

Geomorphology Classification of Shandong Province Based on Digital Elevation Model in the 1 Arc-second Format of Shuttle Radar Topography Mission Data

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Abstract. Based on digital elevation model in the 1 arc-second format of shuttle radar topography mission data, using the window analysis and mean change point analysis of geographic information system (GIS) technology, programmed with python modules this, automatically extracted and calculated geomorphic elements of Shandong province. The best access to quantitatively study area relief amplitude of statistical area. According to Chinese landscape classification standard, the landscape type in Shandong province was divided into 8 types: low altitude plain, medium altitude plain, low altitude platform, medium altitude platform, low altitude hills, medium altitude hills, low relief mountain, medium relief mountain and the percentages of Shandong province's total area are as follows: 12.72%, 0.01%, 36.38%, 0.24%, 17.26%, 15.64%, 11.1%, 6.65%. The results of landforms are basically the same as the overall terrain of Shandong Province, Shandong province's total area, and the study can quantitatively and scientifically provide reference for the classification of landforms in Shandong province.

1. Introduction

Topography is the result of the interaction of tectonics, climate and surface erosion, reflecting the coupling relationship between deep solid geophysical tectonics and superficial erosion [1-2]. The tectonic-geomorphology-climate system is a new trend in the study of tectonic geology and tectonics, which reveals the relationship between internal and external motive forces [3-4]. Shandong topography is mainly manifested as: Shandong Province in the mountains and hilly areas, the eastern peninsula hilly area, Shandong Province northwest plain [5].

SRTM (shuttle radar topography mission) by the United States Aeronautics and Space Administration (NASA), the United States National Image Bureau of Surveying and Mapping (NIMA) and Germany and the Italian space agency to work together to the United States "Endeavor" space shuttle as a platform, using two interference radar SRTM-1 data is sampled at 1 arc seconds, with a horizontal resolution of 30 m; SRTM-3 data, SRTM-1 data, SRTM-1 data, SRTM-1 data, Samples are taken at 3 arcs, with a horizontal resolution of 90 m. The data is processed and finally obtained by the Global Digital Elevation Model (DEM). Many scholars have studied geomorphology based on SRTM data, but most studies are based on SRTM-3 data [6-9].

This data is based on SRTM-1 data, the data plane accuracy $\pm 20\text{m}$, elevation accuracy $\pm 16\text{m}$. Taking the ArcGIS as the platform, the window analysis method and the mean change point analysis



method are used to program and automatically extract and calculate the best statistical unit of terrain in Shandong province, the geomorphology is divided and provide reference for the classification of landforms in Shandong Province.

2. Geomorphological classification principle

Firstly, the SRTM-DEM is used to generate the elevation model (SRTM-DEM), and the landforms are analysed in the whole area. Then, based on the GIS spatial analysis method, a series of averages And the optimal level of terrain is obtained by means of mean change point analysis method, and the best terrain fluctuation degree is determined, and then the basic data of classification and grading of geomorphological features in the study area are obtained. Finally, according to the morphological features Classification grading index system, making geomorphological classification map, and statistics of the area of each district.

In this paper, Shandong Province as the research area, using STRM-1 data, with the support of ArcGIS software, the elevation and the terrain in the region as the basis for the classification of landform classification, the basic process shown in Figure 1.

