ST CATHERINE'S MONASTERY, SINAI: A VIEW FROM ABOVE

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EAMENA
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ABSTRACT

This poster presents a case study from the Endangered Archaeology in the Middle East and North Africa (EAMENA) project, analysing landscape change in the St Catherine's Monastery area in Sinai (Egypt) for heritage management purposes. Using multitemporal remote sensing data from the visible and near-infrared spectra alongside 19th-century Ordnance Survey maps, it reconstructs a detailed picture of landscape change over the last century and a half. This allows us to highlight areas that should be prioritised for archaeological study and preservation. Existing protection and preservation strategies focus on so-called 'flagship' sites (such as the monastic enclosure), routinely ignoring remnants of a more mundane and recent past, such as 19th-century historic orchards.

INTRODUCTION

The EAMENA project (www.eamena.org) is a remote sensing project based at the Universities of Oxford, Leicester and Durham that is creating a large dataset of archaeological sites in some 20 countries in North Africa and the Middle East, from Mauritania to Iran. Its primary focus is the documentation and the protection of sites and landscapes that are at risk of recent changes in land cover, such as building activity and/or agricultural expansion.

The EAMENA project draws extensively on remote sensing data - including open source satellite imagery available via Google Earth and Bing Maps - to identify sites and monitor their condition. Information from remote sensing is routinely combined with information from modern and ancient maps, archaeological surveys and ground photos.

St Catherine's Monastery **(Fig. 1)** was founded in the 6th century AD and is the oldest Christian monastery still in use for its initial function (Ten Harkel *et al.* 2018). Since the first millennium AD, it has been an important destination for religious tourism, which saw a marked increase in the 19th and 20th centuries. The St Catherine Area also comprises the surrounding landscape with numerous sites of archaeological and religious significance, and has been declared a UNESCO World Heritage site (no. 954).

METHODS

The EAMENA remote sensing methodology involves the visual analysis of satellite imagery to identify sites and to monitor any damages and threats over time. Its main source is Google Earth Pro, whose Time Slider function allows for a multitemporal perspective **(Fig. 2)**. In the case of the St Catherine's Monastery case study, the available imagery ranged between June 2005 and February 2016.

To 'travel' back in time, this could be augmented with airphotos from the 1950s and 1930s (donated to the project following an appeal for historic aerial photographs; Bewley and Fradley 2017) **(Fig. 3)** and the Ordnance Survey mapping carried out in the 1860s by the British Royal Engineers (Wilson and Palmer 1869) **(Fig. 5)**. Features of archaeological interest were digitised from the OS map in Google Earth Pro. Further analysis was carried out in QGIS.

A more recent view of the modern land cover could be obtained from Sentinel-2 imagery from 2018, downloaded from the Copernicus hub. Although the resolution is not fine enough for archaeological site identification, the Near-Infrared wavelengths are useful for identifying vegetation. This is useful because agriculture is one of the major threats affecting archaeological sites in the Middle East and North Africa.

***Fig 2**: St Catherine's Monastery in June 2005 and February 2016. Imagery from Google Earth Pro.*

***Fig 3**: Oblique aerial photograph of St Catherine's Monastery looking north, taken by John Clubb (683 Squadron RAF) in 1951. Note that the access road and the car park visible in 2005 and 2016 does not yet exist. They were constructed to deal with a growing number of visitors to the monastery, mostly consisting of religious tourists and pilgrims.*

***Fig 1**: Location of the study area (in red)*

OBJECTIVES

The objectives of the St Catherine case study are:

1) To make a detailed multitemporal analysis of landscape change in the St Catherine Area, Sinai (Egypt), based on the EAMENA remote sensing methodology;

2) To identify areas/sites of that have witnessed particularly rapid changes in land cover; and

3) To identify archaeological and heritage sites that require urgent protection.

