RURAL FIRE HAZARD ASSESSMENT IN THE A.C.T.

A.C.T. RURAL FIRE SERVICE

AUGUST 1991

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This report has been prepared by officers of the Australian Capital Territory Rural Firefighting Service, a branch of the Division of Fire and Emergency Services of the Department of Urban Services.

It is intended to explain the Service's approach to fire hazard assessment to fire managers and other interested bodies. It does not claim to state policy or specific operating procedures.

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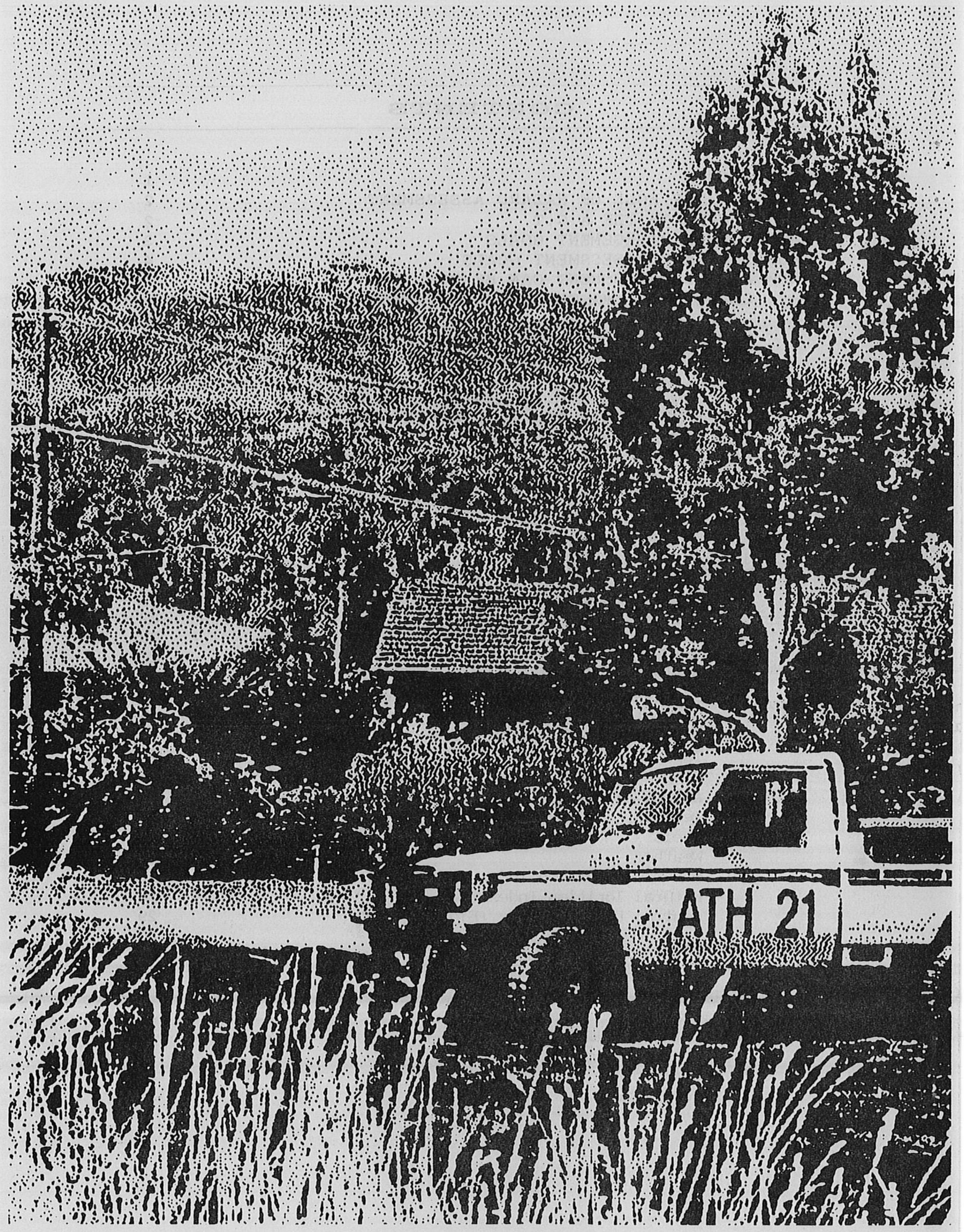
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INTRODUCTION

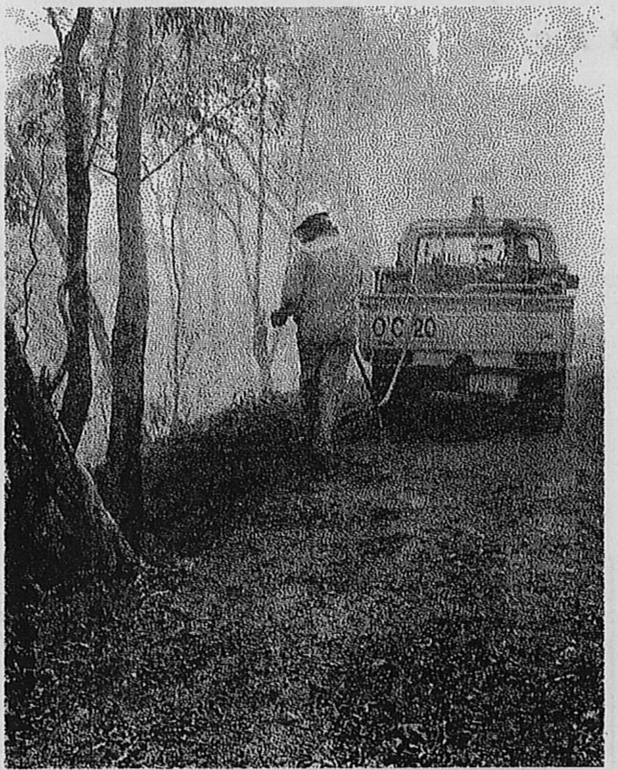


Figure 1. A light unit patrolling the edge of a fire.

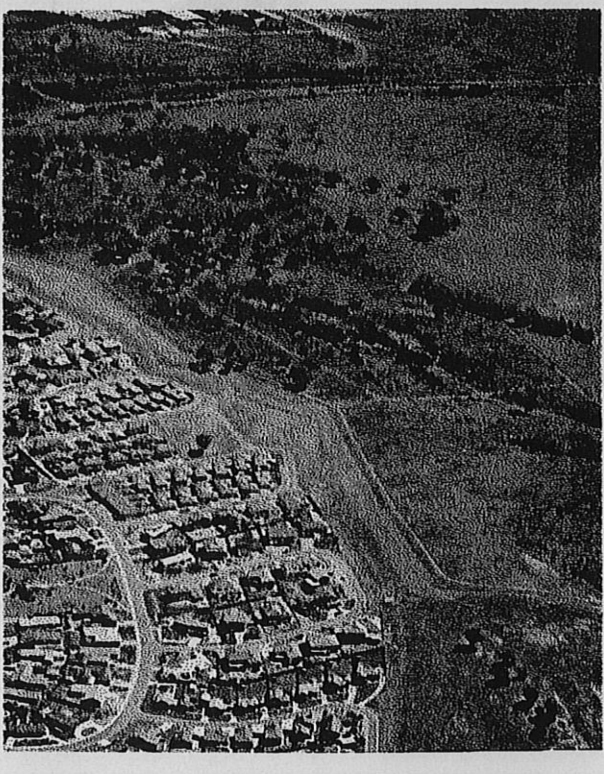


Figure 2. Many fires occur where suburbs back straight onto paddocks.

This report describes a system established by the Rural Firefighting Service to assist fire managers with providing the best possible service to the community.

The Careless Use of Fire Act, 1936, with recent amendments, establishes a rural firefighting service for the Territory and gives its officers certain powers needed to provide this service.

The prime role is to protect life and property from fire. As well as putting fires out, the Service also strives to prevent fires occuring. Given the limited resources available for all arms of Government today, it is essential that all efforts are directed as efficiently as possible. This is made possible by planning based on knowing where high fire hazards are.

The difficulty with planning rural fire protection is the complex patterns of human behaviour, land uses, vegetation types, weather and landforms that play critical roles in determining when fires will occur and what fires will do when they occur.

The integration of these into a process that produces a single index of fire hazard has long been the goal of fire managers, but has always been seen as a very difficult task. In the past partial solutions have been used, but computer technology today allows us to attempt full solutions. In a number of instances the results achieved to date are the most advanced in Australia, and, in one instance, the world.

SECTION 1 - THE ROLE OF HAZARD ASSESSMENT

RURAL FIRE IN THE A.C.T.

Fires in the A.C.T. can be divided into two clear groups. Urban fires involve fires starting in property and only occasionally spreading anywhere. They inevitably cause damage. These fires are handled by the urban fire brigades, who are trained for structural fires and rescue.

Rural fires are primarily started through careless use of fire, arson or lightning strike and spread from the ignition point. It is their spread that leads to damage. These fires are handled by the rural fire brigades, who are trained in forest and grass fire fighting and in remote area techniques. These fires are far more seasonal than urban fires. A spreading rural fire can cause damage to property in a manner typical of an urban fire.

The Service's rural fire hazard assessment is clearly targeted at the latter type of fire.

Most rural fires start around the city fringe. This typically consists of back yards and fences, then a strip of low grass with a few planted trees and a dirt access track, then there is an abrupt transition into a rural land-use - either grazing paddock, nature conservation area or even pine plantation (Fig 2). Canberra's urban fringe is remarkably long and complex (Fig 3) - in detail it is over 1300 km long, and even in a general sense it is 280 km long.

The rural landscape typically has few facilties - few roads, few

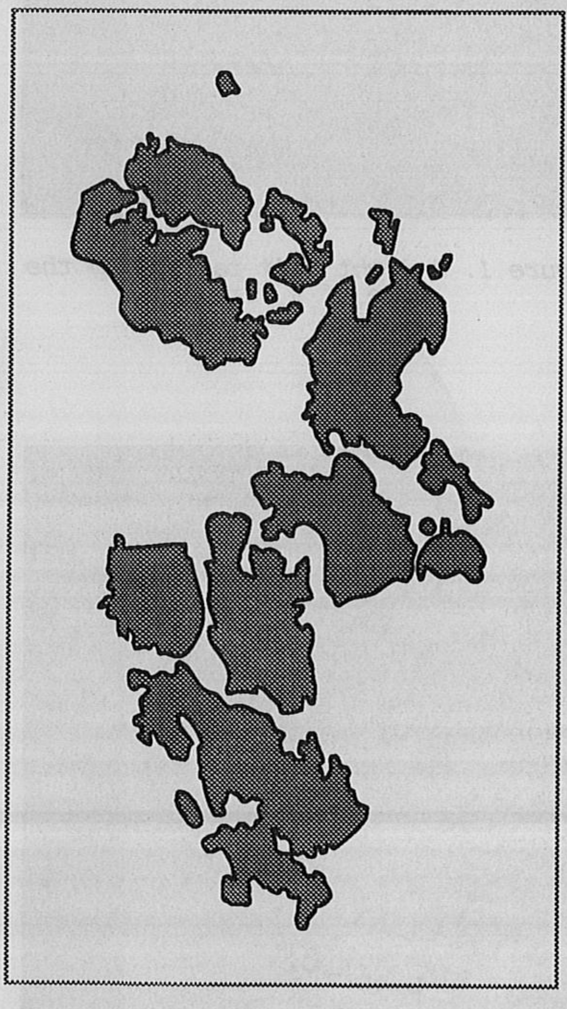


Figure 3. The urban edge of Canberra is remarkably complex.

water hydrants, etc - and is more rugged, making access harder and leading to faster fire spread.

