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RUNOFF AND THE AMELIORATING EFFECT OF PLANT COVER

by

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Abstract. Surface runoff was recorded from small plots situated in the mulga rangelands of Queensland. Even small falls of rain (<15 mm) produced runoff equivalent to over 50% of the rain. Plant tussocks were instrumental in decreasing the number of rainfall events which generated runoff. The maintenance of a perennial grass basal area of $>2\%$ is considered essential to reduce soil movement or erosion through the action of runoff.

Introduction

The mulga (*Acacia aneura* F. Muell) lands of Queensland have been classified as mulga sand plains, soft mulga, hard mulga and dissected residuals (Dawson *et al*. 1975). These authors state that the first two classes are stable, but their productivity and susceptibility to erosion is influenced by plant cover. Mismanagement of the latter two systems increases their inherent instability (Dawson and Boyland 1974).

Surface water movement is somewhat arrested by plant material (Dunin and Downes 1972, Branson 1975). The amount of vegetation required for this in the mulga lands has not been elucidated, even though work in the Northern Territory indicates that sediment yields of 120 kg ha^{-1} are possible on these rangelands from <30 mm of rain (Gifford 1978). In this paper I look at how the frequency of runoff varies with the quantity of rain, and the effect of plant cover on runoff frequency.

Materials and Methods

Rainfall and runoff were recorded between November 1972 and January 1974 from twenty four micro-catchments, each 2.4 m x 1.2 m, installed in the soft mulga zone under tree densities ranging from 0 to 4 000 trees ha^{-1}. Soils were infertile sandy loams (Gn 2.12, Northcote 1965) ranging between 1 and 2 m deep. The frequency of occurrence of four classes of runoff - <1 mm, $>1 \leqslant 5$ mm, $>5 \leqslant 10$ mm and >10 mm - recorded from five classes of rainfall - $>10 \leqslant 15$ mm, $>15 \leqslant 30$ mm, $>30 \leqslant 50$ mm, $>50 \leqslant 100$ mm and >100 mm - was then calculated.

Surface runoff was also collected from 100, 1 m x 1 m plots installed in the soft mulga, hard mulga and dissected residual land zones. Water was applied through a shower rose using a modification of the equipment described by Costin and Gilmour (1970). Water was applied to initially dry soil for either 90 minutes or when the equivalent of 10 mm runoff was collected, which ever occurred first. The basal area of all vegetation within the plot was then measured using either a line transect technique, or measuring the circumference of individual grass tussocks with a flexible steel tape. The frequency of five classes of runoff - expressed as a percentage of rainfall - were calculated for four basal area classes - ≤2.0%, >2 ≤4.0%, >4 ≤8.0%, >8.0%.

Results and Discussion

More than 88% of natural runoff events recorded from rainfall >10 ≤15 mm were <5 mm in aggregate, but in excess of 11% were in the range >5 ≤10 mm (Figure 1). Further, while over 76% of runoff events from rainfall >100 mm exceeded 10 mm, 17% of the runoff events recorded were <5 mm. Rainfall intensity and antecedent soil moisture conditions played some part in these anomalies. For example, 22 mm of rain falling over five hours yielded 88 mm of runoff from 24 plots, whereas 20 mm over eight hours yielded 3.5 mm from the same plots. Similarly, 82 mm falling in 18 hours yielded 246 mm from 22 plots, contrasted with 92 mm runoff recorded from the same plots from 72 mm of rain falling over 42 hours.

