

A new Approach to Wildland Fire Management in South Africa

J.A. Bridgett¹, B. W. van Wilgen¹, F. J. Kruger², G.G. Forsyth¹, T.P. Jayiya¹ and L. Kruger³

¹ CSIR, Stellenbosch, Western Province, South Africa

² Fred Kruger Consulting CC, Pretoria, Gauteng, South Africa

³ University of Cape Town, Western Province, South Africa

Abstract

South Africa has a diverse climate and an equally diverse range of vegetation types, many of which are fire-prone. Fire is an integral process in many of these ecosystems, and indeed is often necessary for the maintenance of healthy ecosystems and biodiversity. However, fire is increasingly seen as a destructive force, impacting on crops, pastures, forestry plantations, livestock, human habitation and even on human life. The management of wildland fires in post-apartheid South Africa, where the country has been re-united under a single democratic government, calls for new institutional arrangements and a co-ordinated approach. The issue of fire management in South Africa will in future be governed by the new Veld and Forest Fire Act, which was passed into law in 1998. The Act aims to facilitate fire management, through the introduction of measures to combat veld, forest and mountain fires throughout the country and thereby reduce the damage and losses to natural vegetation, life and property. This paper outlines the initial steps that have been taken to implement the Veld and Forest Fire Act.

Introduction

South Africa has a long history in the administration of veldfire management. A range of statutes, for the Colonies of the Cape and Natal and the Republics of the Orange Free State and Transvaal, were eventually consolidated in the Union Forest Act (Keet no date). Later, from the mid-1940s onward, administration of the management of veldfires became progressively fragmented, first through the promulgation of the Soil Conservation Act (later replaced with the Conservation of Agricultural Resources Act) and later through the disparate statutes that arose as a result of "Bantustan" legislation (Keet no date).

These statutes institutionalised veldfire administration through Fire Control Committees in terms of the Forest Act, and Soil Conservation Committees in terms of the Soil Conservation Act and its successor. The former were intended to protect forest resources, and the latter, agricultural resources. Control over the use of fire in the open air was exercised through fire prohibition periods in the former case (and these periods, though mostly seasonal, also extended to the whole year) or regulations designed to protect pastures in the latter.

South African law did not provide for fire control measures linked to fire danger ratings. Statutory fire control measures based upon fire danger ratings have been in use in countries such as Australia and the United States for 40 years or more, and have proved useful in the prevention and suppression of fires in forests and pastures. In South Africa, forestry companies imported a fire danger rating model from Zimbabwe (Laing, 1978) during the late 1980's, which they adapted as the "Lowveld system" for local use (Miekle and Heine, 1987). This paper outlines new statutory provisions for the introduction of a national system of fire danger rating in South Africa and describes the steps being followed to introduce the system effectively. At the time of writing, this process is ongoing, and more detailed analyses are expected to arise from the studies being undertaken as part of the introduction. It is our intention to publish these studies at a later stage, as results become available.

The National Veld and Forest Fire Act and its provisions

The White Paper on Sustainable Forest Development (DWAF, 1996) contains the new forest policy adopted by government. Strategies to implement this policy are contained in the National Forestry Action Programme (DWAF, 1997). The National Forestry Action Programme identified among the strategies for implementing policy that of providing law for the sustainable development of the forest sector. The drafters appointed to formulate the new law decided to remove provisions relating to forest and veldfires from the draft forest law. This was because, first, the Constitution has assigned fire services as a local government competence, and second, there was an evident need to formulate law for veldfires that would increase co-operation between sectors and minimise conflict.

The outcome, after extensive consultation in the process of drafting, and review by Parliamentary Committees, is the National Veld and Forest Fire Act (Act 101 of 1998), which introduces the statutory framework for uniform management of veldfire risk across South Africa.

The Act was written to complement other existing or developing legislation (such as the Disaster Management Act, Act 57 of 2002), to provide a basis for minimum standards that owners of land should adhere to for the prevention and combating of wildfires, to provide a framework for local collaboration in managing veldfires, and to introduce a uniform national fire danger rating system that would provide for early warning of dangerous conditions and for the planning of veldfire operations and preparedness measures. Additionally, the drafters formulated the Act recognising that the management of veldfires, including their prevention and control, was a matter of environmental management, extending beyond the management of the emergencies that they frequently come to be.

