

# 连云港连岛海滨旅游度假区三维地形景观图制作

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**摘 要** 本文以连云港市连岛为例,利用1:250 00地形图在ArcView GIS中建立DEM,采用ERDAS IMAGINE良好的三维显示功能,在自定义的投影坐标系统下,通过DEM和遥感正射影像的叠加,生成三维地形景观图,同时阐述了三维地形景观图是一种由基础测绘数字产品相互组合而形成的一种新型的复合测绘产品,并展望了三维地形景观图的应用前景。

**关键词** ArcView GIS DEM ERDAS IMAGINE 三维地形景观图

地图作为人类形象思维的一种方式,地理学的第二语言,源远流长且方兴未艾。随着计算机和通讯技术的发展以及信息化进程的加快,数字化地理信息已成为宏观决策、规划、管理等不可缺少的支撑条件。各种基于测绘产品的立体图、景观图应运而生。目前,随着基础测绘生产项目的开展,各测绘单位都生产大量“4D”(DEM、DOM、DRG、DLG)产品,如何最大程度地利用这些数字产品是当前需要认真研究的问题。

三维地形景观图是采用透视学原理,将DRG投影到DEM模型上,利用DEM模型的三维特性在视觉上产生立体效果,使地形图更直观、易读<sup>[1]</sup>。

ArcView GIS作为被广泛利用的GIS软件之一,可完成大量矢量数据、影像数据的管理,并对多种数据进行融合、转换和建立拓扑关系等。且相对于ArcGIS等大型GIS软件而言,其易掌握性较高,对PC机硬件的需求较低,适合进行低层次的制作和开发。ERDAS IMAGINE不但精于处理栅格数据,而且处理矢量数据的功能也十分强大,特别是与ArcView GIS数据格式的兼容,可以不经转换地读取、查询、检索ArcView GIS生成的Coverage、Grid、Shapefile矢量数据,非常方便地进行跨平台数据处理和数据交换,并提供了多种动态观察功能,从而高效快捷地创造一个虚拟三维真实世界。

本文利用上述两种软件,以近海岛屿、国家4A级旅游度假区——连云港市连岛为例,进行三维地形景观图的制作。

## 1 DEM制作方法

### 1.1 DEM简介

DEM是数字高程模型(Digital Elevation Model),它是利用一个任意坐标场中大量选择的已知 $x$ ,  $y$ ,  $z$ 的坐标点对连续地面的一个简单统计表示,也就是说DEM就是地形表面的简单数学表示。DEM的应用在于通过计算机采用一定的算法,能很方便地将DEM数据转换为等高线图、透视图、断面图以及专题图等各种图解产品,或按照用户的需求计算体积、空间距离、表面覆盖等工程数据和统计数据,同时,DEM还可以与高分辨率遥感影像图相结合,制作出信息丰富、视角逼真的三维地形景观图。

### 1.2 DEM制作方法

DEM的主要制作方法通常有以下3种:数字摄影测量方法、数字化地形测量方法和现有地形图扫描矢量化方法。

全数字摄影测量方法利用PC机和数字摄影测量软件(DPS),能高效地生产DEM。当前的技术甚至可以与GPS自动空中三角测量系统集

成,形成了从外业控制到内业加密和DEM生成,更自动化、更高效的作业流程。这种方法技术成熟,特别适用于大区域、地形连续、全局性DEM表面建模,但设备软件投入大,生产成本高。数字化地形测量方法是利用自动记录的全站仪在野外实测。这种方法工艺流程简单,生产成本较低,但自动化程度较低,生产周期长、效率低。

本文采用的是通过现有地形图扫描矢量化后制作DEM这一普遍采用的方法。采用这种方法的原因是作为元数据的纸质地形图比较容易获取,成本低,另外该方法工艺流程简单,不需要投入大量设备,可按工程的规模实时组织进行。

ArcView GIS中制作DEM步骤如下:

(1)对连岛1:250 00纸质地形图进行扫描。然后根据一定的投影系统对扫描后的影像进行几何校正和配准。

(2)在配准后的地形图上完成等高线的数字化和编辑。

(3)在ArcView GIS的Surface菜单中选择Creat Tin from Features...项,设置Height source为等高线的高程后生成不规则三角网。