There are three levels at which hazards are planned and managed, each with seperate management approaches, responsible bodies and functions. Table 1 summarises these. Each level represents a different scale of thinking. The macro scale covers the entire ACT and adjacent parts of NSW. The meso scale covers large portions of the Territory, and includes single land parcels, such as Namadgi National Park, or "districts", such as the Kowen District. The micro scale refers to specific small parcels of land, including individual blocks or even recognised management units within larger parcels.

Table 1.

	Level (Scale):		
	Macro	Meso	Micro
Management approach	Policy	Strategy	Tactics
Responsible body	Fire & Emergency Services	Land managers	Field staff
Hazard management functions	Advice & coordination	Plan of management	Actions

RURAL FIRE MANAGEMENT GOALS

As mentioned above, the majority of fires start close to property on the urban edge and may quickly cause damage. Thus the Service's operational aims are: .

* Quick detection.
* Quick response.
* Quick suppression.

These aims must be the basis of the rural fire hazard assessment. Hazard assessment should provide a means of assessing the efficiency with which the aims are met.

The Service's prevention aims are:

* Ensure that land holders prevent unsafe fuel build-ups.
* Ensure that property has adequate self-defence capability.
* Ensure that all operational needs are met.

Action taken to meet these aims should reflect the hazard assessment.

RURAL HAZARD ASSESSMENT GOALS

The procedures adopted for hazard assessment had to address a series of basic problems for fire management and planning in the ACT, namely:

1) A consistent approach to hazard assessment is needed to be implemented across the ACT.
2) Sites needing protection from fires often are in difficult or widely dispersed locations.
3) Dynamic factors involved in fire hazard make fire management difficult.
4) Ignition sources and fire weather are both unpredictable but both follow general patterns (Fig 4).

The objectives for fire hazard assessment reflect the priorities of the ACT's fire managers.

1) Provide a useful planning tool.
2) Reduce the threat from fires that occur by prior recognition of the hazard of fire and taking appropriate steps to reduce the hazard.
3) Ensure proper development planning in sites with high fire hazard.

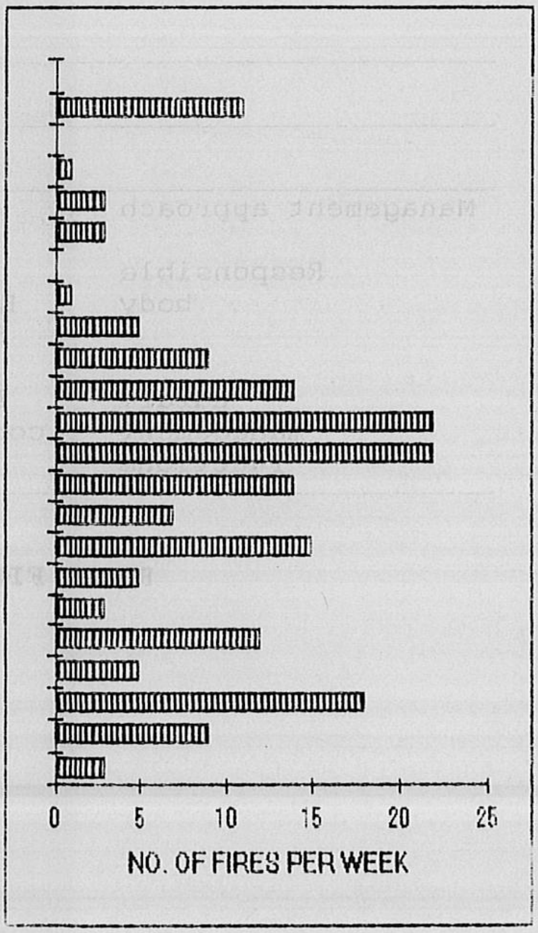


Figure 4. The frequency of fires, and the associated weather, form irregular patterns.

4) Protect existing sites with high fire hazards by reducing the hazard in surrounding areas.
5) Ensure that the best available data are utilised.
6) Ensure that the results of hazard analyses are fully utilised and disseminated.

The details of the assessment procedure are discussed below, in Section 2. Figure 5 shows a general flowchart describing the process, from raw input data to the final modelled hazard index.

HOW HAZARD ASSESSMENT CAN BE USED

It was of prime concern to the Service that the Hazard Assessment fully addresses the key problems for fire managers in the A.C.T. (There has been a tendency in the past in other places for hazard assessment to be a solution looking for a problem.)

A number of positive uses have been identified, and we are working to ensure that we and the community fully benefit from them.

They are discussed below as a series of case studies. Wherever possible they are related to the experiences of the 1990/91 fire season.

Figure 5.

The Hazard Assessment Procedure.

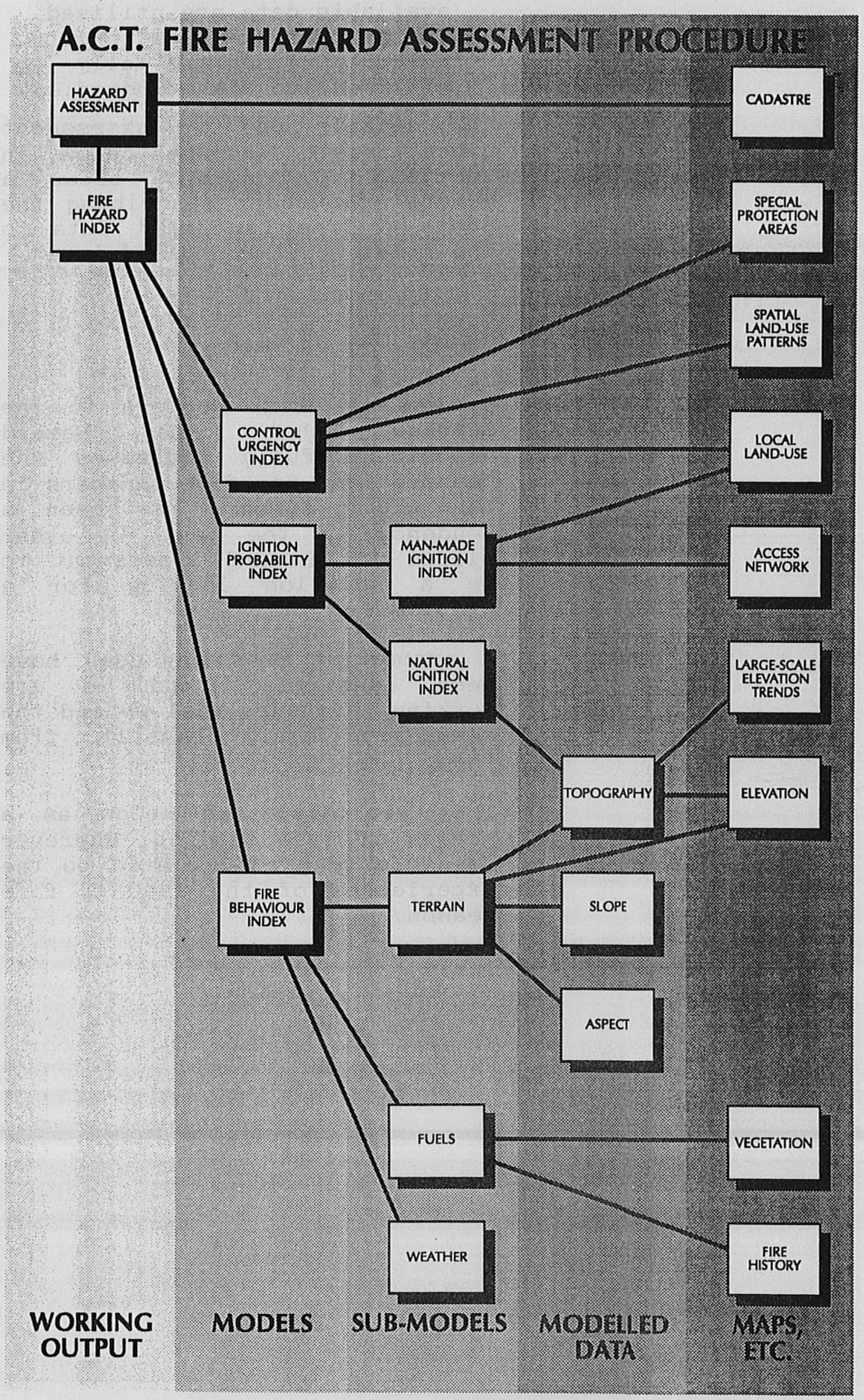
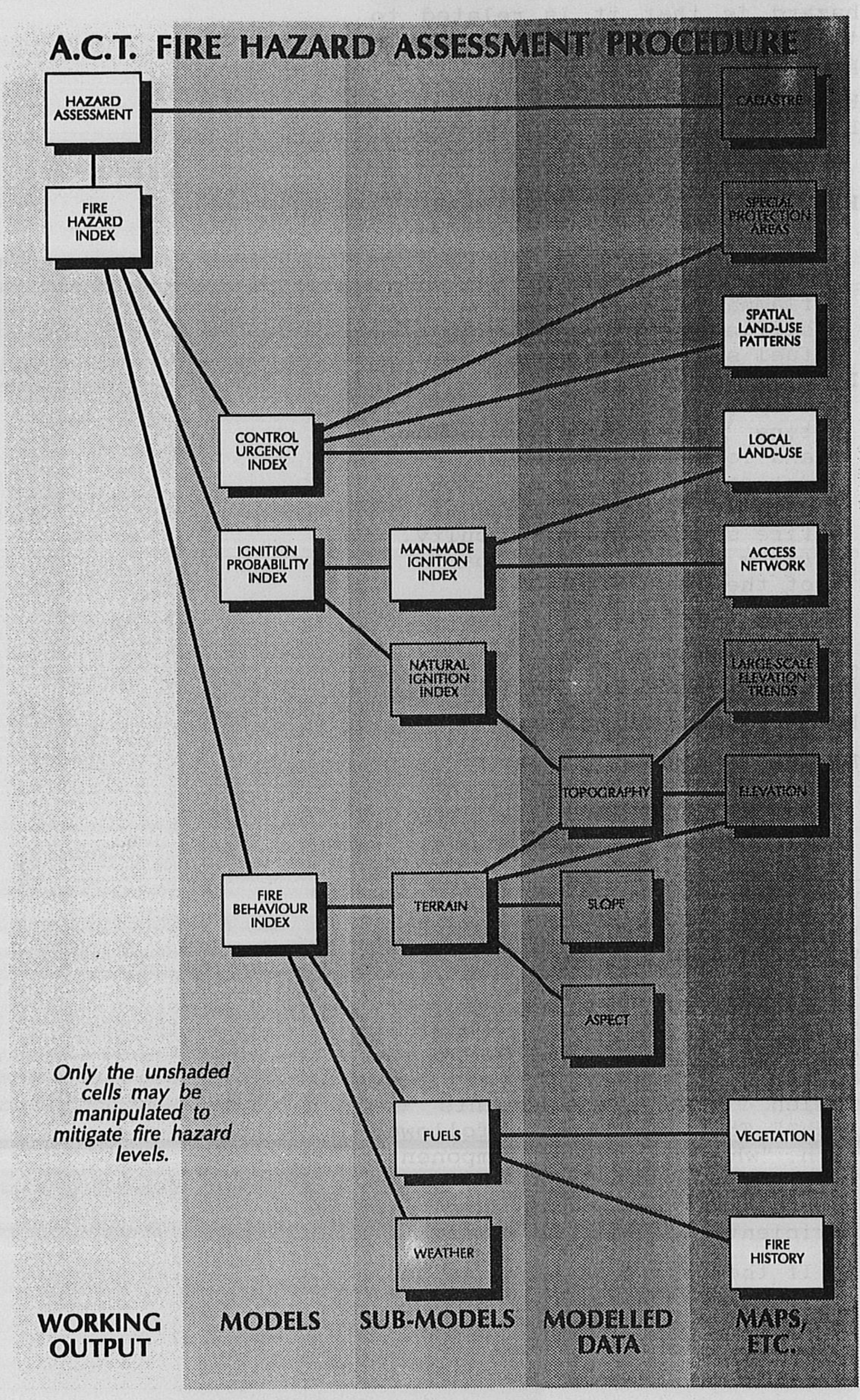


Figure 6.

