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Application of a catchment evolution model to the prediction of long-term erosion on the spoil heap at Ranger uranium mine

Initial analysis

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Variables

$\boldsymbol{a}$	=	channel initiation function
$\boldsymbol{A}$	=	area per unit width
β_1, m_1, n_1	=	sediment transport coefficient and discharge and slope exponents respectively
β_3, m_3, n_3	=	runoff coefficient, and discharge and slope exponents respectively
β_5, m_5, n_5	=	channel initiation threshold coefficient, and discharge and slope exponents respectively
c_0	=	tectonic uplift
D	=	diffusivity
f($\boldsymbol{Y}$)	=	a sediment transport coefficient dependent on the pattern of channelisation
$\boldsymbol{G}$	=	a function dependent of the runoff process modelled
O_t	=	ratio of hillslope to channel erosion rate
$\boldsymbol{q}$	=	discharge per unit width
$\boldsymbol{Q}$	=	discharge in the channel
$\boldsymbol{q_s}$	=	sediment transport per unit width (mass/time)
ρ_{sb}	=	bulk density of the sediment
$\boldsymbol{S}$	=	slope in the steepest downstream direction
t	=	time
τ	=	the bottom shear stress for the flow and
τ_c	=	a shear stress threshold
x,y	=	horizontal distance
$\boldsymbol{Y}$	=	channel indicator variable (0 = hillslope, 1 = channel)
$\boldsymbol{z}$	=	elevation

Abstract

There is a need to assess the long-term stability of engineered landforms associated with the rehabilitation of Ranger Uranium Mine, Northern Territory, Australia, as it is a requirement that mill tailings must be contained for periods in excess of 1000 years. The geomorphic model, SIBERIA, is calibrated on hydrology and erosion data collected by a combination of monitoring and rainfall simulation experiments on the waste rock dumps of Ranger. Preliminary analysis of Ranger's preferred above-grade and below-grade rehabilitation options suggests that erosion of the order of 7–8 m will occur on the structure in a period of 1000 years. This depth of erosion may be sufficient to compromise the integrity of the containment. It is shown that SIBERIA has significant advantages over steady-state erosion models. Suggestions are made for the design that will enhance the stability of the structure and extend the structural life of the containment.