On Fractal Dimensions of China’s Coastlines

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The fractal dimensions of China’s coastlines are preliminarily discussed on the basis of GIS in this paper. Some significant conclusions are drawn. The fractal relationship between the length of China’s continental coastline \( L \) and the yardstick \( r \) is \( \log L = 3.99 - 0.16 \log r \) on the scale 1:2,500,000 map. The fractal relationship between the length of Jiangsu province’s coastline and the yardstick may be established as \( \log L = 2.82 - 0.10 \log r \) on the scale 1:50,000 map. Using the divider method, the fractal dimension of China’s continental coastline is 1.16, Taiwan Island is 1.04, etc. The fractal dimensions of coastlines of the Bohai sea, the Yellow sea, the East China sea, and the South China sea tend to increase from north to south, indicating that the complexity of China’s coastlines increases toward low latitudes. The substantial components of coast, biological function, and climate from north to south result in a change in fractal dimensions along the coasts of China. The fractal dimension of a coastline is different from the average fractal dimension of all its parts. The more parts of a coastline, the larger the difference between the fractal dimension of the original coastline and the average fractal dimension of all its parts. Faults control the basic trends and fractal dimensions of coastlines as a whole in the studied areas of Taiwan Island and Changle-Lufeng. The more the controlling effect of the faults, the smaller the fractal dimension of the coastline. The less the controlling effect of the faults, the larger the fractal dimension of the coastline. The results indicate that the faults control not only the basic trend of a coastline but also the complexity in the studied areas of Taiwan Island and Changle-Lufeng.

KEY WORDS: fractal, fractal dimension, coastline, China.

INTRODUCTION

Coastline length is a traditional field of study in fractal research. Mandelbrot stated the uncertainty of the length of a coastline in his paper “How long is the coast of Britain?” published in *Science* in 1967. The fractal concept was presented for the first time in that paper and has been applied to many fields ever since. The fractal dimensions of different coastlines have been calculated by many researchers, including Mandelbrot (1967), Goodchild (1980), Philips (1986), Qiu

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(1988), Turcotte (1992), Philip (1994), Andrle (1996), Jay and Xia (1996), Paar and others (1997), Jiang and Plotnick (1998), Stomczynski (1999), and Zhu and others (2000). References to the fractal dimensions of China’s coastlines have not been seen until now. Therefore research on the fractal dimensions of China’s coastlines will certainly deepen the related studies.

**MATERIALS AND METHODS**

**Data Sources**

The maps used in our study are from the Quaternary Map of China (Chinese Academy of Geology et al., 1990) and the Atlas of Geo-Science Analyses of Landsat Imagery in China (Department of Research and Development of National Remote Sensing Center et al., 1994).

**Principles for Demarcating Coastlines**

The Jiangsu Survey Bureau demarcated China’s coastline in the 1990 investigation of the land resources of China. The coastlines under study were demarcated using rules similar to those used in 1990.

1. **Principle for demarcating the boundary between land and sea at the river mouth.** The harbor character of the large river mouth is retained. The landforms of sand-spit, shoal, and lagoon are reflected and the horn shape of the river mouth is displayed. If the river mouth is asymmetrical, the boundary is marked where the river becomes narrow or where the curvature of the promontory is the largest.

2. **Principle for demarcating the islands.** The islands off the bedrock coast and silt coast are not counted. The silt beach land, which protrudes during high tide, is considered as an island and its shoreline is not counted.

3. **Principle for demarcating the boundaries of the four seas of China.** According to the traditional principle, the boundary between the Bohai sea and the Yellow sea extends from Laotieshan to Penglaijiao; the boundary between the Yellow sea and the East China sea extends from the north point of the Yangtze River to the southwest point of Jizhou island; and the boundary between the East China sea and the South China sea extends from Nanao island to Oluanpi of Taiwan Island (Fig. 1).

**Methods**

There are two methods available to calculate the fractal dimension: the divider method (Mandelbrot, 1982) and the box-counting method (Grassberger, 1983).