Factors in the procedure that can not be managed to reduce hazard (shaded).



CASE STUDY 1: HOW CAN HIGH HAZARD LEVELS BE EFFECTIVELY REDUCED?

The traditional view of fire hazard is that it is related to the burnability of fuel. Some published definitions are:

Hazard: synonymous with fuel.
Hazard: The chance that damage, injury or loss to something or someone will occur.
Hazard: The condition of fuel, considering such factors as quantity, arrangement, current or potential flammability and the difficulty of suppression if fuel should be ignited.
Fire hazard: (1) A fuel complex, defined by volume, type, condition, arrangement and location, that determines the degree both of ease of ignition and of fire suppression difficulty. (2) A measure of that part of the fire danger contributed by the fuels available for burning.

The definition of hazard used for the Hazard Assessment is much broader than any of these.

Hazard: A measure of how frequently fires occur, how quickly they spread and how close they are to life and property.

A set of basic factors is used to calculate a series of components, which are in turn combined to give the hazard rating.

This may be reversed when it comes to managing hazard. If the hazard is high, you may ask "which of the components is high?" This may then be followed with "why are these components high?" This gives clear indicators as to how to efficiently reduce the hazard:

* If the hazard is high due to the fire behaviour component being high, then the hazard may be reduced by fuel

management - burning, slashing, grazing, species replacement, etc.

* If the hazard is high due to man-made fires, then a range of measures - public education campaigns, schools visits, statutory restrictions, changes to recreational patterns, etc - may be used as needed.
* If the hazard is high due to frequent lightning ignitions then nothing can be done to *directly* manage the hazard.
* If the hazard is high due to proximity to life and property then perhaps planning guidelines and controls are then best approach.

As mentioned, sometimes nothing can be done to directly manage hazard. Figure 6 shows the flowchart with any such factors shaded in. Usually in such cases there are indirect methods available. As an example, where lightning ignitions are common the land use can be changed, so that there are less valuable resources at risk, or more resources can be placed in the area for fire protection.

Figure 7. A fuel reduction burn in progress. Long grass along nature strips can be difficult to mow.

CASE STUDY 2: PREDICTING AREAS WHERE MAJOR FIRES MAY OCCUR.

Large grass fires, driven by strong northwesterly winds, can sweep across the Territory during a single afternoon and large forest fires can defy suppression for up to a month (Fig 8). When major fires reach property they have the potential to cause much damage (Fig 9).

Major fires occur where the *rate of spread* of a fire is such that it can travel far enough to cause damage before dispatched fire fighting units arrive and can stop it.

As a component of the Hazard Assessment is rate of spread the assessment can suggest places where large fires are possible.

Of the large fires that occured during 1990-91, most occured at such places (see Fig 10). This must be seen as *successful prediction*. It further suggests ways of improving our response capabilities in the near future.

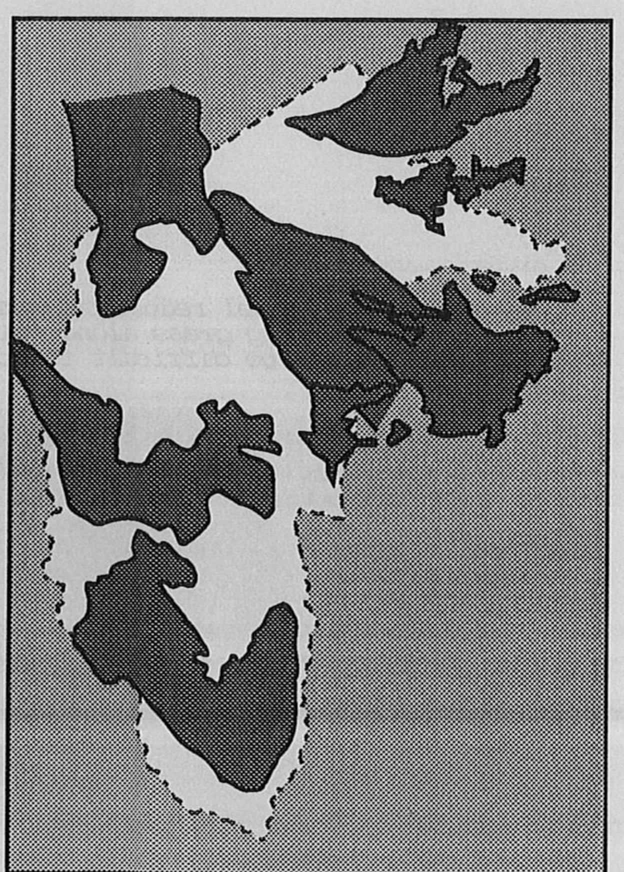


Figure 8. Large fires occasionally sweep across the A.C.T.

Figure 9. This crown fire crossed a highway and threatened houses in a Canberra suburb.

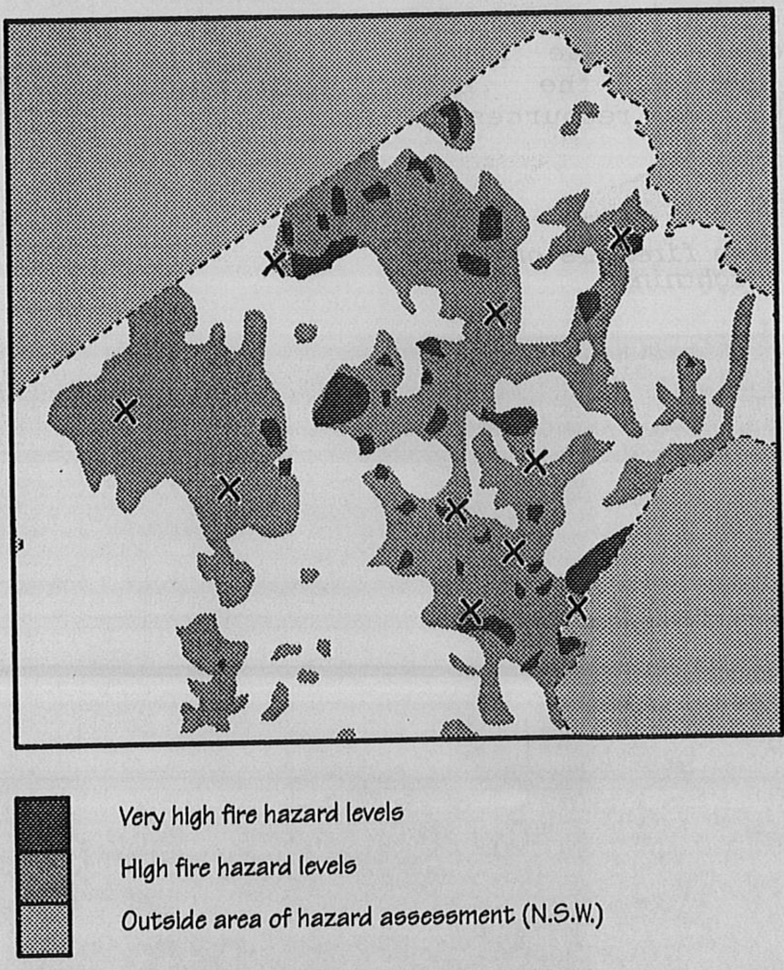


Figure 10. Map showing large fires that occured during the 1990/91 fire season and areas with high fire hazard.

CASE STUDY 3: PREDICTING AREAS WHERE LIGHTNING IGNITIONS MAY OCCUR

Around 5% of all fires in the A.C.T. are caused by lightning striking dry fuels that ignite and cause a fire. Most of these fires are in remote areas where detection is difficult and access awkward. They have the potential to spread and become significant fires.

Prediction of places prone to lightning ignition is thus of vital importance for protection of the Territory's forest, water and conservation resources.

The new predictive model used in the Hazard Assessment works very well. Of the 9 lightning ignitions recorded during 1990/91 (Fig 11), all were within 300 metres of sites predicted by the model, and most were within 100 m. This performance is such that we can expect to *maximise* our ability to detect these fires, and thus ensure the best protection for the resources of the A.C.T.

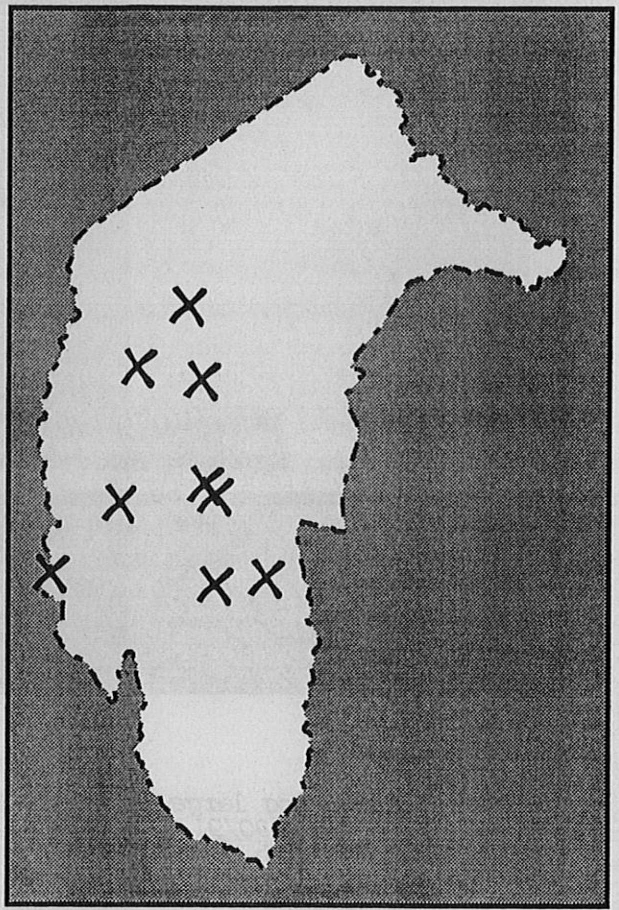
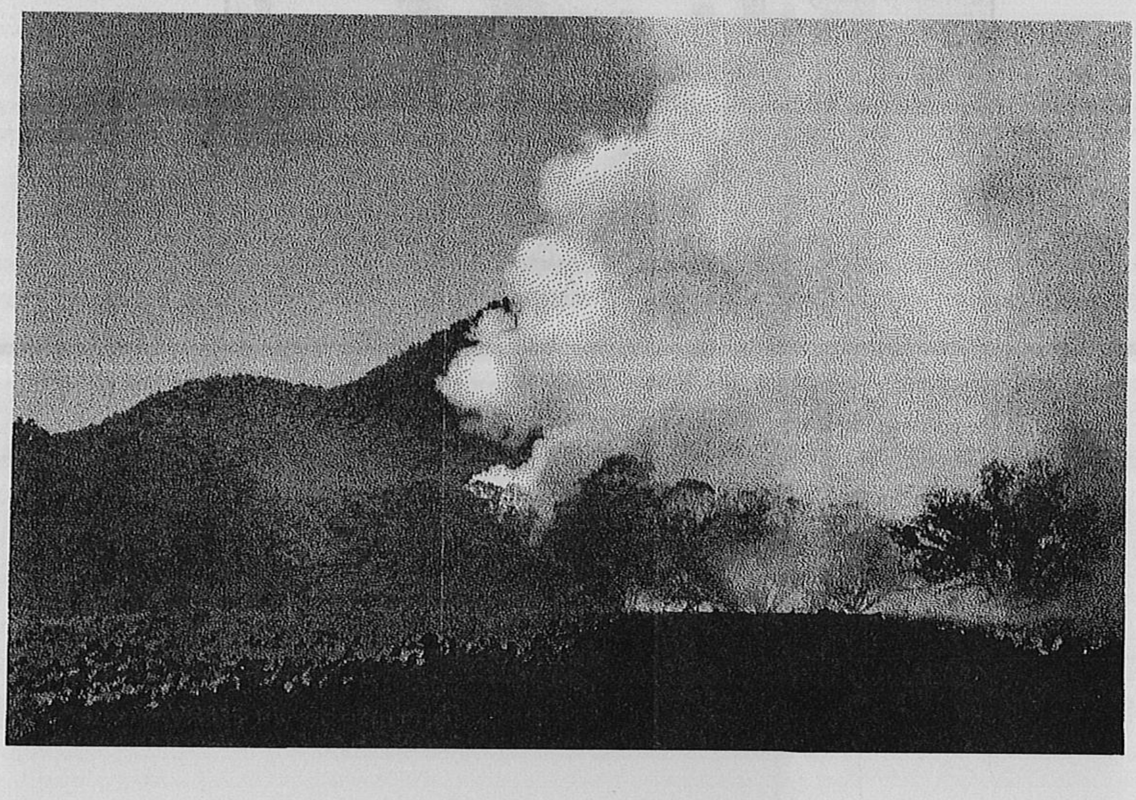


Figure 11. Location of lightning ignitions during 1990/91 fire season.

