

Application of ArcGIS Spatial Analysis Techniques on Topography Teaching

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Abstract

In order to effectively carry out topographic teaching reform, on the basis of current teaching situation, this paper aims to enrich the teaching contents and advancing topographic teaching by means of information technology. Based on the DEM data of a certain regional topographic map [3], adopting the theory of ArcGIS spatial analysis and modeling, the authors have studied and practiced the precise and visualized contours drawing of different brightness values. Providing a scientific method for identifying landforms and gauging elevation as well as other topographic elements, this research also seeks to improve the topographic informationized teaching.

Keywords: ArcGIS, Spatial analysis, Topography

1. INTRODUCTION

Earth information science and technology integrates earth science, surveying, mapping, 3S technology (GPS, GIS, RS) and other disciplines [7]. It is a new major which highlights crossover. The functions, such as view, comparison, analysis of Geographic information system (GIS) on the spatial things, as well as the visualization function of geographic information are irreplaceable. It can bring the spatial analysis and distribution of geographical things into the classroom intuitively and vividly, utilizing spatial simulation analysis to stimulate students' senses. It provides new methods for the teaching of topography, and also plays an important role in the learning of abstract knowledge, spatial geometric analysis, as well as multi-feature overlay information viewing.

ArcGIS is a new generation of software developed by Environmental System Research Institute (ESRI), and is one of the most widely used GIS in the world. GIS software, a comprehensive, perfect, scalable GIS software platform, whether on the desktop, server, Internet or field operation, can be built through ArcGIS. ArcGIS spatial analysis has the function of extracting and transmitting spatial information. As the basis of various comprehensive geological analysis models, spatial analysis provides a basic tool for the establishment of complex models [6]. Spatial analysis model refers to the mathematical model used in GIS

spatial analysis, and spatial analysis modeling refers to the process of establishing mathematical model by using GIS spatial analysis. Combined with the current teaching status and characteristics of topography, spatial analysis technology is used to model the abstract space concept of scientific system problems in the real world, so as to solve complex application problems of topography [4].

2. CURRENT SITUATION OF TOPOGRAPHY TEACHING

Topography is an application subject which studies and makes use of landforms, with strong practicability. The emphasis of teaching is the basic knowledge of map recognition, use and plotting. Topography is a basic course, and its teaching mode is still basically traditional, that is, teacher-centered teaching. Due to the strong theoretical nature of topography and the high requirement of teaching applied skills, it is inevitable that students feel unimpressive and difficult to understand, resulting in low interest in learning and hard to grasp the teaching effect, which is an important reason restricting the improvement of teaching quality of topography. At present, it is difficult for traditional teaching methods to contrast plane topographic map and corresponding field comparison, so topographic map must be relied on in topographic teaching content. Topographic map is the abbreviation of the earth's surface, but it is a plane graph, and the corresponding

field of three-dimensional reality is rather different. It is difficult to form three-dimensional terrain information on the spot with the traditional teaching method and the process of transforming plane into three-dimensional is relatively abstract. It is not conducive to the development of teaching and students' understanding, so the teaching efficiency is also low.

In order to improve the terrain map learning and using in teaching, and ensure the practicalness of terrain training, topography teaching should make full use of advanced technology and means related to GIS, which play a positive role in teaching map recognition, map using, plotting and improving the ability of analyzing and using terrain. As an important extension and prominent achievement of modern cartography, GIS plays an important role in topographical courses. Cultivating students' ability to skillfully use ArcGIS software to solve practical problems has become an important part of course teaching.

3. ADVANTAGES OF ARCGIS IN TOPOGRAPHIC TEACHING

ArcGIS spatial analysis technology is combined with traditional education methods, and GIS software is used for terrain teaching, so as to achieve the visualization and concretization of abstract theory or terrain information, arouse students' enthusiasm for learning, enhance students' understanding and thinking ability, and improve students' creativity. With ArcGIS, complex natural elements, the spatial distribution of social phenomena and abstract concepts are presented through a three-dimensional, dynamic, intuitive way in the process of teaching. The contents which are difficult to examine and grasp in teaching can be showed intuitively. For some information related to use terrain, this technology can make it clear efficiently and accurately, so the calculation speed and precision of terrain elements are improved.

ArcGIS spatial analysis technology is used in topographic teaching, and interactive, autonomous, exploratory and networked learning methods are adopted to make it more distinctive. Its advantages are: multiple sensory stimulation, simultaneous visual and auditory perception, so that students get more comprehensive and more profound information; It can carry out virtual reality and simulation, and realize the integration of attribute data, vector data, image data and DEM (Digital Elevation Model) data. By true 3-dimension display of virtual reality and data fusion, problems can be solved, such as on-the-spot investigation at battlefield rear, distant space environment perception, geographic evolution, development process. It has achieved the ideal situation of changing abstract to concrete, static to dynamic, complex to simple, and intuitive to replace imagination. Using spatial analysis technology, battlefield

environment problems are abstracted into conceptual models to solve specific application problems related to terrain [1]. If the GIS related content is missing from the topography course, the depth and breadth of this subject will be greatly reduced.

