

Mapping Fire Scars
and
Estimating Burned Area Acreage
for
Namibia - 2000/01

A Report to the Atlas of Namibia project.

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1. Summary of results

The spatial extent of significant fire events is represented in figure 1.

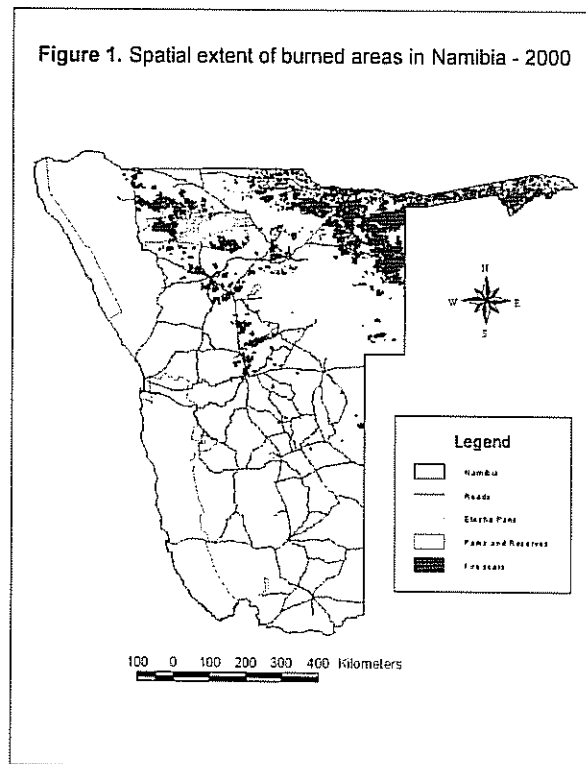
The total area burned during the 2000 season is estimated at 4851667 hectares (48516 sq. km.)

2. Materials and Methods

All mapping was based on multi-temporal analysis of digital NOAA AVHRR HRPT satellite data collected at the Etosha Ecological Institute in Okaukuejo.

A total of 12 datasets were selected to cover the period from early May 2000 to late February 2001. All datasets, with the exception of one NOAA 16 image, were acquired by the NOAA 14 satellite.

The raw channel 3 data, collected in the mid-infrared ($3.55 - 3.93 \mu\text{m}$) region of the electromagnetic spectrum, were calibrated into Brightness Temperature images and co-registered to the same map projection. Standard temporal change detection techniques were applied by consecutive subtraction of image values for date T from image values for date T-1. This yields subtraction images with values around 0 for areas of no change between dates, while positive or negative values indicate areas of change. These images are segmented into burned and non-burned areas, by setting an upper and lower numerical threshold for change areas. A single threshold set does not apply across all parts of the country due to differences in background values, and it is therefore necessary to process each set of images (T and T-1) as several geographical regions. The result is a collection of intermediate regional images which show fire scars across the whole country for the period between image dates. These images are evaluated against the original calibrated channel 3 image for date T. Regional scar maps which pass the evaluation are mosaiced into a single scene for the whole country, while those which fail are re-segmented and re-evaluated. Individual country-wide images are subjected to a concatenation process to yield the final cumulative fire scar image map for the fire season. A digital filter was run over this image map to remove isolated single pixels which were more than 1 pixel distant from other larger burned areas. The process is illustrated schematically in figure 2.