Figure 12. Remote area fires are often caused by lightning.



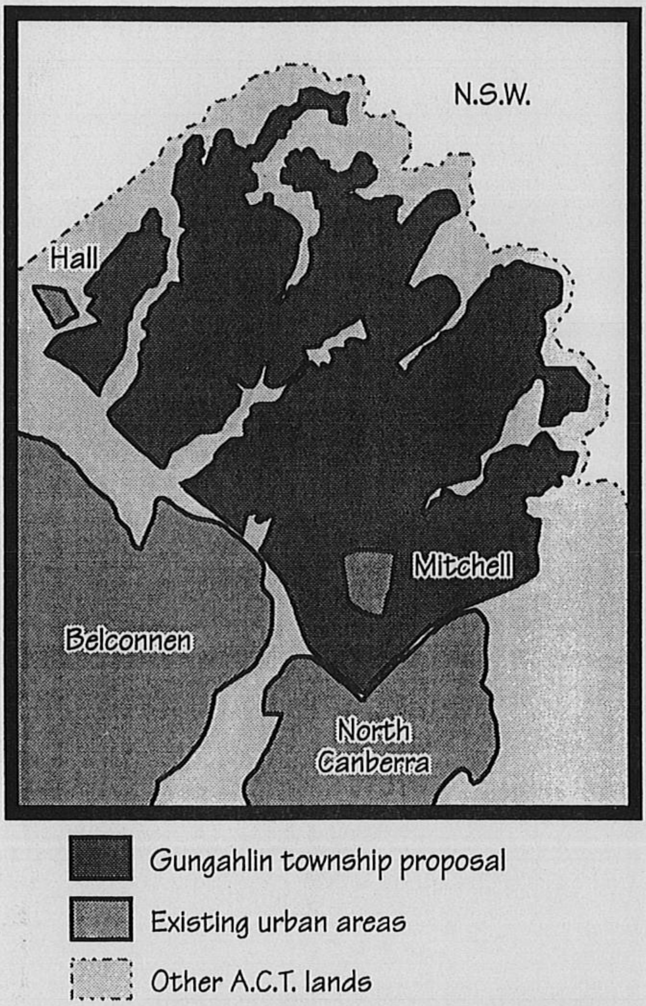


Figure 13. The new Gungahlin development will take up all the land between Belconnen, North Canberra and N.S.W.

LAND-USE	DURATION (years)	EXPECTED NO. OF EXTRA FIRES
Grazing land	0	0
Construction site	2	11
New residentiel	5	71
Aging residential	8	191
Mature residential	15	90
Total	30	363

Figure 14. It is possible to predict the number of fires due to new developments such as Gungahlin.

CASE STUDY 4: EFFECTS OF PROPOSED DEVELOPMENTS

In the event of a proposal for a new development, it is possible to use analysis of the hazard patterns to anticipate fire problems. As an example, the proposed development of the Gungahlin township (Fig 13) was analysed.

The increased population will lead to more fires occuring through human activities - such as children playing with matches, arson and escaped burn-offs. These fires will occur in open spaces within Gungahlin and immediately outside the built-up area. We are able to predict the future trends in fire numbers in this area as it progresses through a series of land use stages. The extra fires that can be attributable to each stage can be predicted[1] (Fig 14).

Thus we *conservatively* expect an additional 381 fires over 30 years, burning at least 4200 ha, that are directly attributable to this development. Further, these predictions are based on *today's* conditions and development patterns. The progress of the planning and development of Canberra must be constantly monitored, with predictions updated as soon as possible.

This level of detail allows potential future problems to be avoided.

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1 (Using an area of 55 km^2 for urban development and 15 km^2 for open space, certain correction factors for population increase and established fire frequency patterns)

CASE STUDY 5: FUEL REDUCTION BURNING PROGRAMS.

While the Service does not manage fire fuels itself, it provides an advisory service to land managers. The Hazard Assessment provides a number of guides for efficient fuel reduction burning.

1) The higher the local hazard, the more effective the burning will be.
2) However, burning will only be useful if the fire behaviour component was a major contributing factor to local hazard levels. Otherwise there could be better ways to reduce hazard.
3) The higher the contribution to hazard due to proximity to life or property, the more effective burning would be.

Figure 15. Fuel levels can be easily reduced with the controlled use of fire.

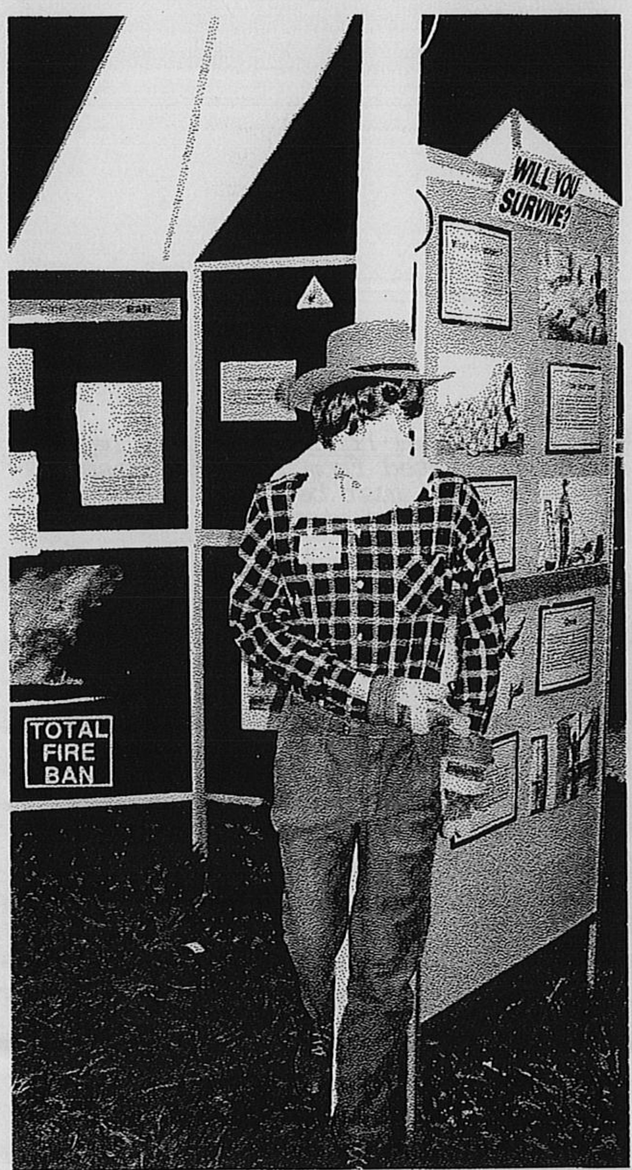


Figure 16. Display material, such as this at the Canberra Show, showing how to survive a wildfire, gets the message across to the public.

CASE STUDY 6: PUBLIC EDUCATION

Where there are a lot of fires resulting from people being careless with fire, the best way to prevent future fires may be through a public education campaign. However these can be very expensive, and everything should be done to make them more cost-effective.

The Hazard Assessment clearly identifies the areas where this is the case, and further shows where this is the main contributing factor for the hazard levels.

Current results show that all such areas are within two kilometres of the edge of established urban areas, and mainly in Canberra Nature Park. These results will enable an efficient campaign to be launched in cooperation with the Parks and Conservation Service and the A.C.T. Fire Brigades.

CASE STUDY 7: A LANDHOLDER WANTS TO KNOW IF HIS HOUSE IS SAFE.

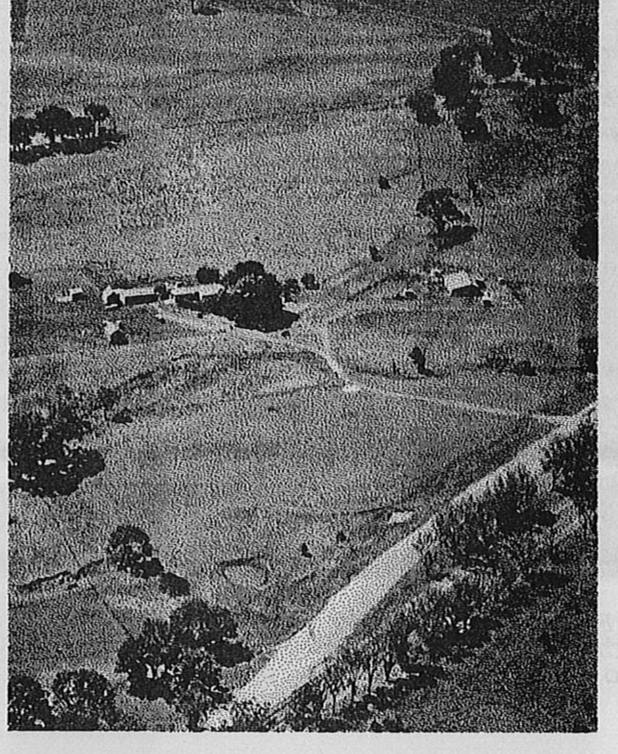
If a fire starts close to a house in a rural area or close to the urban fringe, it has a chance of causing damage before fire units can reach it. The only way to avoid this is to take steps to ensure that the house is well protected.

There is a clear way of thinking about this problem that is suggested by the hazard assessment approach:

1) What is the value of the house? Thinking about what is at risk is a good first step to determine how much effort is needed for protection.
2) How much other property is in the area (am I going to be alone until the Brigade arrives)?
3) What fuels are going to be burning if a fire reaches my house? The intensity of the fire next to the house will determine the chances of the house catching fire.
4) Have I installed enough self-defence measures? This includes: sprinkler systems, clearing out of eaves and gutters, fireproofing windows, doors and under the house, and so on.
5) Is there a clear path for a running grass or forest fire to reach my house, and how long will it take?
6) Beyond what the householder can do is the responsibility of neighbours. If the neighbours manage the fuel on their land, by ploughing fire breaks, fuel reduction burning, etc, then the chances of a running fire reaching the house may be greatly reduced.

But all of these factors must relate to how likely it is for a fire to start in the area.

Figure 17. Rural homes and sheds need to be protected from running grass fires. The work must be done before the fires start.



CASE STUDY 8: ENSURING ADEQUATE RESOURCES ARE ON STAND-BY.

There is a limited number of fire fighting units available in the ACT, although they are generally sufficient for the job. However, it is essential that they are placed on stand-by only as required by the current fire danger index and in places where fires are most likely to occur and present a threat to property.

