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Assessment of the Extent of the Natural Vegetation of the Fynbos Biome of South Africa

E. J. Moll and L. Bossi

The region which comprises the fynbos biome has been variously interpreted by authors in the past and there is still no unanimously accepted definition. In an early report on the CSIR's Fynbos Biome Programme,[1] Kruger[2] followed Werger's[3] delimitation of the '*Capensis*' region in his description of the biome. According to this, it encompassed Acocks's[4] Strandveld, Coastal Renosterveld, Coastal Macchia, Macchi and False Macchia (veld types 34, 46, 47, 69 and 70, respectively). Goldblatt's[5] description was similar to Kruger's except that he excluded Strandveld from the Cape Floristic Region. Boucher and Moll,[6] in their account of Mediterranean climate shrublands, which omitted the heathland components,[7] included Mountain Renosterveld (veld type 43).

In the present study we have attempted to satisfy as wide a spectrum of views as possible and have included Knysna Forest (veld type 4) in addition to Strandveld, Mountain Renosterveld, Coastal Renosterveld, Coastal Macchia, Macchia and False Macchia. The reason for including Knysna Forest is that there are many relic Afromontane Forest patches[8] distributed throughout the Cape Folded Mountains in which a number of species endemic to the Cape occur. On the other hand, true Karoo types belonging to the Karoo-Namib Region and bushveld types belonging to the Sudano-Zambezian Region[3] and associated with nutrient-rich clays and clay-loams, have been excluded as these have never been considered part of the *Capensis* reigon, the Cape Floral Kingdom or the fynbos biome.

Methods

Visual interpretation techniques were used on Landsat satellite imagery of the fynbos biome to map the remaining areas of natural vegetation that were generally more than 100 ha in extent. The images were acquired during February 1981. We chose the summer in which to obtain this information in order to achieve the maximum discrimination between the fynbos vegetation and agricultural land.

The vegetation of the region was plotted on a scale of 1:250 000 and then reduced to one of 1:1 000 000 to produce a final map. Fourteen Landsat images were required to cover the entire biome (Table 1). We used false-colour composite transparencies (wavebands 4, 5 and 7) at a scale of 1:1 000 000 and black-and-white photographic prints at a scale of 1:250 000. The images of the colour transparencies were interpreted using a hand lens and the vegetation boundaries were then delineated on a transparent overlay on the photographic image of waveband 6. Supporting sources of information, in particular the maps of the Geological Survey[9] and personal field experience were used to aid the interpretation. (In the fynbos biome, particularly in the mountains, vegetation and ecological boundaries often coincide.)

A set of nine maps at a scale of 1:250 000 were compiled in this manner and then photographically reduced to 1:1 000 000. The extent of each vegetation type was recorded using a digitizer and the results are given in Fig. 1. A map of Acocks's[4] veld types in the fynbos biome was also reproduced and the extent of each of his vegetation categories was recorded (Fig. 2). By comparing Acocks's map with ours, the areas cleared by human activities, largely over the past 300 years, could be delineated and measured (Table 2). The geology of the region is summarized in Fig. 3.

In his work, Acocks[4] recognized veld types as units of 'farming potential' and did not exclude areas where the natural vegetation had been cleared. We endeavoured to map only areas of natural vegetation but recognize that some areas which are densely

