The Use of Hydraulic Models in Fluvial Geomorphology: Examples from South-Eastern Australia

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Streamflow hydraulics are a key determinant of erosion and sedimentation processes in rivers. Developments in numerical hydraulic modelling and increases in computer power have enabled the simulation of hydraulic processes in sufficient detail to assist in geomorphological explanation and prediction. This paper discusses the use of one- and two-dimensional hydraulic modelling in the assessment of sediment transport, bank erosion, floodplain sedimentation, and avulsion processes. Reference is made to south-east Australian examples where integrated hydraulic/fluvial geomorphological studies have been successfully used as a basis for river management.

Key words: fluvial geomorphology, hydraulic models, sediment transport, bank erosion, floodplain sedimentation, avulsion
The Underlying Gamma law Structure of the River Network Organization
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We propose the application of a statistical physics reasoning to the analysis of water path distribution through a river network to the basin outlet. Indeed by viewing the hydraulic path length as the sum of different Strahler order components, and by taking their scaling property into account, we develop a theory similar to Maxwell’s gas kinetics. We reach gamma law type probability density functions, either for each component and for the whole hydraulic length, expressed in terms of simple and observable parameters. Despite some validity limits due to hierarchy constraints of the branched out river network at the scale of the single basin, we verify the relevance of these theoretical expressions i) for sets of many basins and ii) for combinations of the lowest Strahler components of one basin. This shows the existence of an underlying gamma law structure for any river network, naturally hidden by the hierarchy limits of scaling.

*Key words: statistical physics, scaling, branch out object, hierarchy constraint.*
A computable model of the longitudinal river profile

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We propose a partial differential equation to describe the longitudinal river profile development and river terrace formation;

\[
\frac{\partial u}{\partial t} = \frac{\partial}{\partial x}\left\{ c e^{rx} \frac{\partial u}{\partial x}\right\} + g(t, x) \tag{1}
\]

where \((c e^{rx})\) reveals the diffusion coefficient of which value increases exponentially from \(c\) at \((x=0)\) to downstream, and \(g(t, x)\) is velocity of local crust movement. We obtain an exponential function as the stationary solution of the equation (1) under fixed boundary conditions;

\[
\frac{\partial u}{\partial x} = C_0 e^{-rx} \tag{2}
\]

If \(c e^{rx}\) is inversely as the grain size of sediment, it is well explained the geomorphologic fact that the gradient of river profile is proportional to the grain size and the both decrease their values exponentially from upstream to down.

Key words: longitudinal river profile, river terrace, sea level change, and sediment flux
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A Simple GIS Model for Mapping Landslide Susceptibility
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Maps of geology, slope, and areas of prior landsliding are combined statistically in a geographic information system (GIS) to predict likely sites of future failure. Advantages of the resulting new susceptibility index: 1) it is a continuous variable; 2) regional coverage is limited only by extent of the input data; 3) map resolution is as fine as that of the slope data; and (optionally) 4) it predicts a range of values within, as well as between, existing failures. Susceptibility is defined as the spatial frequency of terrain that has failed, adjusted by steepness of the topography. The index, obtained from a slope histogram for each geologic unit, is the percentage of grid cells in each one-degree slope interval that coincide with areas of prior failure. Susceptibility within mapped failures is this percentage raised by a factor derived from relative spatial frequencies of the most recent failures within and between older failures. We applied the model to an 872 km² region in coastal California, using 120 geologic units, a 30-m digital elevation model (DEM), an inventory of 6714 large pre-1970 slide and earthflow deposits unattributed by mode of failure (no debris flows), 1192 varied post-1970 failures, and the GRID module of the Arc/Info GIS. Two tests revealing fair to good predictive power suggest the model should apply anywhere. Distinguishing the inventoried landslides by process and adding such variables as distance-to-nearest-road and terrain elevation, relief, aspect, and curvature would strengthen the inferences.

Key words: slope failure, susceptibility map, DEM, landslide inventory, GIS

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