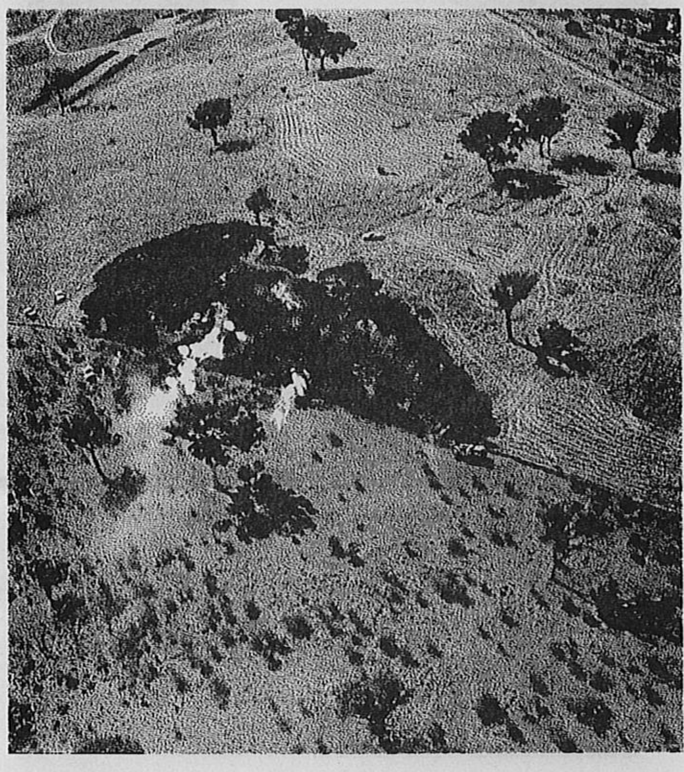
The Hazard Assessment approach can throw some light on this very difficult task. This is best shown by example.

Consider two pine forests - Kowen and Uriarra. Kowen has medium hazard, mainly due to the economic value of the plantation. Uriarra has high hazard, due to its economic value and also the risk of lightning ignitions in the lower blocks and the potential for intense fire in the upper blocks.

The economic value and the lightning risk remain constant, although the latter is best addressed by ensuring aerial reconnaissance flights after storms have passed. However the potential for intense fire requires that fire fighting units are stationed closer in than normal when bad fire weather approaches.

Established practice is to do exactly this, indicating that the Hazard Assessment is working well. The same ideas may be applied elsewhere with equal success.

Figure 18. This is a typical urban edge fire. The grass was being slashed to protect the adjacent houses, but the blades struck a rock and sparks started a fire. Sufficient fire appliances arrived on the scene before the fire had spread far.



CASE STUDY 9: DO WE HAVE ENOUGH FIRE TOWERS?

The Service aims to ensure an adequate network of fire towers. These are manned through the summer, and as the Fire Danger Index goes up more are manned. There are currently five towers in the A.C.T. (Fig 19):

* Mt Tennent - often manned.
* Kowen Forest - usually manned.
* Mt Coree - manned when Danger goes up.
* Mt Stromlo - manned on weekends when the Danger goes up.
* Mt MacDonald - only manned when Danger is extreme.

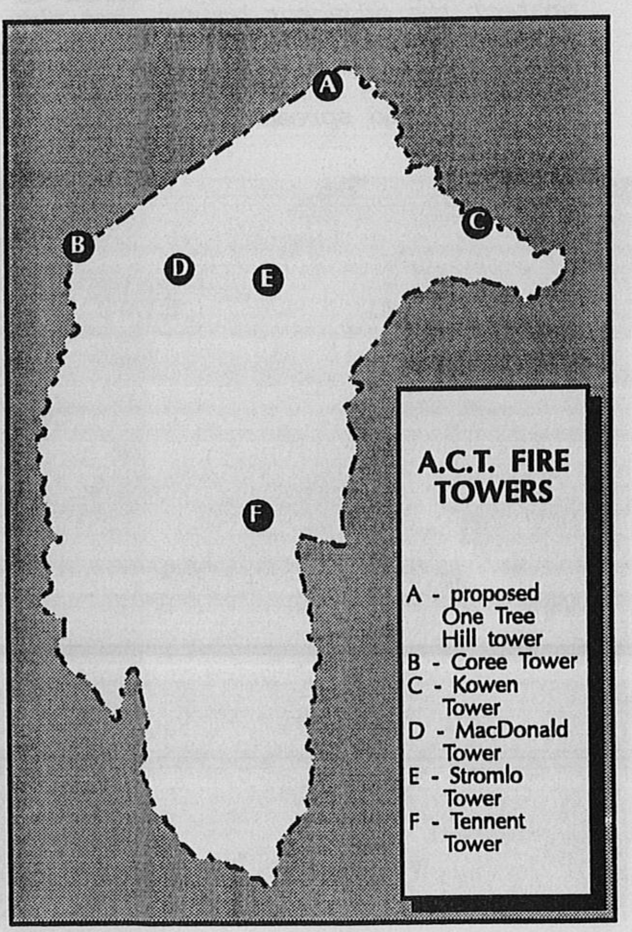
These towers give overlapping fields of view for almost all areas where fires currently are common. The more towers see a fire the better the "fix" through triangulation.

The problem is that the city is spreading and land-use and recreation patterns are changing. It is important that significant changes are anticipated and planned for.

A good example is the proposed Gungahlin development. Here we have an area of quite low hazard in which changes to land-use will dramatically increase the hazard. Lets compare the present and future components of the hazard:

Component	Present	Future
Control Urgency	Low	High
Natural Ignitions	Low	Low
Man-made Ignitions	Low	High
Fire Behaviour	Low	Low

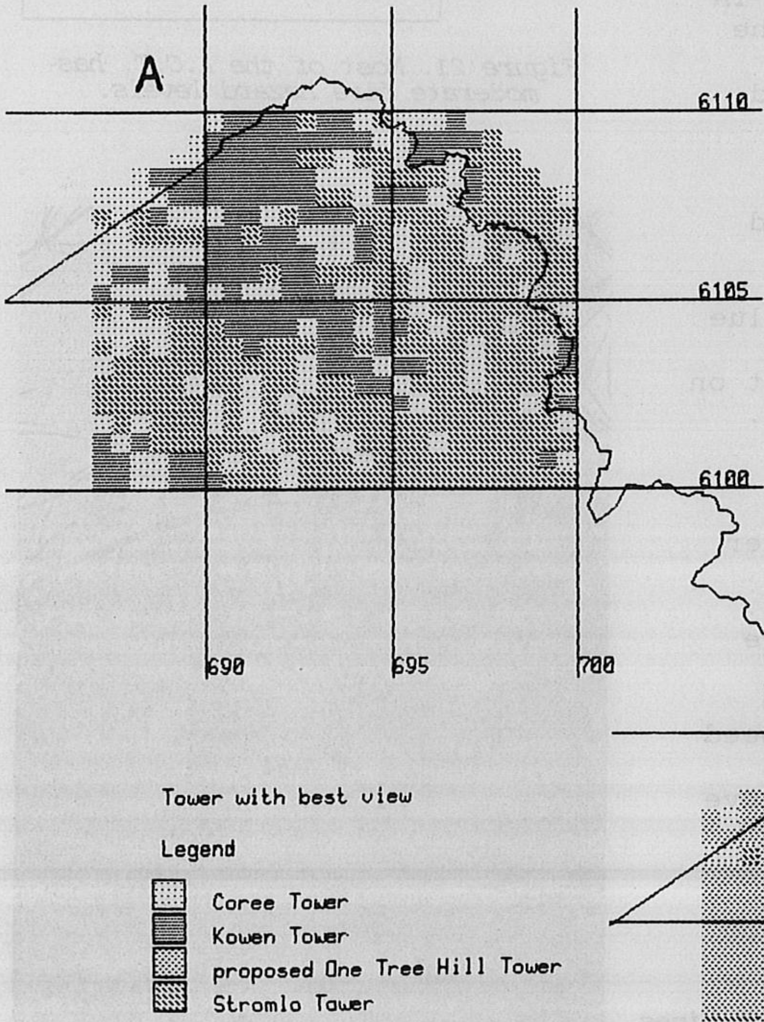
Figure 19. Fire towers.

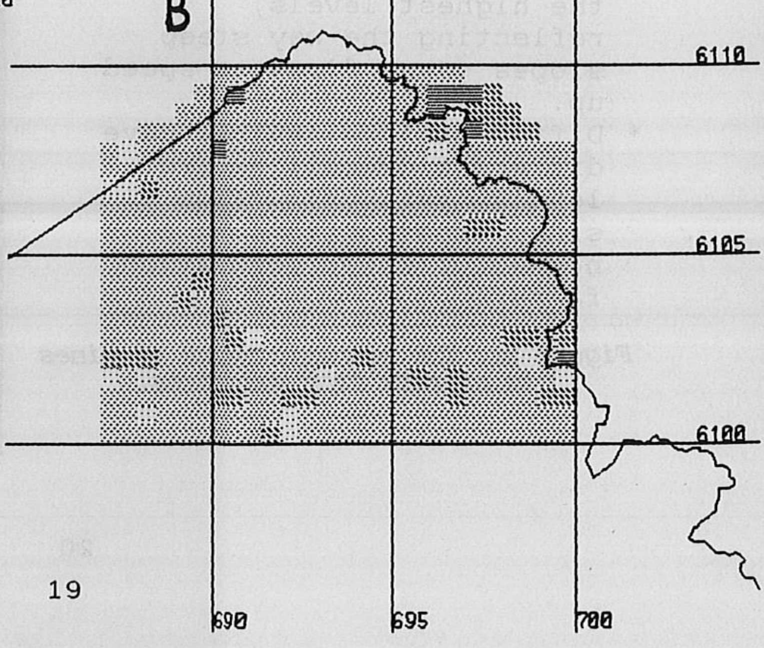


What this tells us is that there will be more fires and they will threaten more property. These fires will be caused by human activity. The demand for quick detection in this area will increase. Currently the landform of the area reduces the effectiveness of fire towers, by either blocking sight all together (Mt Ainslie blocks Kowen Tower) or by not giving good clues for distance estimation (as is the case for Tennent Tower).

We have shown that placing a new tower on One Tree Hill on the State Border we can dramatically improve our detection ability for the Gungahlin area (Fig 20).

Figure 20. A Existing fire tower coverage of the Gungahlin area. B Improved coverage with the proposed One Tree Hill tower.





SECTION 2 – HAZARD ASSESSMENT

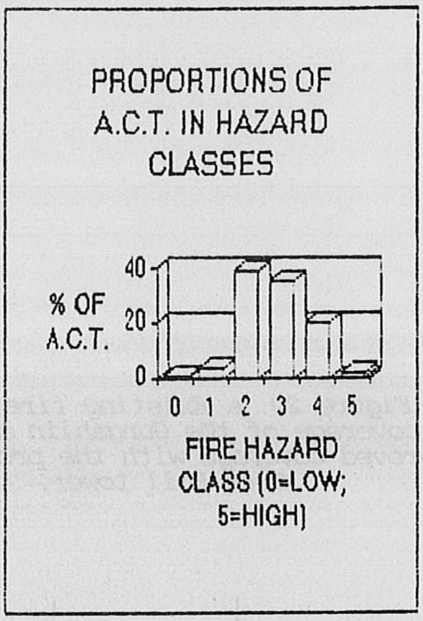


Figure 21. Most of the A.C.T. has moderate fire hazard levels.

CURRENT HAZARD LEVELS

Fig 23 shows the current Fire Hazard Assessment for the A.C.T. It places every square of land into one of five hazard classes. Four and Five are *high* and certainly require some form of hazard management.

It is worth looking at the map and noting the patterns of hazard levels.