Chapter 2 of the Act provides for the formation and registration of voluntary fire protection associations of land-owners (including communities on communal land, and organs of state) as organisations for local, collaborative management of veldfires, their duties, their appointment of Fire Protection Officers, and their appropriate empowerment. Chapter 3 provides for the introduction of a national fire danger rating system, discussed below. Chapter 4 provides for veldfire prevention through firebreaks that are to be prepared on the boundary of any property where there is a risk of a veldfire arising or spreading. Chapter 5 imposes certain additional minimum requirements to be met by landowners where there is a risk of veldfires. These include requirements to maintain adequate local supervision of their land, to ensure adequate availability of trained staff who are properly protected against veldfires, and to provide for adequate response in the case of veldfires igniting and spreading, as well as requiring that landowners maintain appropriate equipment in readiness for fire fighting. The Act applies to veldfires (i.e. fires in vegetation in the countryside), wherever the risk of veldfires justifies its application.

The selection of a fire danger rating model

At the heart of the fire danger rating system is the set of formulas, or model, which calculates an indicator value, or index, related to the current or expected level of fire danger. Index values reflect ambient weather conditions, in some models, and both ambient weather and the state of flammable fuels in others. The index value for any given location and time ideally reflects the likelihood that a veldfire will ignite and spread, and the level of effort that may be required to control or suppress a fire under those circumstances. Some models produce more than one index value, and these different index values relate to different aspects of the fire management problem.

The Department of Water Affairs and Forestry, with the services of the CSIR and in consultation with stakeholders, initiated a process of choosing among the various models available for calculating fire danger indices. The models assessed were the Lowveld Model; the Australian McArthur Forest and the McArthur Grassland Fire Danger Index; and the US National Fire Danger Rating System. A trial of the four candidate models is being conducted to provide a scientific basis for final selection.

Definition of the fire danger ratings

A fire danger rating is a description of the range of elements of veldfire behaviour, the degree of difficulty in controlling fire, and other relevant parameters of fire danger, for each of several ranges or classes of fire index values (Table 1).

There are no values for the fire danger index defining the classes in Table 1. The task of defining the rating table requires two steps, once the fire danger rating model has been chosen. The first is to reach agreement on the descriptions that apply to each rating. The second is to agree, on the basis of objective information, on the values of the index that will define the boundaries of each rating class. These values will vary across the country, and must be relevant to each of the different Fire Danger Regions.

Putting fire danger index values to rating classes requires care. There needs to be a proper balance between the cost of precaution and preparedness for predicted wildfires on the one hand, and veldfire risk on the other. The forecast level of fire danger will affect many activities. Days predicted to be extreme will severely curtail many kinds of economic activities, such as forest operations, while also precipitating costly preparedness measures. The stakeholders in any region cannot afford these costs for more than a few days a year. Similarly, forecasts of high fire danger conditions will result in a regional fire ban, also with costs coming from curtailment of economic activities. Days of moderate fire danger will in most regions require veldfire operations to be subject to permission, which brings administrative costs. Therefore, within any one region, there needs to be a careful balancing of understood fire risk and the likely incidence of days with given fire danger ratings, the latter based on the statistics of fire danger index values.

The problem of balancing ecological requirements with those of safety will also have to be addressed in the determination of thresholds that define days with high fire danger, on which a total fire ban will come into effect. Intense fires, though difficult (and dangerous) to control, are often needed to achieve ecological goals or to maintain biodiversity. These goals include ensuring that prescribed management fires are sufficiently intense to combat bush encroachment in stock-farming areas (Tainton, 1999); to prevent the alteration of savannas to closed woodlands as a result of elevated CO₂ levels that promote tree increases (Bond & Archibald, 2003); to ensure adequate regeneration of component species of fynbos ecosystems (Bond, Le Roux & Erntzen, 1990); and to achieve adequate control of invasive alien plants (van Wilgen, Bond & Richardson, 1992). The choice of index values that define the thresholds of high fire danger should not be so conservative that they preclude the use of fires of sufficient intensity to achieve these legitimate ecosystem management goals.

