EVALUATING THE DISTANCES BETWEEN ROMAN SITES AND PHYSICAL FEATURES IN THE PATRAS AREA (GREECE): A GIS SOLUTION

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In archaeological applications, it is sometimes essential to be able to calculate distances between groups of data, e.g. rivers and towns. In this study, GIS technology was used to automatically measure the distance of each Roman site to the closest branch of the drainage system in the area. An appropriate mathematical formula for calculating distances between points was chosen for the purpose. In our application, the algorithm calculates the distances between each site point and the nodes of each line in the set, and then selects the minimum value. The resulting values are stored in a new field in the site record. In order to provide a better statistical representation of Roman sites, the GIS was also programmed to automatically calculate the altitude of each site, and then produce a histogram of the distribution of sites according to altitude.

Introduction

GIS technology offers great facilities for analysing spatial and altitude distributions. For the Patras area in Greece we created a digital model of both archaeological and geographical data. The archaeological data related to our study were the 139 points that represent the position of known Roman sites. The digital geographical data created were: a) the digital drainage system, and b) the Digital Elevation Model (DEM). All of the above were stored in different data sheets and displayed in separate layers (Fig. 1). The contour lines were categorised by their altitude value in different colours, and show the relief of the area.

Figure 2 displays the Roman sites, the road network and the trigonometric points of the studied area, over the relief information. Here, the relief is rendered in

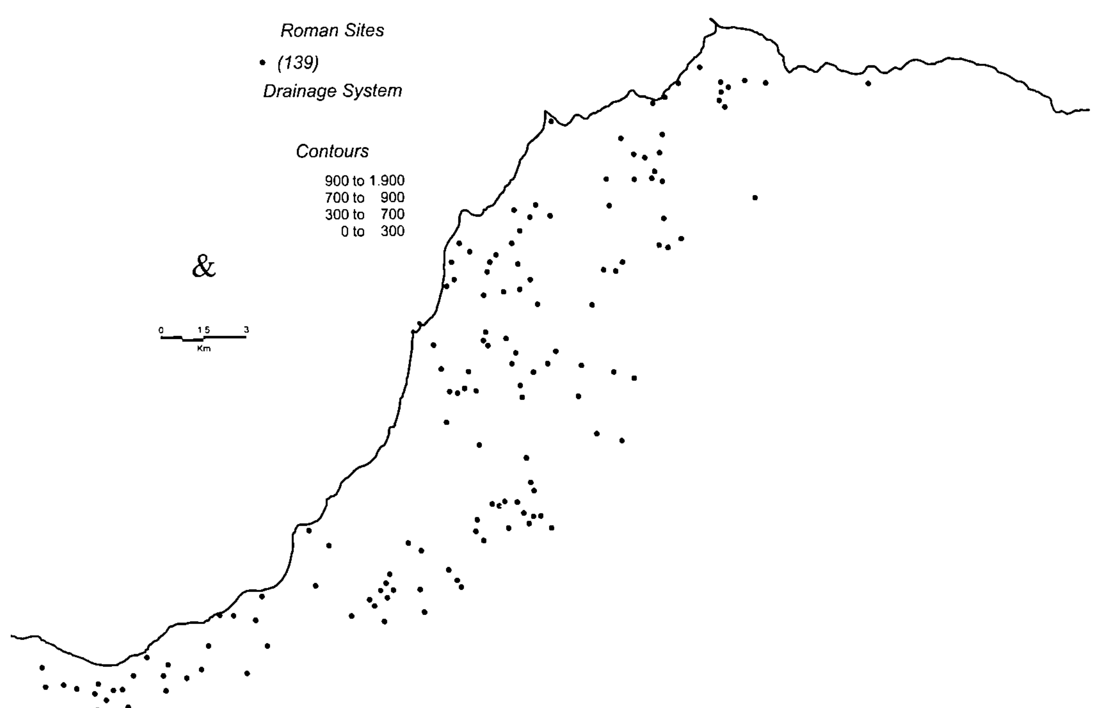

Figure 1. Study area : contour lines, drainage system and the archaeological sites of the Patras area

colour by zones of a given altitude range, between contour lines. This helps to visualise the correlation of the site to other physical characteristics (altitude).

The primary elevation data (contour lines) were processed with the 'Triangulation with smoothing' algorithm to produce the DEM (Digital Elevation Model) grid file, with a total number of 75,304 altitude points. Of course, different parameters could have been used to produce a larger number of altitude points and a more accurate DEM file, but we considered the chosen number of points satisfactory and acceptable in terms of the overall processing time.