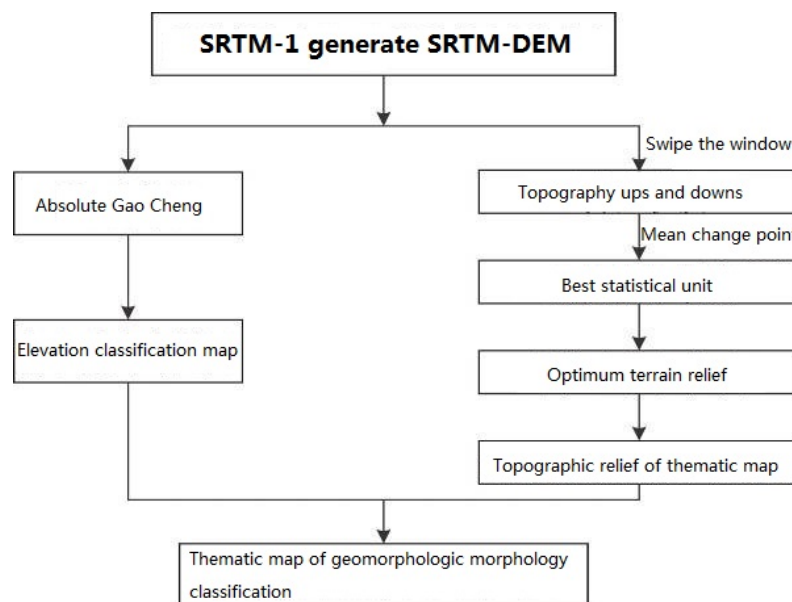


Fig.1 Basic classification of landform classification

2.1. Elevation classification

According to the SRTM-1 elevation value, the elevation range of Shandong Province is divided into six levels: 0 m, 0-50m, 50m-200m, 200m-500m, 500m-1000m, >1000m, and the elevation classification of Shandong Province (figure 2).

2.2. Terrain relief

The degree of terrain is the height difference between the lowest and highest points of a region's terrain in a given area. The key to the concept is "a certain area", which means that a certain amount of area is close to the true reflection of the terrain of integrity, and has a strong range of representation [10-11].

