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EROSION IN PASTORAL REGIONS OF AUSTRALIA

B.R. ROBERTS

School of Applied Science,
Darling Downs Institute,
Toowoomba.

INTRODUCTION

Explorers records of inland Australia indicate that much of today's pastoral zone was subject to wind and water erosion before the land was subjected to domestic stock. Australia's contribution to the United Nations (1977) survey of arid land degradation indicates that Australia now has serious man-made problems of desertification and contributes substantially to the 5.2 million/ha which is added annually to the global area of desert.

In Ratcliffe's (1938) words "Australians have every reason to be intensely proud of their record in settling the great spaces of the inland. They are to be blamed only in that they seem to have done the job too thoroughly". The erosion situation in the pastoral zone was officially recognized as a serious problem for the first time in Australia when a Royal Commission was established in 1901 to investigate the position in the Western Division of New South Wales. Not surprisingly the Commission found an ill-advised land tenure system and gross over-estimation of the carrying capacity to be prime causes of land deterioration. Perry's (1967) graph of the sheep numbers from 1860-1960 in the Western Division demonstrates the return to realistic stocking rates at the turn of the century. The most recent national survey (Dept. of Environment, 1978) indicates that 48% of the arid zone presently suffers from some form of erosion. (Table 1).

The importance of the pastoral region to the national economy is reflected in the fact that the arid and semi arid zones alone carry approximately 34% of Australia's cattle and sheep populations.

SIGNIFICANCE OF EROSION IN THE PASTORAL REGIONS

Although the significance of erosion cannot be evaluated solely in monetary terms, the present estimate (Dept. Environment 1977) of the expenditure required to alleviate erosion in the arid zone is $65 million compared with $86 million in intensively cropped regions.

Surveys of the financial value of pastoral production eg. Bureau of Agricultural Economics' Survey of the Australian Grazing Industry 1973-4, fail to indicate the changes in carrying capacity associated with erosion in the pastoral zone as shown in Figure 1. However, the Department of Environment's (1977) survey estimates that of the 4693,000 km^2 constituting the grazing zone of Australia; 1010,000 km^2 requires management practices to be applied and 3200 km^2 requires a change in land use to protect its productivity. Within the arid zone $13 million is required for soil conservation treatment works in the class of "urgency level 1", ie. within the next 10 years. An investment of $96 million is quoted for a similar period in the non-arid grazing zone. The distribution of the types and severity of erosion is shown in Figure 2.

Although runoff experiments have been criticised from a research point of view and extrapolation to the property scale requires caution, the Hill Grazing Experiments of the Soil Conservation Service of N.S.W. (1953) have a special significance. The demonstration and educational value of these experiments carried out at several stations over a long period has been overlooked by many extension workers in the pastoral region. These data, as shown in Table 2 demonstrate not only the striking differences in runoff resulting from differential stocking, but even more striking differences in soil losses. When these losses are related to Leigh's (1974) estimates of the level of deterioration of each major vegetation type, the significance of the results of both studies becomes more evident.

CAUSES OF EROSION IN THE PASTORAL REGION

Despite the identification of overgrazing as the prime cause of erosion by many authors (Blake 1936, Beadle 1948, Perry 1967, Moore 1969 and Roberts 1972) there exists a sequence of causes which include ecological, historic, economic and social factors.

Beadle's (1960) evidence indicates that the vegetation of the semi-arid zone evolved under relatively light grazing except in the vicinity of permanent waterholes. This is ecologically very different from the evolution of grasslands on other continents where intermittent heavy grazing by large herds of migratory hard-hoofed animals was an important evolutionary force (Roberts 1971).

Perry (1968) points out three other differences between Australia's arid grazing lands and those of other countries:

(a) A short history of use by domestic stock in Australia - in some regions barely 100 years.

(b) Almost total government ownership of Australia's arid lands.

(c) A lack of opportunity to apply a nomadic or seasonal pastoral system due to land tenure, distances and topography.

While much has been written on the evils of overgrazing, Davies (1955) points out that while overgrazing is harmful, moderate grazing may improve the vigour of certain semi-arid pastures as demonstrated by Wood (1936) in the saltbush country of New South Wales. Similarly, Ehersohn (1967) has postulated that stocking may have a beneficial effect in Mitchell grass on cracking clays, through the effect of animals hoofs on soil moisture relations.

