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To cite this article: Dandan Su 2020 *J. Phys.: Conf. Ser.* **1678** 012036

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# Classification Research on DEM Resolution Determination Method Based On Slope Topographic Factor

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**Abstract.** The determination of optimum DEM resolution is helpful to improve the accuracy of the research results. The classification of DEM resolution based on topographic factor is studied. This paper classifies and expounds DEM resolution determination method from four aspects of "micro topographic factor", "macro topographic factor", "micro and macro composite slope topographic factor" and "slope topographic factor extension factor", which provides reference for the quantitative determination of optimal DEM spatial resolution in the future.

## 1. Introduction

Digital elevation model (DEM) is the digital simulation of terrain surface or the digital representation of terrain surface morphology through limited terrain elevation data, and it is the carrier of various geographic information. Determining the accuracy of DEM spatial resolution in the study area directly affects the accuracy of extracted data. How to accurately determine the DEM spatial resolution of the study area is the premise and guarantee for the study of extracting topographic parameters and river network parameters. Over the years, scholars have conducted a large number of studies on the determination of DEM spatial resolution, which can be basically determined from qualitative to quantitative in a designated research area. However, how to ensure the universality and optimum of DEM spatial resolution determination method will be the focus of future studies. In order to advance the research work, this study mainly summarizes, summarizes and analyzes the DEM spatial resolution determination methods of the past ten years. This paper systematically studies the classification and it offers some Suggestions for the future research on the quantitative determination of optimal DEM resolution based on slope topographic factor.

## 2. Classification research on DEM resolution determination method based on slope topographic factor

Slope terrain factor is the most basic content in digital terrain analysis. Slope topographic factor is a mathematical parameter or index with certain significance set for quantitative expression of geomorphologic feature. According to the spatial range of topographic factors, topographic factors can be divided into micro topographic factors and macro topographic factors. Micro-slope topographic factors mainly include slope, slope direction, slope variation, slope direction variation, plane curvature, profile curvature and slope length. The macroscopic topographic factors include slope shape factor, topographic roughness, topographic relief, coefficient of elevation variation, and surface cutting depth.

The research methods for quantitative determination of DEM spatial resolution mainly include four aspects: "based on micro-slope topographic factor", "macro-slope topographic factor", "composite slope topographic factor of micro-and macro-slope" and "extended factor of slope topographic factor".



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### *2.1. DEM resolution determination method based on micro-slope topography factor*

In the quantitative determination of DEM resolution based on micro-slope topographic factor, "slope" topographic factor is one of the indispensable important factors. Experiments were carried out in the loess hilly and gully region[1], and it was found that within the range of 200m DEM resolution, the relationship between average slope and DEM spatial resolution presented a logarithmic function, which was consistent with the conclusion that within the range of 75m DEM resolution, the relationship between average slope and DEM spatial resolution presented a linear function. However, the extension of DEM resolution from 75m to 200m proves that there is a linear functional relationship between slope and DEM spatial resolution. With the deepening of the study, slope, slope direction, plane curvature and profile curvature were introduced into the study[2]. By using EXCEL data statistics software, the corresponding data of slope, slope direction, plane curvature and profile curvature extracted from different DEM spatial resolution were statistically analyzed by comparative analysis and chart method, and the change rule of these four terrain factors with DEM spatial resolution was analyzed. According to the comparison of change rules, DEM spatial resolution suitable for the study area is selected. However, the above researches are qualitative and regular studies, and how to carry out quantitative research on DEM spatial resolution is the focus of subsequent studies. Considering that "slope" terrain factor has a major influence on the determination of DEM resolution, a quantitative method for establishing the best DEM resolution is started by calculating slope mean error, median error, standard deviation and root mean square[3]. The above is only a research method to determine DEM resolution from qualitative to quantitative based on micro-slope topography factor.

### *2.2. DEM resolution determination method based on macroscopic slope topographic factor*

Roughness terrain factor plays a very important role in determining DEM spatial resolution based on macro slope terrain factor. By analyzing the roughness of Luzhou city under different DEM spatial resolutions[4], the regular relationship between roughness and DEM resolution is determined. The determination of DEM resolution based on the macro-slope topographic factor only obtained the results of qualitative and regular studies. Slope, slope direction, slope change rate and slope change rate of various microterrains were extracted under different scales. The correlation between microtopographic change and observation scale is studied qualitatively by slope and slope direction, and the range of slope and slope direction change can be obtained by studying slope change rate and slope direction change rate. Similarly, DEM resolutions of various microterrains can be deduced reversely according to slope, slope direction, slope change rate and slope change rate. The variation of microtopography under different observation scales is obviously different.

### *2.3. DEM resolution determination method based on micro and macro composite slope topography factor*

In order to improve the accuracy of DEM resolution determination in a larger study area, the method of combining macroscopic and microscopic slope topographic factors is considered, that is, qualitative and quantitative research on DEM spatial resolution based on microscopic and macroscopic composite slope topographic factors is carried out. Based on different DEM resolution, we can extract the micro slope topography factor "slope", "slope", "surface curvature" and "profile curvature", as well as the macro slope terrain factor "roughness". We analyze these five different slope terrain factor in DEM resolution in trends. In a larger study area, we qualitatively determine the most appropriate DEM resolution [5]. With the decrease of resolution, the roughness of terrain description increases, and the generalization becomes higher, resulting in the decrease of slope gradient. In the aspect of slope aspect research, the area ratio gradually decreases with the roughness of resolution in flat areas. On the whole, with the roughness of resolution, the area ratio of each type of slope does not change much except for flat areas. The maximum value of surface roughness gradually decreases with the decrease of resolution, and the variation frequency between the maximum values is small. The mean value of

roughness decreases with the decrease of resolution, but the variation between the mean values is relatively stable.

