Grain size, shape and color of dune sands determined by semi-automated image analysis

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Size, shape and color are the most fundamental properties to describe sediments and soils, or basically any object. The characterization of these features may hold in itself information about paleo-environmental conditions, transport mechanisms and source regions. However, traditional approaches to describe shape and color are often time-consuming and at best semi-quantitative. For the investigation of Erg Chebbi (Morocco) and surrounding dune fields a novel and inexpensive research design based on a hand-held digital microscope and open-source image analysis techniques has been developed and successfully applied to quantitatively differentiate 94 crest dune samples by size, shape and color. Mean grain sizes derived from image analysis correlated very well (r^2 = 0. 84) with mechanical sieving. Eleven different shape parameters were evaluated and subjected to Principal Component Analysis (PCA) to detect the most important and meaningful descriptors. PCA in combination with Hierarchical Clustering showed a high potential to discriminate dune sands according to their geographic location and thereby to their transport history and source regions. Additionally, this study proposes an unprecedented approach to classify hundreds of thousands of grains according to their color by combining image analysis with supervised Random Forest machine-learning. Results are compared to bulk sample color measurements of a smartphone-coupled color sensor and a portable spectrophotometer. The results confirm that size, shape and color are valuable features when distinguishing dune sands and sediment sub-populations of Erg Chebbi. A reliable, fast and accurate way to fingerprint granular material like the presented image analysis and color measurement approach may be valuable in sedimentological research, but also for numerous industrial and technical applications.

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