THE IMPLEMENTATION OF A COMPUTER -BASED MANAGEMENT INFORMATION SYSTEM

A.J.M. Hopkins[1] and S.R. Kessell[2]

Abstract

This paper briefly outlines the development and implementation of PREPLAN - The Pristine Environment Planning Language and Simulator, - for Tutanning Nature Reserve in Western Australia. PREPLAN includes an integrated Geographic Information System and modules for predicting site-specific vegetation, fuels and fire behaviour under any specific set of weather conditions. The system utilizes a set of simple English user-commands and so is readily accessible to all management, planning and research personnel. The types of information used in developing the system for Tutanning are described.

Introduction

The manager of land area which is set aside for nature conservation faces a formidable task. He has the responsiblity for a very complex, often poorly understood, resource; a responsiblity to ensure that the biological values are maintained in perpetuity. He faces both long-term planning problems, e.g. where should the next firebreak be constructed to avoid populations of rare plant species X and areas susceptible to erosion; and more immediate problems: e.g. a fire is reported at a designated point in the park or reserve - what action should be taken now? Where will the proposed prescribed fire burn to an what will be the impact on the biota? What will happen if there is a further fire there in 20 years time? Both planners and researchers have similar suites of questions. The correct answers to all these questions are as important for a site in the semi-arid as they are in the tropical part of Australia.

The basic information needed to provide answers to some of these questions may be on various maps or in files. Generally it is not readily accessible. But for the current fire situation mentioned above, the manager is unlikely to have up-to-date fuels data for the area where the fire has been reported, although he may have a firehistory map. The purpose of this paper is to briefly outline PREPLAN a computer based management, planning and research tool which has been desinged for Australian situations and implemented for one reserve in the semi-arid.

PREPLAN- The Pristine Environment Planning Language and Simulator.

A number of Geographic Information Systems (G.I.Ss) are now available to provide improved access to mapped (and filed) information. In general these systems store information on either a point-by-point basis or a grid cell basis. Each point or cell has a set of geographical co-ordinates. Mapped information such as elevation,

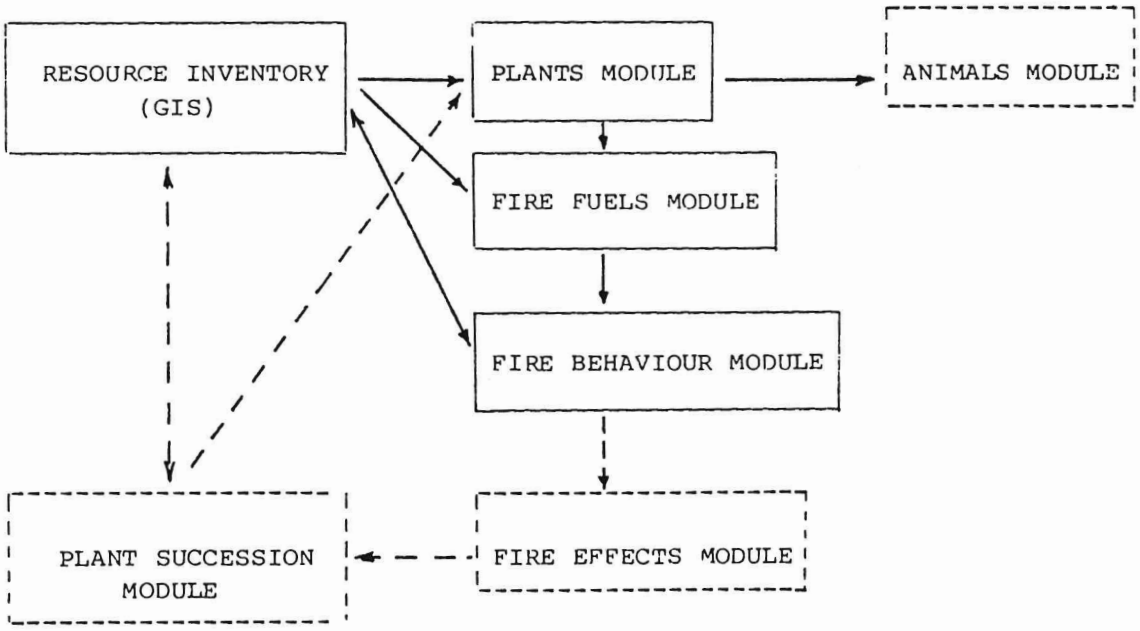
1 Western Australian Wildlife Research Centre, P.O. Box 51, Wanneroo, W.A. 6065.