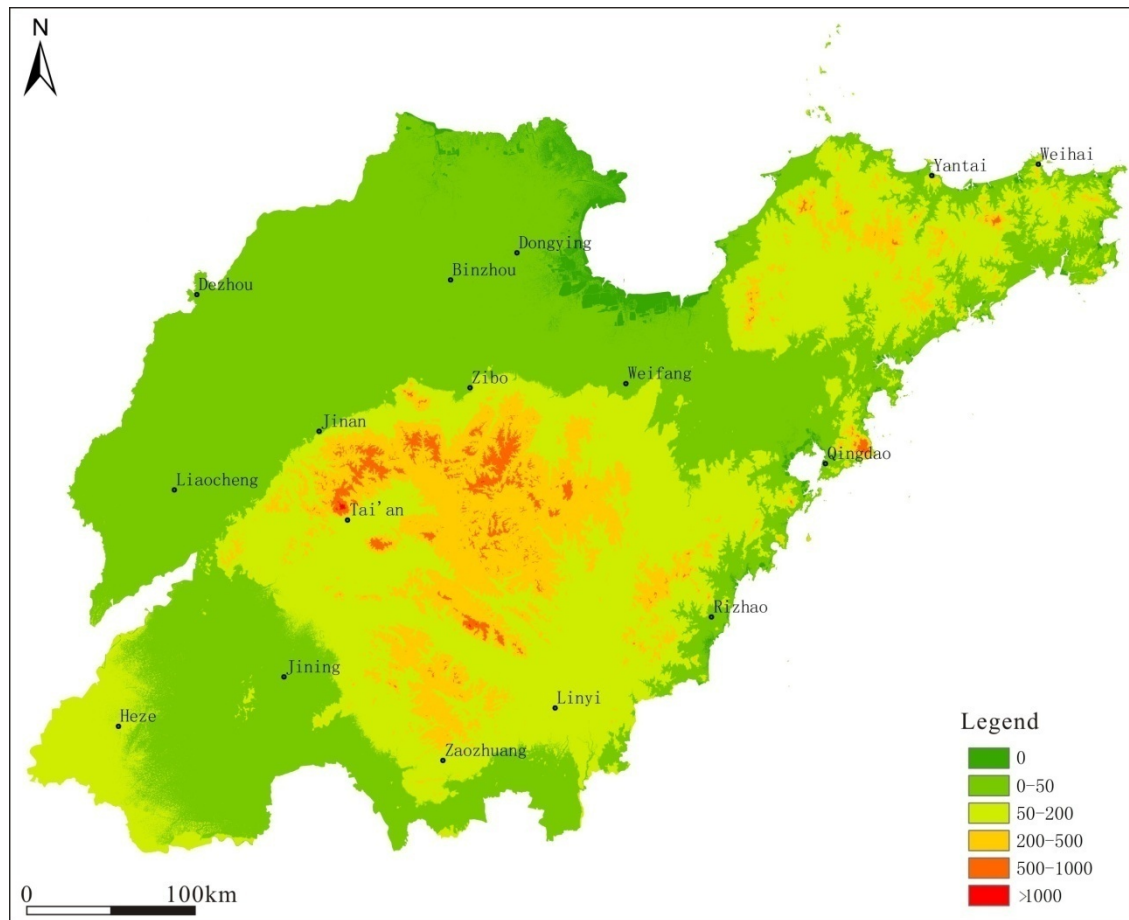


Fig.2 Shandong Province elevation classification thematic map

2.3. Determine the best statistical unit

Taking the Python module of ArcGIS as the platform, the automatic calculation of the best statistical unit of terrain in Shandong province is realized by programming, which is the best statistical unit. The principle is as follows:

Based on the spatial analysis module in ArcGIS, we first use the Neighborhood Statistic tool to start from 3×3 with the rectangle of $n \times n$ ($n = 3, 4, 5, \dots, 60$) Has been calculated to 60×60 to calculate the grid of the maximum and minimum values of the grid; Secondly, the use of grid calculator (Raster Calculator), the maximum value of the mesh in the cell is subtracted from the minimum value, and the fluctuation degree within a $n \times n$ grid is calculated. Finally, the grid unit is calculated from $3 \times 3, 4 \times 4, \dots$ to 60×60 , the statistics of different grid elements within the range of changes in the value of [10-12]. The formula is expressed as follows:

$$\Delta H = h_{ij, \max} - h_{ij, \min} \quad (1)$$

Where $h_{ij, \max}$ represents the highest pixel elevation value in the neighborhood; $h_{ij, \min}$ represents the lowest pixel elevation value in the neighborhood, and ΔH is the height difference in the neighborhood.

The corresponding relationship between the grid size and the average terrain fluctuation is obtained by using the Python module of ArcGIS as the platform (Table 1).

The mean value analysis method is roughly as follows [11-12], with the sample sequence H_0

(1) Let $i = 2, 3, 4, \dots, N$, divide the sample into two segments for each i : X_1, X_2, \dots, X_{i-1} and X_i, X_{i+1}, \dots, X_N . Calculate \bar{X}_{i1} and \bar{X}_{i2} and statistic for each sample:

$$S_i = \sum_{t=1}^{i-1} (X_t - \bar{X}_{i1})^2 + \sum_{t=i}^N (X_t - \bar{X}_{i2})^2 \quad (2)$$

(2) Calculate the statistics of the overall sample:

$$\bar{X} = \sum_{t=1}^N X_t / N \text{ 和 } S = \sum_{t=1}^N (X_t - \bar{X})^2 \quad (3)$$

Table 1 Correspondence between grid size and average terrain in Shandong Province

i	Grid size		Average terrain (m)	area (10 ⁴ m ²)	i	Grid size		Average terrain (m)	area (km ²)
1	2	2×2	0.04	0.36	25	26	26×26	6.08	60.84
2	3	3×3	0.08	0.81	26	27	27×27	6.56	65.61
3	4	4×4	0.14	1.44	27	28	28×28	7.06	70.56
4	5	5×5	0.23	2.25	28	29	29×29	7.57	75.69
5	6	6×6	0.32	3.24	29	30	30×30	8.10	81
6	7	7×7	0.44	4.41	30	31	31×31	8.65	86.49
7	8	8×8	0.58	5.76	31	32	32×32	9.22	92.16
8	9	9×9	0.73	7.29	32	33	33×33	9.80	98.01
9	10	10×10	0.90	9	33	34	34×34	10.40	104.04
10	11	11×11	1.09	10.89	34	35	35×35	11.03	110.25
11	12	12×12	1.30	12.96	35	36	36×36	11.66	116.64
12	13	13×13	1.52	15.21	36	37	37×37	12.32	123.21
13	14	14×14	1.76	17.64	37	38	38×38	13.00	129.96
14	15	15×15	2.03	20.25	38	39	39×39	13.69	136.89
15	16	16×16	2.30	23.04	39	40	40×40	14.40	144
16	17	17×17	2.60	26.01	40	41	41×41	15.13	151.29
17	18	18×18	2.92	29.16	41	42	42×42	15.88	158.76
18	19	19×19	3.25	32.49	42	43	43×43	16.64	166.41
19	20	20×20	3.60	36	43	44	44×44	17.42	174.24
20	21	21×21	3.97	39.69	44	45	45×45	18.23	182.25
21	22	22×22	4.36	43.56	45	46	46×46	19.04	190.44
22	23	23×23	4.76	47.61	46	47	47×47	19.88	198.81
23	24	24×24	5.18	51.84	47	48	48×48	20.74	207.36
24	25	25×25	5.63	56.25	48	49	49×49	21.61	216.09