4. APPLICATION OF ARCGIS SPATIAL ANALYSIS MODELING IN TEACHING

In order to improve the teaching quality and the level of topographic teaching informationization, topography teaching should make full use of GIS, satellite positioning and navigation, and other high-tech means. GIS is a subject developed on the basis of geography, cartography, surveying and computer science and has an independent discipline system. It has the functions of acquiring, storing, displaying, editing, processing, analyzing, output and applying of spatial data [2].

4.1. ArcGIS Spatial Analysis Modeling Features

The appearance of GIS provides an opportunity for the development of topography and infuses fresh "blood" into topography teaching. ArcGIS spatial analysis technology has the characteristics of strong operability, strong interaction and strong autonomy. It can not only collect, edit and comprehensively process geographic data, but also provides functions of map storage, management and creation, as well as strong spatial reflection function, which can intuitively and efficiently reflect complex geomorphic information. It helps to provide modern means for topographic teaching. Moreover, the application of ArcGIS spatial analysis technology in topographic teaching is not simply to introduce GIS software knowledge, but to help students apply the knowledge, technology and related controls of the software to operate a large amount of complex geographic information through the computer system, so as to achieve the purpose of further learning and exploring topographic knowledge.

4.2. Using the Idea of Modeling to Solve Practical Problems in Teaching

The establishment of ArcGIS spatial analysis Model is completed in Model Builder, which can connect data and spatial processing tools to deal with complex GIS tasks. In the model generator, input data, output data and corresponding spatial processing tools are represented by visual graphic language. They are connected by orderly steps, which makes it easier for us to understand the composition and execution process of the model, and to modify or correct the model more easily.

The process of spatial analysis modeling is essentially to express a specific process model in an intuitive graphical language. In this model, different

defined shapes are combined in the form of flow charts and can perform spatial analysis operations. At the same time, users can add extra instructions according to their own needs to make the execution process of the workflow and model easy to understand [5]. As there are many types of models constructed, they can be used to solve many practical problems in topography teaching. For example, suitability modeling refers to the modeling of land and road for certain specific development activities, including agricultural application and road selection. Surface modeling: deployment of facilities in a certain area of the town; Distance modeling: route optimization selection, choice of the best route, etc.

The establishment process of the model is mainly as follows, as shown in Figure 1:

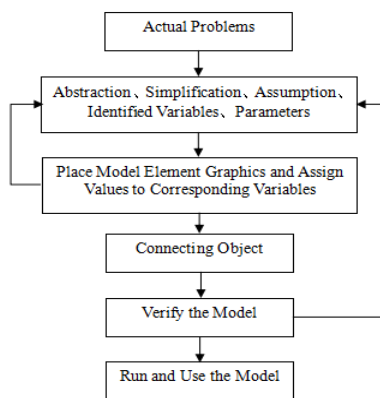


Figure 1: Flow chart of the model building

a. Clarify the problem: analyze the actual background of the problem, make clear of the purpose of establishing the model, and grasp all kinds of information relevant to the analyzed object, that is, to clarify the essence of the actual problem, not only to make sure what the problem is to be solved, what goal to achieve, but also to put forward the specific solution to the actual problem and the data needed;

b. Decompose the problem: find out the factors related to the actual problem, decompose and simplify the problem studied through hypothesis, clarify the factors that need to be considered in the model and their role in the process, and prepare relevant data sets;

c. Modeling: Using mathematical knowledge and GIS spatial analysis tools to describe the relationship among variables in the problem;

d. Test model results: Run the resulting model, interpret the results of the model, or compare the running results with actual observations. If the interpretation of the model results is consistent with the

actual situation or basically consistent, it indicates that the model is consistent with the actual problem. If the results of the model are difficult to agree with the reality, it indicates that the model is inconsistent with the reality and cannot be applied to practical problems. If there are no problems with the graphical elements and parameter settings, you need to go back to the decomposition of the problem before modeling. Check whether the decomposition of the problem and assumptions are correct, whether the choice of parameters is appropriate, whether necessary parameters are ignored or should not be retained, then make necessary modifications to the assumptions, repeat the previous modeling process until the model results are satisfying.

e. Apply analysis results: If you are satisfied with the results of the model, you can use the model to analyze the results.

4.3. The Example Analysis

Contour is the most commonly used method to represent landforms on topographic maps, however, the disadvantage is that the stereo sense of the indicated terrain is not strong. Not all students can accurately read the actual surface form that it describes. Based on GIS technology principle, using spatial analysis model tools, and graphic method to study the modeling of geographical space elements, so that the terrain information is intuitive and easy to read. Taking DEM data of a certain region as an example, the light and shade contour lines are generated by DEM data. The production process is shown in Figure 2.

