



Object-based geomorphological characteristics extraction and the formation of yardang landform in Dunhuang, Northwest China

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Yardang is a wind erosion landform. However, different views existed towards yardangs in Dunhuang, northwest of China. It is puzzling that two types of yardangs with very different alignment co-exist within an area of 350 square kilometers. The two alignments are almost in 90 degree intersection, with one alignment is from north to south, and another is from east to west. In between there are linear sand dunes with alignment from northwest to southeast. The view, that the formative force of yardangs in south Dunhuang is fluvial process (not wind), is dominating ever since its proposal in 1987. We here try to clarify this puzzle. We develop a technique, based on an object-based image analysis (OBIA) using high resolution Google Earth images, to detect yardang geomorphological characteristics. Our results showed that yardangs can be clearly recognized and classified by our technique. Maps thus obtained have an overall accuracy of 94%, and a Kappa coefficient of 0.87. Based on alignments and extracted characteristics, the yardangs can be divided into three subareas: adolescent type in northern area, mature in the southern area, and receding in the middle area. We collected data of wind directions and fluvial processes in the surrounding areas. The wind data show clearly two wind directions, which are in corresponding to the two alignments of yardangs. We demonstrate that the collision of the two winds shapes the linear sand dunes. The distributions and geomorphologies of yardangs and linear dunes vary in response to wind erosion and fluvial erosion. We also simulate to predict the formation wind systems and the evolution of landscapes using atmospheric and geomorphological models. We also conclude that wind is the dominating shaping force for all the yardangs, while the fluvial processes are actually destructing the yardangs. The puzzle initially imposed is solved.