PROCESSES LEADING TO EROSION

The relationship between plant cover and soil loss by water and wind erosion is well known. In the open grassland situation Roberts (1975) has suggested that particular sequential relationships exist between the four main phases of deterioration, as shown in Figure 3. For shrub-dominated vegetation Marshall (1970) has postulated the mechanisms of vegetative protection against wind.

It is of the utmost importance that the irreversibility of certain advanced stages of these processes be recognised by those responsible for determining policy and the allocation of funds for soil conservation. This is particularly the case in areas where the soil is prone to scalding, leading to an ecological fix in which the absence of soil moisture prevents ecesis and succeeding developmental stages in revegetation. In addition, the loss of topsoil nutrients must be accepted as a permanent loss that will be reflected in both the quantity and quality of vegetation growth which follows such losses. The only Australian research to accurately quantify the reduction in yield and nutritive value of plants growing on differentially eroded soils is that of Daniel (1969).

POSSIBILITIES OF ECOLOGICALLY BASED MANAGEMENT

The view is held by many researchers and landholders that variation in annual rainfall has such an overriding effect on the vegetation, that the effects of management can never be more than marginal. Theoretically there exists a relationship between defoliation and plant cover and in the same way erosion rates are generally related to plant cover. The writer (Roberts 1972) has enumerated those factors which may be considered as managerial variables. Within the cost/price structure in which the landholder must operate, the following factors can be controlled:

1. Total number of livestock
2. Breeds of each type of livestock
3. Ratio of cattle to sheep
4. Combinations of animal groups running together
5. Heavy intermittent grazing of paddocks
6. Fencing of main vegetation types into separate paddocks
7. Positioning of waters and licks
8. Burning
9. Mechanical shrub control
10. Water spreading
11. Seeding of improved species

The above factors hold a wide range of combinations which could affect the vegetation and the rate of erosion substantially. Basic to the economic and ecological maintenance of any grazing enterprize is the need for property size to be sufficient to constitute a "Living Area" in the region concerned.

The search for impirical evidence of the difference in condition and long term productivity between well managed and poorly managed properties must continue. Only such differences will convince landholders and policy-makers that erosion control and long term stability can be significantly improved through land management. In this regard, the evidence in favour of lowering stocking rates to increase liveweight gains per animal and to lower costs needs to be further evaluated.

THE ECONOMIC FIX OF REHABILITATION

It is clear that even partial destocking is not acceptable to many landholders whose decisions are largely controlled by financial institutions and pastoral agencies. In many cases the land tenure system has encouraged exploitation and the conservative landholder has not found careful husbandry of the land to be in his best interests. In certain freehold areas, the price paid for the land has borne very little relationship to the level of returns which can be expected at a safe stocking rate. In virtually all cases the low productivity of arid lands cannot bear any financial costs aimed at controlling erosion by the construction of earthworks.

Added to the inability of grazing land to carry restorative costs, is the generally serious position relating to property incomes in the pastoral zone overall. The B.A.E. survey (1976) of the grazing industry indicated that of all the properties in the pastoral zone (as shown in Figure 1), 36% had a negative income and a further 28% had an income of less than $10,000 per annum, giving a nett property income of $7805.00 for all properties in this zone, as compared with $14,125.00 for the wheat-sheep zone.

From an economic viewpoint, careful consideration must be given to which of the four target levels of erosion control should be aimed at: i) Do Nothing, ii) Retard, iii) Maintain or, iv) Improve present erosion rates.

A decision to improve the situation could prove to require an investment beyond the means of many landholders. For instance, while most landholders were making less than 5% on their total investment, one in 5 landholders in Western Queensland had debts exceeding 60% of their property market value (Bain and Waring 1970). Taken in this context, the required soil conservation expenditure of $59/ha in the arid zone and $1300/ha in other pastoral regions (Dept. Environment 1978) is unlikely to be committed unless substantial subsidy increase is forthcoming. Serious anomolies arise when restoration costs exceed land costs and in the 55% of the arid zone and 36% of other pastoral zones requiring soil conservation treatment, deterioration is likely to continue ("Do Nothing") in the absence of more realistic financial aid.

