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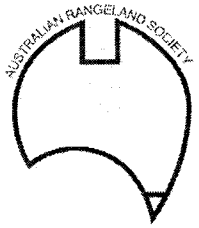

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STREETLIGHTS ON THE WESTERN NULLARBOR

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ABSTRACT

The Western Australian portion of the Nullarbor Plain currently supports 19 pastoral leases. The most remarkable feature one notices when looking at satellite imagery of the area are the 'streetlights' of the Nullarbor. The 'streetlights' are light areas on the satellite imagery that indicate a piosphere effect surrounding each watering point. These areas are created by the exposure of the Nullarbor's lightly coloured soils as a result of over-utilisation that has lead to a loss in vegetation cover and damage to cryptogam crust. However, evidence of this is not always discernible when ground-truthing light areas. Though the effect looks obvious, our experience indicates that a combination of ground-truthing and recent imagery is necessary to reliably assess changes in rangeland condition as a result of pastoralism on the Nullarbor.

INTRODUCTION

The Western Australian portion of the Nullarbor Plain was largely undeveloped for pastoralism prior to 1955, with considerable pastoral development taking place during the 1960's (Mitchell, McCarthy and Hacker 1979). Today, there are 19 pastoral leases operating in the Western Nullarbor. A joint team from the Department of Agriculture and the Department of Land Information is currently surveying the natural resources of the pastoral leases on the Western Nullarbor.

The Nullarbor landscape is unique; it comprises the world's largest arid zone karst (limestone landscape) covering 220,000 km² (Gillieson, Wallbrink and Cochrane 1996). In studying satellite imagery of the area, the most noticeable feature is the 'streetlights' of the Nullarbor. The 'streetlights' are light areas that indicate a piosphere effect surrounding each watering point. A piosphere is the highly utilised area that radiates out from a watering point. In some instances the light areas viewed on satellite imagery extend throughout entire paddocks.

The 'streetlights' are not visible on satellite imagery for any other pastoral area within Western Australia. This paper examines why such areas are only visible on satellite imagery of the Nullarbor. In light of this year, 2006, being the International Year of Deserts and Desertification, the paper also looks at whether the 'streetlights' are an indicator that pastoralism is contributing to the process of desertification in the Nullarbor.

The 1992 Rio Conference (Earth Summit Agenda 21: Programme of Action for Sustainable Development) defined desertification as land degradation in arid and semi-arid areas resulting from various factors including climate variation and human activities. Harold Dregne (1977) suggested that the indicators of desertification are a reduction in the productivity of desirable plants, alterations in biomass and diversity of flora and fauna, and accelerated soil deterioration. Factors other than grazing by domestic stock have also contributed to the alteration of the Nullarbor landscape. These include fire and plague proportions of rabbits, which have significantly reduced the abundance of perennial plants in areas throughout the Nullarbor (Beard 1975). It is proposed that piospheres show up as 'streetlights' on satellite

imagery due to a loss of desirable plants and deterioration of the soil surface due to grazing and movement of domestic stock around watering points. If this is the case then 'streetlights' could be used as a tool to monitor rangeland condition and hence the incidence of desertification as a result of pastoralism on the Nullarbor.

WHY ARE 'STREETLIGHTS' VISIBLE ON THE NULLARBOR?

There are a number of factors that differentiate the landscape of the Nullarbor from the landscape of other pastoral regions of Western Australia, and which contribute to the presence of 'streetlights' in the Nullarbor. One of those factors is the composition of the vegetation communities. Many vegetation communities in other pastoral regions of Western Australia include a tall stratum, such as the mulga (*Acacia aneura*) and Eucalypt woodlands. Grazing of the tall stratum by stock is severely limited due to the height of the plants making them inaccessible. Thus woodlands can hide what degradation is occurring below and so the area appears unchanged on satellite imagery. The majority of vegetation communities on the Nullarbor are low shrublands.

It has been suggested that where vascular plant cover is low and spatially discontinuous, cryptogam crusts may be major contributors to the spectral characteristics of satellite imagery. However observations show that where there are marked similarities in the reflectance patterns of cryptogam crusts and the surface soil, it may not be possible to differentiate between the soil and the cryptogam crust (Eldridge and Greene 1994). The soils in other pastoral regions of Western Australia, range from red to reddish brown and are generally darker than those of the Nullarbor. On satellite imagery the bare surfaces of these dark soils may not be able to be differentiated from the cryptogam crust, which ranges in colour from green to black. In the Nullarbor the soils have a yellowish red colour as they are derived from the limestone karst. Therefore the 'streetlights' of the Nullarbor are likely a result of the reflectance of the light coloured soils in degraded areas where the cryptogam crust has been severely altered or removed.