(4)在Theme菜单下选择Convert to Grid...项,将生成的不规则三角网转换成网格格式(如图1所示)。

## 2 三维地形景观图制作

影像不仅仅是地球表面的描述,还是一个捕

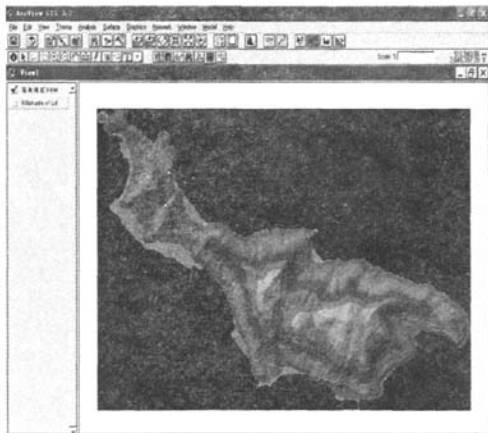


图1 DEM制作效果图

捉在特定时间和位置下,目前世界上所发生事件的有用的数据源,通过影像可以研究地球随时间的变化。ERDAS IMAGINE提供了处理和理解这些数据的工具。ERDAS IMAGINE的虚拟地理信息系统(Virtual GIS)给用户提供一种对大型数据库漫游操作的途径,超越了简单的三维显示或建立简单的飞行穿行观察,它能在真实的拟地理信息环境中进行交互处理,既能增强或查询叠加在三维表面上影像的像元值及相关属性,还能可视化,风格化和查询地图矢量层的属性信息,另外它的一些功能可在防灾、减灾中发挥巨大作用。

制作三维地形景观图步骤如下:

(1)启动Virtual GIS窗口,打开DEM文件后叠加与DEM具有相同地图投影坐标系统的影响文件,并在Select Layer To Add对话框的Raster Options选项卡中确定文件类型和图像显示详细程度等参数,百分比越大,详细程度越高,但数据量也随之增大,运行速度变慢。

(2)在View菜单中选择Sun Positioning...项来调整太阳光源位置,以达到更好的三维显示效果。太阳光源位置包括太阳方位角、太阳高度以及光线强度等参数。



图2 飞行效果图(红线为飞行路线)

(3)根据实际工程需要调整视景特性(Scene Properties),视景特性包括DEM显示特性、背景显示特性和立体显示特性等多个方面。

(4)设置完成后,创建一个二维全景窗口,在全景窗口中利用飞行路线编辑器数字化飞行路线,再设置相应的飞行路线高度和飞行路线特

性。完成后在飞行编辑器中执行飞行操作就可真切地感受到连岛地形(见图2)。如果想增强三维景观图在可视化方面的真实感,还可以在三维场景中增加建筑物、树木等模型。

### 3 其他扩展应用

在以上构建的景观图中还可叠加多种属性数据层,进行多种专题分析。

在Virtual GIS中可以叠加洪水层(Overlay Water Layers),以进行洪水淹没状况分析。在系统提供的Fill Entire Scene模式中,对整个可视范围增加一个洪水平面,水位的高度可以调整以模拟洪水的影响范围;在Creat Fill Area模式中,可选择点进行填充,Virtual GIS将模拟比选择点低的地区所构成的“岛(Island)”的范围,计算出“岛”的表面积和体积。图3表示的是在Fill Entire Scene模式中水深100m时的淹没状况。



图3 Fill Entire Scene模式中洪水淹没状况分析

Virtual GIS的模拟雾气分析功能,提供了一种模拟近地面薄雾与地形上方浓雾的实现途径,实质上就是借助与一系列不同透明程度的层的组合,形成类似于雾气密度的模拟雾层,层数越多,模拟的雾层越逼真<sup>[2]</sup>。

空间视域分析功能是进行空间形态分析的新方法。在视域的行为指导原理上,采用可视集中

性的概念来进行可视分析,进而通过可视分析各参数的具体量化。可以在三维虚拟视景中任意设置观测者,并按照一定的条件创建观测者的可视领空范围,从而进行相互通视分析,可以应用于军事威胁性或防御性分析。也可以应用于民事,在室内完成建筑物高度及其通视性规划、通讯大厦及广播电视发射塔的设计、新型商业网点服务范围的分析等,减少开支,提高最终方案的设计质量<sup>[3]</sup>。

### 4 结 语

从以上操作可以看出,在ERDAS IMAGINE中制作三维立体景观图基本上不需要太复杂的步骤就可以得到比较理想的效果。三维地形景观图是在电子地图技术的基础上,利用虚拟现实技术制作的电子沙盘实景,它实时的给出地物、地形、地貌环境,可以根据不同的需要,对于同一个地形形态作各种不同的立体显示<sup>[5]</sup>。由于三维立体景观图具有很强的真实感、可读性和丰富的信息含量,所以其在地球科学研究中具有很重要的应用价值。在勘察复杂的地质现象,寻找矿藏,工程规划和优化设计方面的优势尤其明显。而连云港连岛三维地形景观图的制作通过形象逼真的视角将连岛海滨旅游度假区全方位地展现出来,对连云港市旅游经济的发展将起到一定的促进作用。同时,三维地形图的扩展应用能在海岛发生气象、地质灾害时方便政府部门进行灾情预计和灾后重建。