#### *2.4. DEM resolution quantitative determination method based on extended factor of slope topographic factor*

In order to achieve quantitative determination of DEM resolution in a larger study area, extended factors of topographic factors such as "topographic classification number", "topographic texture feature" and "topographic humidity index" were introduced. Based on the resolution of 25m, the multi-scale ground slope, lighting simulation and roughness data sequence is constructed, and the spatial grayscale symbiosis matrix is introduced to conduct quantitative analysis of terrain surface texture features, revealing the qualitative relationship between terrain texture parameters and the most appropriate DEM resolution[6]. The raster calculator in map algebra of ARCGIS is applied to extract topographic humidity index with different DEM resolution, and the relationship between DEM resolution and topographic humidity index is qualitatively studied through the regional statistics of topographic relief and coefficient of variation<sup>[7]</sup>.

### **3. DEM resolution determination method based on river network topographic parameters**

The shape of landform is closely related to the function of river system. The application of ArcGIS technology, combined with fractal fractal dimension theory and statistical analysis method, reflects the coupling influence degree of local river system and terrain factors. The application of river system related factors of topographic factors and the qualitative and quantitative indirect application of slope factors to determine DEM resolution are also the key contents of the study.

#### *3.1. A qualitative determination method of DEM resolution based on river network extraction parameters*

The qualitative determination method of DEM resolution based on river network extraction parameters is mainly to approximate the DEM spatial resolution suitable for the study area by studying the qualitative and regular study between DEM spatial resolution and river network extraction parameters. The relation between DEM spatial resolution and river basin area, river network position, river boundary, river network line length and longest river length is studied. It is found that DEM resolution increase has no obvious influence on river basin area and river network position, but both river boundary and river network line length have influence, and the longest river length may become longer or shorter. The relationship between runoff simulation of small watershed and DEM spatial resolution was studied. With the decrease of DEM resolution, watershed area decreased and longest channel length became shorter. With the increase of DEM resolution, the error of runoff in small watershed decreases[8,9]. DEM resolution decreases, peak and valley values of simulated and measured runoff are homogenized, and the error increases. The relation between DEM resolution and river network extraction parameters was studied by using ARCGIS hydrological analysis tool. The statistical analysis of EXCEL shows that DEM resolution has little influence on the area, elevation and slope direction of small watershed, but has great influence on slope, river length, river network density and river classification[10,11].

#### *3.2. DEM resolution quantitative determination method based on river network extraction parameters*

The quantitative determination method of DEM resolution based on river network extraction parameters mainly studies the functional relationship between DEM resolution and river network extraction parameters, and calculates the optimal DEM resolution of the study area. Due to the influence of DEM spatial resolution with scale effect and confluence area threshold and other parameters in the extraction process of digital river network, the result of river network extraction is highly subjective. Therefore, how to optimize the value of both is of great significance for more accurate simulation of surface river network[12].

The relationship between the total length of the channel and the threshold and DEM resolution satisfies a compound function expression. When the threshold remains unchanged, the total length of the river decreases with the decreasing of DEM resolution. On the contrary, when DEM resolution is determined, the total length of channel decreases with the increasing of threshold. The DEM spatial resolution satisfies the complex function expression between the total length of channel and the threshold of catchment area. The optimum DEM spatial resolution and catchment area threshold are analyzed and calculated by using mathematical principle. The "Thousandmillion" empirical formula for calculating the ratio of grid area to basin area is less than 0.05 can be used to quantitatively determine THE DEM spatial resolution. There is a power function relationship between DEM spatial resolution and the number of river split points, and the number of split points decreases with the decrease of DEM spatial resolution, which conforms to the law of power function decline. Based on DEM data and hydrologic analysis principle, the relationship between river specific drop and threshold of catchment area, number of sections of main channel and DEM spatial resolution is quantitatively analyzed, so as to calculate the optimal DEM resolution of average river specific drop<sup>[13]</sup>.

#### 4. Conclusion

This study mainly focuses on "relevant methods to determine DEM resolution based on slope topography factor" to qualitatively and quantitatively determine the most appropriate DEM resolution within the study area. "DEM resolution determination method based on slope topographic factor" can be divided into "DEM resolution determination method based on microslope topography factor", "DEM resolution determination method based on macroscopic slope topographic factor", "DEM resolution determination method based on micro and macro composite slope topography factor" and "DEM resolution quantitative determination method based on extended factor of slope topographic factor". This study elaborated from the above four aspects, and fully demonstrated the influence of slope topography factor in the process of determining DEM resolution from qualitative to quantitative, which provided a powerful reference for the future quantitative determination of optimal DEM resolution.

#### Acknowledgments

This work was financially supported by "The Science and technology project of the 13th five-year plan of The Education Department of Jilin Province "The study on the drainage extraction and offset control algorithm of adaptive composite terrain"(No.JJKH20181183KJ)" fund and "The General topic of higher education research of The Jilin province society of education in 2018 "Research and practice on the training path of interdisciplinary compound talents of Urban and rural planning and geographic information science based on the SOI mode" (No.JGJX2018D33)" fund.

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