The Fire Danger Regions

The Act requires the Minister to divide the country into regions for the purposes of rating fire danger. Each region is to be such that the fire danger is usually sufficiently uniform to allow for a single rating which is meaningful for the entire region. In addition, the Act requires fire

danger ratings to be communicated separately to each of these regions. To address these requirements, the Department started by examining the weather forecast districts employed by the SA Weather Service in providing weather forecasts specific to different regions. There are 45 of these districts. Since the patterns of weather vary geographically from west to east and south to north across South Africa, it is obvious that so large a number of districts will serve to accommodate the environmental variation in South Africa, and each be distinguished from the other by topography, vegetation, climate and typical weather. Each district is also served by weather stations maintained by the Service, as well as by other agencies. Examination of the boundaries and distribution of these districts shows that they clearly form a basis for the definition of Fire Danger Regions. Although 45 is a large number for the purposes of the Act, the districts used by the Weather Service have been defined in consultation with national and provincial stakeholders, and thus make a good starting point for Fire Danger Regions.

Because the Act needs to be enforced in a practically effective way, and because the enforcement of bans on fires in the open air when the fire danger is high is a particularly important provision in the Act (contravention of a fire ban is the only first category offence in the Act), the boundaries of Fire Danger Regions should be conducive to effective law enforcement. To assist in this, the Department examined each of the metropolises, local municipalities or district management areas in the country and placed each within a danger rating region according to a general rule that a municipality with more than half its area within a given weather forecast district was placed with the other qualifying municipalities in the same rating region. In addition, municipalities were assigned to Regions so that each Region is relatively uniform in terms of veldfire risk. This gave 41 danger rating regions (see Figure 1), each complying in a reasonably adequate degree to the requirements of the Act. The draft regions have been widely distributed among stakeholders for their comment, and with few exceptions, stakeholders find the regions acceptable. The Department will adjust the boundaries of exceptional cases in consultation with the SA Weather Service.

The fact that each region has a relatively uniform level of veldfire risk, and that regions are distributed across the variation in South Africa's climate, will facilitate the next step in the development of the Fire Danger Rating System, i.e. the definition of threshold values of the fire danger index that will define the limits of each rating for each given region.

Communication of fire danger rating

The Act requires the Minister to communicate the rating of the fire danger for each region to the fire protection associations in that region regularly. However, when the fire danger is rated as high in any region, he or she must publish a warning at the earliest possible opportunity in all the main languages used in that region:

- on three television channels and three radio stations broadcasting to that region; and
- in two newspapers circulating in that region;

To provide evidence in the case of court proceedings, he or she must ensure that recordings are kept of the broadcasts and copies are kept of the newspaper notices. When the Minister has published a warning of high fire danger, no person may light, use or maintain a fire in the open air in the region where the fire danger is high. Contravening this provision of the Act will constitute a first-category offence, carrying heavy penalties.

This warning will affect potentially every person within a region, and every person must therefore have a reasonable chance of knowing in time that a day is predicted to be a day of

high (or extreme) fire danger. Even on other days, members of Fire Protection Associations and landowners, as well as Fire Services, will need each to know the forecast rating, to plan prescribed burning operations and manage activities that create a fire hazard. Introducing the fire danger rating system will therefore depend critically on effective communication, including the successful education of a diverse public in the meaning and consequence of fire danger ratings. The drafters of the Act did not anticipate as many as 41 Fire Danger Regions. Subsequent analysis shows that there are not three television channels and three radio stations that broadcast to each Fire Danger Region in the country. This situation therefore requires an amendment to the Act before the Fire Danger Rating System can be put into effect.

Conclusion: steps towards implementation

Fire danger rating systems have proved useful as early warning and fire risk management aids in many parts of the world, including South Africa. Introducing the statutory requirement for a danger rating systems in South Africa provides the basis for substantial improvement in the way that we manage veldfires here.

