

Monitoring Archaeological Sites along the New Via Egnatia

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Abstract. Archaeological sites and monuments are irreplaceable cultural resources. Just like any other resource they can be threatened either by the natural environment or by people, or a combination of both. Apart from utilising a GIS to analyse archaeological data it can also be utilised as an effective tool for managing the protection of archaeological sites. Sites along a section of the new Egnatia motorway in Northern Greece were recorded in a GIS database that provides a field to record the “threat level” at each site. This threat level may vary over time given changes to parameters in the surrounding environment or human activity in the area. As such procedures for monitoring the “threat level” or providing a “safety indicator” for sites and monuments on a regular basis should be incorporated into a GIS database to ensure for the ongoing preservation of archaeological remains.

Keywords: environmental/human parameters, monitoring, threat level benchmark, GIS safety indicator

1. Introduction: Preserving the Past in the Present

Besides excavating, observing, recording, cataloguing, and analysing, archaeologists also have a moral obligation to protect by putting into place mechanisms that will preserve sites for future generations. Increasingly more emphasis is being placed on systematically managing and protecting the irreplaceable resource of cultural heritage (Cornish 2004 and Matero et al. 1998). Sites are especially threatened by construction work. Perhaps when the Via Egnatia was originally constructed over 2000 years ago, archaeological sites were disturbed or even destroyed in the process. No records survived or perhaps were even kept about whether any attempts were made at preserving ancient sites. Modern day attitudes are sensitive to past cultures and aim to preserve as many sites as possible. Given this present-day attitude towards cultural heritage, the recent construction work for the Egnatia motorway in Northern Greece aimed at rescuing and preserving sites in the area.

However as a consequence of increased traffic in the area the Egnatia motorway threatens archaeological sites none-the-less (ECO Consultants 2003). It was this threat that influenced the development of a GIS database model that can incorporate potential negative impacts by people and the environment in order to monitor their effects on a site over time. A GIS can be used to determine and then highlight likely threats to a site. The location of a site can be used to determine the likelihood that certain aspects in its surrounding natural environment or a nearby town threaten it. Any known human activities in the area can be consolidated into the final value of the “threat level” a site has. Furthermore regular monitoring can assess the safety of each site and if any protective measures have been put into place a “safety indicator” attributed to each site can also be included in a GIS database. So far minimal research has been undertaken to create GIS databases that take into consideration the environmental impact on a site and its

artefacts. Having carried out the case study a number of environmental parameters were identified and subsequently incorporated into a GIS database that if implemented could effectively monitor a site’s state of preservation.

A variety of environmental threats should be considered because apart from people, the surrounding environmental and climatological conditions pose the greatest threat to archaeological sites. For the most effective means of protecting sites, national site monitoring systems would have to be established and linked with public works departments. In one case a similar concept has actually been implemented for sites in forested areas in Finland (Hamari, forthcoming). In the future all national Cultural Heritage registries should incorporate a comprehensive GIS monitoring system in order to protect archaeological remains. This paper further demonstrates that beyond data recording and analysis there exist alternative GIS applications for the management and protection of archaeological sites.

2. How a GIS can be Used to Protect a Nation’s Cultural Heritage

A nation’s cultural heritage can be threatened by a variety of environmental and human-induced factors. Besides utilising a GIS to record for instance the stratigraphy at a site, a GIS database can also be used to record and then monitor environmental, human or other conditions that may be endangering a site’s existence. The condition a site and its artefacts are in should firstly be recorded and then may be monitored by using a number of parameters that include climatic conditions, impact by visitors to the site, surrounding geographical threats or potential development projects in the area. By monitoring potential negative impacts on archaeological sites and monuments with relevant GIS applications and models, factors that are detrimental to a site can be determined. This then allows for a proactive approach

to predicting and addressing negative factors to ensure minimal impact on archaeological resources.

Archaeological sites and monuments may be compared with non-renewable resources that unless they are properly managed will disappear forever. So it is essential to introduce methods to protect archaeological sites from the long-term effects of the environment or visitors to a site. Tourism not only affects natural resources but can also impact cultural heritage. By monitoring the impact of tourists to archaeological sites a better understanding of the consequences of tourism to an area can be determined. Furthermore recording the impact and changes to sites over time may allow for better management of what has been discovered. By using a GIS both the location and condition of sites can be monitored, and regions that have been surveyed can be kept track of. Any development projects can be planned to minimize impact on archaeological resources (Cabeza 2000).

