UNIVERSITY OF SOUTHAMPTON

Modelling the Effects of Climate Change and Sea Level Rise on the Evolution of Incised Coastal Gullies.

by

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ABSTRACT

FACULTY OF SOCIAL AND HUMAN SCIENCES
GEOGRAPHY AND ENVIRONMENT

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Under projections of future (next ∼100 years) anthropogenic climate change, it is predicted that marked changes in environmental driving conditions, with relation to baseline (1961 - 1990) climates, will be experienced. Such changes have the potential to induce substantial geomorphological and ecological change. Numerical models of landscape evolution provide powerful tools to assess the impacts that environmental changes may have on landscape morphology. Accordingly, this research seeks to utilise landscape evolution models (LEMs) to understand how projected changes in climate will affect the geomorphic response of a series of incised coastal gullies found on the Isle of Wight, UK. Incised coastal gullies are known to be dynamic and sensitive landscape features which intersect the terrestrial - marine boundary; as such their evolution is influenced by changes in both terrestrial (i.e. precipitation) and maritime (i.e. sea level and wave height) climates. In order to ensure the processes driving incised coastal gully evolution are represented within the LEM, an existing LEM was modified to include processes of soft cliff erosion. This represents the first such inclusion of coastal processes within a LEM framework. The modified LEM was forced with ensemble projections of precipitation, sea level and wave height downscaled from HadCM3 and CGCM2 Global Climate Model (GCM) outputs for two emissions scenarios (A2 and B2). Comparison against a baseline scenario based on the 1961-1990 climatology allows for climate induced changes in system response to be quantified. To constrain the uncertainties associated with the application of landscape models and downscaled GCM data, a Monte Carlo analysis framework is employed, resulting in ∼22000 model runs. This method also permits the development of probabilistic results describing geomorphological change in gully systems. Results suggest that the likelihood of extreme loss in gully extent will increase by up to 61%. Furthermore, it is projected that extreme rates of coastal erosion will increase by 22% by 2100 (under HadCM3 runs forced with the A2 emissions scenario). However, under certain scenarios the possibility of extension of the gully systems exists, with *likely* (>66% probability) increases in gully length of 13.7 m projected under CGCM2 runs forced with the A2 emissions scenario. The novel application of a Monte Carlo methodology with a LEM framework permits the identification of key climatic parameters responsible for causing extreme changes within these gully systems, allowing the relative importance of each climate parameter in driving incised coastal gully evolution to be assessed. Furthermore, the successful application of this technique suggests it may be applicable to other studies applying LEMs to scenarios of future climate change.

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Declaration of Authorship

I,

Christopher Hackney

declare that the thesis entitled

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and the work presented in the thesis are both my own, and have been generated by me as the result of my own original research. I confirm that:

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- where I have consulted the published work of others, this is always clearly attributed;
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- I have acknowledged all main sources of help;
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Signed: .....

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