Firstly, vector contour lines with a certain contour distance are extracted from DEM. The region is divided into the light part and the backlight part, the slope direction is extracted from the original DEM data, and the vector contour lines are classified according to the slope direction, so as to generate the light and shade contour map. Backlit and grated grid are determined according to the direction of incident light. For example, assuming that the light source is located in the northwest direction of the ground, the ground surface is the smooth surface when the slope direction is $0-45^\circ$ and $225-360^\circ$, which is represented by white. When the slope direction is $45-225^\circ$, the ground surface is backlit and is represented by black. Binary - that is, in terms of 0 and 1. And convert to a vector. Finally, it is superimposed with contour lines and symbolized to form light and shade contour lines. Based on the Model Builder function of ArcGIS, spatial activities, process data and process relationship flow in the

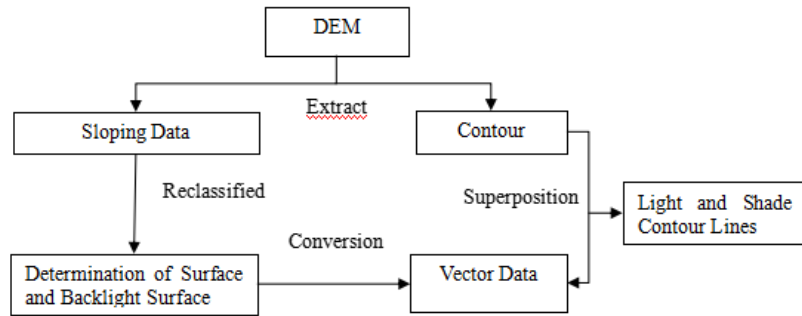


Figure 2: Flow chart of contour line making

process are defined as models, as shown in Figure 3. Then, using Model Builder, select Properties command to set parameters Raster Dataset, Output Feature Class,

Input Raster or Constant Value2, Input Raster or Constant Value2 (2).

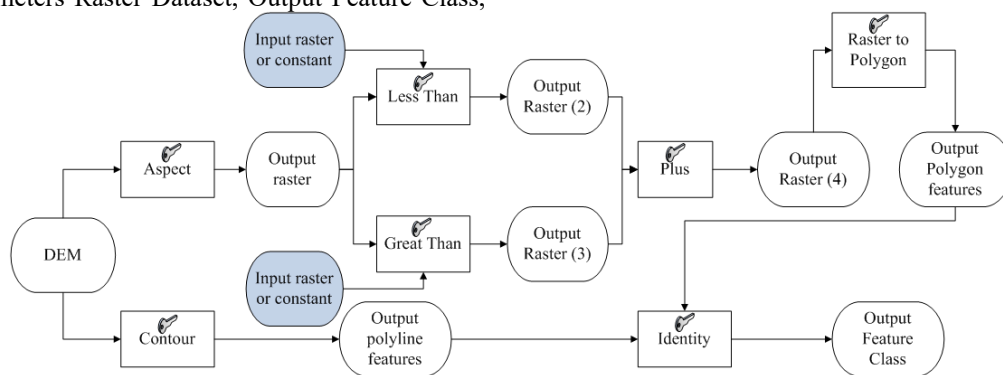


Figure 3: Model of light and shade contour

After running the model, open the generated result in ArcMap and set the color. Because there is no tool that automatically adjusts the line color to load the model, the processed contour line must be manually printed with the receiving part of the light as white, while the contour line of the backlight part is shown in black. This processing is done with the ArcMap. Students select

“data prosperities” in the ArcMap's view menu, open “frame”, modify “background”, and choose the “Grey” 40%, as shown in Figure 4.

Finally, the GRIDCODE field in the contours property table is used to set the illuminated part of the contours to white and the backlit part to black, and the result is shown in Figure 5.