The texture of the soil surface also contributes to the light appearance of degraded areas. Areas of soil that have an intact cryptogam crust have highly textured surfaces, thus light reflected from such surfaces is scattered. Light reflected from soil surfaces that have become deflated and scalded is not scattered and consequently appear as bright areas on satellite imagery.

NULLARBOR 'STREETLIGHTS' FROM THE GROUND

In ground-truthing the areas that appear as 'streetlights' on satellite imagery, the area of degradation in which all shrubs and surface crusting have been removed is predominantly restricted to a 500 metre radius surrounding each watering point. According to the satellite image the area of the 'streetlight' extends beyond this point, and in some cases extends throughout the entire paddock. To investigate whether there was any physical evidence of deterioration in rangeland condition we studied four sites on either side of a fence on a Nullarbor pastoral station. One pair of sites was dominated by *Atriplex vesicaria* and the other pair co-dominated by *Atriplex vesicaria* and *Maireana sedifolia*. One side of the fence was developed for pastoralism and appeared as a light area on the satellite image. The other side of the fence was undeveloped and appeared as a dark area on the satellite image.

Number of individuals of the dominant plant species were recorded along transects at each site. The extent of soil crusting and proportion of intact soil surfaces were recorded for 20 quadrats performed along each transect. The results are displayed in the tables below.

Table 1: Number of plants and level of soil crusting for sites dominated with *Atriplex vesicaria* and that appear as light or dark on satellite imagery

	Undeveloped	Developed
Appearance on satellite imagery	Dark	Light
No. of *Atriplex vesicaria* plants	98	73
Proportion of site with intact cryptogamic cover (%)	30	25
Proportion of site with extensive crust brokenness (%)	0	20
Proportion of site with >50% crusting (%)	30	35
Proportion of site with <10% crusting (%)	30	30

Table 2: Number of plants and level of soil crusting for sites co-dominated with *Atriplex vesicaria* and *Maireana sedifolia* that appear as light or dark on satellite imagery

	Undeveloped	Developed
Appearance on satellite imagery	Dark	Light
No. of *Mairiana sedifolia* plants	52	50
No. of *Atriplex vesicaria* plants	33	37
Proportion of site with intact cryptogamic cover (%)	100	100
Proportion of site with extensive crust brokenness (%)	0	0
Proportion of site with >50% crusting (%)	75	100
Proportion of site with <10% crusting (%)	0	0

Table 1 shows that there were a lower number of *Atriplex vesicaria* on the developed site and that a greater proportion of the crust on that site was extensively broken, however plant and crust cover on the developed site were still substantial. Table 2 illustrates there is very little difference in the number of plants and the condition of the soil crust between the developed and undeveloped site co-dominated by *Atriplex vesicaria* and *Maireana sedifolia.*

'STREETLIGHTS' AS INDICATORS OF DESERTIFICATION

Indicators of desertification include the loss of desirable vegetation, loss of soil structure and cohesion, the loss of soil roughness and increased albedo (Dregne 1977, Prince 2002). Using this definition it follows that the appearance of 'streetlights' on satellite imagery of the Nullarbor could be used as an indicator that pastoralism is contributing to the process of desertification. However, field results have shown that at a distance of greater than 500 m from water, plant numbers and the condition of the surface crust do not support the wide-reaching area of 'streetlights.' This may indicate that the piosphere effect is not as extensive in the Nullarbor as the 'streetlights' on satellite imagery portray, though further research is required.

The Nullarbor also shows a markedly seasonal response to rainfall. The dense annual cover following rainfall changes the spectral signature of bright areas in contrast to times of low rainfall. This is another constraint in using satellite imagery as a tool to measure the incidence of desertification. For an area to be considered in a state of desertification, the change in the landscape must be irreversible and thus will not respond to rain following extended dry periods.

Due to the long time scale and the unpredictability of vegetation change in arid rangelands, the time for a transformation in the landscape to take place may exceed the human lifespan (Prince 2002). As such it is important that there is an independent means to monitor changes in rangeland condition to assess whether desertification is progressing, or likewise show an

improvement in rangeland condition as a result of improved land management. Thus further investigation is required into reliably interpreting areas of degradation that appear on satellite imagery to assist in managing the Nullarbor and to ensure it is not heading inexorably towards a state of desertification.

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