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## 相似文献(10条)

1. 外文会议 [Jong-Gun Kim](#), [Younshik Park](#), [Dongsun Yoo](#), [Nam-Won Kim](#), [Bernie Engel](#), [Sung-jun Kim](#), [Ki-Sung Kim](#), [Kyoung Jae Lim](#) [Development of a SWAT ArcView GIS Patch for Accurate Analysis of Soil Erosion and Sediment Yield at Steep Sloping Watershed](#)

The watershed scale SWAT model divides the watershed into smaller subwatersheds for rainfall-runoff and pollutant generation at the field level and routing through stream networks. The SWAT model first needs to be calibrated and validated for accurate estimation through adjustment of various input parameters. However, in some instances the SWAT simulated results are greatly affected by the watershed delineation and DEM cell size. In this study, the SWAT ArcView GIS Patch II was developed for steep sloping watershed and its performance was evaluated for various threshold value and DEM cell size scenarios when delineating subwatersheds using SWAT. The SWAT ArcView GIS Patch II was developed using the ArcView GIS Avenue program and Spatial Analyst library. The SWAT ArcView GIS Patch II is better than the SWAT ArcView GIS Patch I by Lim et al. (2007) because it reflects the topographic factor in calculating the field slope length of the HRU in the SWAT model. The simulated sediment value for 321 watershed (threshold value of 200 ha) is greater than that for 43 subwatershed (threshold value of 25ha) by 201% without applying the SWAT ArcView GIS Patch II. However, when the SWAT ArcView GIS Patch II was applied, the difference decreases (12% difference) for the same scenario. The simulated sediment value for DEM cell size of 50m is greater than that for DEM cell size of 10m by 19.80% without the SWAT ArcView GIS Patch II. However, the difference becomes smaller (3.41% difference) between 50m and 10m DEM scenarios. As shown in this study, the SWAT ArcView GIS Patch II can reduce differences in simulated sediment values for various watershed delineation and DEM cell size scenarios. Without the SWAT ArcView GIS Patch II, variations in the SWAT simulated results using various watershed delineation and DEM cell size scenarios could be greater than those from input parameter calibration. The results obtained in this study show that the SWAT ArcView GIS Patch II needs to be used when simulating hydrology and water quality for steep sloping watersheds (especially if average slope of the subwatershed is greater than 25%) for accurate simulation of hydrology and water quality using the SWAT model. The SWAT ArcView GIS Patch II is available at <http://www.EnvSys.co.kr/~swat> for free download.

2. 外文期刊 [Jong-Gun Kim](#), [Younshik Park](#), [Dongsun Yoo](#), [Nam-Won Kim](#), [Bernard A. Engel](#), [Seong-joon Kim](#), [Ki-Sung Kim](#), [Kyoung Jae Lim](#) [DEVELOPMENT OF A SWAT PATCH FOR BETTER ESTIMATION OF SEDIMENT YIELD IN STEEP SLOPING WATERSHEDS](#)

The watershed scale Soil and Water Assessment Tool (SWAT) model divides watersheds into smaller subwatersheds for simulation of rainfall-runoff and sediment loading at the field level and routing through stream networks. Typically, the SWAT model first needs to be calibrated and validated for accurate estimation through adjustment of sensitive input parameters (i.e., Curve Number values, USLE P, slope and slope-length, and so on). However, in some instances, SWAT-simulated results are greatly affected by the watershed delineation and Digital Elevation Models (DEM) cell size. In this study, the SWAT ArcView GIS Patch II was developed for steep sloping watersheds, and its performance was evaluated for various threshold values and DEM cell size scenarios when delineating subwatersheds using the SWAT model. The SWAT ArcView GIS Patch II was developed using the ArcView GIS Avenue program and Spatial Analyst libraries. The SWAT ArcView GIS Patch II improves upon the SWAT ArcView GIS Patch I because it reflects the topographic factor in calculating the field slope-length of Hydrologic Response Units in the SWAT model. The simulated sediment value for 321 subwatersheds (watershed delineation threshold value of 25 ha) is greater than that for 43 subwatersheds (watershed delineation threshold value of 200 ha) by 201% without applying the SWAT ArcView GIS Patch II. However, when the SWAT ArcView GIS Patch II was applied, the difference in simulated sediment yield decreases for the same scenario (i.e., difference in simulated sediment with 321 subwatersheds and 43 subwatersheds) was 12%. The simulated sediment value for DEM cell size of 50 m is greater than that for DEM cell size of 10 m by 19.8% without the SWAT ArcView GIS Patch II. However, the difference becomes smaller (3.4% difference) between 50 and 10 m with the SWAT ArcView GIS Patch II for the DEM scenarios. As shown in this study, the SWAT ArcView GIS Patch II can reduce differences in simulated sediment values for various watershed delineation and DEM cell size scenarios. Without the SWAT ArcView GIS Patch II, variations in the SWAT-simulated results using various watershed delineation and DEM cell size scenarios could be greater