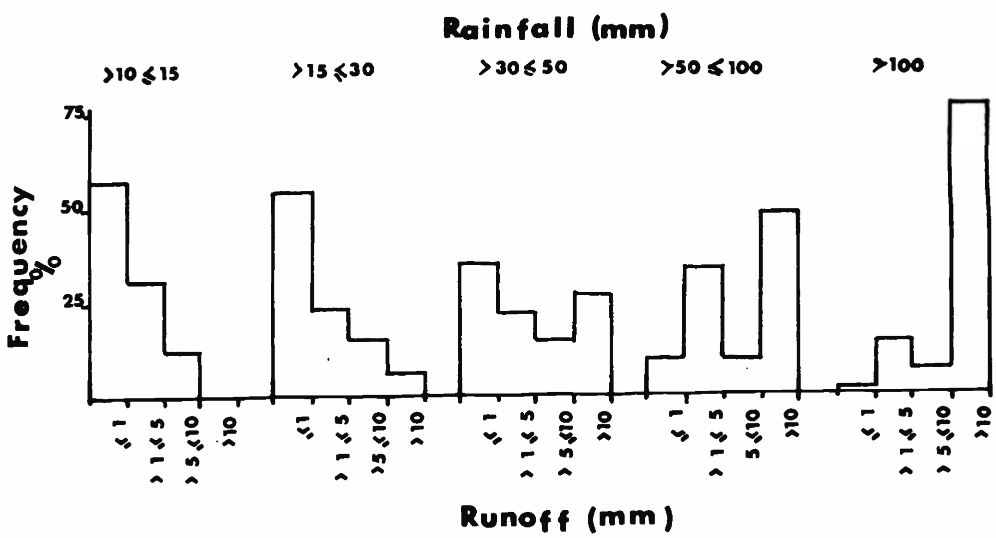

Figure 1. The frequency of four classes of runoff events related to amount of rainfall.

Rainfall totalling 42 mm fell two days after 165 mm of rain. The soil surface was wet and runoff exceeded 308 mm from the 24 plots. In contrast, 40 mm fell over a similar time interval three months later yielding only 212 mm of runoff from the same plots. The soil surface was dry prior to this as no rain had fallen for the previous 3 weeks and no runoff was recorded in the plots between the two events.

The frequency distribution of runoff with respect to four classes of plant basal area is shown in Figure 2. Runoff in excess of 60% only occurred when basal area was < 2%.

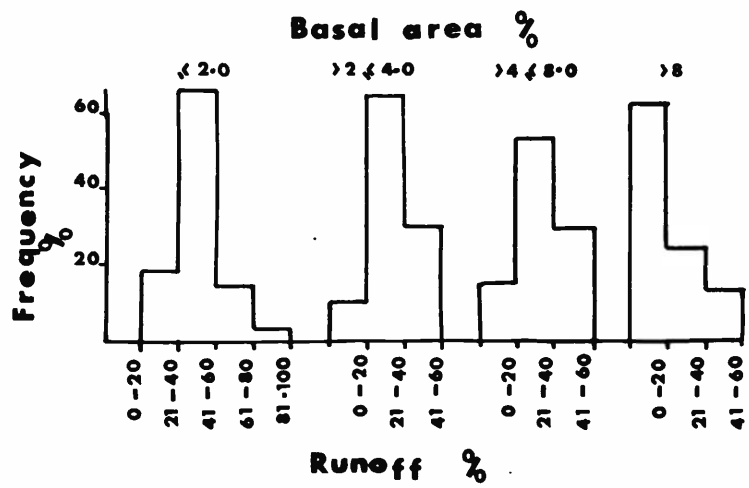

Figure 2. The effect of the basal area of vegetation on the frequency of runoff, expressed as a percentage of rainfall.

The overall data show that basal area was positively correlated with runoff but there was no relation when the data from the hard mulga and residuals were analysed separately from the soft mulga areas. This is probably a reflection of the low basal cover of the vegetation on these areas: the maximum and mean basal area recorded for them was 2.6% and 0.7% respectively. It appears that on these areas other factors such as the bulk density of the soil, and slope tend to dictate runoff potential, and unless the basal cover of the pasture can be increased substantially it is unlikely that stock management will succeed in reducing runoff.

However, as basal areas on the soft mulga areas (3.9 ± 0.6%) are higher than those on the hard mulga and dissected residuals (0.7 ± 0.1%), the data in Figure 2 indicate that stock management to maintain a basal cover in excess of 2% on these areas will result in less surface water movement and greater infiltration of rain water. The removal of standing plant biomass and litter through extended periods of over-grazing or other means will tend to increase runoff and together with increased wind and water erosion - particularly on the hard mulga land zones and dissected residual land zones (Skinner and Kelsey 1964) - will inevitably lead to poorer conditions for germination and establishment of plants (Condon et al. 1967). Major changes to the soil surface condition will then be necessary to encourage increased soil water availability and thus plant growth.

It is inevitable though that deterioration of portions of some mulga landscapes will occur - if not from the extended periods of drought common in the mulga regions, then from the continuance of the present stock management. A more flexible attitude to stock numbers may be one way of reducing this problem. Research in the Charleville district is continuing towards a management policy of adjusting stock numbers at the end of summer in accord with pasture on offer at that time. This approach may also result in a reduction in the quantity of mulga pushed or cut for stock feed and so aid in the maintenance of ground cover.

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