Strategies for monitoring a site and reporting on its condition to ensure for its long-term protection are necessary for archaeological remains (Jones 2002). The current condition of a site and its surrounding environment should be recorded in a format that can later be easily accessed for regular monitoring. A GIS database can easily facilitate questions relating to what a site's characteristics are and in what condition it is in, how stable a site's environment is, how secure it is from any threats, how or if it is being maintained, and who or if anyone is monitoring its condition. A GIS database can also be designed to include as many details and parameters as are necessary in each specific case. For example a GIS database can be used to record the number of visitors to a site; to monitor CO₂ gases in an enclosed area; to record the environmental impact such as increased fumes from tourist buses; or to record the on-going effects of sulphuric acid rain on monuments.

Every archaeological site is threatened at some stage of its existence by negative impacts. For excavated sites there is a need to protect artefacts and features that have been exposed to a variety of environmental factors. The environmental impact on archaeological sites can be monitored and models can be used to predict possible negative factors that may be detrimental to a site's preservation (Retalis 2002). A GIS database can be established that will take into account environmental factors influencing a site allowing for an interactive approach to addressing negative factors in order to ensure a site's survival. As such a GIS can be used to manage the safety of archaeological sites. The condition of sites can be monitored by using a number of parameters, and development projects can be planned to minimize impact on archaeological resources. Ultimately the preservation of a site will allow for the ongoing analysis of all the artefacts and features found there.

In practical terms to protect a site from further damage it may be fenced, roofed or even re-buried. If necessary its surrounding environment may also require modification to ensure that it does not pose a threat to the site. For example to control soil erosion, plants may need to be planted. However though measures may be put into place they are not always perfect. For instance a poorly designed roof may not keep out all moisture from damaging a site (Aslan 1997). In such cases

protective measures that have been put into place should also be recorded and then also be monitored. Any protective measures and the state they are in can be factored into a GIS database as well.

Most importantly regular monitoring is required to maintain a high level of preservation, which translates into a high safety indicator for a site that has been discovered. Monitoring is essential to maintain a site in a good state by keeping up repairs to any measures that have been put into place to protect it. For instance repairing a fence or roof when necessary. Regular monitoring may also have the added benefit of deterring vandals or looters from damaging a site. In all cases access to information about the safety of archaeological sites can be maintained and updated by using a GIS database.

3. Case Study: The Via Egnatia

The Via Egnatia was named after Proconsul Gaius Ignatius who conceived and built this road at around 146 BC in order to connect Asia with Europe. In the past the Via Egnatia was part of a road network that made the existence of the Roman Empire possible. All roads literally led to Rome and were designed that way to maintain quick access in order to control and prevent provinces from organising resistance against the Empire. The Via Egnatia, which traversed territories from the Eastern extents of the Empire, was an extension of the Via Appia, which connected Rome with Brindisi on the Italian Adriatic coast.

Roman roads were built on deep roadbeds of crushed stone to ensure that they kept dry, since water could flow out, instead of becoming mud in clay soils. These roads were essential for maintaining both the stability and growth of the empire, because they enabled the Roman Army to move across the territories in what those days was very good time. And even today saving time is of great importance to the modern traveller. About 5 hours travelling time are saved by crossing the 680 kms or so of the new Egnatia motorway that was named in recognition of its original promoter. Little could Gaius Ignatius have known that when he built the road through northern Greece his ideas would have survived for more than two millennia.

The 680 kms or so of the modern motorway has 50 interchanges with existing roads, 70 tunnels and 1,650 bridges. Such major construction work necessitated salvage excavations. Of the 270 archaeological sites that were identified, the "Egnatia Odos" company financed more than 45 salvage excavations (www.egnatia.gr). In several cases, the motorway alignment was diverted in order to preserve archaeological sites. Approximately a 40 km section of the new Egnatia motorway between the towns of Kozani and Veria was selected for this case study. ARC view 3.2 was used to test ideas about creating a GIS monitoring system that can allow national authorities to maintain a relatively safe level of preservation of archaeological sites from henceforth.