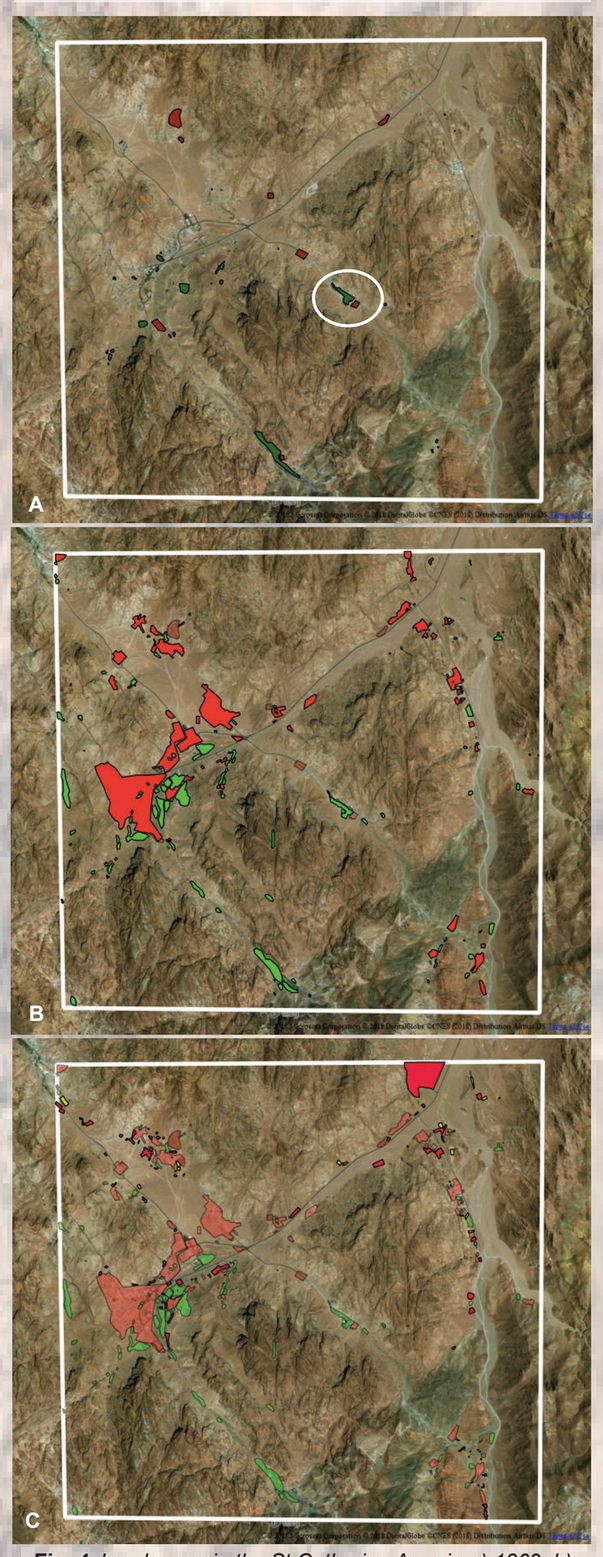

***Fig. 4**: Land cover in the St Catherine Area in a) 1869, b) 2005 and c) 2016. Built-up areas are indicated in red, and fields/orchards in green. Newly built-up and cultivated areas are opaque, whereas existing areas are transparent. The monastery and its orchards are indicated by a circle in the top image*

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RESULTS

Visual comparison of the satellite imagery from Google Earth Pro and a RAF airphoto from 1951 of St Catherine's **(Figs 2-3)** shows that the monastic enclosure with its historic buildings remained largely unchanged over this 65-year period. It also shows, however, that a new access road to the monastery was constructed in the period between 1951 and 2005 to accommodate the increase in religious tourism. This raises the question to what extent this increase in travel to the UNESCO World Heritage site has impacted on the surrounding landscape, in particular in terms of historic settlement and agriculture. To gain a better understanding, more detailed analysis was carried out of a wider area **(Fig. 4)**.

Fig. 4 compares the land cover of the area surrounding the monastery in 1869 (based on the 1869 OS map), 2005 and 2016 (based on satellite imagery from Google Earth Pro). It shows a substantial increase in built-up and cultivated land cover between 1869 and 2005, with additional expansion between 2005 and 2016. This can be explained by the additional economic potential of the area as a result of increased tourism. The largest built-up area in the centre left of the images is the modern town of St Catherine, one of Egypt's newest townships.

Thus, although the monastic World Heritage site of St Catherine's itself is adequately protected and therefore preserved, elements of its wider historic landscape setting such as orchards - important for our understanding of the socio-economic networks that supported the monastic community before the increase in tourism - are potentially under threat or being damaged by rapid population increase and settlement expansion. A sustainable heritage management policy needs to be developed (Shams 2012), but first detailed understanding is required of the date and current condition of the various landscape elements.

Here, remote sensing data, especially when combined with other data, can provide valuable insights. **Fig. 5** takes a detailed look at a group of orchards in a wadi (seasonal watercourse) to the south of the modern township of St Catherine, contrasting the 1869 OS map with satellite imagery from 2013. This simple exercise allows us to conclude that the three southern orchards date back to the 19th century, whereas the northernmost (indicated by the turquoise symbol) was of more recent date.

Finally, **Fig. 6** again takes a broader look at the landscape, overlaying the outline (in yellowish green) of the orchards mapped on the 1869 OS map onto an image generated from Sentinel-2 data in 2018 (false-colour infrared, bands 8, 4 and 3), showing areas of vegetation in red. The coincidence between the two indicates that all the orchards that were in use in the 19th century are still in use today, and that a substantial increase in vegetation land cover seems to have taken place since, potentially endangering the preservation of the historic orchards.

