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Scientific Methods and Writing

Assignment 1

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Space greatly influences the extraction of dune entities using the Digital Terrain Analysis (DTA) method. DTA is a digital information processing technique that uses Digital Elevation Models (DEMs) to calculate terrain attributes and extract characteristic factors. It creates a mathematical representation of the terrain surface to depict the landscape and extract various landforms. DEMs are used to compute topographic attributes and extract feature factors, including sand dune landforms found in arid and semi-arid zones worldwide. However, there have been limited studies on automating the identification and extraction of these landforms using the DTA method. Therefore, research on extracting wind-sand landforms, particularly focusing on sand dune entities, is one of the main areas in DTA research. Space plays a crucial role in determining the precision and contour accuracy of extracted dune patches using the DTA method. These impacts primarily arise from differences in spatial scale, spatial location, and geospatial complexity.

Spatial location will have an important impact on the extraction of the extent of dune entities, which mainly comes from the differences in availability of dune categories and high-resolution data in different geographical locations. As a kind of sand source accumulation formed under the action of wind forces, sand dunes generally show different shapes and distribution characteristics due to the comprehensive influence of local wind conditions, sand source availability, underlying terrain, and other factors. The current dune extraction scheme based on DTA proposed by GIS researchers usually uses slope, aspect, and relief as terrain quantitative factors, and uses hierarchical thresholds to segment dune entities and inter-dune areas. This poses a problem: to extract dunes with different morphological features, it is necessary to select different reference terrain factors and set different terrain factor classification thresholds, which will greatly increase the difficulty of dune extraction. At the same time, the extraction of some dune entities relies on high-precision DEM or laser point cloud data. Affected by geographical location and natural conditions, the original data required for dune extraction based on DTA is not easy to obtain, which will result in constraints on dune extraction research in this area.

Apart from the heterogeneity of regional natural features brought about by spatial location, changes in spatial scale will also have an impact on the extraction of the extent of dune entities based on the DTA method, which comes from the differences in the topographic factor analysis window. On the one hand, the terrain factor derived from DEM serves as a fundamental data for identifying dune range, and its calculation is influenced by the size of the neighboring window. As a result, different window sizes produce significantly different terrain factor results at the same raster location, indicating a clear scale effect. On the other hand, there is a strong correlation between the fitness of morphological features of dune entities and the analytical window size with regards to extraction accuracy. For instance, linear dunes widely found in Australia are typically large-scale, narrow, and long due to prevailing wind direction and synthetic sand transport direction control. These dunes have a stable width

ranging from 60m to 120m; therefore, an analysis window measuring 90m*90m is highly suitable for them. However, extending this window to accommodate dunes of varying scales would yield much worse result than in Australia.

Geospatial complexity will also have an impact on the extraction of the extent of dune entities based on the DTA method. In the automated extraction experiment of sand dunes, the individual independence and contour integrity of the dune extraction results are important indicators for evaluating the accuracy of the results. As mentioned before, dune landforms will be affected by the base topography and wind conditions of the location, thus showing different distribution patterns. Therefore, once the spatial complexity of the underlying terrain in the area increases, or the dunes have irregular adhesion and interaction due to the secondary wind, the topographic indication effect of the topographic factors extracted based on the DTA method on the dune landforms will weaken, which will further affect the to the accuracy of overall dune extraction.

In general, the impact of space on the study of dune entity extraction based on DEM data sources and DTA methods cannot be overlooked. Specifically, the spatial location affects both the shape and availability of data for dune entities. The scale effect caused by the spatial analysis scale will have an important impact on the identification of dune patches, but it may also provide with better extraction results in some high-fitness situations. The high complexity of geographical space will affect the independence and accuracy of dune extraction results. Therefore, we can design a dune extraction model with optimal accuracy by fully understanding how a specific space affects dune entity extraction and at the same time grasping the characteristics of dune objects. I am also researching and exploring in this area now, hoping to develop a new model for characterizing dune objects that is different from traditional methods.