Monitoring Fire Impact

George and Happy Valley Forest Blocks

February – November 2000

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Introduction

Forest fire occurrence is a major ecological process, both positive and negative, on the natural cycle of vegetation succession and on the ecosystem's structure and function. The characteristics of fire such as intensity, type and timing can influence the dynamics of the ecosystem. Development, on a permanent basis, of appropriate statistics of fire occurrence and a complete and accurate database of burnt areas should be initiated and included in a well structured decision-making system regarding the management of forest fires. Moreover, the long term monitoring of burnt areas and their restoration to pre-burn condition status requires accurate location and mapping.

Satellite remote sensing data, acquired before and after the fire, has been used successfully to map burnt areas, species affected, and severity levels of damage, as well as to monitor the vegetation regeneration status after fire.

The purpose of this paper is to demonstrate image enhancement and classification techniques for the rapid, easy, and effective mapping of burnt and non-burnt areas within two nominated forest blocks within the forest region.

Method

Several classification techniques have been developed and used to detect and map burnt areas, ranging from the simple enhancements to the more complex, such as spectral unmixing and principal component analysis.

In this project we used two rectified and calibrated dates of imagery, one pre-burn the other post-burn, produced a Normalised Difference Vegetation Index (NDVI) image of both, and subtracted one NDVI image from the other to produce a NDVI difference image. An unsupervised classification was then applied to this difference image to make the final product.

Project Area

Two areas were nominated to trial the procedure, George and Happy Valley forest blocks of the SW of Western Australia (Figure One).

Landsat Imagery

Landsat satellite imagery used was dated 13th February 2000 (pre-burn) and 11th November 2000 (post-burn).