CONCLUSION

The pastoral zone is suffering widespread deterioration some of which has reached serious proportions. Certain of the retrogressive processes are irreversible in the absence of expensive restorative practices. The economic situation presently precludes landholders from undertaking much of the required conservation work. The economic value of the pastoral regions to the nation warrants greater support through research, extension and financial assistance if the productivity of these regions is to be maintained.

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TABLE 1: Form of degradation and construction costs of necessary works in areas requiring treatment in arid zone of Australia at June,1975 (Dept. Environment, 1978)

	Land used for grazing		Construction cost of works needed.	
	000 km²	(%)	$m	(%)
Area in use	3356	–	–	–
Area not requiring treatment	1506	–	–	–
Vegetation degradation and little erosion	950	(51)	10	(15)
Vegetation degradation and some erosion	467	(25)	25	(38)
Vegetation degradation and substantial erosion	284	(15)	21	(32)
Vegetation degradation and severe erosion	148	(8)	10	(15)
Dryland salinity – sometimes in combination with water erosion	1.1	(0.059)	0.18	(0.28)
Total treatment needs (areas and costs)	1850	(100)	65	(100)

Figure 1: Pastoral Zone (B.A.E., 1976)

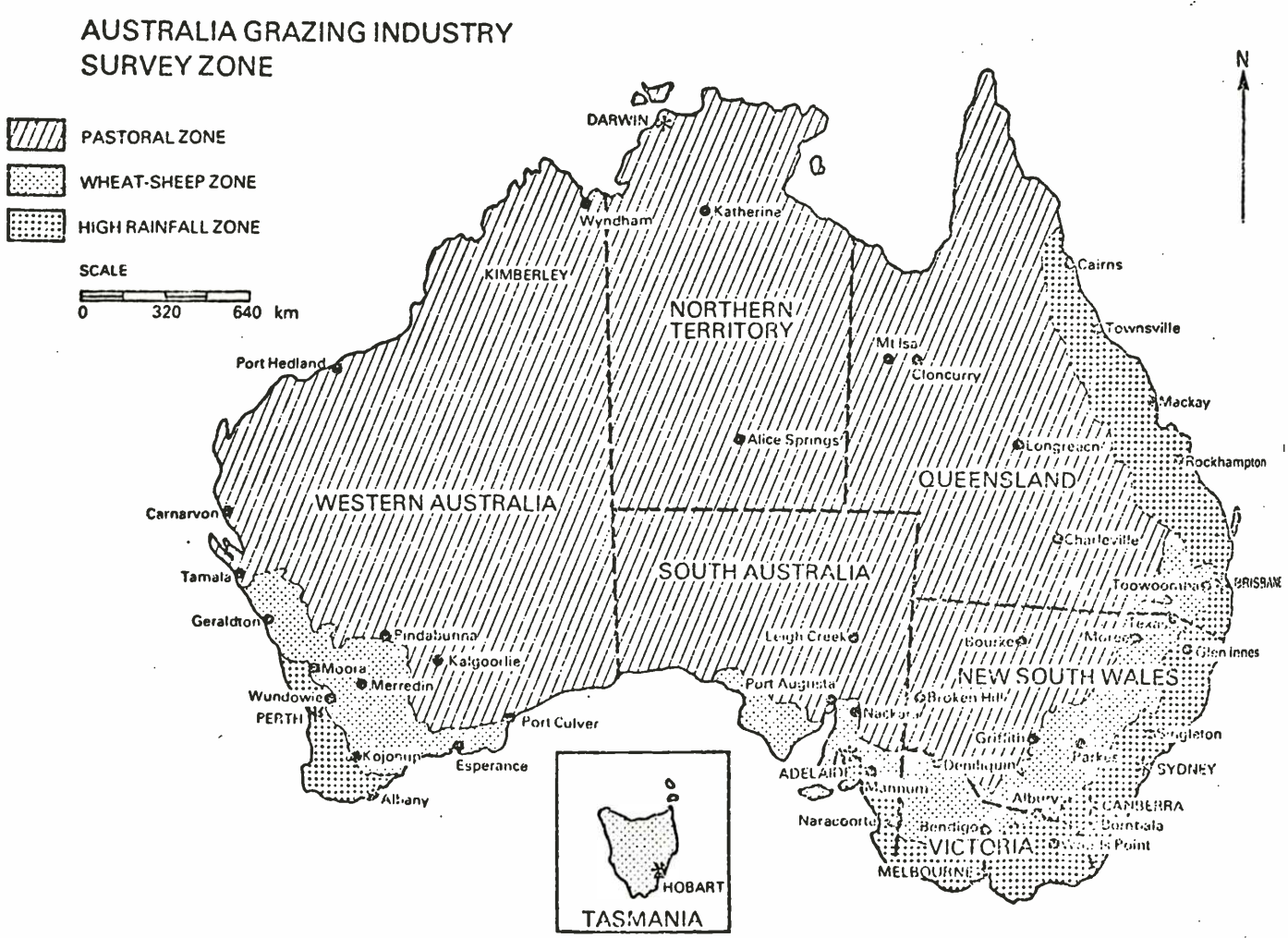


TABLE 2: Run-off and Soil Loss from Hill Grazing Experiments, Soil Conservation Service of N.S.W. (See Buckley 1953).

GUNNEDAH RESEARCH STATION*

Grazing Treatment	Run-off (inches)	Soil Loss (lbs/acre)
Heavy	20.67	18,584
Light	2.68	709
Nil	1.10	127

* Totals are from 1948 to 30th June, 1972.

WELLINGTON RESEARCH STATION [T]

Grazing Treatment	Run-off (inches)	Soil Loss (lbs/acre)
Heavy	11.28	12,638
Light	1.50	738

[T]Totals are from 1st September, 1949 to date.

COWRA RESEARCH STATION [(a)]

Grazing Treatment	Run-off (inches)	Soil Loss (lbs/acre)
Heavy	4.03	806
Light	0.73	84

[(a)]Totals are from 1953 approximately to 30th June, 1972.

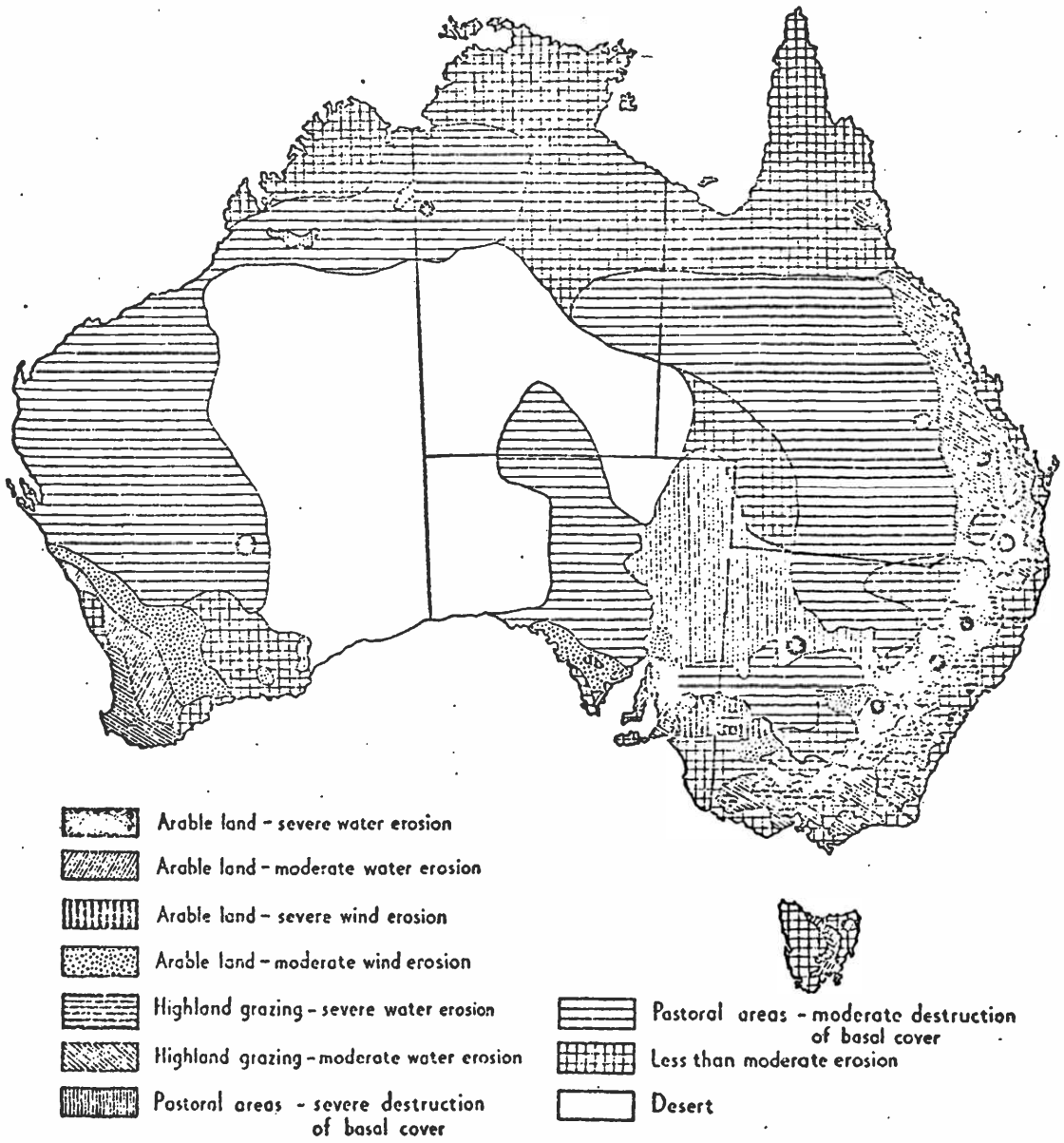
WAGGA RESEARCH STATION [(b)]

