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Perspective – Synthetic DEMs: A vital underpinning for the quantitative future of landform analysis?

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Physical processes, including anthropogenic feedbacks, sculpt planetary surfaces (e.g., Earth's). A fundamental tenet of Geomorphology is that the shapes created, when combined with other measurements, can be used to understand those processes. Morphological data, including metrics and mapping (manual and automated), are a key resource in this endeavour. However, how good are these data that analyses rely on? Artificial or synthetic DEMs are widely used to examine the distortions of 'noise' (e.g., on topographic parameters), but only rarely to make strong 'absolute' statements about landform detection and quantification; e.g., 84% of the river channels in the real landscape are found, or 47% of all actual drumlins $H > 3$ m are mapped. In theory synthetic DEMs *a priori* containing known, idealised components can give such absolute conclusions regarding effectiveness if they can be constructed so as to represent well the actual landscapes. So, do we need good realistic synthetic DEMs, how can we best construct them, and what for? From our perspective, they are vital to verify the statistics that will link physics-driven models of processes to morphological observations, allowing quantitative hypotheses to be formulated and tested. We will outline current approaches, and some speculations about the future, but we are seeking a discussion on how best to construct realistic synthetic DEMs and proceed with uncertainty-aware landscape analysis to examine physical processes.