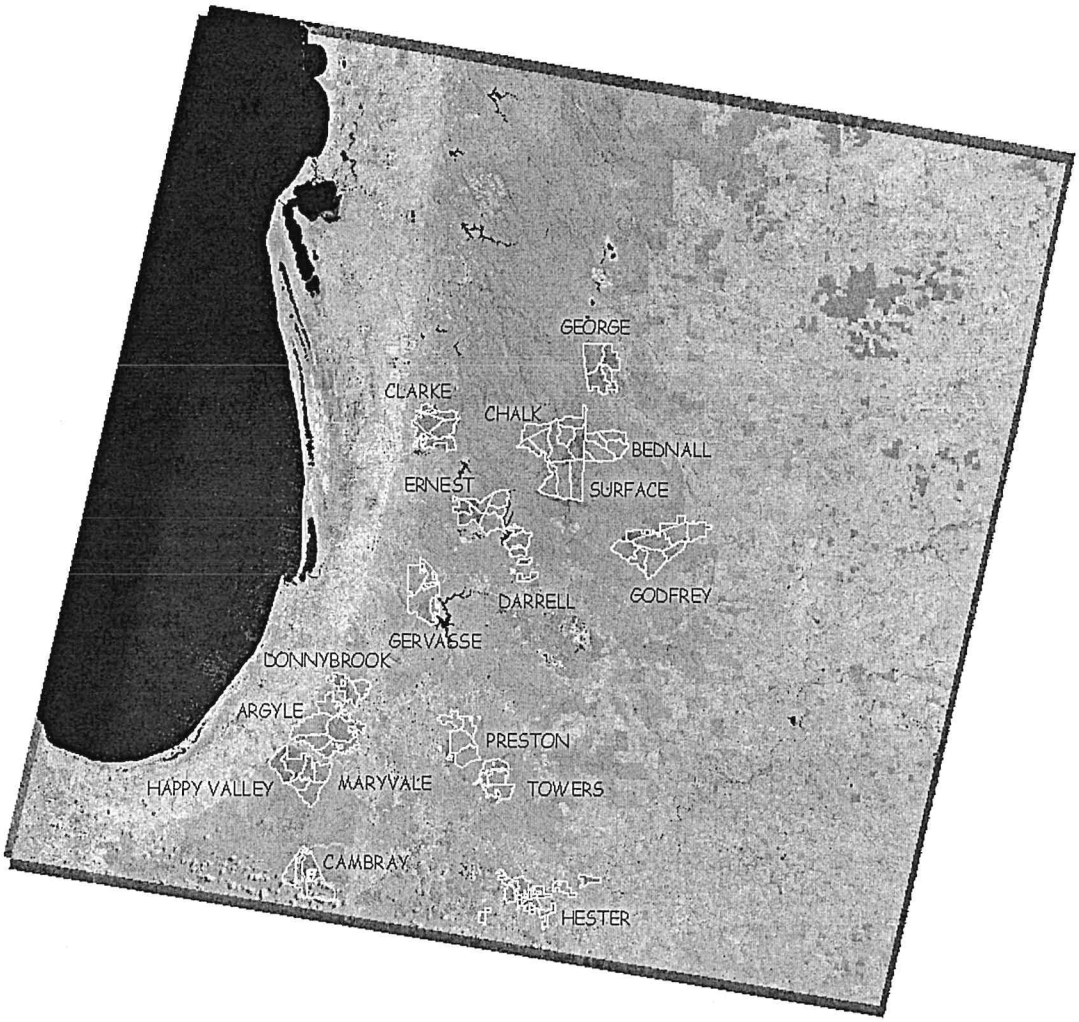

Figure One **Two image dates overlaid, Feb 2000 in red and Nov 2000 in green. George Block being the northern area outlined in white and Happy Valley to the bottom SW of the image.**

The extent of the Landsat satellite scene can be seen from Figure One above, approximately 185km X 185km. The two image dates have been registered and calibrated to one another.

The following Figures show a before-fire and an after-fire sequence, finishing with a classification of both (Figures Six and Thirteen) which maps the fire occurrence. The classification forces the data into four broad classes, green being unburnt, red the severe burn followed by less severe yellow and blue respectively. Both George block and Happy Valley block were mapped together with the results being consistent between both areas. Statements of the area burnt and unburnt are available.

The description for the methodology of Happy Valley Block mirrors that of George Block and isn't repeated in this report.

George Block

Figures Two and Three below are images of pre and post burn within George Block. Figure Three clearly shows the extent and location of the forest burn.

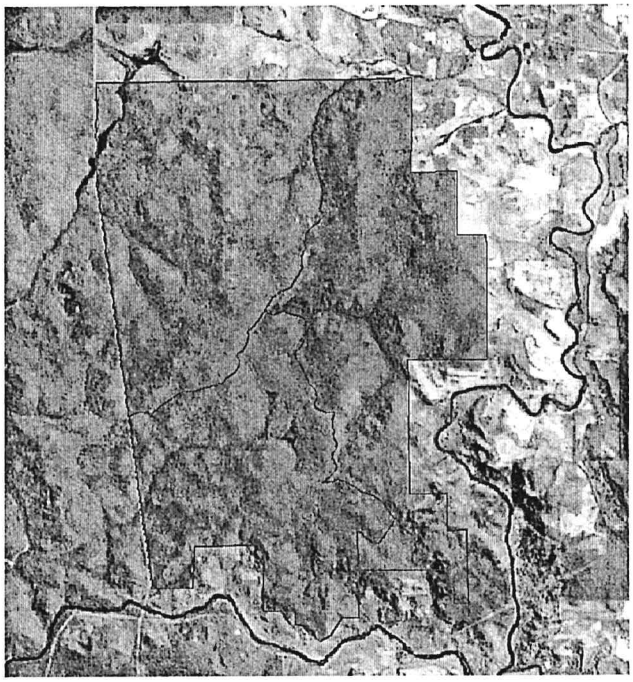

Figure Two **Enhanced image of February 2000 using spectral bands 3,4,2 in the R,G,B respectively, and showing the unburnt forest as varying shades of green. The block boundary is shown in blue.**

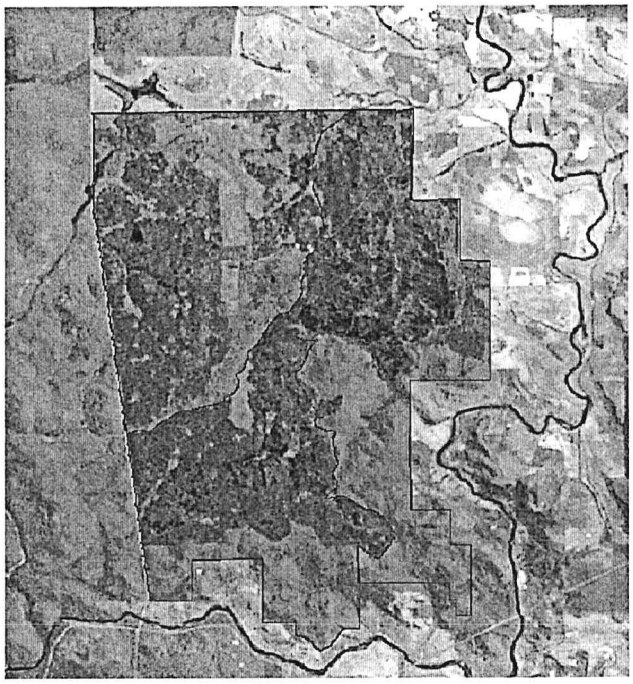

Figure Three **Enhanced image of November 2000 using spectral bands 3,4,2 in the R,G,B respectively, again showing the unburnt forest as varying shades of green and burn areas as shades of black. The block boundary is shown in blue.**

The NDVI index for each date is an indication of the greenness within the block. Generally the lighter or whiter the area the greener the vegetation. From Figure Four the forest area appears green and healthy while the cured grasses of the adjoining paddocks are black. Likewise the areas of burnt forest within Figure Five appear black.

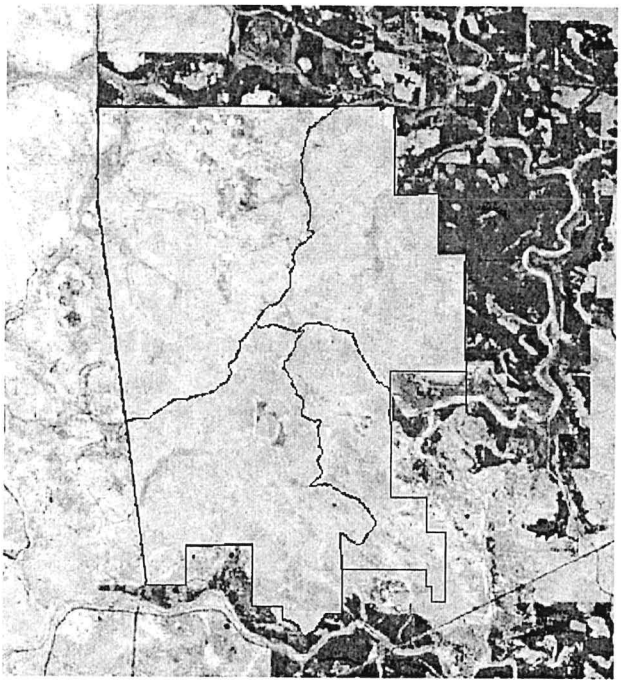

Figure Four **NDVI Index February 2000 – light to white areas being healthy vegetation, while the darker areas are generally cured grasses within pasture. Again the block is shown with a blue boundary.**

Figure Five **NDVI Index November 2000 – light to white areas within the block boundary are healthy vegetation and the dark to black areas are burnt.**

By subtracting the November 2000 NDVI image from the February 2000 image (Figure Six), estimation on the fire intensity and impact can be assumed, although this requires field validation and is dependent on vegetation description and uniformity. Black areas (A) are likely to have had a hotter burn then burns at B, although this may also be associated crown scorch.

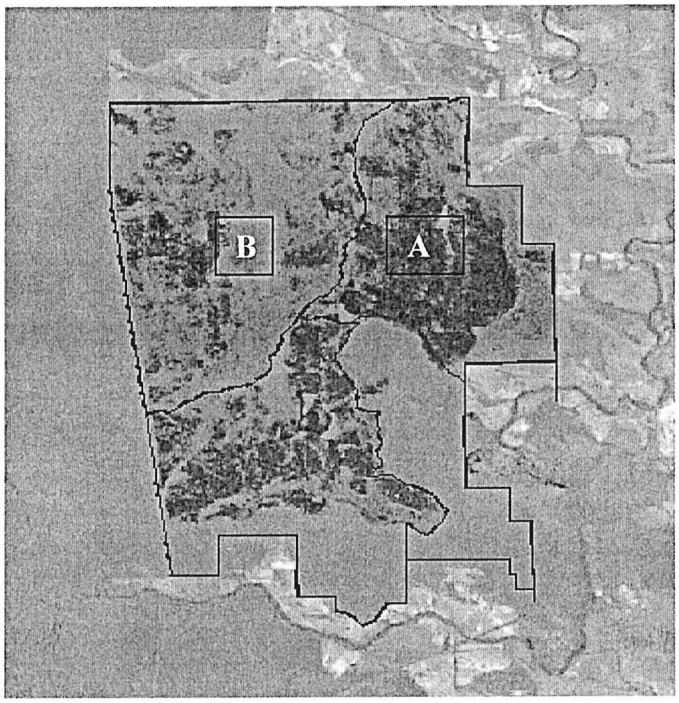

Figure Six **Difference image showing shades of grey as unaltered vegetation and black as negative changes. In this case the black within the forest block is due to fire.**

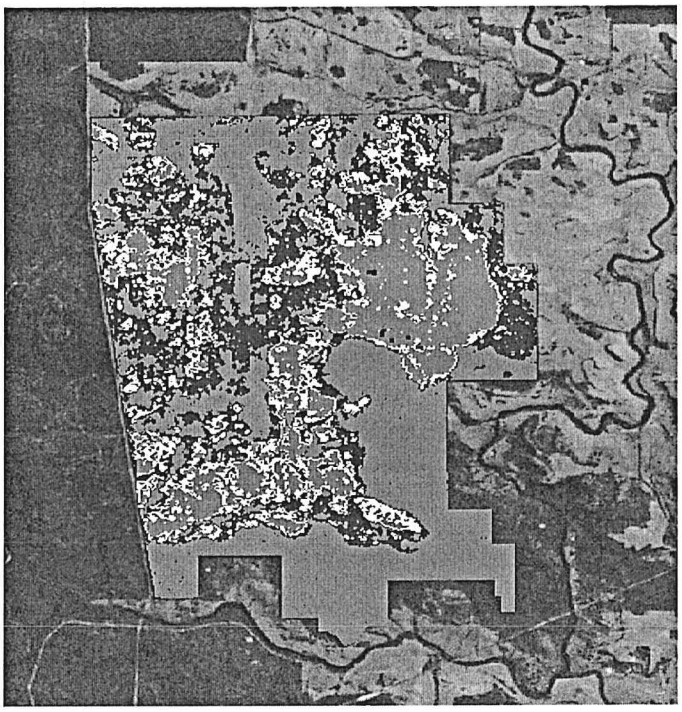

Figure Seven **Unsupervised classification of the difference image. Green being unburnt areas with yellow, red and blue being locations of burn patterns most likely related to fire intensity.**

Happy Valley

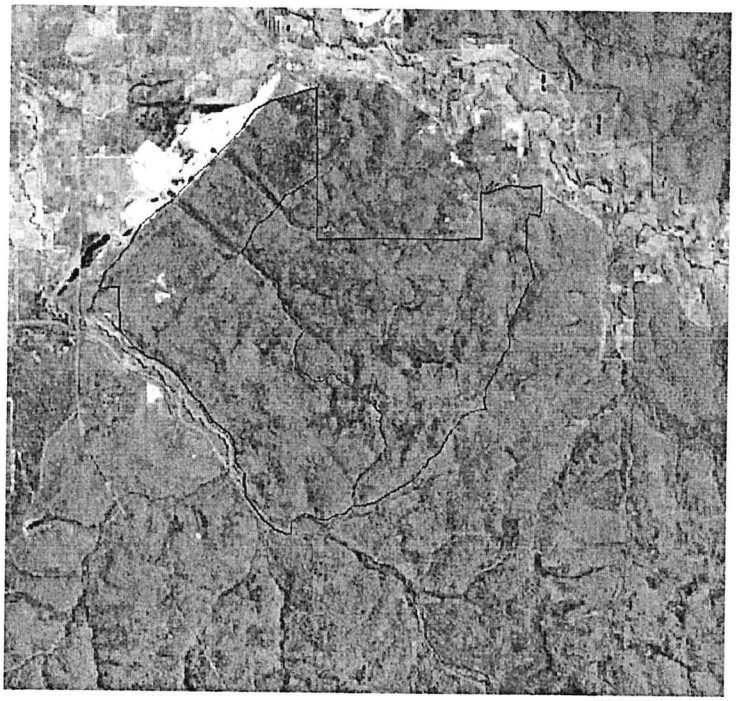

Figure Eight Enhanced image of February 2000 using spectral bands 3,4,2 in the R,G,B respectively, showing the unburnt forest as varying shades of green. The block boundary is shown in blue.

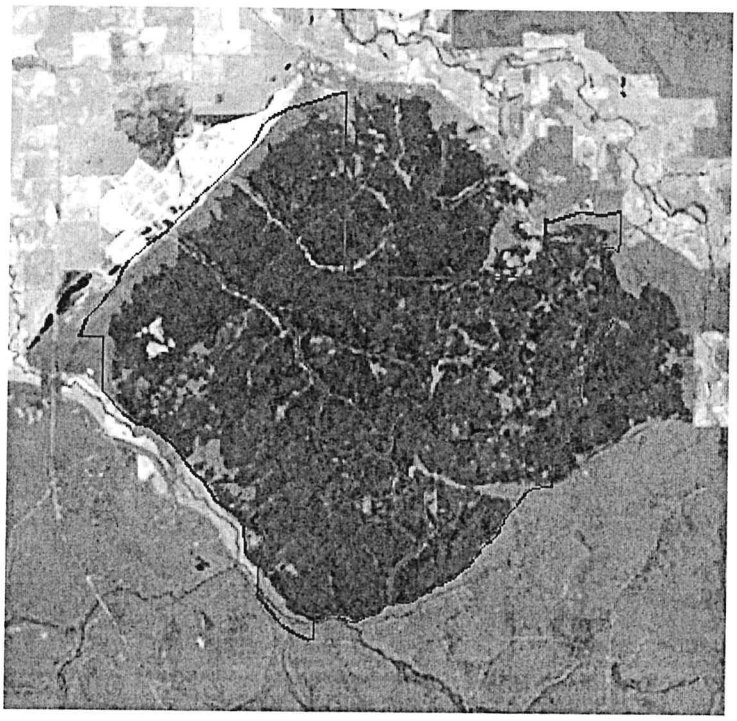

Figure Nine Enhanced image of November 2000 using spectral bands 3,4,2 in the R,G,B respectively, again showing the unburnt forest as varying shades of green and burn areas as shades of black. The block boundary is shown in blue.

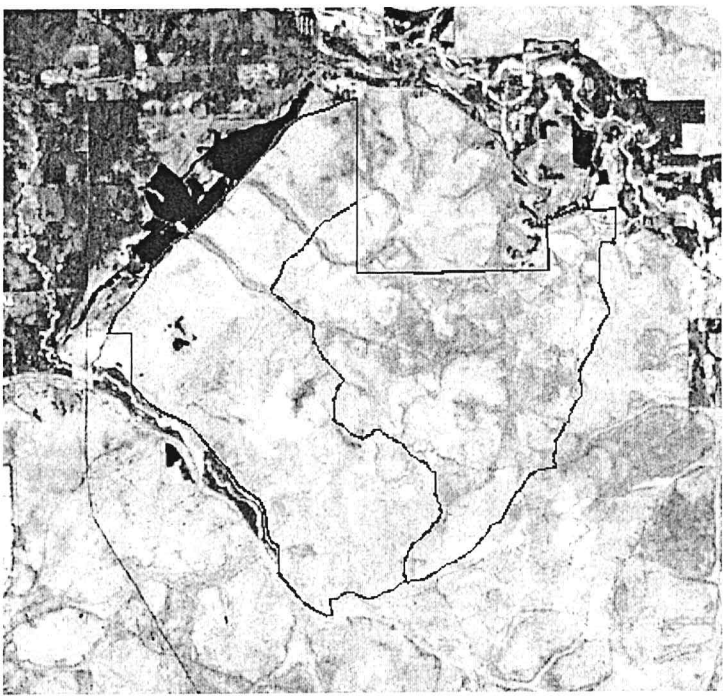

Figure Ten NDVI Index February 2000 – light to white areas being healthy vegetation, while the darker areas are generally cured grasses within pasture. Again the block is shown with a blue boundary.

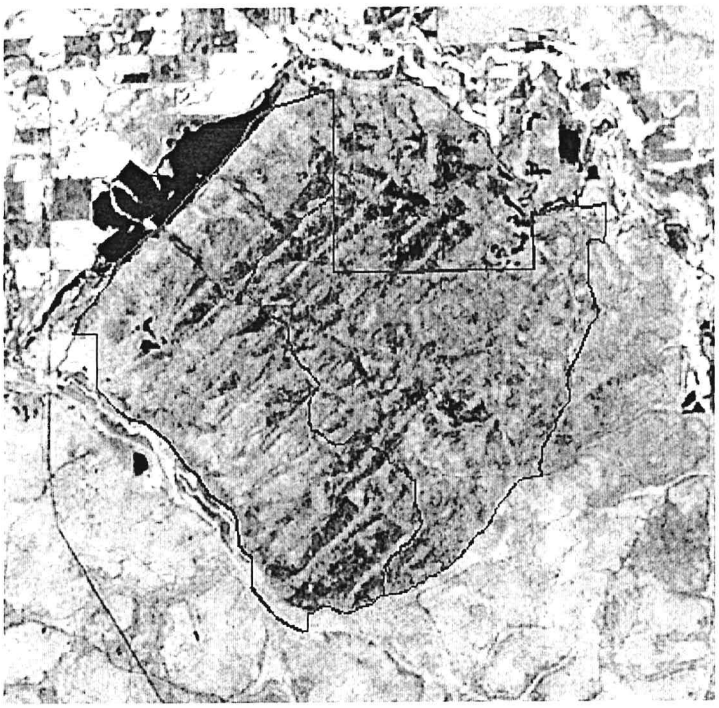

Figure Eleven NDVI Index November 2000 – light to white areas within the block boundary are healthy vegetation and the dark to black areas are burnt.

Figure Twelve Difference image showing shades of grey as unaltered vegetation, black as negative changes. In this case the black within the forest block is due to fire.

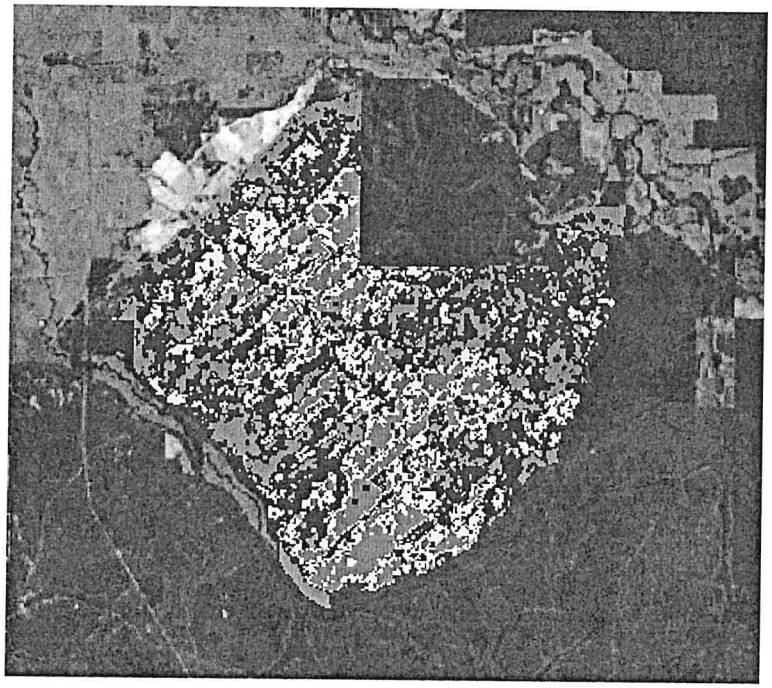

Figure Thirteen Unsupervised classification of the difference image. Green being unburnt areas with yellow, red and blue being locations of burn patterns most likely related to fire intensity.

Conclusion

From this technique it can be concluded that mapping fire occurrence within the forest areas of the SW is possible using satellite TM imagery. The project used data available to CALM and a methodology developed using imagery that has been precisely rectified and calibrated. Historical sequences of imagery can also be used to monitor both vegetation recovery rates after fire and to map previous burn locations.

For qualitative information the results require ground validation for accuracy and confidence. The techniques can be applied to large areas, given the vegetation homogeneity or to small discrete locations and are repeatable and reliable.