than those from input parameter calibration. Thus, the results obtained in this study show that the SWAT ArcView GIS Patch II should be used when simulating hydrology and sediment yield for steep sloping watersheds (especially if average slope of the subwatershed is >25%) for more accurate simulation of hydrology and sediment using the SWAT model.

### 3. 期刊论文 [舒振文, 张火青 ArcView GIS在流域水文特征分析中的应用 - 人民长江2001, 32 \(9\)](#)

Arc ViewGIS(以下简称ArcView)是美国环境系统研究所(ESRI)的系列产品之一。ArcView是一种“基于GIS的桌面制图系统”软件,它不仅具有强大而丰富的空间数据编辑、查询和分析、可视化等GIS功能,而且还可以方便、灵活地制作各种专题地图,设计了一种在Arc View GIS中利用数字高程模型(DEM)进行流域水文特征分析计算的新方法。包括如何利用DEM自动识别流域边界并提取流域特征;不同蓄水位条件下,水库的淹没范围,淹没深度分布情况及库容的计算。这种方法与手工计算相比,具有高精度、高效率的优点。

### 4. 外文会议 [F. H. Jaber, R. H. Mohtar ARCVIEW INTERFACE TO A 2-D FINITE ELEMENT OVERLAND FLOW MODEL](#)

Overland flow modeling can be physically represented by the kinematic wave equations. These are partial differential equations with respect to time and space (X and y). Analytical solutions for these equations are only available for very simple and limited cases. The kinematic wave equations are usually solved using traditional numerical methods such as finite differences and finite element methods. A model developed by Vieux and Mohtar in 1990 (FORTRAN) was able to solve this equation for a variety of scenarios using the finite element method. Since this is a spatially distributed model, its potential cannot be fully reached unless it is coupled with a GIS system. This paper presents an interface to the Finite element model with Arcview GIS. To run the model we need a DEM, a slope map, a landuse map, (to generate Manning's roughness). Additional maps maybe needed later if infiltration need to be included in the model. The outcome is a map of flow depth and velocity at each point in the watershed. A hydrograph can be generated also. Avenue scripting was used for developing the Arcview Interface to the two dimensional model.

### 5. 期刊论文 [Mushtak Talib Jabbar Application of GIS to Estimate Soil Erosion Using RUSLE - 地球空间信息科学学报\(英文版\)2003, 6 \(1\)](#)

This paper describes the use of the Arc/Info and ArcView GIS tools to estimate soil erosion with Universal Soil Loss Equation (USLE). Calculations are done by using capabilities available. This study start with a digital elevation model (DEM) of Shaanxi, which was created by digitizing contour and spot heights from the topographic map on 1:250 000 scale and grid themes for the USLE K and C factors. It is note worthy that USLE K can be obtained by adding the K factor as an attribute to a soil theme's table. The C can be obtained from tables or using the information about land use and management given by USLE program. A land use theme can be used to add the C factors as an attribute field. The purpose of this study is to establish spatial information of soil erosion using USLE and GIS and discuss the analysis of the soil erosion and slope failures in GIS and formulate the possible framework.

### 6. 外文会议 [SHANKER KUMAR SINNAKAUDAN, AMINUDDIN AB GHANI, CHANG CHUN KIAT, MOHD SANUSI S. AHMAD, NOR AZAZI ZAKARIA INTEGRATED TRIANGULAR IRREGULAR NETWORK \(ITIN\) MODEL FOR FLOOD RISK ANALYSIS CASE STUDY: PARI RIVER, IPOH, MALAYSIA](#)

Accurate river channel and flood plain representation plays vital part in flood risk analysis. Terrain models such as TINs and DEMs are normally used to represent floodplains. But unfortunately finding a terrain model with a high density of stream channel elevation points that are sufficient for hydraulic modeling is not a easy task. However for years engineers and researchers have developed a high-resolution cross-section data for hydraulic modeling from field surveys, photogrammetries and topographic maps. This research presented here introduces the procedures for creating integrated multiresolution TIN (ITIN) models for highresolution flood plain representation for flood risk analysis. The high-resolution river channel geometric data stored in HEC-6 hydraulic model and low-resolution flood plain data in the form of DEM created in ArcView GIS 3.2a were integrated by resolving the coordinate incompatibility in the both system. An integration procedure (ArcView extention) namely AVHEC6. avx has been developed between HEC-6 Hydraulic Model and ArcView GIS 3.2a to visualize model outputs in a more presentable manner through 3D capabilities of GIS.