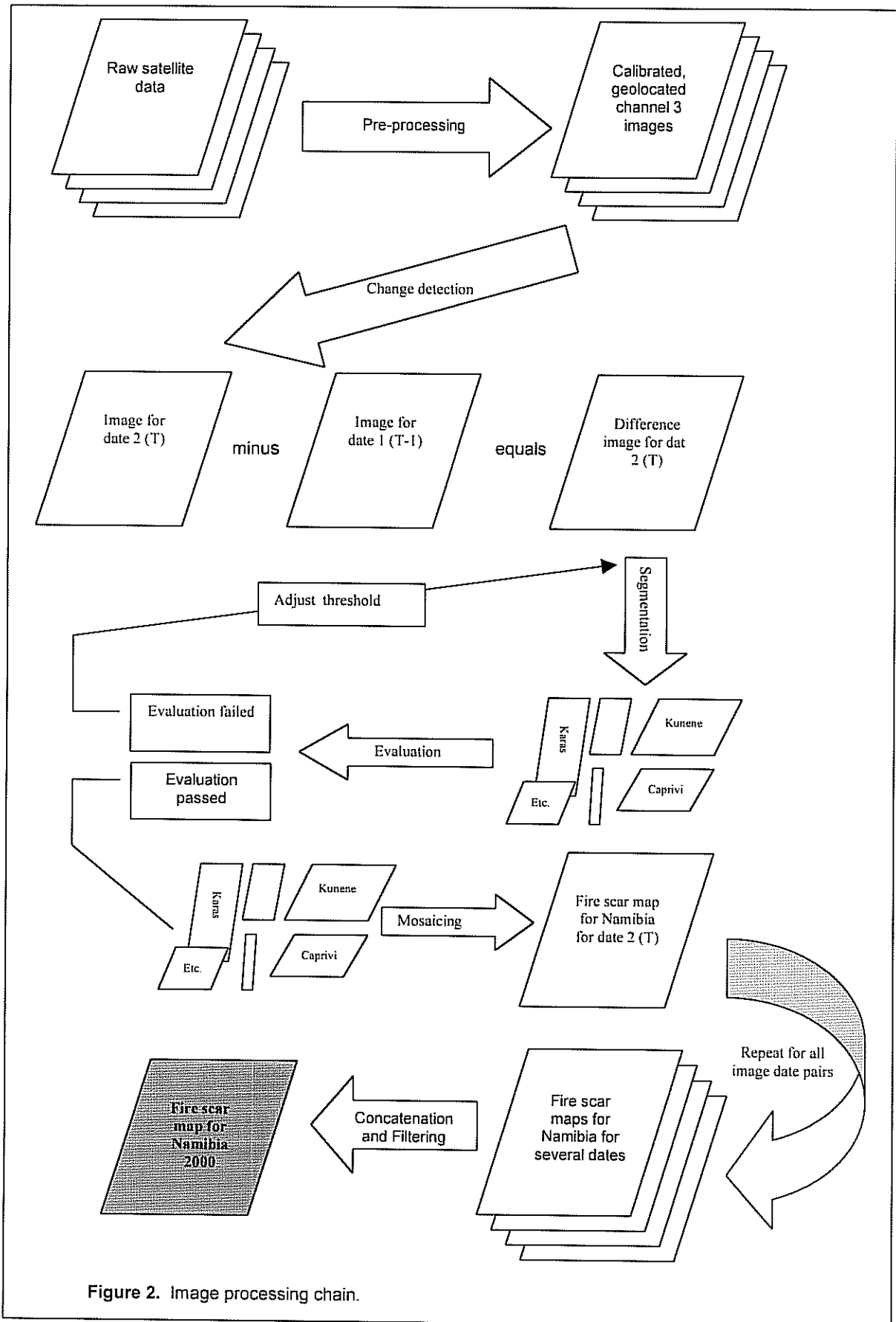