Distance analysis

For our research, we developed an automatic method to measure the minimum distance between each Roman site and the surrounding river branches. Having the drainage system and the Roman site points on two separate layers, we used the algorithm we developed to calculate the distance of each site point from all the nodes of each branch of the drainage system, and extract the minimum value. This value represents the sought for distance of the Roman site from the closest river branch. We stored the resulting value in a new field (the distance) of the corresponding record.

The algorithm uses the equation of geometry, that calculates the distance between two points of known position A (X1, Y1) and B (X2, Y2):

$$d(A,B) = \sqrt{(\mathrm{X2} - \mathrm{X1})^2 + (\mathrm{Y2} - \mathrm{Y1})^2}$$

These resulting values are measured in kilometers, but other units could have also been used, depending on the projection system and the initial GIS settings. These values were used for the creation of a thematic map (Fig. 3) which shows all the sites classified by their minimum distance from the closest river branch.

From the thematic map of Figure 3, we can extract results for sites in each distance category, and the geographical relation of the sites and the river branches. For example, the yellow coloured dots represent the sites that are extremely close to river branches (0 to 0.09 km). The count number is printed in the legend, next to the category.

Such results can be extracted for all the categories. The user is able to alter the range of each category and the total number of categories, in order to extract specific results.

The distance results are given also on a histogram (Fig. 5). This histogram, as expected, indicates that most of the Roman sites (76) were located next to rivers at a distance of 0 to 0.2 km. For larger distances we note a continuous decline of site numbers, and over a distance of 1.3 km we have no Roman sites at all.

Analysis by altitude

The next aim of our research was to estimate the altitude of each Roman site. This was achieved using the DEM grid file created by processing of the initial altitude information.

By the DEM grid, the GIS is able to indicate the exact altitude at every point of the studied area. When the query point is not one of the grid points, the GIS calculates the intermediate values between the neighbouring grid points. In this way, we have full altitude coverage of the studied area.

The 'Point Inspection' algorithm of our supplementary software inspects the DEM file and retrieves the altitude value for each point of a given data file (in this case the Roman sites data sheet). The results are stored in a new field of the Roman site data sheet, next to the description of each site.

These results were then used to produce the thematic map of Figure 4. This map displays all the sites by their altitude, in different colours within the specified ranges. By examining the map, we can appreciate that the majority of sites are located in the areas close to the sea zone (altitudes 0-100 m) and that the number of sites reduces with increasing altitude. The histogram of sites against altitude shows an almost regular exponential decline in the number of Roman sites with increasing altitude ranges (Fig. 6). The small increment that is noted between the last two ranges (500-600m and over 600m) is not remarkable as the number of cases is very small (3).

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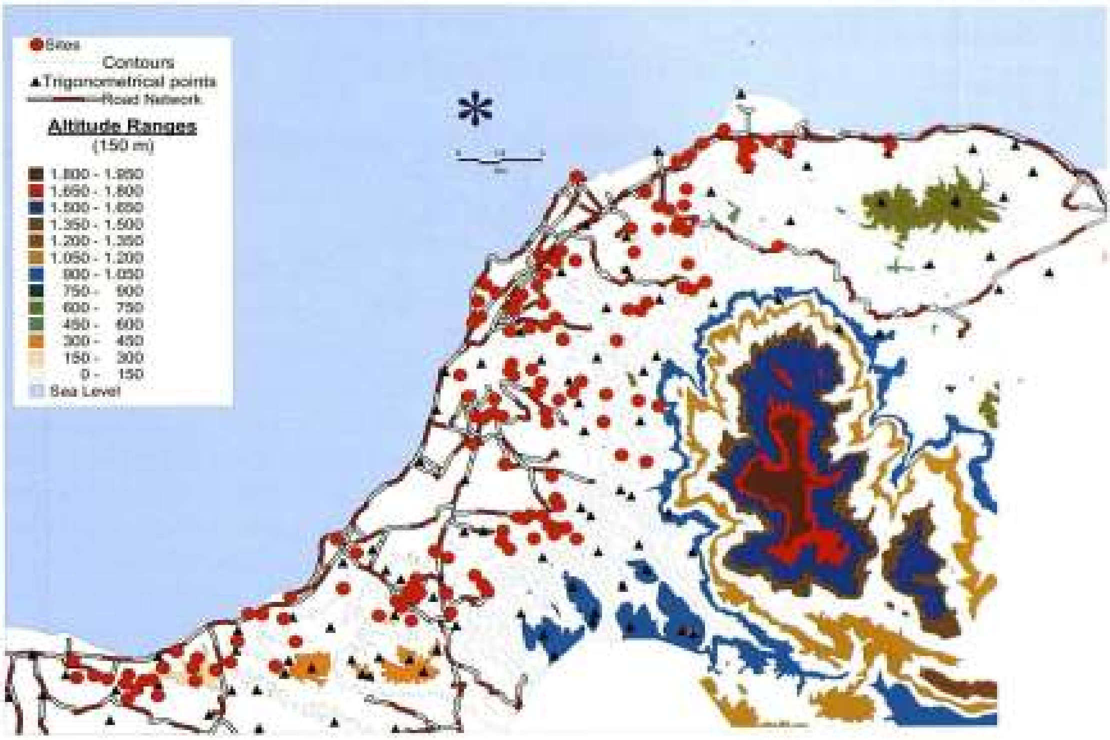