Grazing Treatment	Run-off (inches)	Soil Loss (lbs/acre)
Heavy	16.76	5,278
Light	4.35	431

[(b)]Totals from 1950 approximately to 30th June, 1972.

(1" = 25mm; 1lb = 0.45kg; 1 acre = 0.4 ha)

Figure 2: Distribution of Soil Erosion in Australia *



* Adapted from a map by R.1. Heriot, Dept. Agric. S.A.

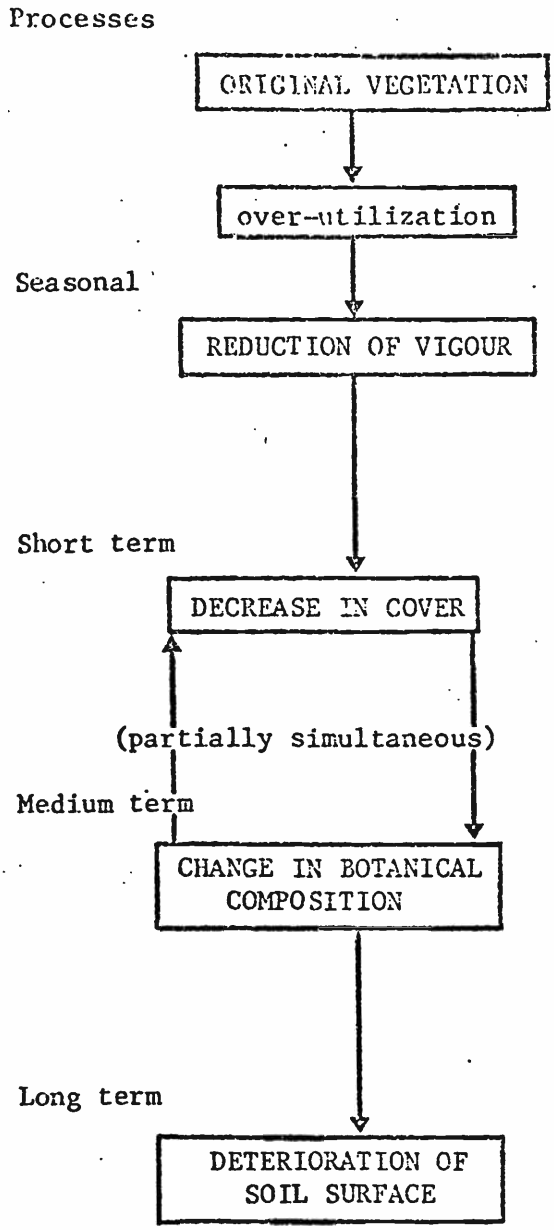


Figure 3: Theoretical sequence of processes in land degradation following continued over-utilization of the vegetation. (Roberts et al, 1975)