GIS in Archaeological Predictive Modeling

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Abstract:

This project applies an archaeological predictive model to the Blackwater River area, approximately 80 kilometers southwest of Prince George. Analysis of slope, aspect, elevation, soil composition, and distance to water sources reveal that areas most suitable for human habitation correlate strongly with known archaeological sites. Problems arose when trying to select areas with coniferous forest cover however, as this included almost all forest cover polygons, making it unusable.

Introduction:

This area is within the traditional boundaries of the Naskutin band of the Carrier First Nations, and has been used as an important north-south intersection of the eulichan "grease" trail for at least five thousand years. The study area is comprised of nine 1:20,000 tiles from mapsheet 93G: 23-25, 33-35, and 43-45. The aim of this project is to determine areas that are most suitable for pit house habitation based on attributes such as slope, aspect, proximity to water sources, forest cover, elevation, and soil composition. After establishing areas suitable for habitation, referencing is done against known archaeological sites to test for compatibility. The initial hypothesis is that areas which meet designated requirements will contain, or be in close proximity to known archaeological sites upon overlaying.

Methods: Data Source

One of the most important goals of this project was to gain a greater understanding of data management, presentation, and analysis. All analysis for this project was done in ESRI ArcMap, ArcToolbox, or in ArcCatalog.

-All datasets used in this project are projected in UTM zone 10, NAD83.
-All datasets can be found in N:\abrahamd\geog413\project\small_project.
-TRIM I data was provided by the UNBC GIS Department, as was the forest cover layer.
-TRIM I layers used are: bc20k_grid (coverage), rivers.shp, and lake_utm (coverage).
-Forest cover layer was imported as forestcover.shp.
-Known archaeological site information was provided in Excel format through the Land Information of BC website. Selected features were exported as a .csv file.
-These data were received as req929.xls and exported as xy4.csv.
-Soils information was provided through the Canadian Soil Information System (CANSIS) website, and was provided as a .zip file containing a single Shapefile, soils.shp, and associated tables, soil.cmp, soil.layer, soil.mapunit, and soil.name.

Methods: Data Manipulation

The first challenge in this project involved selecting a suitable area. Originally planned to cover an area totaling 56 1:20,000 map sheets from 93G and 93J, I quickly learned that analysis on such a scale takes a tremendous amount of time. After selecting the final analysis area, all layers were reprojected into UTM. The only layers that needed to be clipped to the study area were the forest cover layer and the soil composition layer. The next step was to build topology for the TRIM I data, and then to clean it up using the "build" and "clean" options available in layer properties. In the case of the lakes layer, polygon topology was built to facilitate greater visualization and to passively select lakes of greater area. Selection was done on the rivers layer for only those listed as definite, left bank, or right bank. This was done to remove intermittent or seasonal rivers from the layer, as they would be unsuitable for human settlement. Finally, info tables needed to be joined to the forest cover layer and an XY projection was defined for the known archaeological sites layer. Analysis could then begin, as all layers possessed topology and were projected correctly.