### 7. 期刊论文 [张伟 基于DEM的沟谷地貌自动提取与实现技术 - 人民黄河2004, 26 \(5\)](#)

基于数字高程模型的GIS空间信息提取与分析方法是获取地形要素的重要手段。以栅格数字高程模型为基本信息源,以地理信息系统软件ArcView GIS及其面向对象的二次开发环境Avenue为技术平台,对黄土丘陵沟壑区沟谷地貌特征进行了综合分析,并以丘陵沟壑区为样区实现了沟间地、沟坡地和沟底地等基本地形因子的自动提取。试验结果表明,利用DEM提取基本地貌类型速度快、效率高。

### 8. 期刊论文 [杜军, 林孝松 校园环境规划中DEM的建立及应用 - 重庆交通学院学报2004, 23 \(z1\)](#)

在Arcview GIS基础上主要介绍了在校园环境规划中DEM的建立方法,及其在校园规划中的应用进行了探讨。文章以某高校为例,通过建立其数字高程模型的地形图数字化方法和GPS定位方法等,绘出校园地理专题地图,并进行三维立体直观感受分析利用,对校园环境规划的信息化进行了应用研究。

### 9. 期刊论文 [郑卫江, 张爱武, 侯敏, Zheng Weijiang, Zhang Aiwu, Hou Min 数字高程模型的原理与应用——以北京市周口店地区为例 - 首都师范大学学报\(自然科学版\)2007, 28 \(4\)](#)

数字高程模型(DEM)作为地球空间信息框架的基本内容已经成为各国十分重视的基础地理信息产品,并在国民生产中发挥着越来越大的作用。ArcView GIS软件是ESRI公司开发的桌面GIS开发系统,软件功能十分强大。论文首先简要介绍了数字高程模型的相关概念和原理,并应用ArcView GIS软件对周口店地区数据进行处理,重点讨论了软件的空间和3D分析模块在DEM上的应用功能,完成对土地进行适宜性评价、3D建模等分析工作,并给出了分析结果。

### 10. 外文期刊 [Raimundo Alípio de Oliveira Leao, Adunias dos Santos Teixeira, Eunice Maia de Andrade,](#)

[Francisco Olivera Delimita e caracteriza o território automático de uma micro-bacia hidrográfica da Fazenda Experimental Vale do Curu - Pentecoste-CE Automatic delimitation and characterization of a catchment located at the Fazenda Experimental Vale do Curu in Pentecoste County - Brazil](#)

Este trabalho visou à comparação dos resultados de duas metodologias de delineamento e caracterização de uma bacia hidrográfica da Fazenda Experimental Vale do Curu em Pentecoste - Brasil (3° 48' 49.1" S; 39° 20' 17.8" W 2.). Os resultados obtidos pela extensão CRWR-PrePro do software ArcView foram comparados com o método tradicional (uso de planímetro e curvímeter). A base de dados foi extraída de um mapa topográfico na escala de 1:5000, com curvas de contorno espaçadas a cada 5 m. O mapa topográfico foi amostrado segundo uma grade de elevação de 50 x 50 m pela interpolação digital (DEM). Usando-se a extensão CRWR-PrePro do ArcView GIS 3.2, identificaram-se duas bacias com mais de 300 ha, uma das quais foi analisada. Considerou-se os seguintes parâmetros: perímetro, área, número e comprimento de cursos, densidade de drenagem, comprimento do curso principal, comprimento

e declividade da bacia, fator de forma e relação de circularidade. Os resultados apresentaram uma subestimativa por parte de CRWR-PrePro dos parâmetros área total (5,4%), declividade do curso principal (8,7%), declividade da bacia (5,4%), fator de forma (16,7%) e relação de circularidade (8,1%) e superestimativa para perímetro (24,9%), comprimento de cursos (17,4%), densidade de drenagem (24,1%), comprimento do curso principal (8,4%) e comprimento da bacia (4,8%). O número de cursos foi o mesmo para os dois métodos. Concluiu-se que os métodos apresentaram resultados cujas diferenças são irrelevantes no gerenciamento de bacias, com a vantagem de padronização, facilidade e rapidez na análise com o uso da extensão CRWR-PrePro.

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