However, introducing the system for application across the country requires the simultaneous addressing of a number of developments that must be achieved to ensure successful introduction of the system. Each of the available and possibly suitable models and the way that each is applied attempts to provide in a simple, way for quite complex natural phenomena. An example is the difference between vegetation types and how these differences affect the availability and state of flammable fuel. Choosing a model thus needs a sound understanding of vegetation variation, and how this affects fire management, as well as of the other important environmental variation that we encounter in South Africa. Defining danger ratings needs objective analysis of the variation in fire-related climatic factors, as well as fire risk variation. We need to mobilise all the available information and knowledge of the relevant dimensions of the South African environment, as they affect fire danger, as well as conducting rapid, highly focused research, such as that currently under way to test candidate fire danger models.

Once the system has been defined and adopted, the different parties involved in its use will need to bring local knowledge and observation to bear on local fire danger predictions. No mathematical model can adequately predict the condition of flammable fuels locally, as this condition is affected by variations over time by such factors as drought, frost, grazing and past fires. The models need to be provided instead with information based on local observation. For example, some of the candidate fire danger rating models require the users to make local estimates of the degree to which the grass sward is cured. The accuracy and usefulness of the fire danger ratings will depend on the care with which they make these estimates. Fire managers will therefore need to be even more systematic and regular observers and interpreters of their local environments.

For the same kinds of reasons, the details of and use of fire danger rating systems will need to be continuously improved as knowledge of local environments and the local performance of the system grows (Figure 2). To aid this process of continuous improvement, the Department is introducing a National Veldfire Information System, a web-enabled system that will allow Fire Protection Associations and others to collect and process veldfire information in a systematic way that will aid the building of local knowledge on veldfires and their relationship with fire danger conditional, as well as building up knowledge at regional and national levels.

South Africa has the advantage of being able to adopt and adapt fire danger systems that have had the benefit of lengthy research and development, rather than having to develop a system afresh. This allows for rapid progress at relatively low cost, and will have the added benefit, depending on which model is chosen, and enjoying the spill over of continued research elsewhere. But despite this we will need to invest in further research and development to meet local needs, as well as investing in the development of local competence in fire management.

References

Bond, W.J, Le Roux D and Erntzen, R (1990). Fire intensity and the regeneration of myrmecocherous Proteaceae. *South African Journal of Botany* 51, 181 – 186.

Bond, W.J. & Archibald, S. (2003). Confronting complexity: Fire policy choices in South African savanna parks. *International Journal of Wildland Fire* (in press).

DWAF(1997): Department of Water Affairs and Forestry: National Forestry Action Programme, Discussion Document 1, Pretoria, South Africa.

DWAF(1996): Department of Water Affairs and Forestry: The White Paper on Sustainable Forest Development in South Africa – The policy of the Government of National Unity. Pretoria South Africa.

Keet, J.D.M. (no date). Historic review of the development of forestry in South Africa. Typed manuscript, Department of Water Affairs and Forestry, Pretoria.

Laing, M.V. (1978) Forecasting bush and forest fire weather in Rhodesia. *Meteorological Notes, Series B, No. 60.* Dept. Meteorological Services, Rhodesia. 29pp.

Meikle, S & Heine J., 1987. A fire Danger Index System for the Transvaal Lowveld and Adjoining Escarpment area. *South African Forestry Journal* 143, 55-56.

Tainton, N.M. (1999). Veld management in South Africa. University of Natal Press, Pietermaritzburg.

Van Wilgen B.W., Bond, W.J. & Richardson, D.M. (1992) Ecosystem management. *The Ecology of Fynbos: Nutrients, Fire and diversity.* Ed: Cowling, R.M. Oxford University Press, Cape Town, pp 345-371.

Table 1. Five fire danger rating classes proposed to by the Department of Water Affairs and Forestry to meet the requirements of Chapter 3 of the National Veld and Forest Fire Act, Section 9(4)(c) and 9(4)(d). Adapted from Willis *et al.* (2000).