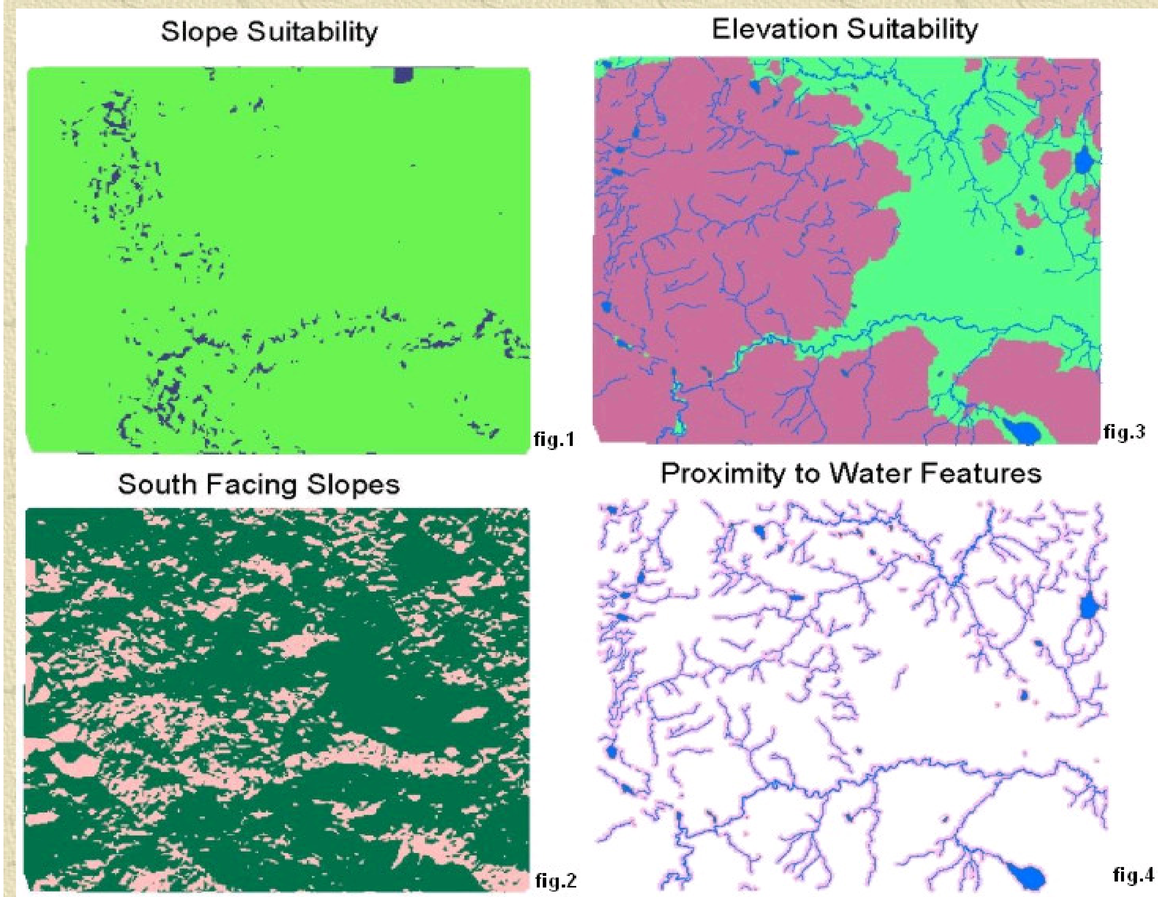
Methods: Spatial Analysis

After all datasets were prepared for analysis, the first step was to create a TIN out of the contours for added visualization. From the created TIN, slope, elevation, and aspect layers were derived using the 3D analyst extension in ArcMap. The slope layer was queried using the raster calculator to find those areas which possess a slope of less than or equal to fifteen degrees. A similar method was used for the aspect layer; using raster calculator, all areas between 112.5 degrees and 247.5 degrees were selected, which is the same as selecting those areas which face south, south east, or south west. The elevation layer was queried using raster calculator as well, selecting only those cells with an elevation value below 1000 metres.

Humans require water, so it is therefore sensible to settle in close proximity to a permanent water source such as a lake or river. A maximum buffer extent of 250 metres was placed on both the rivers layer and the lakes layer. The two layers were then unioned, and features dissolved between them to establish a buffered water features layer used for further analysis. After dissolving, the resultant buffered water features layer was rasterized to be used in analysis with other raster layers.

The next step was to intersect the slope, aspect, elevation, and buffered water features raster layers to determine which areas meet all four requirements. After that, overlay was done with the soil composition layer, which had been modified to show unique values with regards to rocky content (Stoniness). No intersecting or further analysis was done with regards to this layer because a strong correlation already existed between soil composition and sites of potential settlement areas.

Finally, a query was performed on the forest cover polygon layer which looked for coniferous leading species such as Douglas fir, spruce, and pine. This was done because of the added shelter coniferous tree species would provide over deciduous ones, especially when considering placement of a winter shelter.