***Fig. 5**: Detail of the 1869 OS map showing three orchards south of the town of St Catherine, and the same area on satellite imagery from 2013, showing a new orchard to the north.*

DISCUSSION

Modern-day tourism has an extensive impact on archaeological landscapes. Although 'flagship' sites such as the monastery of St Catherine are often well-protected by international heritage management institutions like UNESCO, there is often a lack of focus on their wider landscape setting. This is especially true for remnants of a more recent past, which are often considered to be 'too modern' to deserve special attention, let alone protection.

If we want to gain knowledge about the way in which communities like the one at St Catherine's engaged with their surroundings and about the kinds of socio-economic networks that were in place, it is vital that we shift our focus to the wider landscape. In the case of the St Catherine Area case study, this provides additional challenges because of the continued use of historic landscape features (in this case orchards) by present-day Bedouin communities. These are living landscapes, preserving remnants of a deeper past that are at risk of disappearing as a result of their continuous use and expansion.

In order to understand and protect these landscapes, and preserve knowledge for future generations, we need to obtain a detailed picture of changes in land use over time, identifying the oldest surviving elements in the landscape and subsequent changes. Both are important from a heritage management perspective, as changes in land cover constitute potential threats to the archaeology. The EAMENA team provides a series of training programmes in the Middle East and North Africa to engage local heritage specialists with this methodology as well.

CONCLUSION

The approach showcased in this poster is interdisciplinary, combining historic map analysis with visual interpretation of remotely sensed images (airphotos as well as satellite imagery) to analyse the landscape of St Catherine's Monastery in Sinai (Egypt) from a multitemporal perspective. Remote sensing data from the visual and near-infrared spectra, in combination with 19th-century maps, has been used to make a detailed multitemporal analysis of land use in this remote landscape. This methodology allows us to identify sites of historic or archaeological interest, as well as areas where rapid or more sustained changes in land cover are taking place. Remote sensing data provides a valuable datasource, as it allows for rapid and low-cost analysis and can be successfully applied even when it is impractical to visit the area in person.

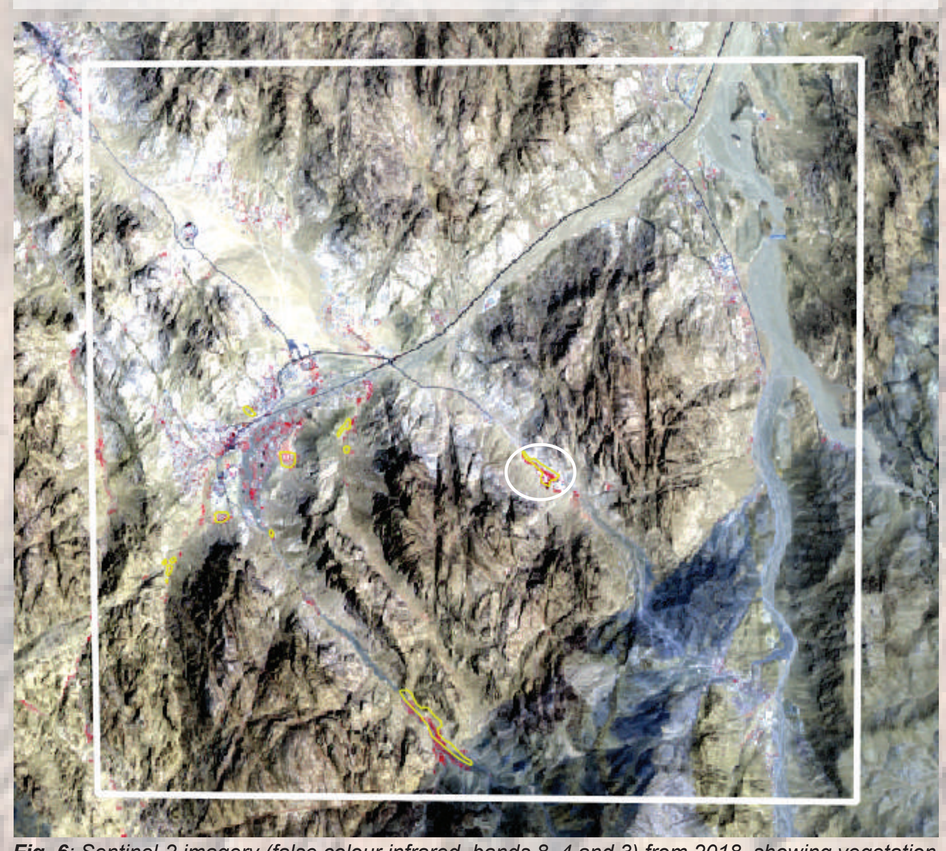

***Fig. 6**: Sentinel-2 imagery (false colour infrared, bands 8, 4 and 3) from 2018, showing vegetation land cover in red. Outlined in yellowish green are the 19th-century orchards depicted on the 1869 OS map. This shows that all orchards that existed in the later 19th century are still vegetated, and that a substantial increase in vegetation land cover has since taken place. The monastery is again indicated by a circle.*