimony, are controlled or stopped, and the ethical issues are addressed

(22) the time-tables for completing projects must be kept without delay or postponement

(23) the results of hazard's and cultural projects may be disseminated and include public participation

(24) the research into the social aspects of hazards may be enhanced

III. Regarding DISMA's objectives, three main goals need to be further elucidated in a future NOE project:

(1) the elaboration of risk analysis for: a. intangible heritage, b. active archaeological excavations and other forms of scientific interventions on the landscapes, and c. features & formations of natural landscapes

(2) the monetary evaluation of cultural 'items' or targets in case of various hazards, and in terms of their strict 'economic' value (standardization)

(3) the crossing of existing GIS data with monitoring techniques available via Internet technologies, that offer real time solutions.

Objective no 1 has not been realized sofar, due to Greek administrative reasons which block the immediate diffusion of data into research projects, and restrict critically the availability and operability of available information.

Objective no 2 has not been realized sofar, because this is not yet an established area of interest in Greece, so there are not available data for similar assessment. Moreover, cultural targets need multi-levelled risk analysis (many factors t act synergistically) and they can not be fully evaluated in strict economic values.

Objective no 3 has not been realized insofar, for these technologies have just emerged in Greek research environment, thus there was no time for their evaluation and use within the existing GIS platform.

A poignant problem for societies, of late, is how to go about protecting one of humanity's most valued resources: the world's cultural patrimony. We strongly wish that Greek authorities, local communities and research centres will soon be fully aware of risk analyses' potential and their role in cultural management. We also looking forward to viewing in our country, humanitarian-oriented policies, innovative methodologies, long-term integrated infrastructures and

inspiring capacities that will be able to reassure a healthier, more equilibrated and mutual relationship between humans and their environment, both natural and cultural.

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9 GLOSSARY

Acceptable risk

(1) Risk tolerance

(2) That level of risk that is sufficiently low that society is comfortable with it. Society does not generally consider expenditure in further reducing such risks justifiable (Australian National, 1994)

(3) Degree of human and material loss that is perceived by the community or relevant authorities as tolerable in actions to minimize disaster risk (UN, 1992:3)

Accident

Unintended damaging event, industrial mishap (Disaster and Emergency Reference Center, 1998)

Archaeological Systems

Any kind of information which is revealed today and concerns the human life in the past, refers either to the past human ecosystems or the archaeological landscapes. The structure of the later is narrower than this of the former, because archaeological landscapes can be 'frozen' in time (e.g. the fossil landscapes of Akrotiri and Pompei / Herculaneum) and may represent only some functions and choices of the society that are registered on the environment in specific 'coordinates' (tempo, locales) or reflect the cultural 'universe' of a human group during a specific period of time. Thus, an archaeological system includes the remains of human civilizations and their environmental setting. On the contrary, past human ecosystems embrace all the parameters, natural and cultural, that may leave various remains (ecofacts, artefacts & mentifacts) and interrelate to each other constantly. This point of view reinforces us to study the whole spectrum of natural and cultural phenomena, requiring an apt knowledge ranging from our solar system and Space weather to the microcosm of living cells, from the climax of historical events to the vast periods of geological time (Laoupi, 2007c)

Assessment

Survey of real or potential disaster to estimate the actual or expected damages and to make recommendations for prevention, preparedness and response (UN, 1992: 15)

Calamity

"A massive or extreme catastrophic disaster that extends over time and space" , i.e. the Black Death of the 14th cent. (Drabek, 1996: 2.4)

Catastrophe

An unusually severe disaster, with irreversible impacts in the economy, the social life and/or the environment

Change

As natural phenomenon, change can be: a) cyclical , encompassing the rythmically repeated events (e.g. the seasons of the year, day and night, tide), b) progressive, when the process lasts for many centuries exceeding the lifespan of man and few generations ahead (e.g. the formation of icesheets or the erosion of the coasts) and c) irregular or chaotic (e.g. storms, volcanic eruptions, spread of epidemics). As cultural phenomenon, change can be distinguished into three levels: a) the adaptive adjustments (e.g. the phases during Classical Period), b) the adaptive modification (e.g. the boundary between Classical and Hellenistic Era) and c) the adaptive transformation (e.g. the starting point of Industrial Epoch in western societies) (Laoupi, 2006)

Conflict Hazards

War, acts of terrorism, civil unrest, riots, revolutions

Conservation-Preservation

Mild form of intervention (prevention and protection) that it is limited in interventions on the surface, without degrading the form and the structure of the monument. In a wider meaning of the protection of culture, it also includes other units: a) periodical or regular maintenance, b) preventive maintenance (preventive conservation), c) repairs, d) fixings (consolidation/stabilization), e) reinforcement/strengthening, f) further reinforcement (restoration) (Mallouhou-Tufano, 2004).