INDICATIVE COLOUR	BLUE	GREEN	YELLOW	ORANGE	RED
DANGER RATING	Insignificant	Low	Moderate	High	High - extreme
FIRE PREVENTION AND PREPAREDNESS MEASURES	No precaution is needed	Fires including prescribed burns may be lit, used or maintained in the open air on the condition that persons making fires take reasonable precautions against the fires' spreading.	No fires may be allowed in the open air except those that are authorised by the Fire Protection Officer where a Fire Protection Association exists, or elsewhere, the Chief Fire Officer of the local fire service, or fires in designated fireplaces.	No fires may be allowed under any circumstances in the open air.	No fires may be allowed under any circumstances in the open air and Fire Protection Associations and municipal Disaster Management Centres must invoke contingency fire emergency and disaster management plans including extraordinary readiness and response plans. All operations likely to ignite fires halted. Householders placed on alert.
APPLICATION OF THE ACT			Above precautionary measure to be prescribed and made applicable nationally on days rated moderate.	Section 10(1)(b) applies: no person may light, use or maintain a fire in the open air.	Section 10(1)(b) applies: no person may light, use or maintain a fire in the open air.
RELATIONSHIP WITH DISASTER MANAGEMENT				The threat of disastrous wildfires exists at municipal level under these conditions. Municipal Disaster Management Centres must invoke contingency plans and inform National and Provincial Disaster Management Centres. (Section 49 of the Disaster Management Bill).	The threat of disastrous wildfires at provincial level exists under these conditions. Municipal Disaster Management Centres must invoke contingency plans and inform National and Provincial Disaster Management Centres. (Section 49 of the Disaster Management Bill).
FIRE BEHAVIOUR	Fires are not likely to ignite. If they do,	Fires likely to ignite readily but spread	Fires ignite readily and spread rapidly, burning	Fires ignited readily and spread very rapidly, with local crowning	Conflagrations are likely in plantation forests, stands of alien invasive

INDICATIVE COLOUR	BLUE	GREEN	YELLOW	ORANGE	RED
	<p>they are likely to go out without suppression action. There is little flaming combustion.</p> <p>Flame lengths in grassland and plantation forest litter lower than 0.5 m and rates of forward spread less than 0.15 kilometres per hour.</p>	<p>slowly.</p> <p>Flame lengths in grassland and plantation forest litter lower than 1.0 m and rates of forward spread less than 0.3 kilometres per hour.</p>	<p>in the surface layers below trees.</p> <p>Flame lengths in grasslands and plantation forests between 1 and 2m, and rates of forward spread between 0.3 and 1.5 kilometres per hour.</p>	<p>and short-range spotting. Flame lengths between 2 and 5 m, and rates of forward spread between 1.5 and 2.0 kilometres per hour.</p>	<p>trees and shrubs, sugar cane plantations, and fynbos. Long range fire spotting is likely in these fuel types.</p> <p>Rates of forward spread of head fires can exceed 4.0 kilometres per hour and flame lengths will be in the order of 5 – 15 m or more.</p>
FIRE SUPPRESSION DIFFICULTY	<p>Direct attack feasible: one or a few field crew with basic fire fighting tools easily suppresses any fire that may occur.</p>	<p>Direct attack feasible: fires safely approached on foot. Suppression is readily achieved by direct manual attack methods.</p>	<p>Direct attack constrained: fires not safe to approach on foot for more than very short periods. Best forms of control should combine water tankers and back burning from fire control lines.</p>	<p>Direct attack not feasible: fires cannot be approached at all and back burning, combined with aerial support are the only effective means to combat fires. Equipment such as water tankers should concentrate efforts on the protection of houses.</p>	<p>Any form of fire control is likely to be precluded until the weather changes. Back burning dangerous and best avoided.</p>