The principle of mean change point method, that is, the existence of change points, will increase the difference between the statistical S of the original sample and the statistic S_i after the sample segmentation (Fig. 3). According to figure 3, take the 17 * 17 as the best statistical unit.

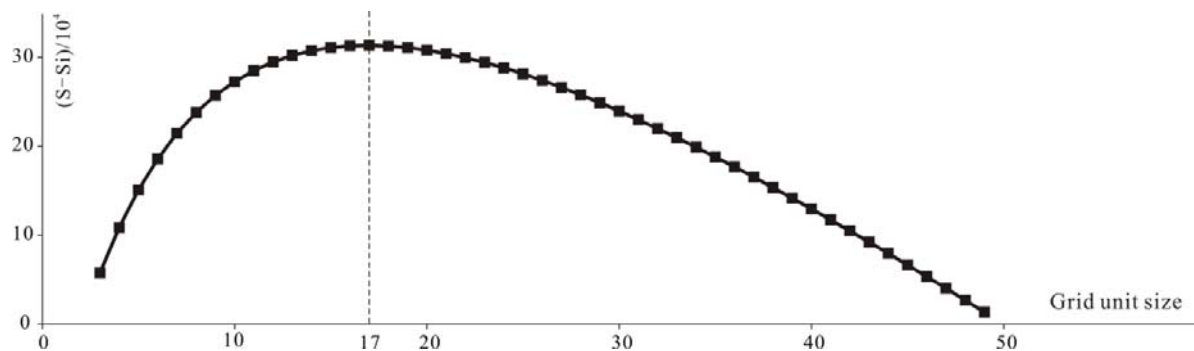


Fig.3 Difference graph of S and Si

It can be determined that the best statistical area of relief is 0.26km^2 in Shandong province, Shandong Province terrain can be divided into four levels: 0-20, 20-75, 75-200, 200-417, Shandong Province terrain relief classification thematic map (Figure 4).