* Most remote areas have low hazard levels. This reflects the fact that most fires in the ACT occur close to the urban edge.
* In the rural areas hazard levels are highest along road corridors.
* The highest rural hazard levels are centred around the commercial pine plantations. There is considerable economic value in these, and their loss could have a large impact on the Territory's finances.
* Closer to the city, the urban edge has a consistently high hazard level, reflecting the ever increasing recreational usage of the open spaces.
* The hills and ridges have the highest levels, reflecting the way steep slopes cause fires to speed up.
* Different town centres have different overall hazard levels, reflecting time since construction and a number of other population factors.

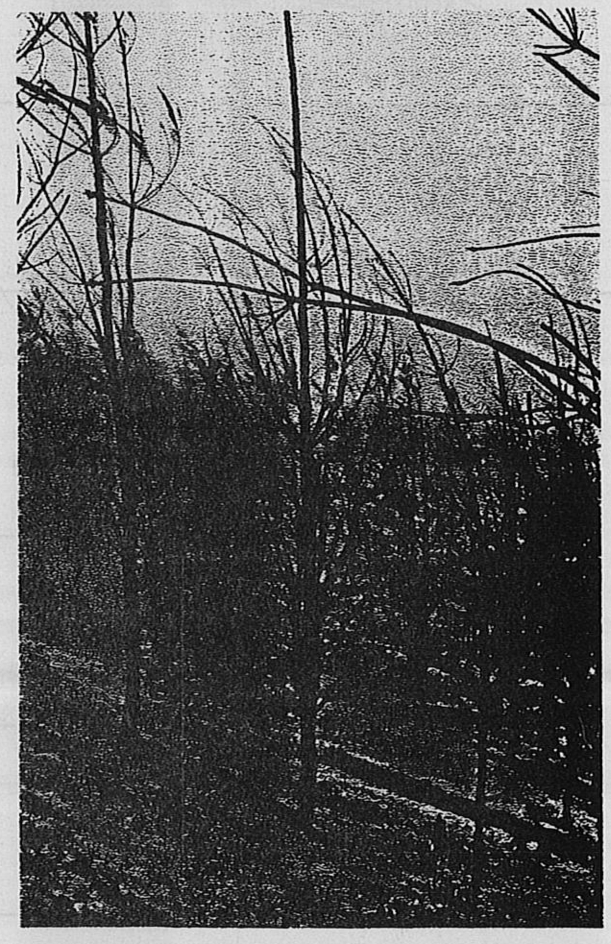
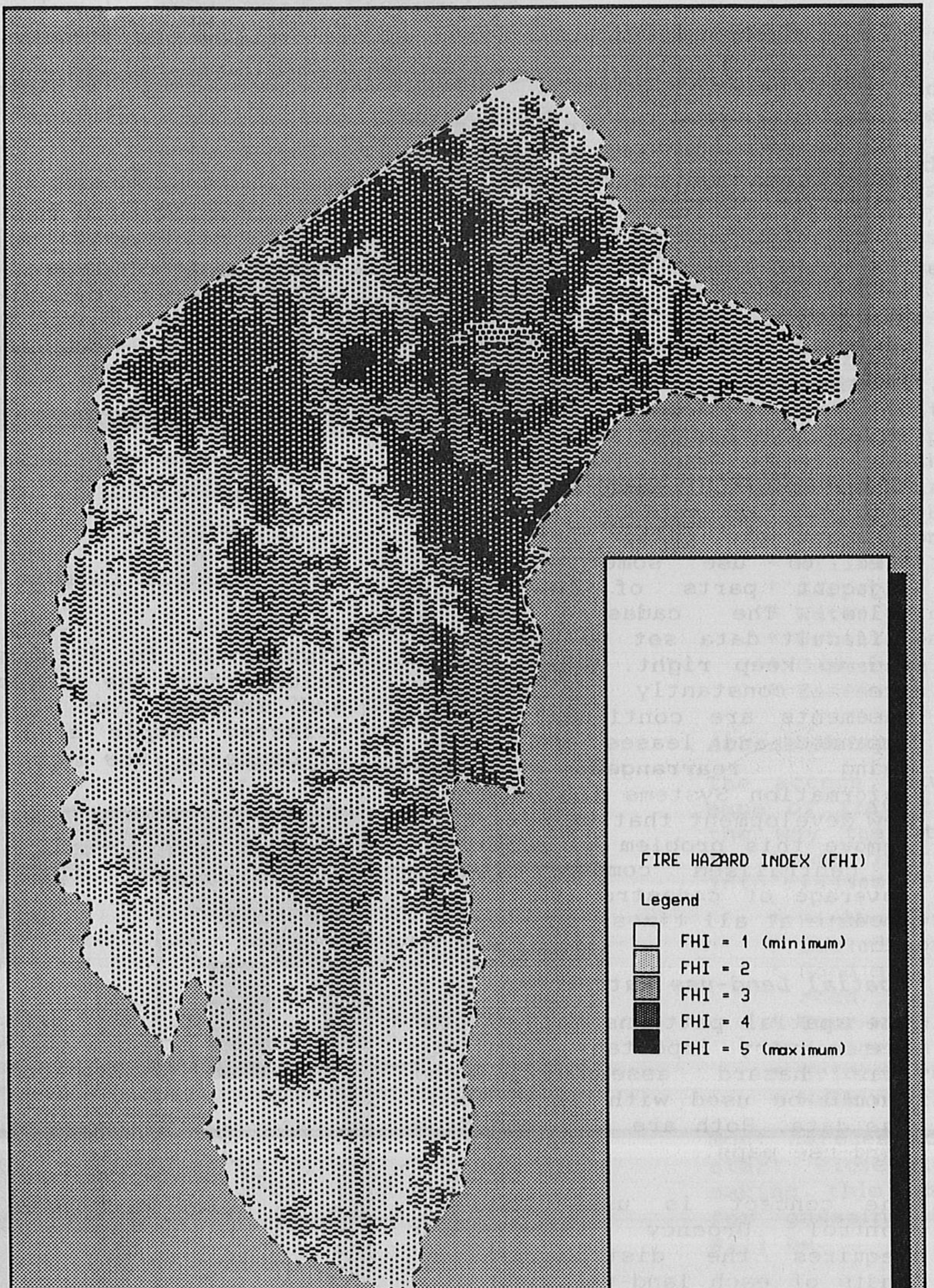


Figure 22. The economic value of pines is at risk from wildfires.

Figure 23. Current hazard levels.



Elevation (Fig 27)

Elevation varies from over 400 m to over 1900 m. While elevation is not directly relevent to hazard, it is used for scaling of weather factors and to calculate some important factors: slope, aspect and topography.

Large-scale Elevation Trends (Fig 28)

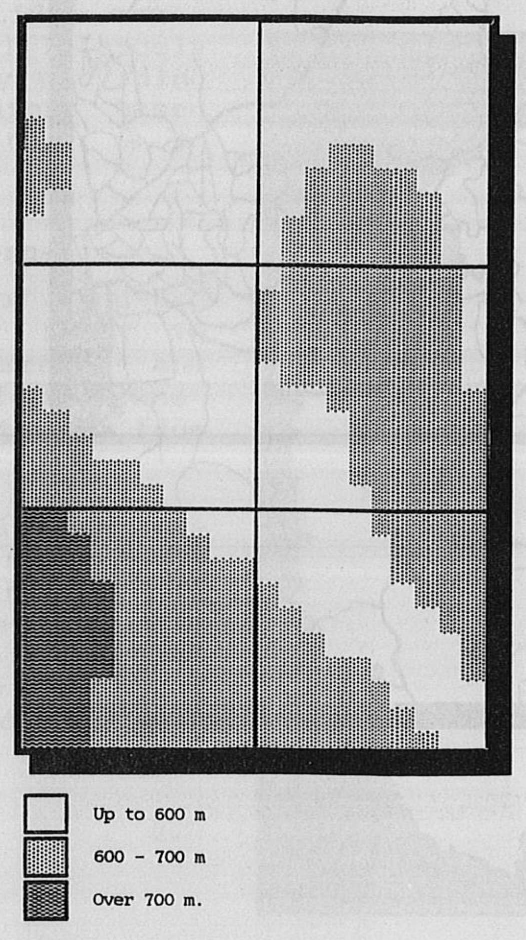
This is a new concept and will become more important for natural resources management as time passes. The variations in elevation across the land surface may be put into three classes:

* The micro-scale variations, which cover localised landforms and all of the smaller scales of features (rock ledges, boulders, and so on).
* The meso-scale variations, which cover the effects of mid-sized landform units, such as ridges and gullies.
* The macro-scale trends, which account for the effects of large ridge systems, mountain ranges and large river valleys.

Each of these has different levels of effect on natural processes, such as meteorology, and dynamic processes, such as fire behaviour. They are used to calculate topography and also to predict places prone to lightning ignitions for the Natural Ignition Index.

Figure 27. Elevation

Figure 28. Large-scale elevation trends



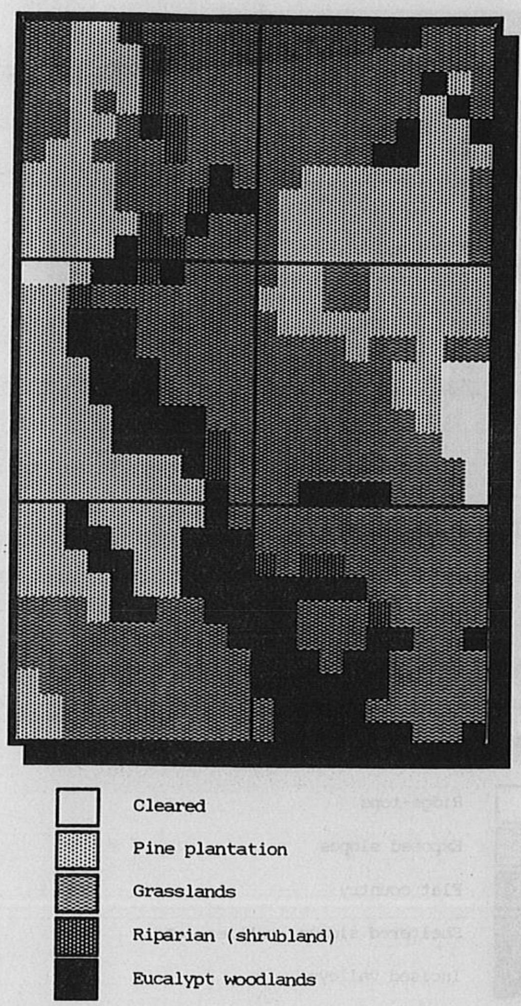
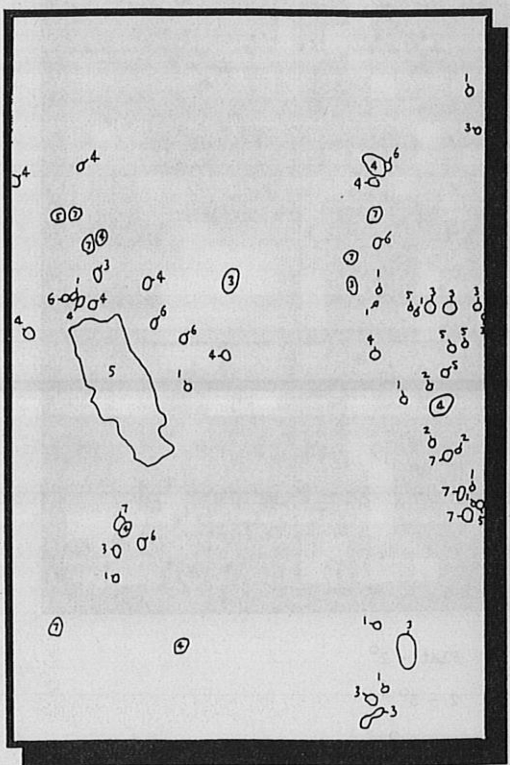


Figure 29. Vegetation association groups

Figure 30. Fire history



Showing years since last fire.