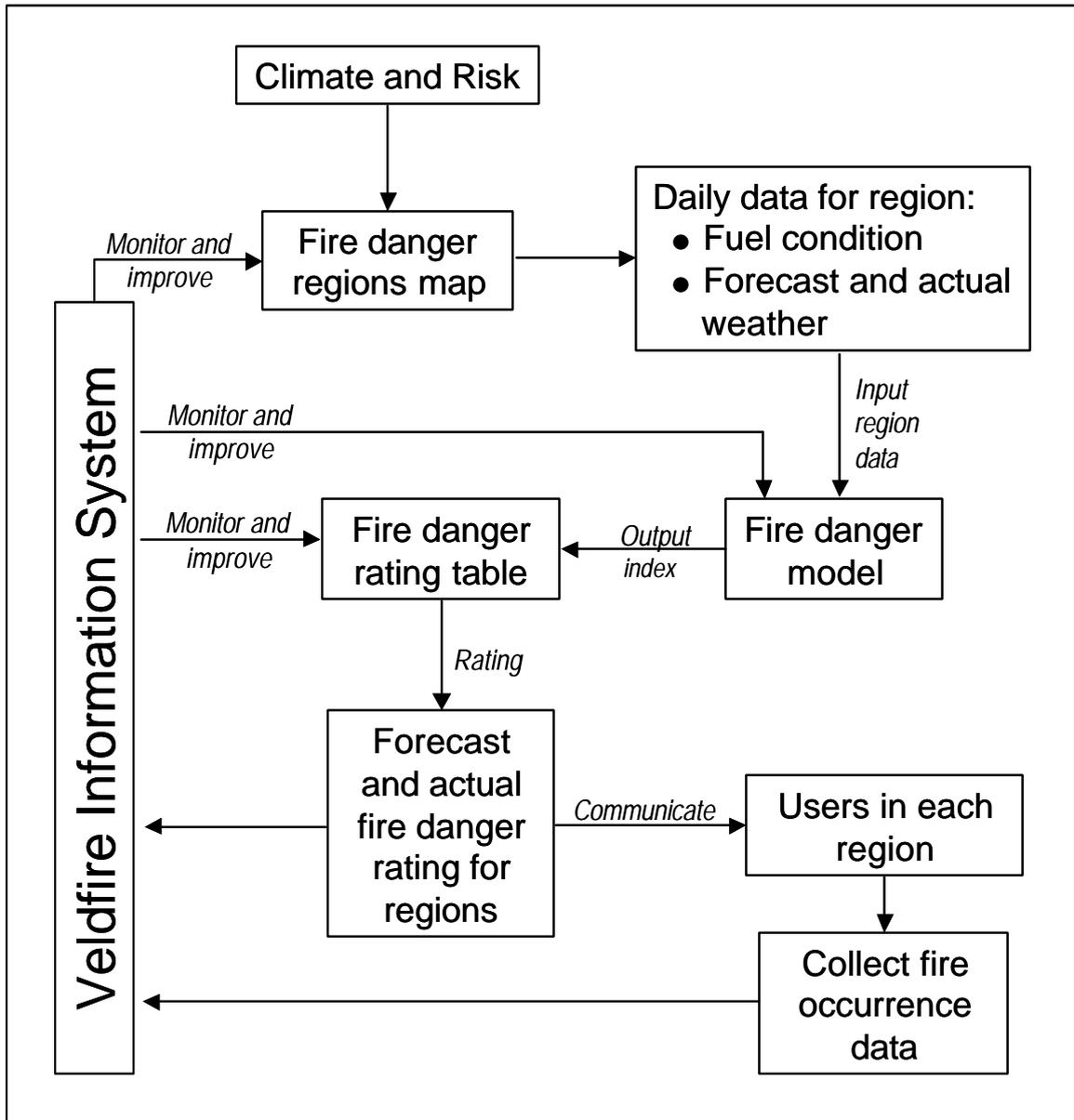


Figure 1. Illustration of the main elements of the National Fire Danger Rating System. The first part is the national map of Fire Danger regions, of which 41 have been proposed. Within each region certain data relating to flammable fuel structure and condition are provided together with daily forecast weather data for inputting to the Fire Danger model. This model calculates daily forecast Fire Danger index values, which are used to enter the Fire Danger Rating Table. The index value leads to a danger rating for the region, which is communicated daily to relevant parties, and broadcast to everyone if the rating is High or Extreme. The Veldfire Information System, which will be available for the management of fire reports from Fire Protection Associations and others, will be employed in the continuous improvement of the Fire Danger Rating System, among other things.