4. Recording Archaeological Sites along the New Egnatia Motorway

If no records about sites are ever kept then any hope for protecting a site is diminished. The easier it is to access records about a site the better the chances are for preserving it. An integral process in recording and documenting a site should therefore include the assessment of any known or potential threats to the existence of a site. Threats can be determined by a GIS that has been designed to analyse potential threats to a site by examining surrounding features in the area and accessing any recorded threats in the attributes database. Ultimately such GIS databases can be registered and incorporated within the relevant Public Works department of every nation so that all the available data are taken into consideration when planning public works that may affect a site's safety.

The construction of the new Egnatia motorway in Northern Greece led to the discovery, recording and protection of sites, in some cases by diverting the road. Archaeological sites between Kozani and Veria in the region surrounding the construction of the Egnatia motorway have been recorded in a GIS database. Potential threats by the natural environment and human induced threats have been recorded for each site. Environmentally related fields in a GIS database can help assess potential threats at each site. Models concerning potential flooding by the local dam in the area, potential fire zones, and possible landslides that may affect each site have been included. Further research can improve models for "screening" environmental and human threats that are likely to affect each site.

The archaeological sites that were recorded in the GIS database were classified according to their type, chronology, size and major finds, allowing sites to be selected for example either by size or chronology. It is proposed that strategically located sites are accessible to visitors but at the same time protected by monitoring the effects of tourism in the area. Apart from the archaeological sites, towns, museums, rivers, lakes and other significant features in the landscape were included, along with the new and existing road network.

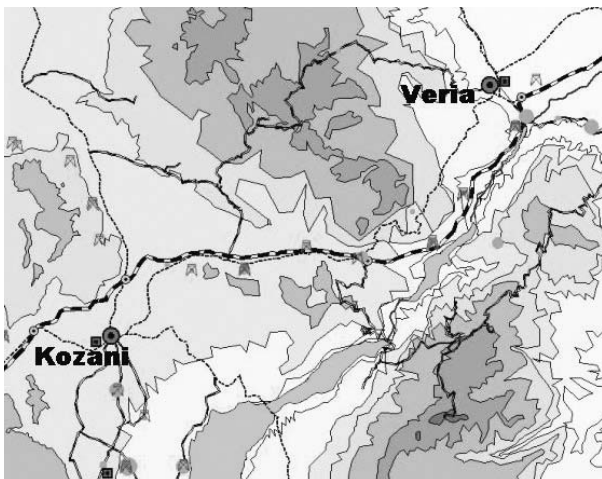


Fig. 1. Archaeological Sites (shown here as pentagons) in the region between Kozani and Veria.

When recording and documenting sites their immediate environment should also be considered since this will effect the survival of a site. So sites should be recorded within their broader environmental surroundings to monitor any likely threats. That is why the archaeological sites were plotted with the contours of the landscape, in order to gauge their safety in relation to the gradient of the land. Towns and villages have been plotted based on their population. The larger the village, the larger is its symbol on the map, reflecting the greater threat it poses on any nearby sites. Natural features such as rivers, lakes and dams in the region were also included. Finally the new Egnatia motorway with interchanges (shown by circles on the road) have also been included to indicate points where sites may be threatened due to increased traffic in the area.

Depending on each area there is a multitude of negative threats that should be considered. There is the climate of the region that should take into consideration a number of aspects. For example what are the rainfall patterns? Are heavy rains perhaps eroding sites, and does increased rainfall also mean that there is a risk to sites by flooding rivers, or lakes in the area? Do dry seasons increase the threat from fires? What is the gradient of the landscape- is the site located on a slope? If so is it threatened by landslides? What activities are people, either visiting or living nearby, carrying out that may threaten a site? For example what are the effects of pollution from a nearby factory? Are there any planned or illegal construction works in the area that may damage a site? What threat do animals pose either by grazing, or wandering across the site? These are only some of the major impacts that potentially threaten archaeological sites, and should be considered for each case. A field was added to the database that rated the level of a site's safety based on a number of threats the surrounding area posed on the sites.

A combined score of likely threats in the immediate area surrounding a site, in this case less than a 1 km radius, provides the final total threat level. This field takes into consideration a number of negative impacts that potentially threaten a site. This level can be used to make recommendations to the relevant authorities so that they can subsequently take any necessary action to protect any extremely threatened sites. In this case a combination of threats were used to create a Threat Level where a score of 10 indicates that a site is significantly threatened by its environment. Decreasing to 1 for a site that is either isolated from imminent threats, or appropriate measures have been taken to thoroughly protect it.

Once a site's Threat Level has been analysed and rated by a proposed scale that is determined for each area, the Threat Level score can be recorded in a GIS database and then be used to identify sites that should be further protected. Varying the site symbol colour or size for sites that are endangered could be used to visually identify threatened sites. In this case sites depicted with larger symbols (pentagons) indicate that their surrounding environment threatens them more than other sites. And of course visualising all this with 1km buffer zones highlights what the immediate threats to the sites are. A Threat Level that combines threats from the immediate natural environment and any human induced threats can be recorded for each site in a field in the table. The "Threat" field in this

Shape	Id	Name	Chronology	Area	Type	Location
Point	0	Mavromouria	Post Byzantine	0	Settlement	Asonahi
Point	0	Prothi Iliot	Roman	0	Aqueduct	Kessaria
Point	0	Pala Patis	Mesa-Neolithic to Early Bronze	18000	Settlement	Eani
Point	0	Trikana	Hellenistic	0	Cemetery	Eani
Point	0	Kalipetra	Neolithic to Roman	12000	Settlement	Lefkopeta
Point	0	Galavromiti	Hellenistic	0	Settlement	Mikri Sanda
Point	0	Prinaios	Bronze Age to Byzantine	20000	Settlement	Prinaios
Point	0	Kioneri	Middle Bronze Age to Late Ror	20000	Settlement	Mikri Sanda
Point	0	Kienastli	Late Neolithic	7500	Settlement	Kolada
Point	0	Karditsa	Prehistoric	0	Cemetery	Karditsa
Point	0	Vassilopado	Late Neolithic to Early Bronze	1550	Cemetery	Kolada
Point	0	Stavros	Late Bronze Age	0	Settlement and C	Ano Kona
Point	0	Voukochon	Early Christian, Late to Post By	0	Bath, Cemetery	Voukochon
Point	0	Asonahi	Bronze to Byzantine	0	Settlement, Quar	Asonahi
Point	0	Palakomana	Roman	0	Rural Villa	Mesi
Point	0	Asapa	Hellenistic	0	Periodic Settlem	Mikri Sanda
Point	0	Scoutara	Early Christian to Early Byzantine	8400	Cemetery	Galani
Point	0	Agona	Roman	0	Cemetery	Xalidra
Point	0	Koufogiannoi	Late Bronze to Early Iron Age	0	Settlement	Lefkopeta
Point	0	Pufes	Neolithic, Hellenistic and Roman	0	Settlement, Temp	Xalidra
Point	0	Avlagas	Neolithic, Late Bronze	0	Figurines, Potte	Pontokoma
Point	0	Agorema-Kastio	Classical	8400	Fortified Settle	Mavropag
Point	0	Diarakopeta	Roman, Christian	0	Settlement, ceme	Avvestopeta
Point	0	Mourtsourades	Late Neolithic	4200	Settlement	Avvestopeta
Point	0	Vlasi	Achaic to late Roman	15000	Settlement, ceme	Pontokoma
Point	0	Slasi	Neolithic	1100	Settlement	Mavrodendi

Fig. 2. Field for recording the Threat Level at each site.

case indicates the Threat Level at each site in this area (see-Fig. 2).

Apart from hazards due to human activity, a number of natural hazards ranging from floods to fires can also threaten archaeological remains. A GIS can effectively manage sites by providing an effective way of recording, modelling and then monitoring any negative environmental and human impacts on a site that can be used to warn authorities of any imminent threat in order to ensure for the ongoing preservation of a site. Potential threats can be shown on the digitised map. Here for example is a worst-case scenario of potential flooding in the area if the dam collapses (Fig. 3.). Fire hazards in the area could be modelled based on the vegetation and rainfall patterns recorded for each year. Any archaeological sites that are likely to be threatened by fire can also be highlighted on the digitised map.

Another negative impact in this case can be due to increased traffic. By monitoring road traffic, estimates as to the potential threat posed by the new Egnatia motorway, may also be made. Increasing the thickness of the road could indicate the projected level of this threat over time. This can depict the level of potential threat caused by air and other pollution that can affect sites in proximity to the motorway. In all cases the Threat Level can be determined based on a combination of “impact” parameters that have been identified within a 1 km radius of each site. A field showing whether a site is protected in any way, for example if it is surrounded by a fence, or has