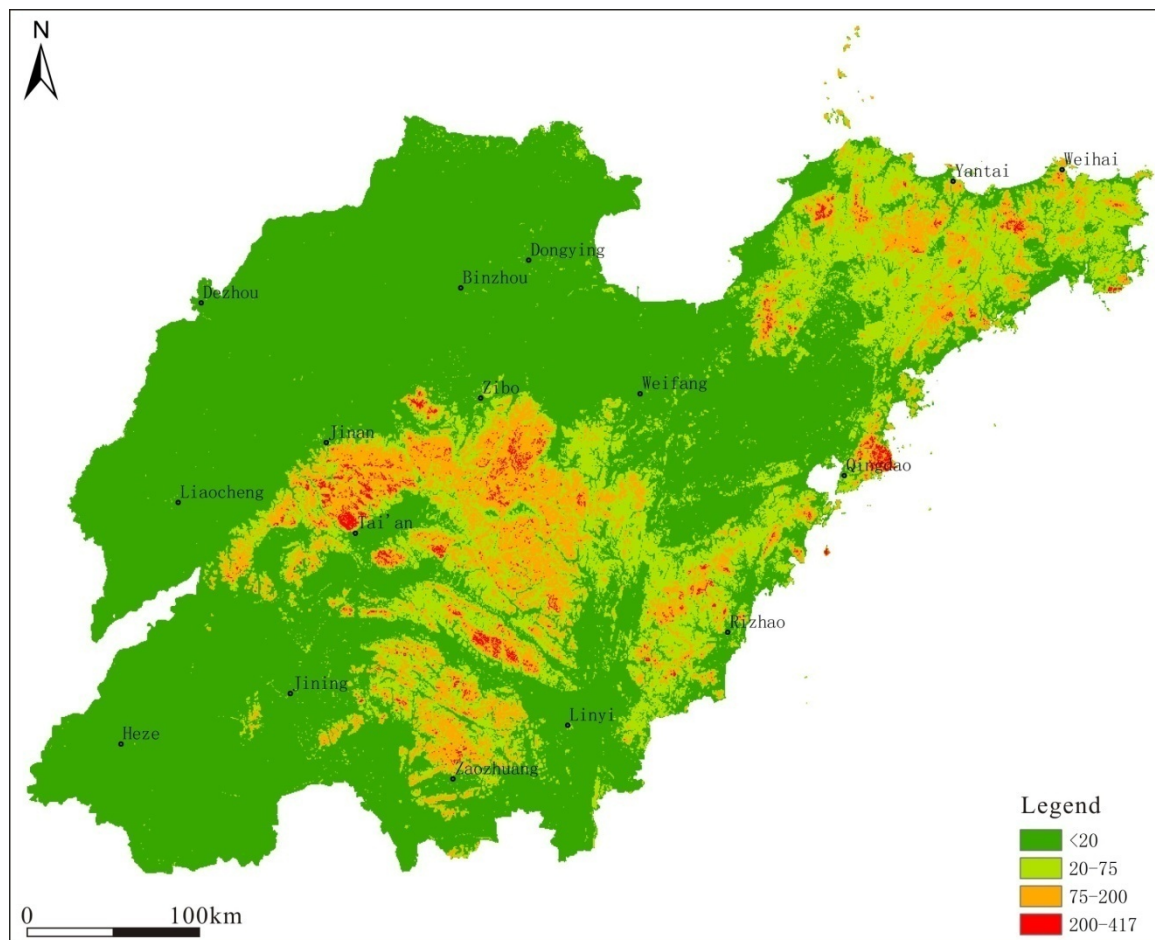


Fig.4 Shandong Province Terrain classification thematic map

3. Shandong Province landform classification

According to the terrain condition of Shandong Province, the landforms of Shandong Province are divided according to the combination of altitude and terrain. SRTM-1 image shows that the total area of Shandong Province is $168,300\text{ km}^2$, according to the classification criteria of elevation classification

and topographic map, the landforms of Shandong Province can be divided into eight types: low elevation plain, middle elevation plain, low elevation platform, middle elevation platform, low elevation hills, middle elevation hills, low elevation mountainous region, middle elevation mountainous region, accounted for 12.72%, 0.01%, 36.38%, 0.24%, 17.26%, 15.64%, 11.1% and 6.65% of the total area respectively. According to the above classification using Arcgis Shandong Province to get the topography of the classification of thematic map (Figure 5).

