AN ANALYSIS OF THE TRANSPORT OF SOIL BY RAINSPLASH AND AN EVALUATION OF METHODS OF MEASUREMENT

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DECLARATION OF ORIGINALITY

All sources of information used in the preparation of this thesis have been acknowledged - in particular the study by Alan Bush, reported by Bush (1981), which used experimental designs developed in this thesis and thereby provided data which has been used in the preparation of this thesis. Parts of the study embodied by this thesis have already been published - copies are provided in Appendix 4.

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ABSTRACT

Land degradation due to soil erosion continues to be a threat to the maintenance of the productivity of Australia's agricultural and pastoral lands. The development of techniques of predicting soil losses to assist in management decisions concerning these lands is of considerable importance if future management strategies are to maintain long-term agricultural productivity. Deterministic modelling techniques would appear to be the most appropriate research direction to be taken in Australia, as the Universal Soil Loss Equation cannot be directly transferred to Australian soil and climatic conditions, nor is the establishment of the required data basis within financial reach of Australia's soil conservation instrumentalities.

The inter-rill erosion component of published erosion models seems to be almost invariably based upon splash cup-based relationships of splash detachment to rainfall kinetic energy or intensity despite published analyses that suggest splash cup and soil tray measurements may be subject to configurational artefact. In view of the potential shown by a number of such analyses of the splash transport process, this aspect was chosen for further research, with a view to improving the predictive performance of the inter-rill component. It was found that inter-rill transport could be validly represented as a drop impact-induced soil particle displacement process. Analysis of this process showed that the transport rate of soil was a function of both the detachment rate and the magnitude and direction of particle displacements. The success of this analysis depended upon strict definition of detachment rate and transport rate as follows.

Component transport rate in a particular direction defined as the mass per unit time, of soil particles with displacement components in that direction, crossing unit length of a line on the soil surface perpendicular to that direction. It has units $ML^{-1}T^{-1}$. The detachment rate should be defined as the mass per unit time per unit area of soil surface, of soil particles being set in motion. It has units $ML^{-2}T^{-1}$.

The splash transport process was usefully conceptualised as a simplified representation that assumed radially uniform displacement of mass about each drop impact. Analysis of this representation showed that the component splash transport rate is a function of the detachment rate *and* the impact variables such as ejection velocity and splash angle that determine the magnitude and direction of particle displacement.

The full inter-rill transport process including splash and flow transport was found to be usefully represented by a distribution function giving the disposition of mass of displaced soil particles about the drop impact point. The component inter-rill transport rate was readily expressed in terms of this function.

Applying these analyses to methods of measurement that have been used in studies of inter-rill erosion showed:

a) a splash cup diameter as small as is practicable gives the best estimate of detachment rate;

b) it is an inevitable consequence of the inter-rill transport process that the distribution of resultant transport rates on a section of soil surface is drastically altered when the section is held in isolation as in a laboratory soil tray. Some source/collecting area configurations were shown, despite this, to have collecting rates that are directly related to the component transport rates that would apply *if the sections of soil were once more surrounded by a similar soil surface*. The configuration for total loss measurement from a soil tray was found not to have this desirable characteristic;

c) it is likewise an unavoidable consequence of the inter-rill transport process that the resultant transport rates on a soil surface are distorted in the vicinity of a field splash trap that is acting as a sink for splashed material. The splash board and two types of splash trap developed in the study, the modified Bollinne trap and the pipe trap, were shown to have collecting rates that are equal to the component transport rate in the direction appropriate to the trap orientation;

d) the resultant and component transport rates can be determined from post-event tracer distributions.

Testing of these measurement methods for splash transport in laboratory and field showed:

a) a splash cup diameter as small as 3.1 cm can be used for detachment measurement. Kinetic energy/splash loss relationships were found to be affected by the size of splash cup used;

b) measurement of upslope and downslope component splash transport using a soil tray with a single boundary type 3 configuration at each end was found to be no more difficult or time-consuming than total loss measurement. Comparison of slope/net downslope component splash transport relationships from this study with published slope/splash erosion relationships suggested the latter are subject to configurational artefact;

c) measurement of component splash transport rates in the field was found to be feasible using splash traps with vertical sampling apertues. Measurements with such traps showed that wind and inclined rainfall have a significant effect on the resultant splash transport direction. Splash traps should therefore have a minimum effect on air flow over the plot and the pipe traps, due to their narrow section, meet this requirement;

d) tracer measurements were found to be unsuitable for continuous routine monitoring of inter-rill transport. Their freedom of boundary effects warrants their use in special cases as an absolute reference measurement.