2 ESRI - Australia, 18 Prowse Street, West Perth, W.A. 6005.

vegetation type, time since last fire, or animal species observed can be coded and entered into a computer file for each point or cell. Alternatively, the boundaries of each particular feature type, e.g. contours (elevation), vegetation ecotones, fire scars, can be digitised. This last method permits the abstraction of more information than is entered. For example slope, aspect and terrain type can be computed from digitised contours and precise areas of each vegetation type can be calculated from the digitised ecotones.

The data can be retrieved simply as it was entered or in combinations: e.g. areas of mallee woodlands on north facing slopes of sand ridges which have remained unburnt for > 10 years can be mapped. All that is required to do this for most park and reserve uses is an on-site mini or desk top computer or on-line access to a larger unit, plus the appropriate programme software.

A GIS like that described above forms the basis for the PREPLAN system. Basically PREPLAN links a geographically-referenced resource inventory data base directly to a number of dynamci models. It also has highly interactive, English language conversational abilities which thus permit a user, with no format training in computer operation, to fully utilize the entire system. The PREPLAN system is composed of the following components or modules (in solid lines); the additional modules can be added as information becomes available.



The Plants Module reads the basic inventory data for a site and, on the basis of known ecological information, then predicts the plant species and/or vegetation type which should be found at that site.

The Fuels Module takes the information from the Plants Module and relevant information from the resource inventory such as fire history, utilizes known relationships between fuels accumulation and

decomposition, and calculates the available flammable fuel loadings at each site.

The Fire Behaviour Module takes the calculated fuels data plus information on topography, slope, aspect, etc. and uses (presently) existing fire behaviour tables to calculate fire behaviour under given meteorological conditions.

The Fire Effects Module utilizes fire behaviour (rates of spread) calculations to estimate effects of the fire on both vegetation and fuels.

The Plant Succession Module predicts the floristic and structural attributes of the vegetation through time following one fire or a sequence of fires.

The Animals Module relates animal species presence or relative abundance to various environment - vegetation type or floristic assemblages.

PREPLAN has two important attributes which have not yet been mentioned:

Automatic update - calculations on fuel loadings, floristics, etc. can be automatically updated on an annual basis.

Simulations - the system can be used for any real fire situation or for simulations to test effects of any single fire or any sequence of fires over any period of time.

The Application of PREPLAN

PREPLAN was initially developed by one of us (S.R.K.) in conjunction with Roger Good (N.S.W. National Parks and Wildlife Service) for Kosciusko National Park. It is a direct descendant of the Gradient Model for Glacier National Park (U.S.A.) developed for the U.S.A. National Park Service and FORPLAN (Forest Planning Language and Simulator) developed for the U.S.A. and Canadian Forest Services. These earlier systems together with some aspects of PREPLAN are outlined in Kessell (1979). A paper describing PREPLAN in detail is currently in preparation (Kessell, Good and Hopkins, in prep.). The purpose of this section of the present paper is to outline procedures used for the implementation of PREPLAN for Tutanning Nature Reserve, an area of ca.2000 ha in the central wheatbelt of Western Australia. (Figure 1). Tutanning lies about 150 km south east of Perth and has a Mediterranean-type climate with an annual rainfall of about 420 mm.