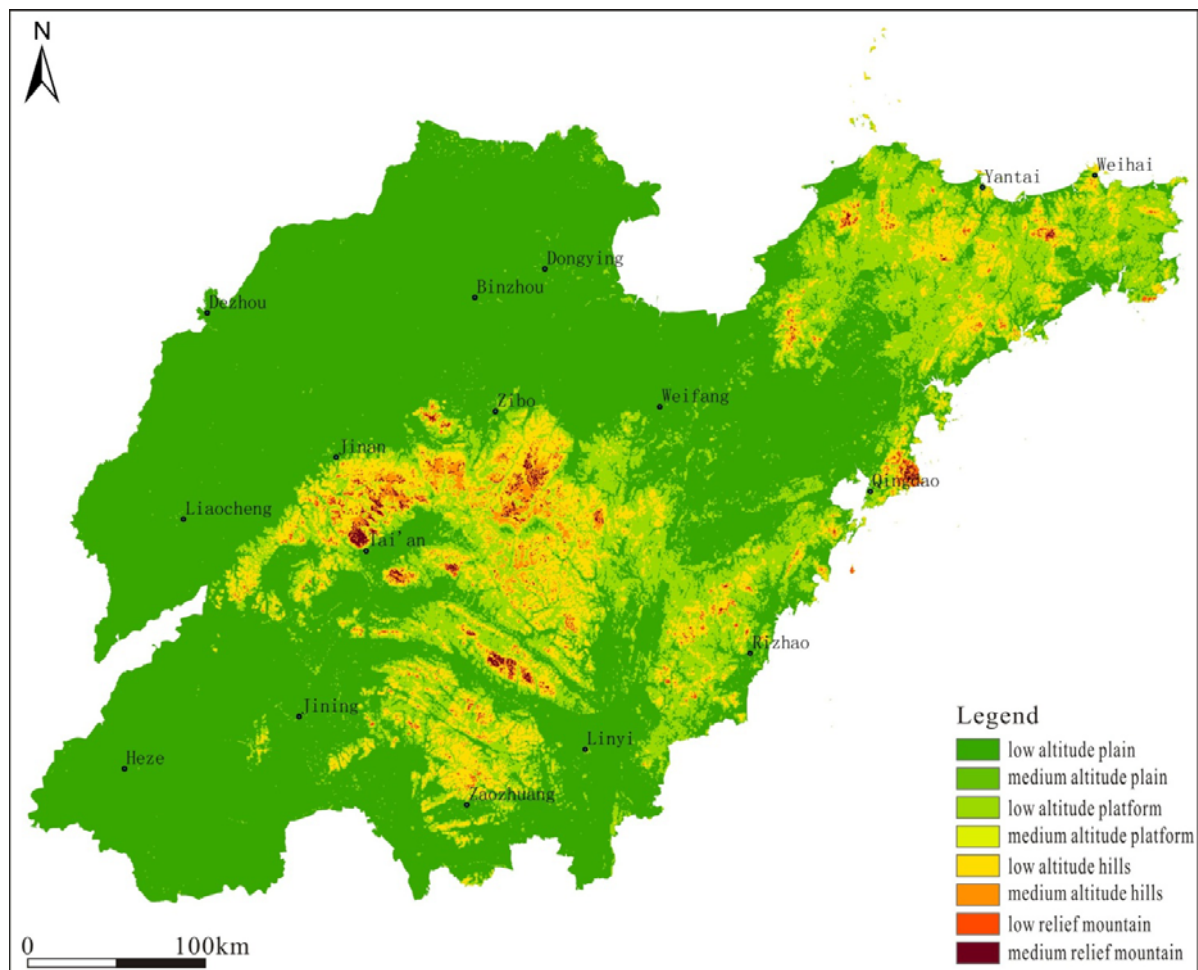


Fig.5 Shandong Province landform morphology classification thematic map

4. Conclusion

(1) Based on SRTM-DEM, SRTM-1 is based on ArcGIS, the window analysis method and mean point analysis method are used to automatically extract and calculate the best statistics of terrain in Shandong province by using Python module programming Unit, which determines 17×17 for the best statistical unit, the terrain of the best statistical area of 0.26km^2 , Shandong Province, the terrain can be divided into four levels.

(2) According to the classification of landform type in China, the landforms of Shandong Province are divided into eight types: low elevation plain, middle elevation plain, low elevation platform, middle elevation platform, low elevation hills, middle elevation hills, low elevation mountainous region, middle elevation mountainous region, accounted for 12.72%, 0.01%, 36.38%, 0.24%, 17.26%, 15.64%, 11.1% and 6.65% of the total area of the province. The results of the division of landforms are basically consistent with the overall terrain of Shandong Province (Shandong Province in the mountains and hilly areas, the eastern peninsula hilly area, Shandong Province northwest plain).

(3) SRTM-1 data plane accuracy $\pm 20\text{m}$, elevation accuracy $\pm 16\text{m}$. Compared with the previous SRTM-3 data used by scholars, the accuracy is improved, the study of terrain fluctuation and the practicability of landform classification research are strengthened, and the research method can quantitatively and scientifically provide accurate reference for the classification of landforms in Shandong Province.

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