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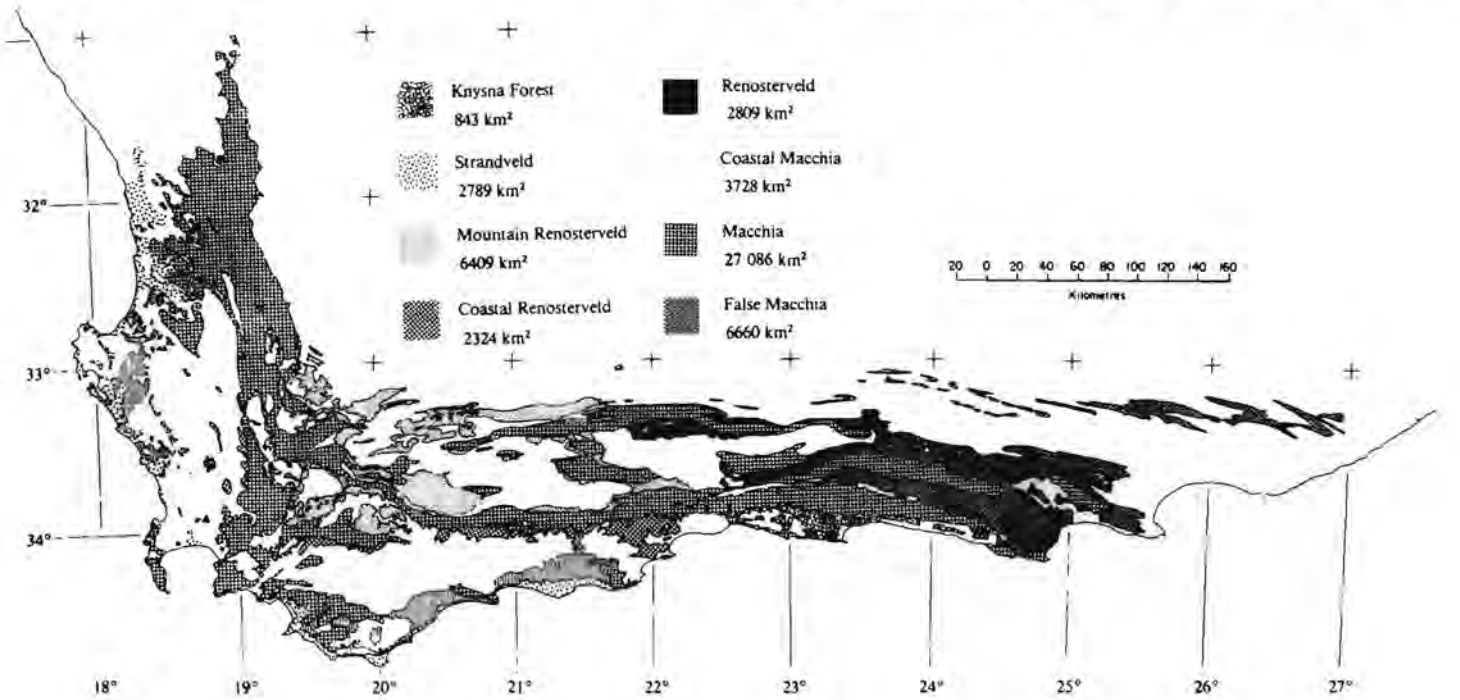

Fig. 1. Remaining natural vegetation of the fynbos biome as mapped from the 1981 Landsat images. The area for each type is given in the legend.

or partially infested by alien vegetation, or fallow areas recolonized with shrubby vegetation, have been included as 'natural'.

The satellite imagery available in this study did not include all the areas mapped by Acocks[4]; specifically, the Roggeveld and Kamiesberg mountains covered by Mountain Renosterveld were missing. These areas have, therefore, been excluded from Figs 1 and 2.

Table 1. Listing of the 14 Landsat images which cover the fynbos biome.

WRS	Scene — ID	Date	Area Description
188-082	22229-07533	81-02-28	Verlorenvlei
188-081	22211-07535	81-02-10	Langebaan
187-082	22228-07474	81-02-27	Calvinia
187-083	22228-07481	81-02-27	Ceres
187-084	22228-07483	81-02-27	Cape Town
186-083	22209-07422	81-02-08	Laingsburg
186-084	22209-07424	81-02-08	Bredasdorp
185-084	22208-07370	81-02-07	Mossel Bay
185-083	22208-07363	81-02-07	Oudtshoorn
184-083	22243-07305	81-03-14	Uniondale
184-084	22243-07312	81-03-14	Plettenberg Bay
183-085	22224-07251	81-02-23	Port Elizabeth
183-084	22224-07254	81-02-23	Humansdorp
182-083	22169-07195	80-12-30	Grahamstown

Table 2. The extent of natural vegetation as mapped by Acocks[4] and that remaining as interpreted from the 1981 Landsat imagery.

Veld type No.	Name	Area (km²)	Remaining area (km²)	Natural vegetation lost (%)
4	Knysna Forest	3 844	2 930	24
34	Strandveld*	4 453	2 072	24
43	Mountain Renosterveld	4 754	3 448	27
46	Coastal Renosterveld	15 285	2 256	85
47	Coastal Macchia	8 770	4 627	47
69	Macchia	18 345	16 305	11
70	False Macchia	18 965	18 347	3

*Excluding northern coastal portion.