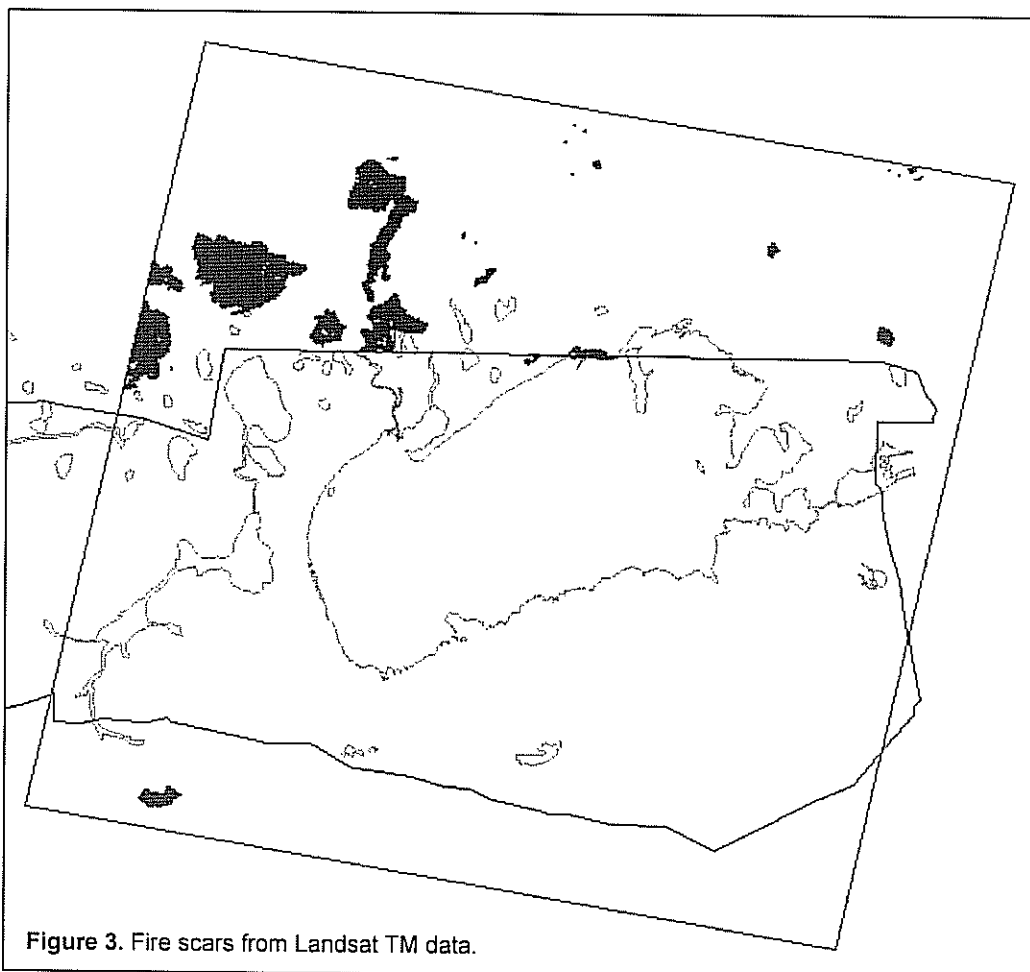