Contamination

Each form of pollution that is characterized by the presence of pathogenic micro-organisms in the environment or other indicators that imply the probability of the presence of such micro-organisms. Any undesirable and dangerous change in the natural, the chemical and the biological properties of air, soil, subsoil, and the water, which can influence and threaten the health, the survival and the operations of all forms of life (Constitution of Greece)

Crisis

Short period of extreme danger, acute emergency (D & E Reference Center, 1998)

Crisis Management

(1) Coordination of actions during acute emergency (D & E Reference Center, 1998)

(2) The unplanned strategies that may be implemented to respond effectively to the challenges arising when a disaster strikes

Cultural heritage

(1) Any 'product' of human creativity and expression considered significant for its scientific, historic, artistic and anthropological value

(2) Monuments, caves of archaeological interest, groups of buildings, archaeological sites (open air areas, subterranean, submarine or coastal), mobile objects, archival material, scientific works, paleontological & paleoanthropological remains, industrial sites and landscapes of memory (e.g. languages, oral traditions, sacred and mythical landscapes), museums and collections (UNESCO)

Degradation

Anthropogenic pollution or any other change in the environment, which is likely to impact: a. the ecological balance, b. the quality of life and the health of residents, c. the historical and cultural heritage, and d. the aesthetic values (Constitution of Greece)

Disaster

(1) Calamity beyond the coping capacity of the effected population, triggered by natural or technological hazards or by human actions (D & E Reference Center, 1998)

(2) An occurrence inflicting widespread destruction and distress in the economy, the social life and the environment

(3) The word etymologically entered the English language from a work in French (desastre), which in turn was a derivation from two Latin words (dis, astro). So, in its early usage, the word had reference to unfavorable or negative effects, usually of a personal nature, resulting from a star or planet (Quarantelli, 1987: 8)

Disaster Archaeology

Interdisciplinary scientific field that : a) defines the identity, the impact and the dynamics of natural hazards into the evolution of human civilization (biological, ecological, environmental, socio-economic, political, technological, geographical, & cultural results), b) tries to find and analyze the kinds, frequency & magnitude of natural hazards that are hidden in the 'archaeological landscapes', c) searches for the adaptation process in past human societies and the 'unfamiliar

landscapes' formed after natural disasters. Furthermore, D.A. deals with conservation / management matters of the cultural heritage in modern societies (Laoupi, 2006)

Disaster-induced Collapse of Human Ecosystems

Long- interval event in human history, both environmental and cultural. The end of the 13th cent. B.C. and the collapse of Eastern Mediterranean civilizations is included among them (Laoupi, 2006)

Early warning

To inform efficiently those potentially affected by the hazard of the actions to be taken in order to reduce the risk and respond effectively to the impending danger

Ecosystem

The totality of abiotic and biotic elements and parameters within the environment, that exist in a given geographical area and have a strong relation to each other. Ecosystems are complex adaptive systems that behave in a 'non-linear' way through non-equilibrium thermodynamics

Emergency

A more serious situation than an incident, but less serious than a disaster (Oxford Canadian Dictionary, 1998)

Environment

It can be distinguished into : Real / Objective and Perceived. The first can be further analyzed into : a) Geographical = the physical and biological landscape within which humans live and act, b) Operational = the space that can provide food and other sources for the survival of the humans and c) Modified = the area which shows the visible 'fingerprints' of human action. Moreover, the Perceived Environment includes the parts of Geographical and Operational Environment, visible or not, that human society knows about and make decisions out of them (Butzer, 1982).