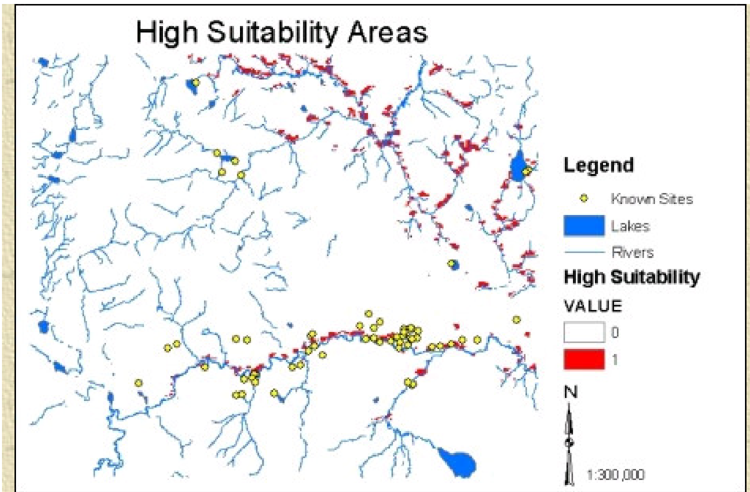


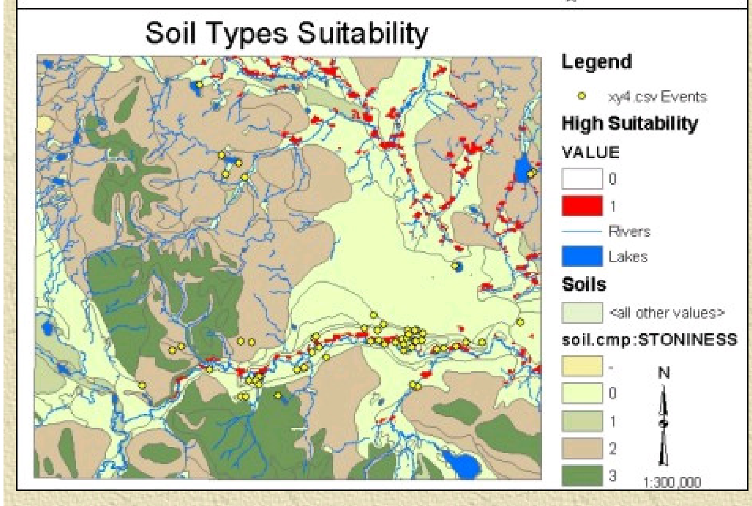
(fig.1) Green areas represent less than fifteen degree slopes, anything above is coloured in blue.
(fig.2) Pink areas are slopes which face south, south-east, or south-west (112.5-247.5 degrees), everything outside of this range is green.
(fig.3) Green areas are under 1000 metres, anything over is coloured pink.
(fig.4) Pink shaded areas represent a 250 metre buffer placed on all water features.

Analysis Results:

Overlaying the known archaeological sites layer with the spatial analysis results reveals a strong correlation between the two. The large majority of known sites are either within, or in close proximity to areas deemed suitable for habitation. Unfortunately, the forest cover polygon layer proved to be unusable for two reasons. The first is because almost all polygons had a coniferous primary species, and the second is that forest cover is a dynamic characteristic, and analysis of dominant species limits temporal depth to perhaps a few centuries.

Probably the most remarkable feature of this project is the strong correlation between known site placement and soil composition; almost all of the known sites are found in areas of low rocky content. Building a pit house in such a location is a wise choice for two reasons. The first is that it is physically harder to dig in soil with a high rock composition, and second, if one managed to construct a pit-house, it would be horribly uncomfortable to sleep in.



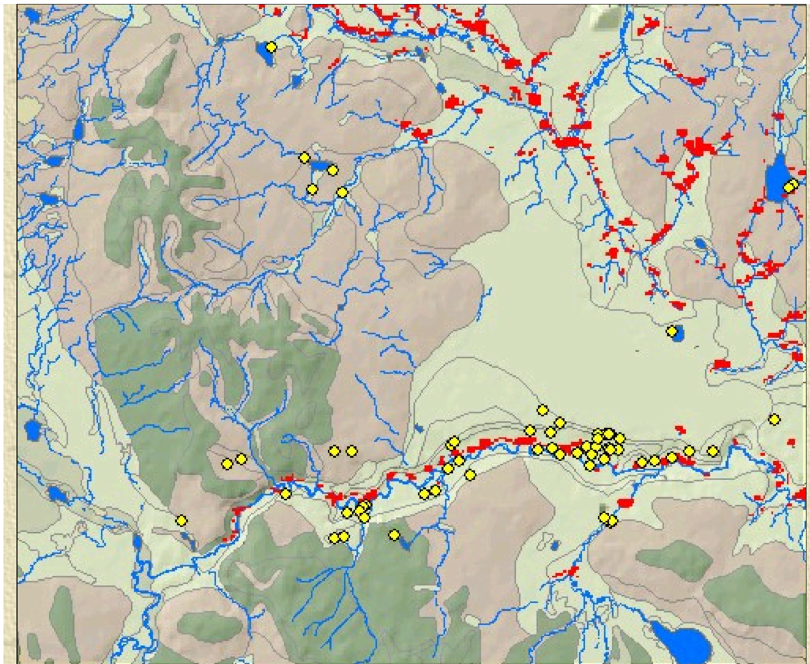


Conclusions:

This project appears to have been quite successful in establishing areas of high house-pit suitability, based on the strong correlation with known sites. There is a very large problem with these results however, which concerns the known sites themselves. Archaeological surveyors use predictive modeling to determine where areas of high potential archaeological value are, similar to this project. Correlations between known sites and these results are high because a similar model has already been applied to this region. Also, archaeological surveying assumes that higher concentrations of sites will be within selected regions, which may be misleading because areas deemed marginal are outright ignored.

Another problem with these results has to do with the presence of the 'eulichan' trail, also known as the Alexander McKenzie Heritage Trail, which could not be found in a digital format, or in any image illustrating its entirety. This is unfortunate because it played a major role in local trade and transport, and ran along the north bank of the Blackwater River, which would explain the high number of sites in that area.

In summary, this project has illustrated how GIS can be used in the field of cultural resource management and predictive modeling. The original goal of this project was to enhance my knowledge and understanding of GIS analysis, in a personally related field, which also includes understanding the weaknesses of GIS as well.



Final area illustrating high suitability regions (red), known sites (yellow), and soil types, with a transparent hillshade overlayed.

Future Developments:

One area which needs immediate attention is the field of GPS mapping applied to Indigenous trail systems. This project has shown that proximity to large trail systems is another factor which should be considered when conducting archaeological surveys shown by the large number of sites along the north bank of the Blackwater River. therefore, it is imperative that data be collected on ancient transport networks. Failure to do so could result in the loss of archaeological sites to industrial interests.

References: