

**The distribution, extent and seasonality of large  
fires in Australia, April 1998 - March 2000, as  
mapped from NOAA-AVHRR imagery**

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## **1.0 Introduction**

### **1.1 Fire Regimes in Australia**

The Australian environment has been transformed by fire through natural and anthropogenic causes. The anthropogenic fires have had by far the greatest impact on the landscape. Firstly indigenous Australians used fire to aid in hunting practices and to encourage the growth of edible plants. Secondly, the arrival of European settlers caused a dramatic increase in the number of fires, which has had a rapid detrimental effect on the environment (Bond and van Wilgen, 1996). This rapid change in fire regime has led to the extinction of many species of flora and fauna due to their inability to adapt to such environmental change and landscapes suffer severe water and wind erosion after a fire event (Recher, Lunney and Dunn, 1986). Fire regimes will continue to change in Australia, as humans will persist in using fire as a management tool to maintain landscapes.

Future study on fire regimes will hopefully lead to more sustainable use of fire as a management tool. Ecologists, Bond and van Wilgen (1996), suggest areas of study could include; determination of maximum or minimum time between fire events to successfully manage species; determine best time for control burning; best weather conditions to control fire intensity; and determine size and location of a fire which best influences post fire recovery, animal range quality and landscape patchiness.

Fire regime and fire impact studies in Australia have been mostly limited to regional areas in the past, due to the diversity of landcover types and the vast area of the continent.

### **1.2 Satellite Remote Sensing and Fire**

Satellite remote sensing has opened the way for mapping and monitoring of fire activity on a continental scale. Robinson (1991) suggests that fire forms four signals that can be observed from space; 1] direct radiation from active fires (heat and light); 2] smoke; 3] post fire char and 4] altered vegetation structure. Remote sensing can be employed in three stages of fire management; before, during and after a fire. Pre fire remote sensing is important in the prevention of fire and the design of controlled burns (Gonzales-Alonso et al., 1997; Craig et al., 1995; Paltridge and Barber, 1988). During the fire, remote sensing can be used to detect and monitor the movement of fire across the landscape (Flasse, 1998; Martin et al., 1998; Smith et al., 1996). Post fire remote sensing is used to map the fire scar (footprint) and assess the area burnt (Fuller and Fulk, 1998; Flasse, 1998; Ehrlich, Lambin and Malingreau, 1997; Smith et al., 1996).

### **1.3 NOAA-AVHRR**

The National Oceanographic and Atmospheric Administration's (NOAA) Advanced Very High Resolution Radiometer (AVHRR) satellite sensor is suited to map and monitor fire activity on a continental scale. The spatial, spectral and temporal resolution of the sensor allows large areas to be viewed on a regular (up to six times daily) basis. The daily coverage, 2500km wide swath and five spectral bands of the AVHRR sensor enables fire regimes to be characterised from both the hot spots of active fires and from the area burnt. The ground field of view of the AVHRR sensor is

1.1 kilometres, meaning that the sensor averages the information it receives over this 1.1\*1.1 km<sup>2</sup> area to give a single value in each band. The effective ground resolution is about 3 kilometres. The AVHRR sensor has one visible band, one infrared band and three thermal bands, all of which are operational in fire detection, monitoring and mapping (Lillesand and Kiefer, 1996). See also <http://www.ngdc.noaa.gov/seg/globsys/avhrr.shtml>

#### **1.4 Data Processing and Image Analysis**

The following is a brief description of the processing required to create the base data products of fire hotspots (FHS) and fire affected area (FAA). The raw NOAA data were geometrically and radiometrically corrected using Common AVHRR Processing Software (CAPS), which was developed by the CSIRO using best practice Australian algorithms. The data were used to produce two individual products: FHS and FAA. These are proxy indicators of the location of the active fire and the actual area burnt. FAA which approximates the actual area burnt, is limited to fires greater in size than 4 km<sup>2</sup> and misses all the smaller fires which are often detected by FHS.

Locations of active fires (FHS) from the nighttime overpasses of NOAA-AVHRR data were generated through an automated process. A FHS exists where a hot feature (bushfire, stubble fire, industrial waste burn) is not obscured by cloud at the time of satellite overpass and emits sufficient radiance to be detected. FHS are often detected where the size of the fire is much smaller than the size of the pixel due to the high sensitivity of the AVHRR channel 3. The total area associated with the FHS that is ultimately burnt is unknown. Reliable detection of FHS from daytime overpasses of NOAA-AVHRR over much of Australia is not possible due to the high reflectivity of the desert regions causing the reflected solar irradiance to either saturate the AVHRR channel 3 sensor or cause significant errors of commission. Therefore to provide consistent and unbiased FHS in this context only night time NOAA-AVHRR overpasses were processed for FHS detection.

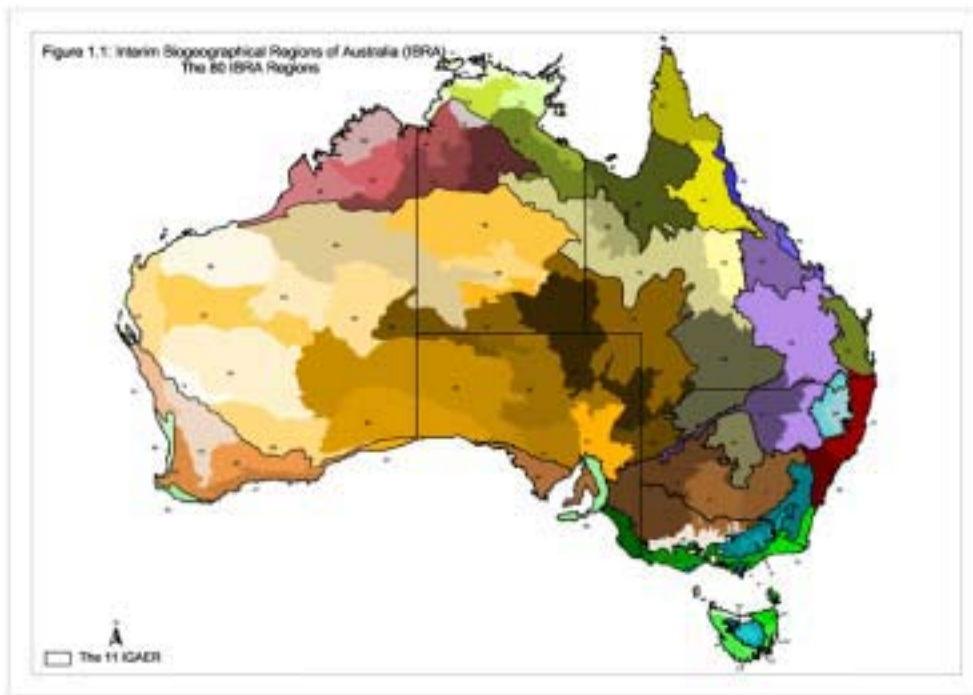
Based on changes in surface reflectance and temperature caused by bushfires, daylight NOAA-AVHRR satellite passes were used to map FAA on a nine-day cycle. Manual digitisation of areas affected by fire is carried out using ER-Mapper image processing software. Given the filtering process inherent in this manual method and the resolution of the sensor, the minimum area that can be detected is at least 4 km<sup>2</sup> in size thus the detection of fires smaller in area than this is not possible. For a pixel to be fire affected it is reasonable to assume that at least 50% of the area has been burnt.

#### **1.5 Geographical Information System and Interim Biogeographical Regions Of Australia**

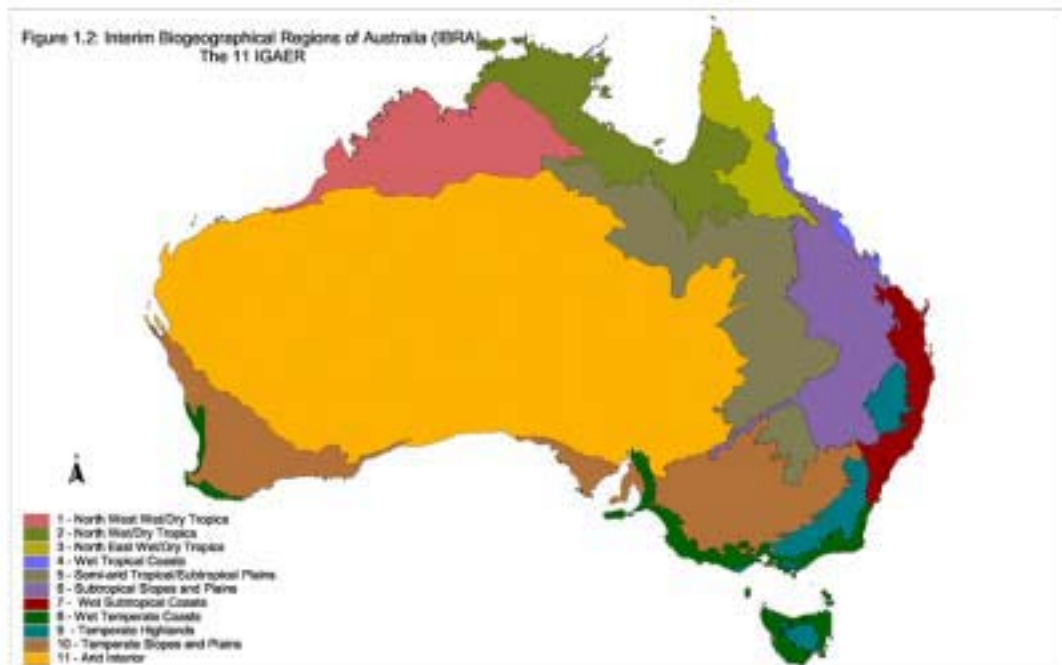
The Fire hot spots (FHS) and Fire affected area (FAA) data were exported to a locally developed Geographical Information System (GIS). The software used in the GIS is Arc View, and Microsoft Access and Excel.

To relate fire activity to vegetation type, the continent was divided into regions based on the Interim Biogeographical Regions Of Australia (IBRA) (Thackway and Cresswell, 1995). The Australian continent is divided into eighty IBRA regions, and these eighty regions are aggregated into eleven IBRA regions Grouped by Agro-Ecological Regions (IGAER), also referred to as IPR (IBRA Preliminary Regions) in

this document (Figures 1.1 and 1.2 respectively). FHS and FAA data were then related to vegetation type through the GIS, allowing a spatial and temporal analysis of fire regime patterns.



**Figure 1.1 The Interim Biogeographical Regions of Australia (IBRA), legend appears in Appendix 1.**



**Figure 1.2 IBRA regions Grouped by Agro-Ecological Regions (IGAER).**