Figure 2. Image processing chain.

3. Accuracy assessment

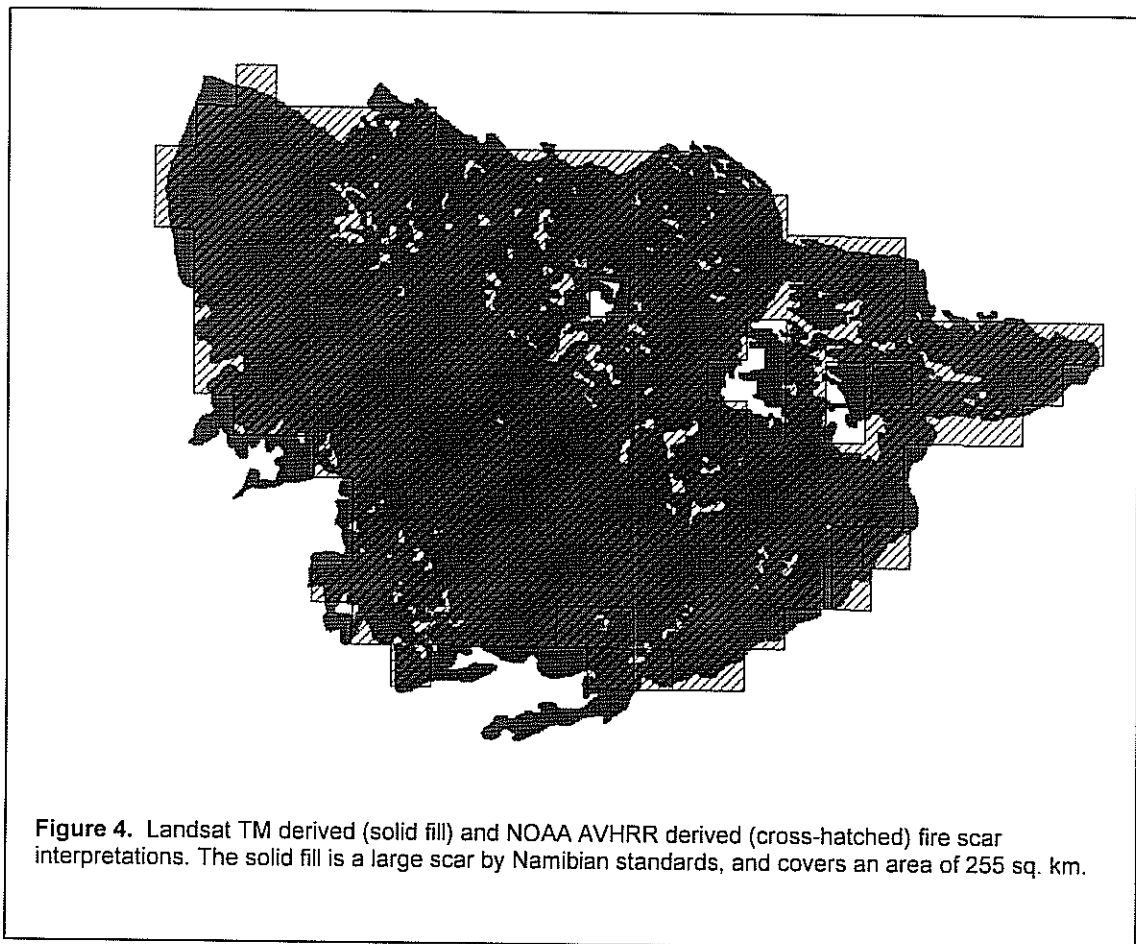
Burned area estimates for a sample drawn from the country-wide map, were assessed against burned areas derived from a visual interpretation of Landsat TM data for the Etosha Nat. Park area. The TM data contained a suitably wide size range of fire scars (Figure 3), and its interpretation is accepted as a true representation of the situation on the ground. Results of burned area estimates from the TM and AVHRR interpretation are given in Table 1. The accuracy of the spatial location of burned areas was not assessed, but results from the confusion matrix (Table 2) indicate that it is expected to be better than 71%.