Discussion

Although we have endeavoured to follows Acocks's veld types, because we used modern remote-sensing techniques our map and its interpretations are not always compatible with the earlier study. The major differences between the vegetation boundaries of the two maps are as follows:

1) Knysna Forest (veld type 4). We were more conservative in the recognition of this category and have mapped essentially high forest and not 'potential' Knysna Forest areas.

2) Mountain Renosterveld (veld type 43). Two forms of Mountain Renosterveld have been distinguished. One form (Mountain Renosterveld) is restricted to the winter-rainfall region in the west and the other form (Renosterveld) to the areas of all-year and summer rainfall. There are two reasons for this; firstly, two types of Mountain Renosterveld could be distinguished on the Landsat images, and secondly, the controversy over whether Mountain Renosterveld should be included in the fynbos biome made us particularly careful when distinguishing this type. In addition, field experience indicated that the eastern form has more grassy elements and merges into Sudano-Zambezian types compared to the western form, which merges into Karoo-Namib types[3].

3) Strandveld (veld type 34). Acocks recognized this veld type only along the west coast. However, we distinguished limited areas of Strandveld also on the south coast.

4) Coastal Renosterveld (veld type 46). Most of this veld type as mapped by Acocks has been cleared for agricultural purposes

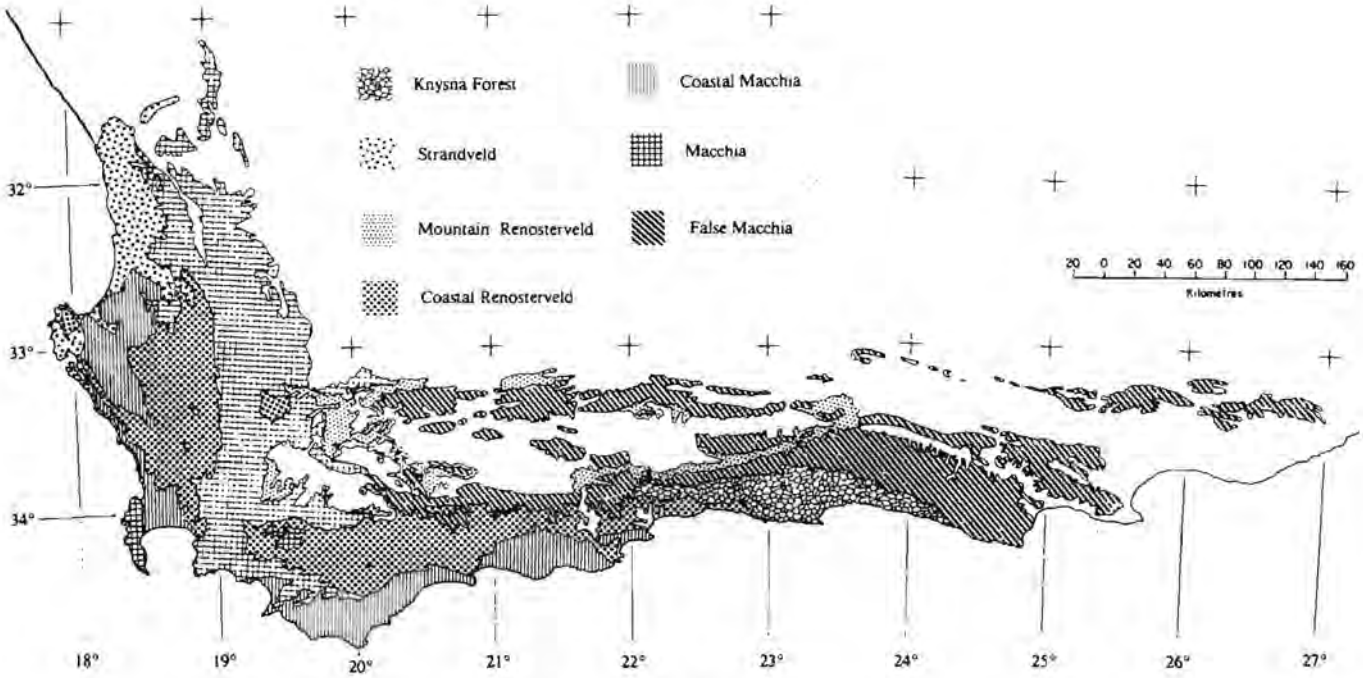

Fig. 2. Map of the fynbos biome based on part of Acocks's veld-type map of South Africa.[8]