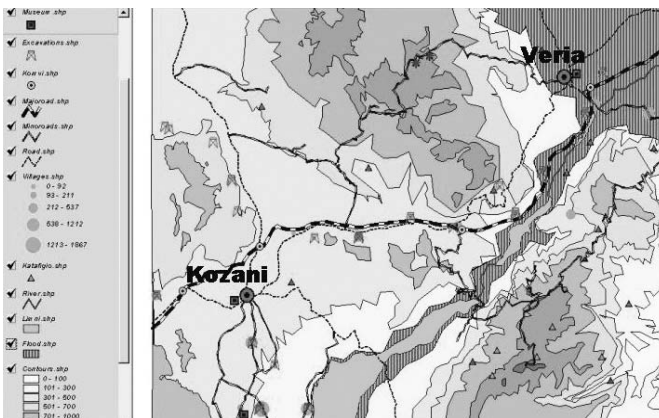


Fig. 3. Shaded areas are threatened by potential flooding.

any other measures in place can also be included in a GIS database as a Safety Indicator. A Threat Level can be significantly reduced if protective measures are put into place, at the same time increasing the Safety Indicator that a protected site has.

Unfortunately negative environmental or human impacts are not static, so Threat Levels can vary, since the environment is forever changing. As such archaeological sites should ideally be monitored at the very least on a yearly basis by recording the state a site is in. So a monitoring system should be established, and be used at each site. Given the increasing requirement to use GIS for the management and protection of sites a methodology for future GIS applications to monitor a site’s state of preservation, and any threats that can be controlled in order to protect the site, was developed in the course of mapping these sites along the Egnatia motorway.

5. Conclusions: Monitoring Archaeological Sites along the New Egnatia Motorway

Apart from online internet GIS applications the future of GIS applications in archaeology lies in establishing monitoring tools for Cultural Resource Managers or Sites and Monuments Registers that should aim at not only recording sites but monitoring their condition and putting into place a proactive approach that can allow for their ongoing maintenance. This paper presents information about building a GIS database that can be used to monitor the environmental conditions affecting a site. The aim is to provide a database model for the efficient recording and documentation of the safety status of each site. This enables the state of every site to be monitored and appropriate measures be taken to avoid negative impacts on artefacts and features at the site.

There is a need to establish on-site and wide area monitoring mechanisms to ensure the effective protection of sites and monuments. Monitoring should also be established to protect and make recommendations for the effective preservation of sites for future generations. Such monitoring systems can also ensure that an accurate historical record is kept of the state of the site at different times so that future analysis of remains takes into account the original state of preservation. This is where digital photography is essential to record all finds at a site and keep them for future analyses. So a photo catalogue stored in a GIS database is also proposed as an essential element of this ongoing preservation of archaeological remains.

Theoretically a database that is designed to record the condition of a site on a regular basis can be used to determine when actions should be taken to prevent damage to a site. Along with factors that impact on the total Threat Level on a site for each year, whether a site is protected in any way, for example by a roof or is surrounded by a fence, should also be recorded and monitored. These yearly recordings can be plotted in charts and by setting up a benchmark, or a Threat Level benchmark that is considered dangerous to a site’s existence, recommendations can subsequently be made to the relevant authorities so that they take any necessary actions to protect extremely threatened sites (see Figure 4.).

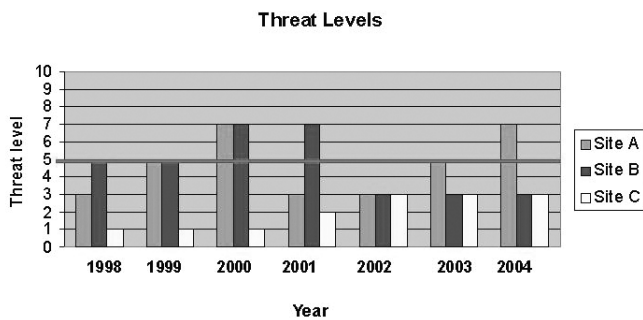


Fig. 4. Threat Level Benchmark (set at level=5) indicating which of the hypothetical sites require further protective measures to be implemented or repaired.

There is an increasing requirement to establish on-line monitoring tools to ensure for the effective protection of sites and monuments. As such apart from documenting features and artefacts at a site, any potential environmental threats to the site should also be documented. This paper has designed a GIS database that can be used to assess any threats and manage environmental data at archaeological sites within a given area in order to make recommendations for the continual preservation of each site. Such GIS monitoring systems should be incorporated with a nation's Monuments and Sites registry to ensure that cultural resources are protected for future generations.

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