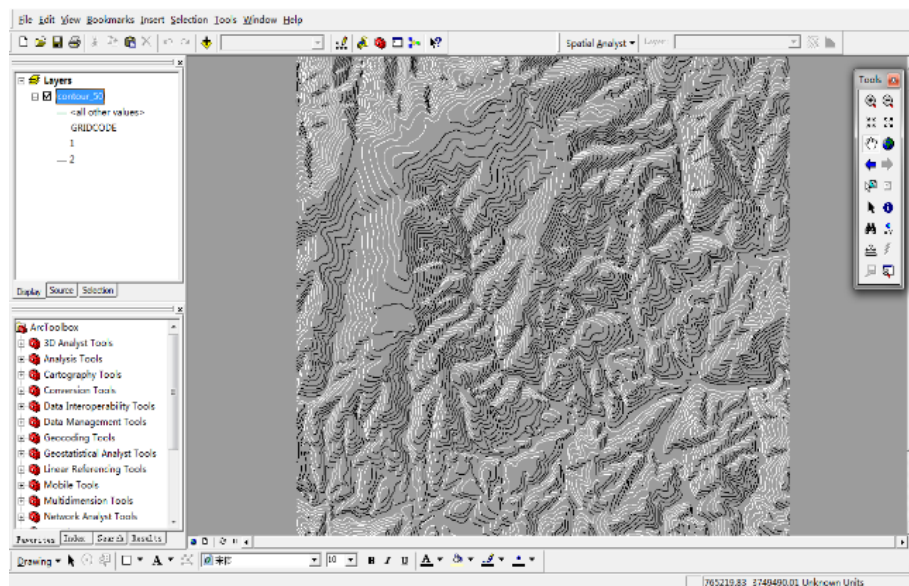


Figure 4: Data frame properties dialog box (photo credit:original)

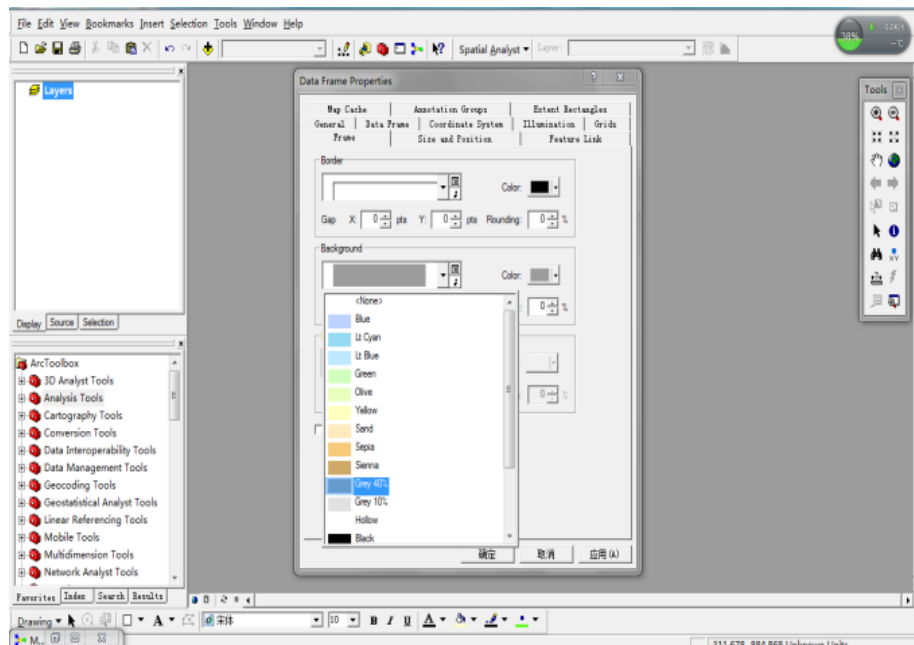


Figure 5: Map of light and shade contour (photo credit:original)

5. CONCLUSIONS

The following three conclusions are obtained by example analysis:

a. The Model Builder in ArcGIS is used to establish spatial geography Model, and to integrate the complex spatial analysis process. On the one hand, the teaching amount of information is greatly increased, and on the other hand, the intuitiveness, vividness and flexibility of topographic teaching are enhanced, so that the level of topographic teaching informatization is improved.

b. The establishment of geographic analysis model based on ArcGIS spatial analysis technology can effectively edit and manage spatial data by using spatial analysis model, which greatly improves work efficiency and makes the production of various terrain elements more scientific.

c. Based on the analysis technology of location and spatial data of geographical objects, spatial information such as elevation and slope is extracted, and spatial data is transformed into 3D graphics.

With the gradual penetration of information technology into the field of teaching, the power of ArcGIS will certainly be promoted and applied. With geographic information technology, creating an intuitive, real-time, vivid teaching environment for topography, and using various GIS software for teaching is the embodiment of the application of modern geographic information technology in topography teaching. Therefore, geographical knowledge is no longer rote memorization, but vivid images and instructions. The data analysis visualized in the diagram replaces the cumbersome data interpretation and the difficulty of the board map is lessened. Cultivating students' ability to

use ArcGIS software to solve practical problems is an important part of modern mapping science teaching. The ArcGIS software has powerful digital mapping and spatial analysis capabilities. It has become the best choice for students to practice under limited credit hours, which can also greatly promote students' understanding and mastery of modern mapping related theories, techniques and methods. The application of ArcGIS spatial analysis technology in topographic teaching provides modern teaching means for teaching, making topographic knowledge no longer rote memorization content, but vivid images and explanations, which promotes the development of topographic teaching.

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