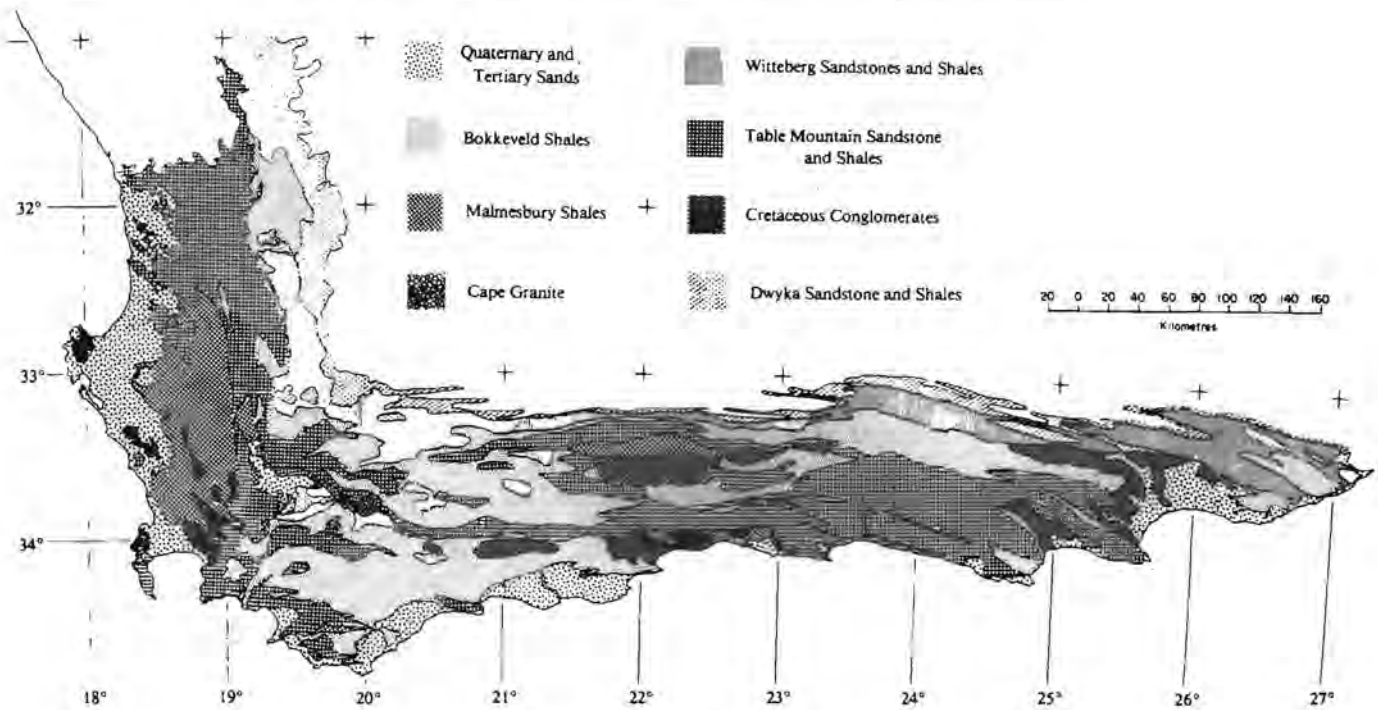

Fig. 3. Major geological formations of the southern and western Cape Province.[9]

but the boundaries of what little natural vegetation remains were well matched between the two maps.

5) Coastal Macchia (veld type 47). For convenience we adhered to Acocks's delimitation for this veld type (except for recognizing some Strandveld on the south coast). However, we could distinguish different fynbos types along the south coast, notably on limestone and lateritic substrates.

6) Macchia (veld type 69). Our boundaries for this category extended further eastwards than Acocks's, because much of what Acocks recognized as a more grassy and useful agricultural type was interpreted as true Macchia.

7) False Macchia (veld type 70). We concluded that this veld type occurred only in areas of all-year or summer rainfall. Some of the areas mapped as False Macchia by Acocks were recognized as Renosterveld on our map, possibly owing to the encroachment of *Elytropappus* into the False Macchia.

Conclusions

In this study we have undertaken to improve the vegetation map of the fynbos biome as given by Day *et al.*[2] and to provide data on the extent of the remaining natural vegetation. We calculate that 34% of the natural vegetation has been removed by far-

ming and other human activities. In contrast, Hall[10] estimated that some 61% had been so lost. (It is not known how much of the fynbos biome area was included in Hall's estimate, so a direct comparison between these two figures may not be valid.)