Figure 2. Visualisation of the relief of the Patras area, the primary road network and the distribution of Roman sites

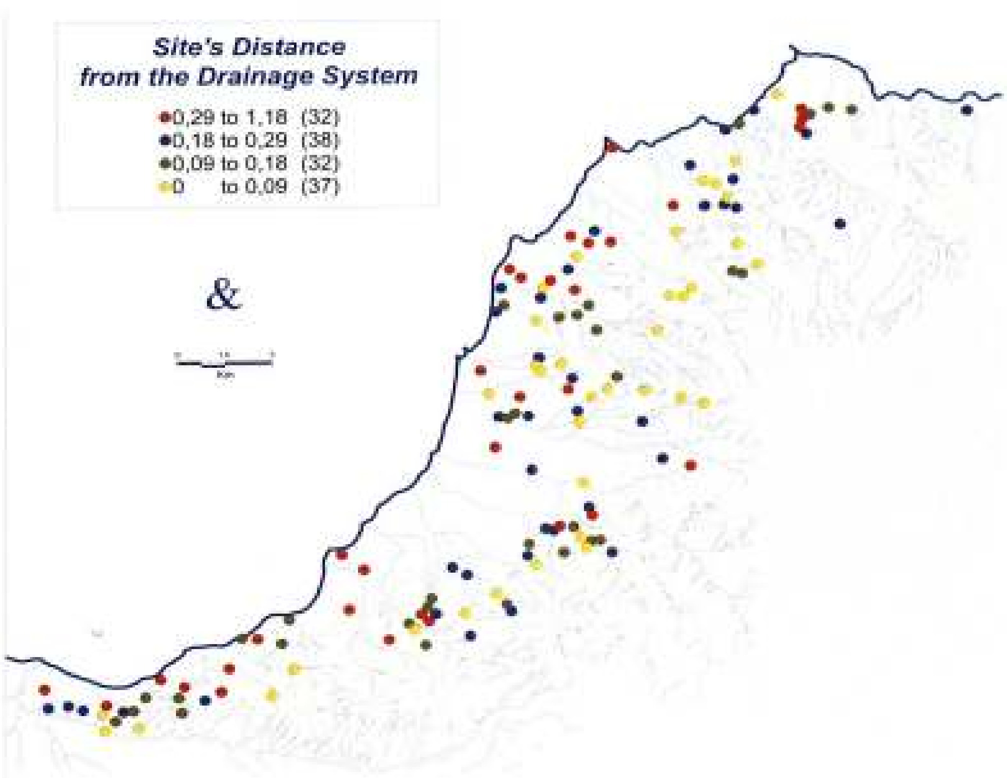

Figure 3. Roman sites categorised into 4 ranges depending on their distance from the closest river branch

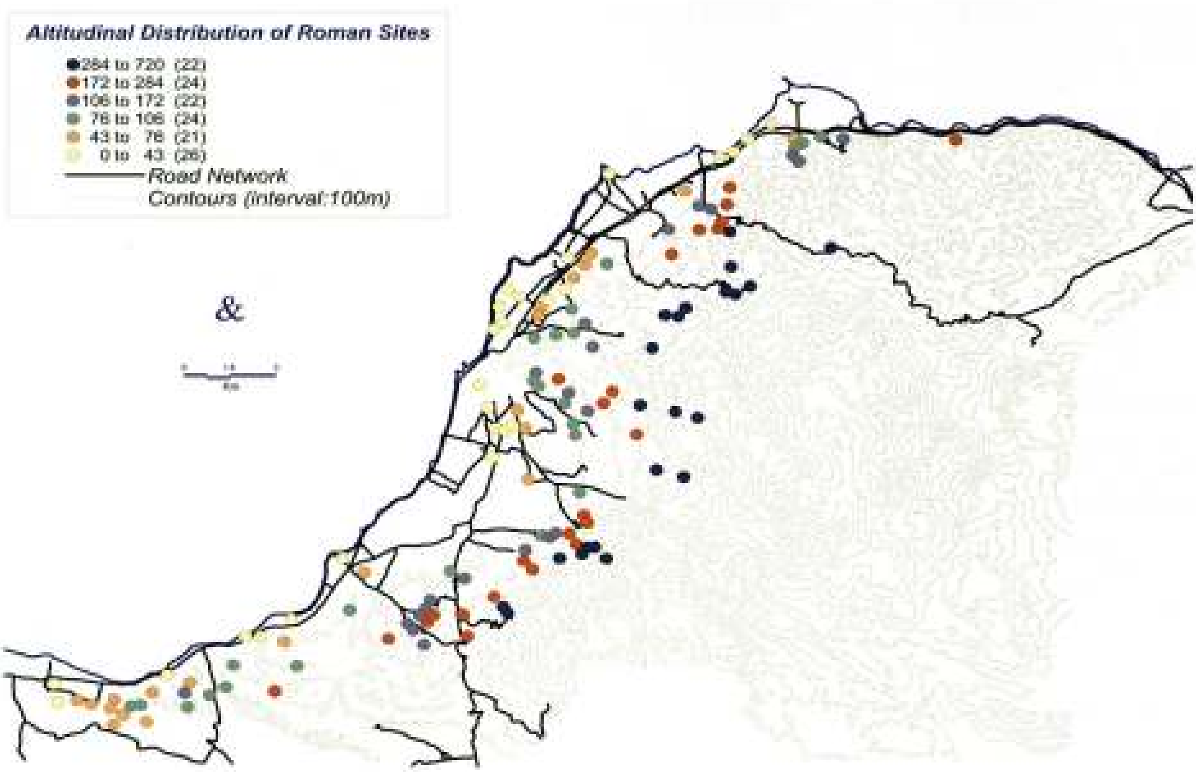

Figure 4. Roman sites categorised in six altitude ranges. The number of sites in each range is shown next to the range in the legend

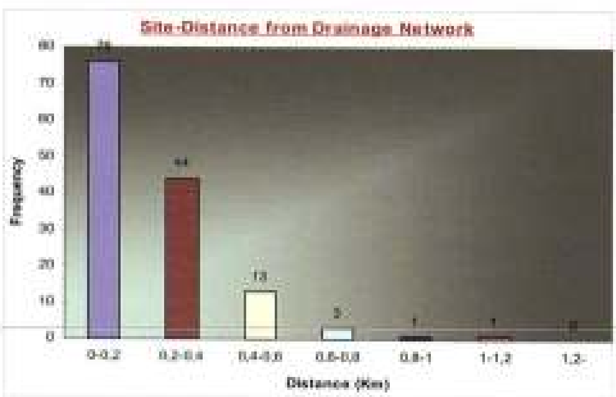

Figure 5. Histogram showing the distribution of Roman sites, depending on specific distance ranges; it shows that most of the Roman sites were established near river branches

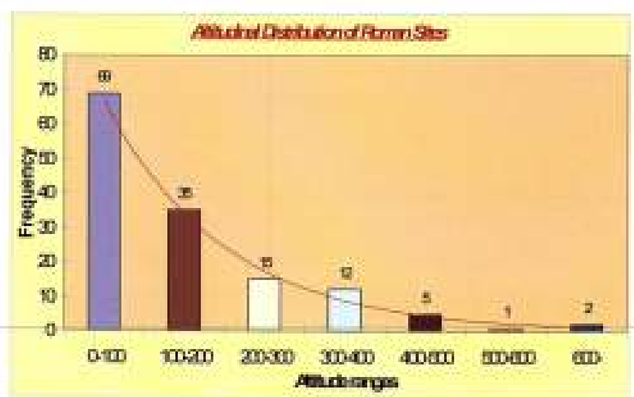

Figure 6. Numbers of Roman sites by altitude, showing an exponential decline of sites with increasing altitude