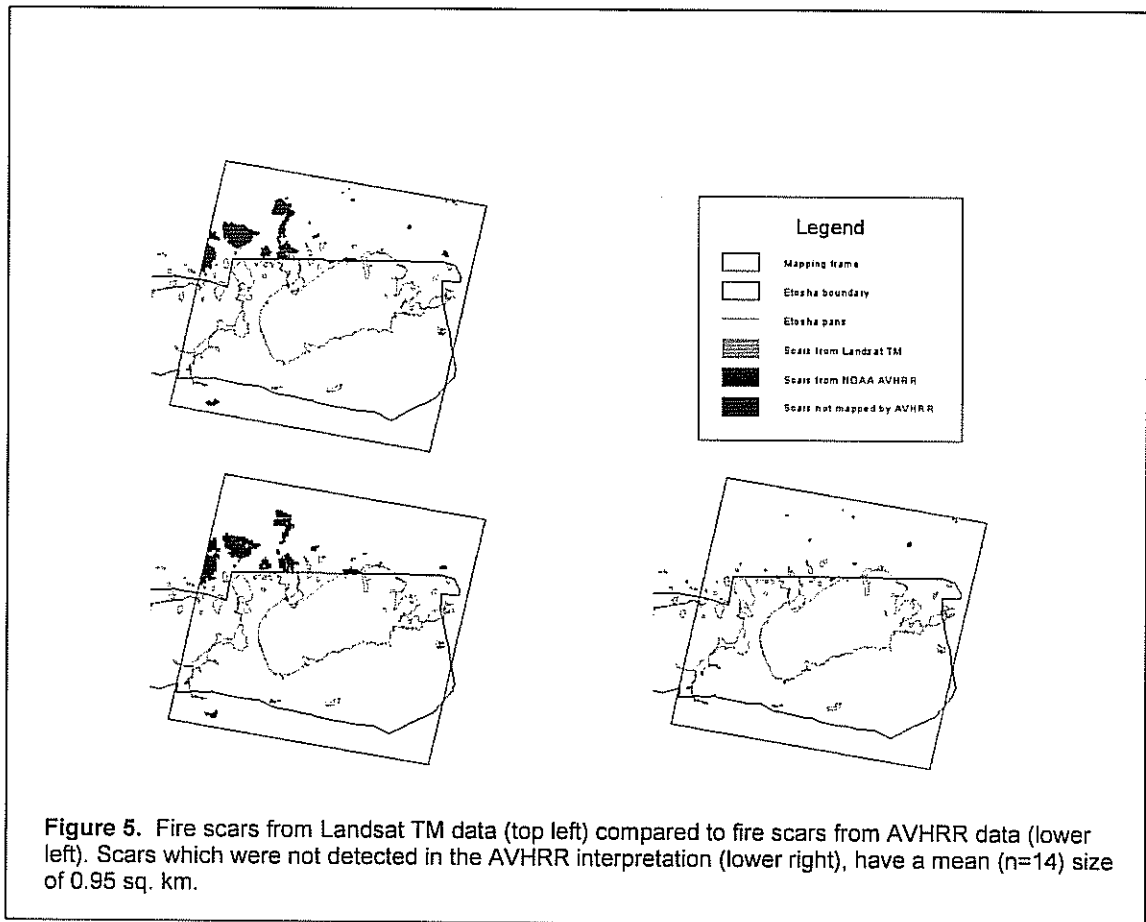


		Hectares	
Landsat TM			
Not burned:	4979683.4		%
Burned:	67988.6		1.37
AVHRR			
Not burned:	4971851.4		
Burned:	75469.2		1.52

Table 1. Burned/Non-burned area estimates derived from interpretation of Landsat TM and NOAA AVHRR data for the Etosha National Park area, between 22 April 2000 and 19 September 2000.

- The overestimate of 0.15% in the AVHRR interpretation can be ascribed to two factors:
- The inherent inability of coarse (± 1.1 km) spatial resolution data to map fine spatial detail, even for large fire scars (Figure 4).
 - The inability of coarse spatial resolution sensors to detect individual burned areas which are much smaller than the spatial resolution of the data (Figure 5).





The overall accuracy of the AVHRR derived fire scar map for the area covered by the Landsat TM scene, was determined empirically by comparing the thematic AVHRR map to the thematic TM map. The results are tabulated in the confusion matrix shown in Table 2. Overall accuracy for the AVHRR interpretation is 68%. This figure is perhaps lower than might be expected, given an area estimate difference of only 0.15%, and is due to the fact that accuracy figures derived from the confusion matrix are effected by spatial mis-registration between the TM and AVHRR derived thematic maps.

	TM Interpretation				
	Not burned	Burned	Total	Commission error (%)	User accuracy (%)
AVHRR Interpretation					
Not burned	46811535	216269	47027804	0.46	
Burned	296766	539160	835926	35.5	64.5
Total	47108304	755429	47863732		
Omission error (%)	0.63	28.63			
Producer accuracy (%)		71.37			

Table 2. Confusion matrix for the AVHRR derived fire scar map of the Etosha Nat. Park area.

Omission errors correspond to those pixels which the classifier has failed to recognise as belonging to a class of interest, while errors of commission result when pixels from other classes are added to the class of interest. Producer and user accuracy figures are simply the inverse of omission and commission errors respectively.

The Kappa statistic, which is a measure of the actual agreement between two datasets minus the chance agreement, is tabulated in Table 3. Kappa is an index, and its value lies between 0 and 1. A value of 0 indicates agreement due to chance only, while a value of 1 represents total agreement. The overall index of agreement between the TM and AVHRR thematic maps is 67.22%.

Class	Kappa index value
Not burned	0.6393
Burned	0.7086

Table 3. Kappa Index of Agreement, between the Landsat TM and NOAA AVHRR derived fire scar maps for the Etosha Nat. Park area.

4. Conclusion.

If this accuracy assessment is accepted as generally representative of the whole country, the following assumptions can be made about the fire scar map for Namibia:

- The burned area figure of 4851667 hectares should be accepted as a reasonably accurate estimate, which should not be corrected.
- Fire scars as indicated on the map has a locational accuracy of more than 71%
- Fire scars smaller than 1000 hectares will only be represented in exceptional cases.