Vegetation (Fig 29)

The vegetation is the source of the fuels consumed by fires, and as such it is of great importance to have an accurate map of the vegetation. For fire hazard assessment purposes the major vegetation units in the A.C.T. include:

* Alpine Ash open-forests.
* Montane open-forests.
* River Oak.
* Stringybark - Scribbly Gum woodlands.
* Subalpine Snow Gum woodlands.
* Yellow Box - Red Gum woodlands.
* Montane heathlands.
* Alpine herblands.
* Subalpine grasslands.
* Tussock grasslands.
* Modified grasslands.
* Pastures.
* Pine plantation.
* Mixed exotic plantings.

Fire History (Fig 30)

Fire history is used to indicate how much fuel is present. It builds up with time after fire at a rate that depends mainly on the vegetation type.

Fire history also indicates how fire prone an area is. Statistical interpretation of fire records can provide important clues to the frequency of fires in the future for use in the Man-made Ignition Index.

Topography (Fig 31)

Topography is a widely used term that is poorly defined. For the purpose of fire hazard the topography at a point is defined by a description of the geometric shape of the surrounds of that point. It does not include elevation, slope or aspect, but is provides a context for them. Typical classes for topography (for hilly or mountainous country) include:

* Ridge-top.
* Plateau.
* Exposed slope.
* Sheltered slope.
* Valley floor.
* Cliff.
* Ravine.

Topography is important for estimating the interaction between fire and weather.

The Service is carrying out research on development of new topographic models.

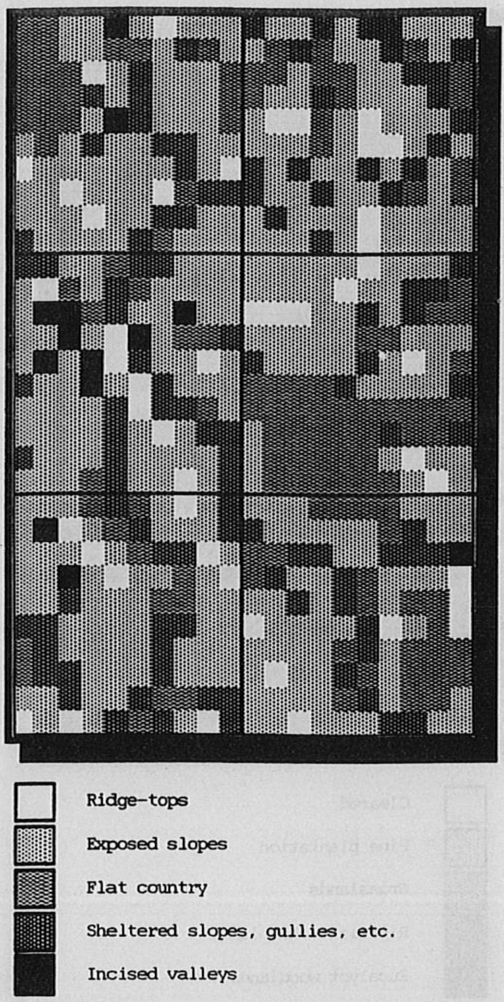


Figure 31. Topography

Slope (Fig 32)

Slope is important for fire rate of spread. As a crude guide, for every 10 degrees extra upward slope it is possible for rate of spread to double. Reliable slope values are thus critically important. There are many ways of defining slope and careful research by the Service has identified the best way for fire prediction.

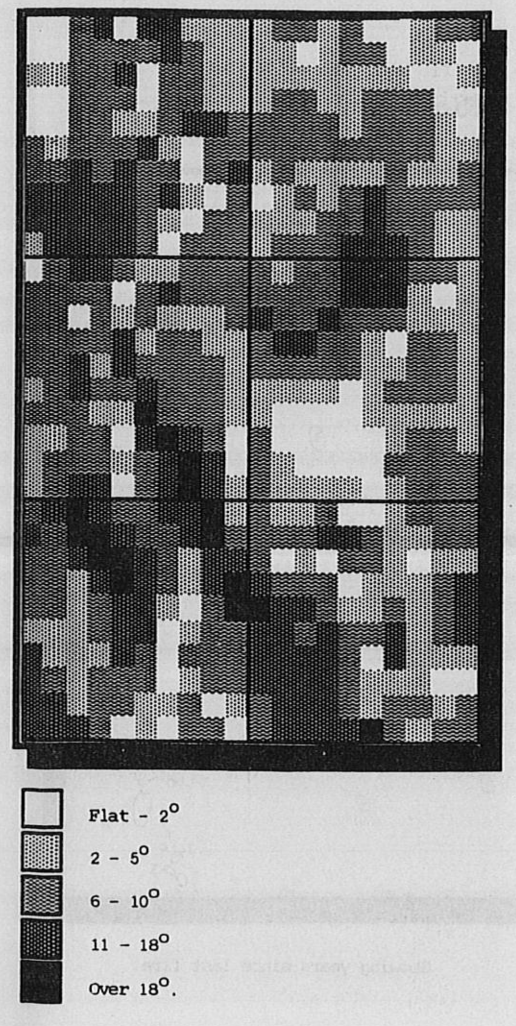


Figure 32. Slope

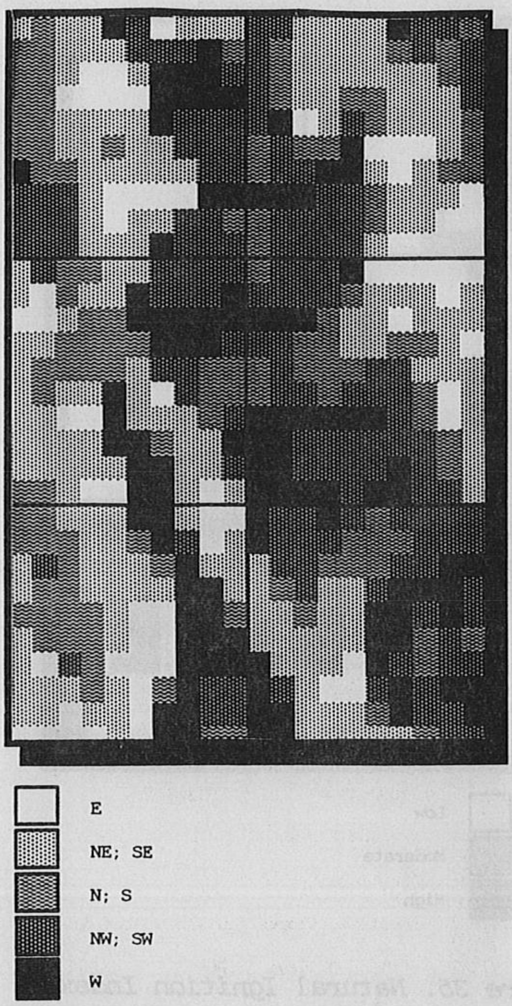


Figure 33. Aspect

Aspect (Fig 33)

Aspect is defined as the direction in which the ground faces in the direction of maximum slope. Aspect and slope together determine how much sun any point gets, and thus how quickly the fire fuels dry out after rain or fog. More importantly it determines the net effect of wind on a fire, in conjunction with slope. The same slope and wind values will mean quite different fire behaviour on a sheltered slope compared to a slope facing into the wind.

Terrain

Terrain is a collective term for all data relating to the lie of the land. There is a complex set of interactions between terrain, weather and fire behaviour, and a lot of research around Australia has gone into quantifying these.

Fuels

The fuels that burn in a fire are arranged in a very complex pattern that depends on vegetation, land-use and disturbance history. The fire behaviour prediction models used predict the size and structure of the fuel load from these inputs, using standard fuel build-up curves. Further information on recent weather allows prediction of fuel moisture content.

Weather

There are many aspects to weather that affect fire behaviour, and at present, our understanding of many of these is limited. There are three ways of looking at weather that correspond to different applications:

* A full description of local weather conditions may be used for suppression purposes. Here the data are obtained from most recent

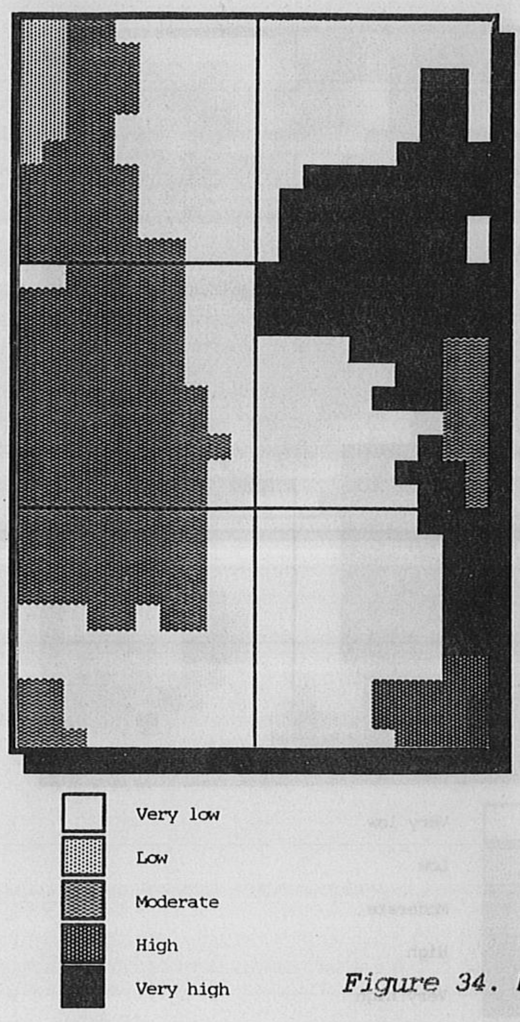


Figure 34. Man-made Ignition Index

weather reports and from meteorological instruments taken to the fire. This approach is used for predictions of the future course of actual fires.

* A complete statistical summary of historical weather data can be used to assess overall fire hazard levels. Here all weather trends are used to generate one output figure.
* The historical weather data may be ranked along a gradient from mildest to severest and one or more points along this gradient may be selected as inputs to calculation of fire hazard. This may be used to answer questions along the line of "what will be the hazard if we have bad weather this season?"

Hazard assessment uses only the statistical summary of weather.

Man-made Ignition Index (Fig 34)

The man-made ignition index (MII) is based on:

* Division of the ACT into a series of 46 Fire Accounting Blocks (FABs), each with fairly uniform land use and recreation patterns.
* Records of the points of ignition of all fires, except those caused by lightning, for the last 12 years.

The number of fires recorded in any FAB over the last 12 years is divided by 12 and then by the area of the FAB to give an expected number of fires per hectare per annum.