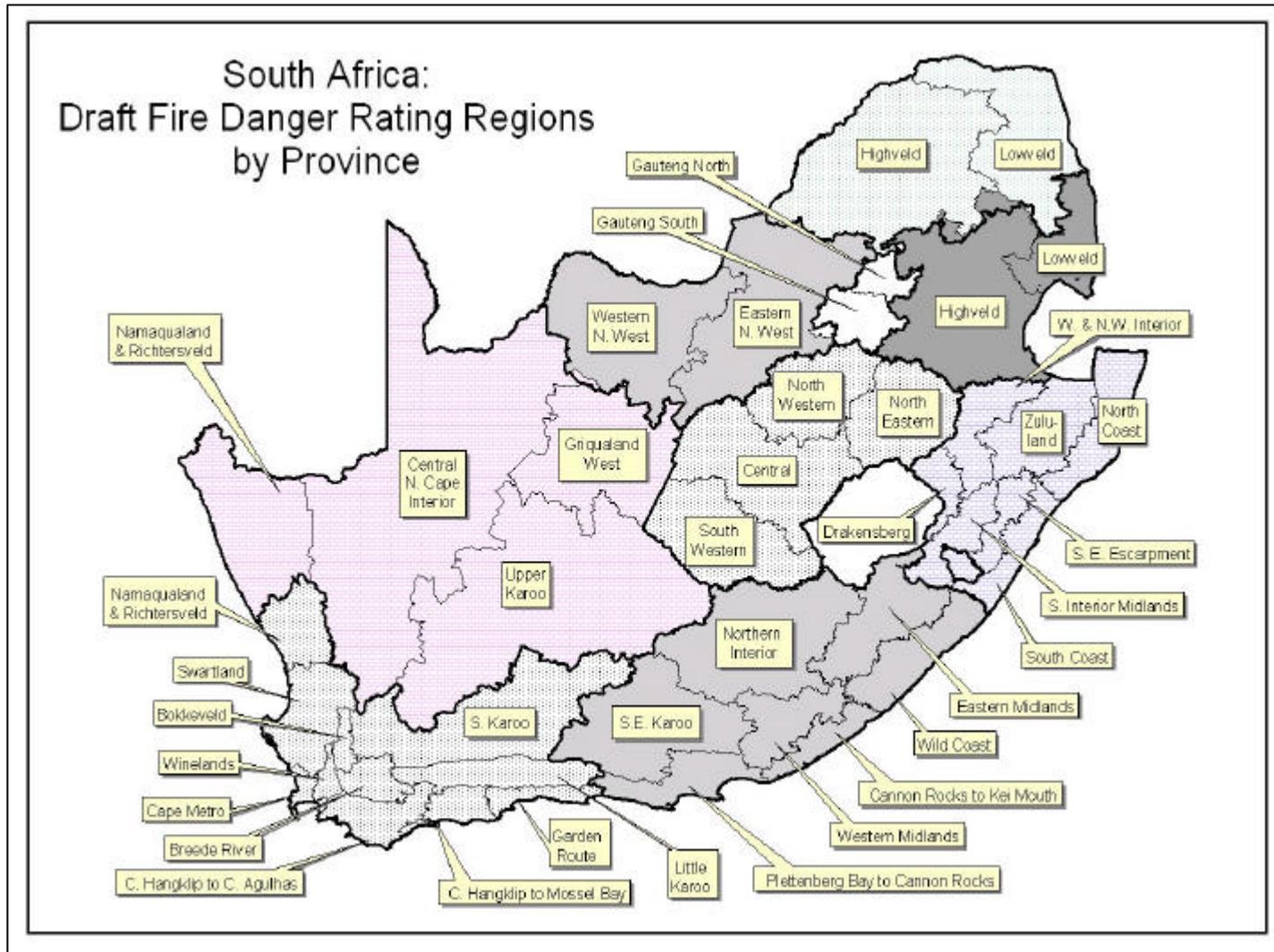


Figure 2. Map showing the 41 Fire Danger regions proposed for South Africa. These are based on the 45 weather forecast districts used by the South African Weather Service, adjusted for approximately uniform veldfire risk within each region, and to take account of municipal boundaries. See text for details.