Environmental Archaeology

Interdisciplinary scientific field that studies the natural, built & socio-economic environments of the past within the integrated approach of human ecosystems. The framework of three components (resources, processes & effects) is related to three axes (A: flora, fauna, human beings, minerals, water, land, air, etc.; B: buildings, housing, communication system, water supply, etc.; C: human activities, education, health, arts and culture, economic activities, heritage, lifestyles in general) and based on archaeological remains (ecofacts, artefacts, mentifacts). E.A. is concentrating its interests on the collection

of various types of information to 'reconstruct' the natural and cultural landscapes of the past that were 'used' and modified by humans

Exposure

The state in which a subject (human beings, property, infrastructure, or the environment) is susceptible to the impacts of a Hazard

Forecast

Statement or statistical estimate of the occurrence of a future event.

This term is used with different meanings in different disciplines, as well as 'prediction' (UN, 1992: 4)

Hazard

(1) Dangerous natural or man made phenomenon that expose a vulnerable location to disastrous events (D & E Reference Center, 1998)

(2) A threatening event, or the probability of occurrence of a potentially damaging phenomenon within a given time period and area (UN, 1992: 4)

Hazard Probability

The estimated likelihood that a hazard will occur in a particular area

Integrated Conservation

This term that was adopted in the Statement of Amsterdam (1975) and the Convention Granada (1985). It concerns the protection of the European architectural cultural heritage (monuments, cities, old historical districts, traditional villages, historical parks and gardens). In this category of intervention the following are included: 1. the integration of monuments not only in the natural and the historical environment, but also in the general city- and urban-planning, 2. the dynamic participation of all involved institutions, services and citizens, 3. the planning of the economic development and 4. various interventions, such as: a) revitalization, b) reuse, c) rehabilitation / improvement, d) regeneration, e) renewal, f) enhancement (Mallouhou-Tufano, 2004)

Integrated protection / conservation and management

This term was used in the International Map for the Protection and Management of the Archaeological Heritage (1990). It includes the execution and implementation of developmental programs, that take into account a lot of parameters (environmental, educational, cultural, urban planning, city planning) and in which all the levels of power (local government, state, revenue service, archaeologists, citizens, associations) are actively involved. The basis of these programmes is the promotion and utilisation of the information for the public (Mallouhou-Tufano, 2004)

Landscape

- (1) Each dynamic set of biotic and abiotic factors and elements of the environment that form an optical encounter, individually or by interacting within a certain space (Constitution of Greece)
- (2) International conferences have defined the term as 'the visualization' of abiotic and biotic elements and parameters within the environment, that exist in a given geographical area and have a strong relation to each other, the natural place of ecosystem's expression, an area, as perceived by people, whose character is the result of the action and interaction of natural and / or human factors (Palermo Declaration 14 - 16 November 2003 ; European Convention 2000)
- (3) Landscapes are created out of people's understanding and engagement with the world around them, constantly shaped and reshaped, always temporal, polyvalent and multivocal. They are not a 'record' but a 'recording' as they provoke memory and facilitate or impede action. They embrace both the untidiness of spatial temporalities and structural inequalities , as well as the past embedded in them. The complex intersections of memory and landscape (e.g. material or idealized, mental, inner, symbolic, gendered, sacred, familiar, of diaspora, of loss, of silence) are registered on the pathways of power, fiction, architecture, symbolism, gender, art, space's organization and death's reality. Thus, landscapes are no longer to be separated from human experience or seen as purely visual, instead they include movements, relationships, memories and histories through space and time (Laoupi, 2007c) .

Management

The Management of Archaeological Heritage arose as a concept and it was established as a research field in the middle of the 1980's. Given its dynamic and interdisciplinary properties, it includes: 1. the search and discovery of monuments (surface research, recording), 2. the excavations, 3. the interventions of fixing, maintenance and restoration, 4. the interventions of recognition, organisation, configuration, presentation and use of the monuments. The cultural monuments are considered to be 'wealth-producing resources' (cultural resources), which the citizens experience via means of educational and recreational processes (Mallouhou-Tufano, 2004)

Mitigation

Measures taken in advance of a disaster aimed at decreasing or eliminating its impact on society and on environment (UN, 1992: 4)

Natural Hazard

- (1) An environmental source of potential harm; a threat or condition that could potentially cause the loss of life or injury, property damage or

destruction, social and economic disruption and/or distress, and/or environmental degradation

(2) Unexpected or uncontrolled / inevitable natural event of unusual magnitude, that threatens the life and activities of humans and has some special characteristics : a) reforms the natural and cultural landscapes, b) intensifies the degradation's processes, especially when human factors play a prominent role, c) may provoke a broad spectrum of losses within human society