Natural Ignition Index (Fig 35)

The natural ignition index (NII) is based on a model of where lightning tends to cause fires. This identifies where the meso-scale elevation variation is

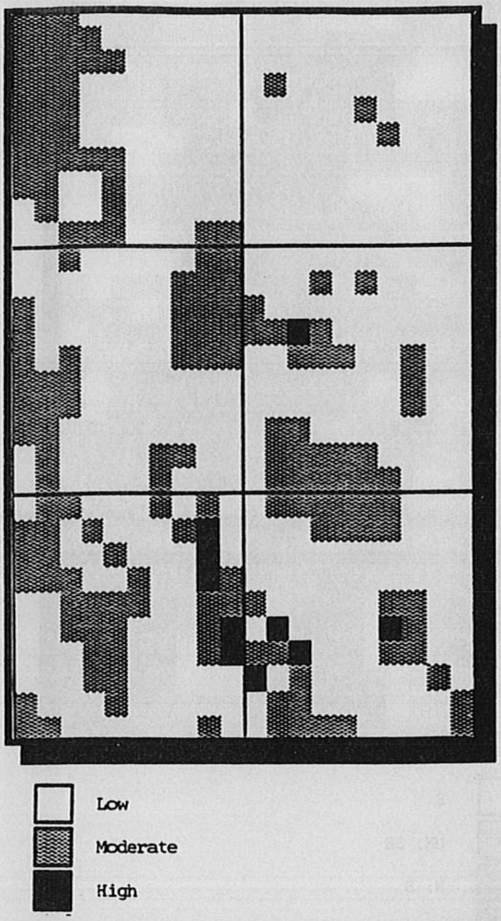
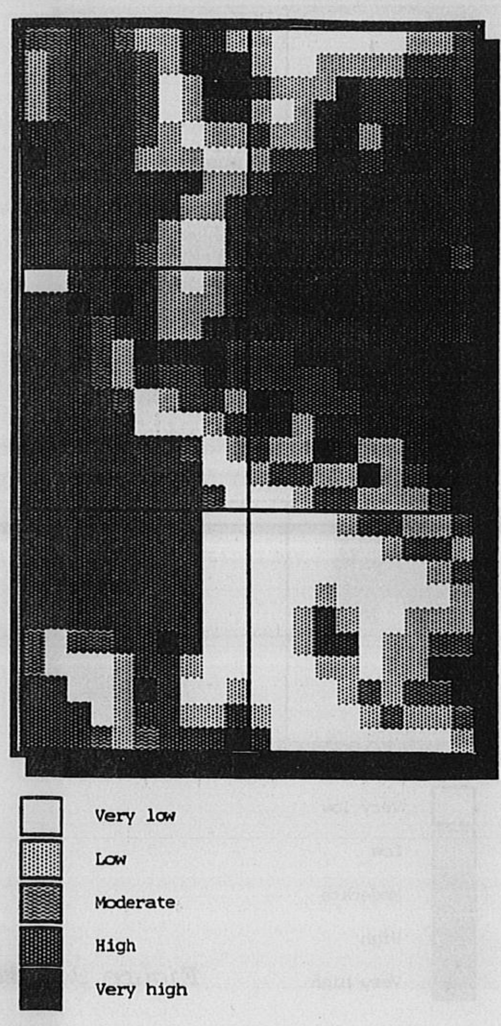


Figure 35. Natural Ignition Index

Figure 36. Control Urgency Index



close to zero. A further analysis, identical to that for the MII, is carried out for lightning caused fires, and used to qualify the results. This is the most advanced system in the world for predicting if an area is prone to lightning ignitions.

Control Urgency Index (Fig 36)

The basis of this index (the CUI) is "if there was a fire burning at a certain point, what would be the urgency of controlling it in order to prevent the loss of life or property?" This is achieved by a special model. It takes a point and then calculates the closest distance to each of a series of land-use classes. For each land-use class this gives a potential CUI, which is a number from 0 to 5. The CUI is simply the highest potential CUI for that point. The values for the potential CUI for each distance from each land-use class are:

Range of distances (in 100 m units):					
Minimum:	0	2	5	10	20
Maximum:	2	5	10	20	+
Urban development:					
- Scattered dwellings	5	4	2	1	0
- Urban area	5	4	2	1	0
Infrastructure:					
- Government installations	4	3	2	1	0
- Powerlines	3	2	1	0	0
- Pipelines	2	1	0	0	0
Communications:					
- Railways	3	2	1	0	0
- Highways	4	3	2	1	0
- Sealed roads	3	2	1	0	0
- Management tracks	1	0	0	0	0
- Unsealed roads	2	1	0	0	0
- 4 wheel drive tracks	0	0	0	0	0
Land-use:					
- Silviculture	4	3	1	1	0
- Market garden	2	1	0	0	0
- Orchards	3	2	1	0	0
- Vinyards	3	2	1	0	0
- Cereal crops	1	0	0	0	0
- Improved pastures	2	1	0	0	0
- Unimproved pastures	1	0	0	0	0
- Uncleared land	0	0	0	0	0
- Yards, sheds, etc.	4	3	2	1	0
- sites on heritage places register	4	1	0	0	0

Ignition Probability Index

The IPI is simply the sum of the numbers of fires per hectare per annum from the NII and the MII.

Fire Behaviour Index. (Fig 37)

The FBI gives an indication of the severity of a fire at a specified place and with a specified set of weather conditions. It is based on using site description data, such as vegetation, fire history and terrain, (usually from a geographic database) and weather data. These are used as input to a fire behaviour prediction model, which predicts the fire's rate of spread and intensity, which are averaged to give the FBI.

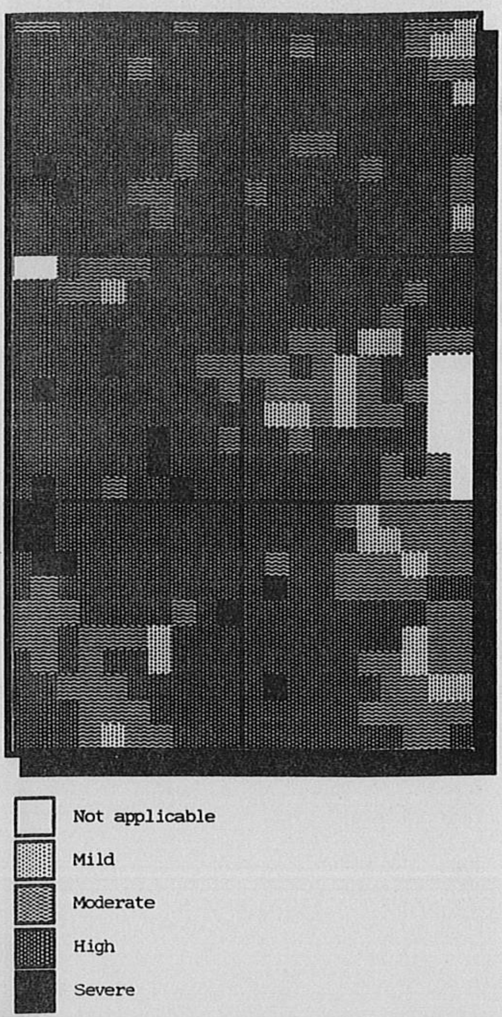


Figure 37. Fire Behaviour Index

Fire Hazard Index (Fig 38)

The fire hazard index (FHI) is derived in the following way:

FHI = FBI (scaled to 0 to 5 range)

+

IPI (maximum of MII scaled to 0 to 5 range and NII scaled to be either 0 to 5 range)

+

CUI (scaled to 0 to 5 range)

then divided by three.

Main Contributing factor (Fig 39)

The process for calculating the FHI lends itself to also flagging which of the inputs contributed most to the FHI. Clearly, if there are limited resources available for hazard reduction, then it is important to expend these in the most effective manner. As an example, if the hazard is high because people light lots of fires close to property then burning off the fuel will help, but public

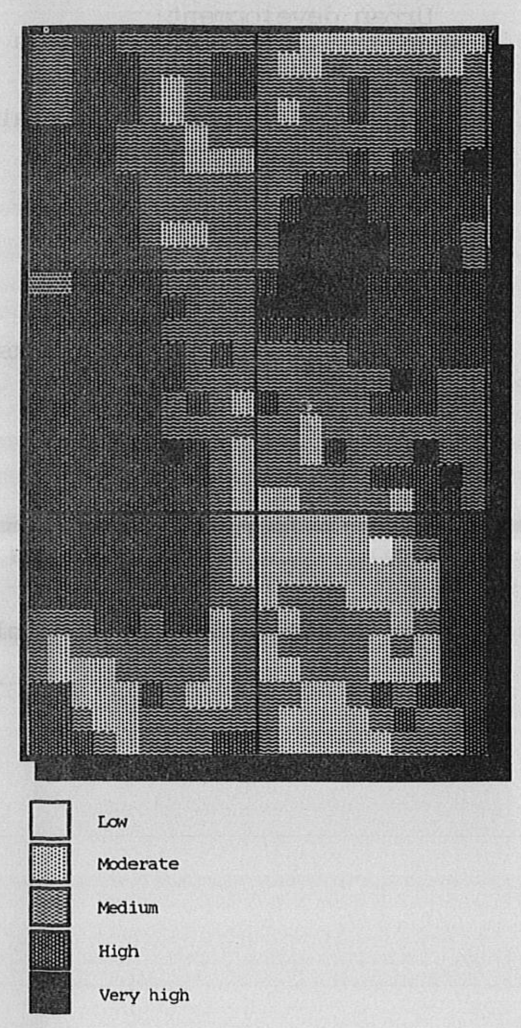


Figure 38. Fire Hazard Index

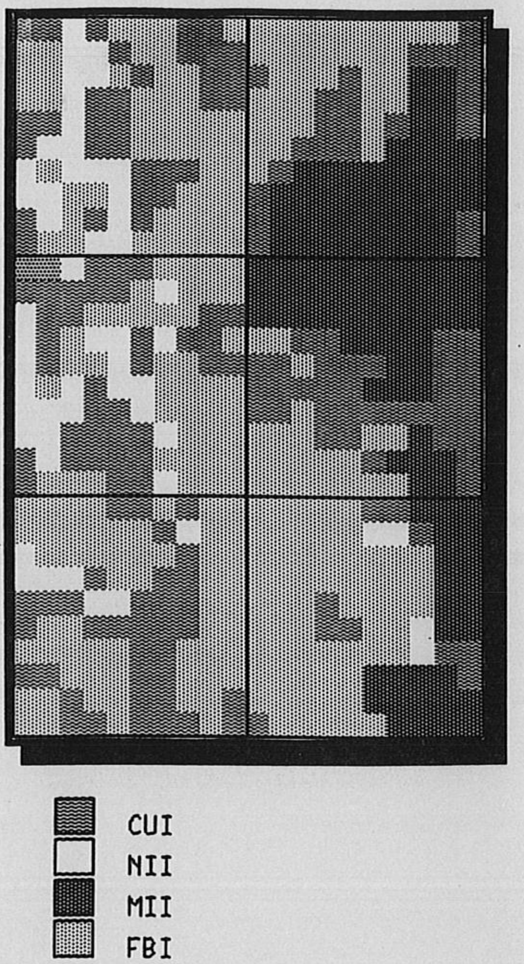


Figure 39. Main contributing factor

education or changing recreation patterns could be better.

RESULTS

The output from the Hazard Assessment is presented as a report based around a series of maps and a series of frequency charts.

IMPLEMENTATION

The macro-scale hazard assessment is being presented to all major land managers in the ACT. They would then need to use this information to upgrade their management plans. The Service is willing to provide any assistance needed to allow them to fully utilise the information and for them to implement meso-scale assessment.

FUTURE DEVELOPMENTS

As mentioned before, the hazard assessment procedures are new and need to be developed further. Even though the system works very well at present, it can work better and address more problems.

Some of the areas where research is currently on-going are:

Grass curing:

Grass curing refers to how much of the grass matter is dead. Grass curing assessment is one of the important inputs to fire danger for grassland areas. Each main grass type in the ACT responds differently to seasonal and once-off weather factors. The germination, growth, flowering, setting of seed and dying off of grasses may be predicted. Each of these stages affect the amount of fuel available for a fire front, and thus rate of spread and intensity.

Sampling at fixed sites has been under way for 2 years now, and the results have been regularly relayed to the Bureau of Meteorology for inclusion in fire weather reports used throughout the Region.

Future possibilities include the analysis of satellite images to follow curing trends across the region.

It has already been shown that monitoring of curing in the early and late stages of a fire season allows accurate prediction of where fires will tend to occur.

Climatology

There are a number of aspects of weather and climate that are the focus of extensive research throughout the international fire community. New techniques will soon allow improved fire behaviour prediction through better models of the interaction of weather and landform. Climatological studies could be carried out for Canberra, allowing improved statistical summaries of fire weather severity. In the longer term, climate change studies and El Nino - Southern Oscillation research may be of benefit.

Terminology

Remarkably, the most difficult part of hazard management is the naming of the various components, or, at times, even the use of the word *hazard*. It is essential that a full description of the components and their linkages be developed.