In preparing our map, we found that the veld types as plotted by Acocks did not give a satisfactory description of the extent of the different vegetation types in the biome. We are therefore planning to compile a yet more detailed vegetation map in the future.

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Fire Climates in the Southern and Western Cape Province and Their Potential Use in Fire Control and Management

B. W. van Wilgen

The climate of the southern and western Cape Province is examined with respect to fire potential. Five major fire climate zones, which differ in magnitude of mean fire potential and in seasonal fluctuations are recognised. The uses of these zones in the fire management of the area are discussed.

Die verband tussen klimaat en brandpotensiaal van die suidelike en westelike Kaapprovinsie is ondersoek. Vyf hoofsones wat verskil in hul gemiddelde brandpotensiaal en seisoenswisseling van brandpotensiaal is geïdentifiseer. Die toepassing van brandbestuur word aan die hand van hierdie klassifikasie bespreek.

The southern and western Cape Province has important mountain catchment areas, which are managed by the Directorate of Forestry to ensure a sustained yield of high quality water and for nature conservation. Most of the vegetation cover in these mountain areas consists of mountain fynbos (Acocks'[1] veld types 69 and 70), a sclerophyllous shrubland which is prone to periodic fires. The Directorate of Forestry faces a fire management problem in these areas firstly in relation to wild-fire control, and secondly from the point of view of prescribed burning operations, which are carried out to reduce fuel loads, to enhance catchment water yield, to control woody weeds and to rejuvenate the fire-adapted vegetation.

The dominant climate in the western half of the region is Mediterranean, with wet winters and relatively dry summers. Rainfall ranges from 250 to 2500 mm or more per year, increasing with altitude. Towards the east, the rainfall becomes more evenly distributed throughout the year. Föhn-like bergwinds often occur along the southern coastal regions, and are accompanied by sudden increases in temperature and decreases in humidity which result in severe fire hazards. Some descriptions of the influence of climate on fires in the region exist but no formal classification of the region into fire climate zones has been attempted. Kruger and Bigalke[2] have discussed the characteristics of fynbos fires with reference to weather factors, while Wicht and de Villiers[3] have described weather conditions and fire danger at the southern coastal town of Hermanus. Reifsnyder[4] has ranked the major Köppen[5] climate zones in order of descending fire-weather severity as follows: Cs, Cw, Cf, Dw, Bs, Aw, ET, EF and BW.* The Köppen designations in the fynbos biome are Cs, Cf and BS[6] and it is thus a very fireprone region by this classification.

The delineation and definition of areas that experience similar climatic conditions from the standpoint of potential fire risk is needed in order to apply meteorology to fire management. Such areas could be called fire climate areas, and should greatly enhance fire-weather forecasts and the planning of management operations. While fire-weather forecasts have reached various levels of sophistication in many countries,[4] no formal system exists in South Africa. The study reported here was conducted to define fire climate zones in the southern and western Cape.

Weather and plant fuels are the two most important factors determining fire potential. Fynbos fuels contain substantial amounts of litter, and although they are somewhat coarser than grassland fuels, they are nonetheless finely divided and can rapidly become flammable under suitable weather conditions.[7] Fuel moisture provides the link between weather and potential fire behaviour. Any system of defining fire climates should thus be based upon the effects of weather variables on fuel moisture. Studies of this nature have been carried out in the United States of America. Fire climate zones were delineated for Arizona and New Mexico[8] based on values of an adjusted equilibrium moisture content of the fire fuel complex. Similar zones were described for coastal Alaska by Finklin,[9] who related climatic variables to an index of fire danger. In this study I have used the energy release component of the U.S. National Fire Danger Rating System (NFDRS),[10] based on a fynbos fuel model and climatic features to define preliminary fire climate zones in the southern and western Cape.

Methods

This study was based on the climatic records from 40 weather stations in the southern and western Cape. A daily weather

*Köppen's climate zones are as follows: Cs = temperate (warm) climate with winter rainfall; Cw = temperate (warm) climate with summer rainfall; Cf = humid temperate (warm) climate with sufficient rainfall in all seasons; Dw = boreal (snow) climate with cold, dry winters; Bs = arid (steppe) climate; Aw = tropical climate with summer rainfall; ET = tundra (snow) climate; EF = permanent frost (snow) climate; and Bw = desert climate.

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