(<http://www.naturalhazards.org/discover/index.html> ;

http://www.unesco.org/science/earth/disaster/about_disaster.shtml ;

Burton et al., 1978)

Natural Heritage

Natural features (physical or biological formations), geological and physiographical formations, natural sites and protected natural areas (marine parks, national parks, aesthetic forests, protected monuments of nature, game reserves and hunting reserves, eco-development areas), along with the four types of biodiversity (genetic, species, habitat, landscape), worldwide accepted for their scientific, ecological and environmental value (UNESCO)

Natural Phenomena

Earthquakes, typhoons, torrential rainfalls and volcanic eruptions are among the environmental activity that occur in Nature, independently of the human presence on Earth, even if they are considered as negative inputs of ecosystems' stability

Pollution

The presence of pollutants in the environment of (all kinds of substances, noise, radiation or other forms of energy), in such quantity, concentration or duration, that it can impact the health of humans, other living organisms and the ecosystems or it can cause material damage, and generally, render the environment inadequate for its desirable uses (Constitution of Greece)

Preparedness

The measures and activities taken to ensure effective response to the potential impacts of a hazard

Prevention

The measures and actions taken to avoid the potential impacts of a natural hazard

Proactive management

Measures taken and actions planned in advance, involving adjustments in the infrastructure and/or the existing legislature, in addition to arrangements among the relevant institutions

Protection

A term of broader meaning that includes all the above mentioned terms (i.e. Conservation-Preservation, Integrated Conservation, Restoration , Reconstruction, Management, Integrated protection / conservation and management) as well as the establishment of legislative measures and ensuring the economic resources for the promotion of the desirable objectives (Mallouhou-Tufano, 2004)

Reconstruction

Drastic intervention in the monuments, that involves their construction anew or significant additions and reconstruction, with disproportionate percentage of new materials relative to the salvaged parts. Generally it is considered to be a condemnable practice. It is applied in cases of severe destruction (eg wars, fire and earthquakes) or within the frame 'of educational/teaching' policy for defining the social profile of Archaeology, always observing the term of faith for authentic restoration (Mallouhou-Tufano, 2004)

Recovery

Those long-term activities and programs beyond the initial crisis period of an emergency or disaster and disigned to return all systems to normal status or to reconstitute these systems to a new condition that is less vulnerable (FEMA, 1992)

Response

Those activities and programs designed to address the immediate and short-term effects of the onset of an emergency or disaster (FEMA, 1992)

Restoration

Specialised intervention that aims on one hand to preserve the natural substance of the monuments and on the other hand to bring out their general cultural and innate characteristics (Mallouhou-Tufano, 2004)

Risk

- (1) A measure of the exposure of a subject (human being, property, infrastructure, or the environment) to suffering harm or loss given its vulnerability
- (2) Expected losses (lives, injuries, property damage and economic activity) due to a particular hazard for a given area and reference period
- (3) Hazard x Vulnerability x Exposure
- (4) Likelihood (probability) x Consequences

Risk analysis

Qualitative and quantitative analysis to determine the nature and the extent of risk, considering the potential impacts and the vulnerability of the subject (human being, property, infrastructure, or the environment).

Risk assessment

A risk assessment tells you:

“The hazards to which your state or community is susceptible”

“What these hazards can do to physical, social and economic assets”

“Which areas are most vulnerable to damage from these hazards”

“The resulting cost of damages or costs avoided through future mitigation projects” (FEMA, 2001:iii)

Risk evaluation

Evaluation of the tolerability of the estimated risks based on certain acceptability criteria

Socio-ecological system (SES)

A system that includes societal (human) and ecological (biophysical) subsystems in mutual interaction. It can be specified for any scale from the local community and its surrounding environment to the global system constituted by the whole of humankind (the ‘anthroposphere’) and the ecosphere (Gallopθin, 1991)

Sustainable development

It is that which “meets the needs of the present without compromising the ability of future generations to meet their own needs” (UN World Commission, 1987: 8)

Uncertainty

The state in which the probability of occurrence of the natural hazard and its impacts are unknown

Vulnerability

“A set of conditions and processes resulting from physical, social, economic and environmental factors, which increase the susceptibility of a community to the impact of hazards” (U.N.I.S.D.R., 2002: 24).

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