In the setting of the relatively subdued topography of south-western Australia, Tutanning Nature Reserve encompasses a diverse cross-section of the landscape. It includes the Dutarning Range and its associated lateritic plateau remnants to 440 m elevation and a variety of lower members of the landform sequence to about 340 m elevation. These include valley floor landforms. The dissection of the landscape has

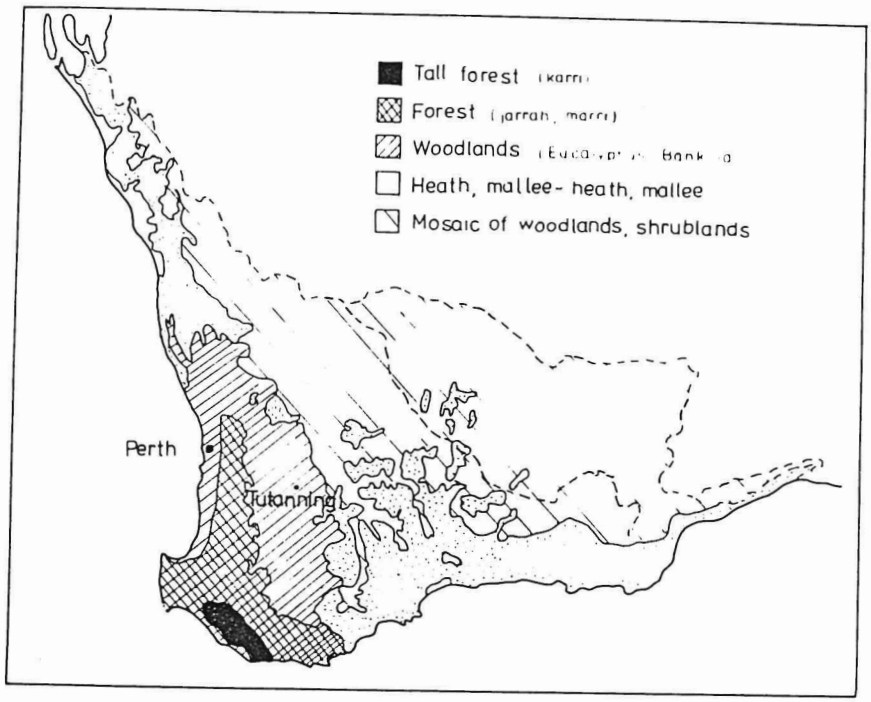


Fig. 1. Location of Tutanning Nature Reserve

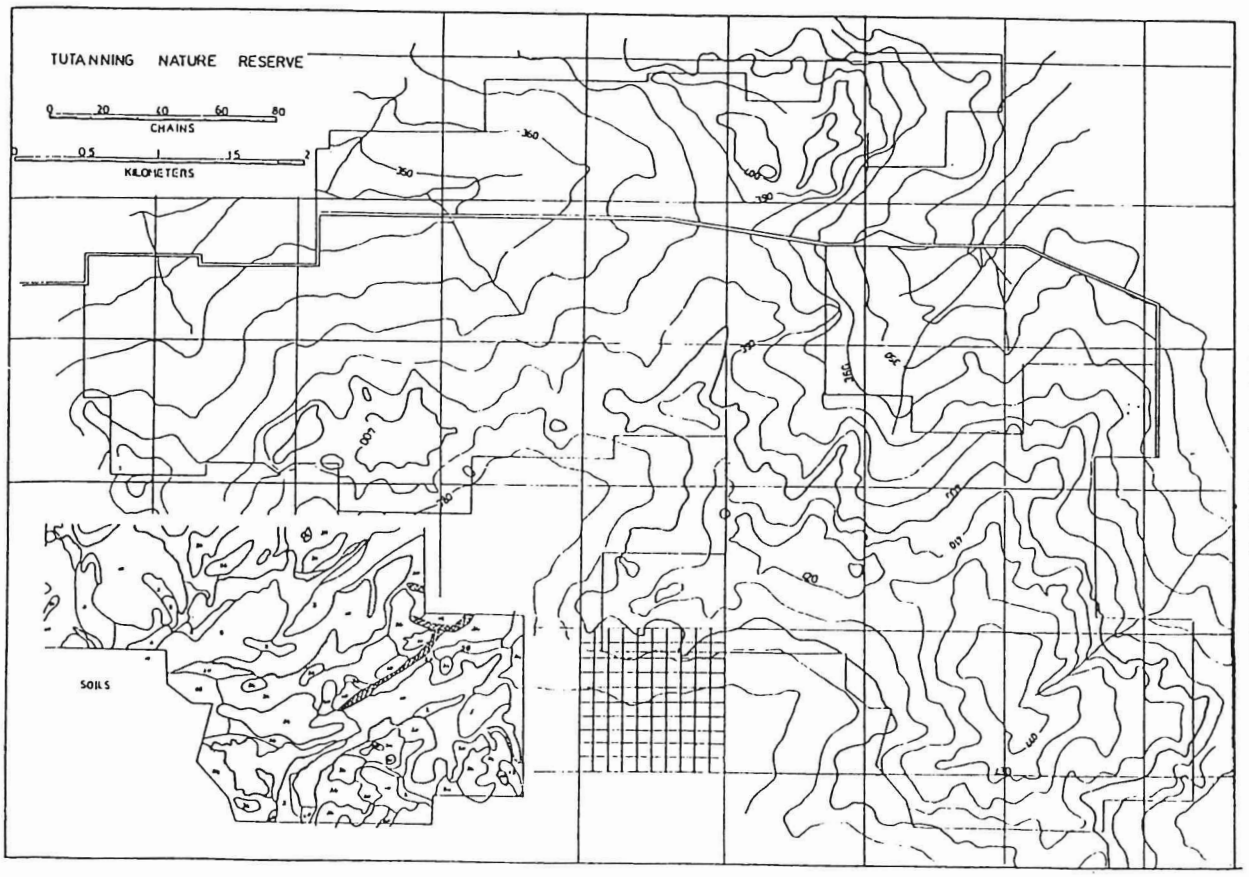


Fig. 2. Topographic map of Tutanning Reserve with insets showing the 1 ha grid and the mosaic of soil types

produced a fine scale mosaic of soil types (Figure 2) with a corresponding mosaic of structural and vegetation types. Vegetation types include Eucalyptus and Casuarina woodlands, mallees, Dryandra shrublands and species-rich heaths. It is considered to be one of the more important reserves in an area where, overall, only about 1.5% of the land area is in reserves.

The information for the resource inventory was coded manually from maps and air photos for 1 ha grid cells (100 m x 100 m, see Figure 2). The following attributes were recorded:

Cell co-ordinates: Australian Map Grid co-ordinates for lower left corner of each grid cell.

Ground-Truth Sample: see later for details of the comprehensive grid sampling scheme employed in the reserve.

Soil Type: from soil map

Vegetation Type: from vegetation map

Formation Type: physiognomy and canopy density, from air photos

Elevation: from topographic map

Type of Terrain: i.e. plateau, slope, ravine, etc. from air photos

Aspect: from air photos

Slope: from air photos

Year of last hot (understorey) fire: from fire history map

Year of last cool (understorey) fire: from fire history map

Firebreak: presence of a firebreak, reserve boundary or access break, from map of reserve.

Because of the scale of variability within the reserve, the inventory coding sheet was designed to permit each hectare to be subdivided into 3 units each of which could be characterised separately, and the proportion of the hectare covered by each unit could be specified.

The Plants Module was developed from the results of an ordination/ classification of data from a set of 316 systematic samples from the reserve. At each sample point, data collected included Soil type, Elevation, Aspect, Slope, Terrain, Vegetation type and Structure, Fire history (using the same system employed in the inventory) together with plant species present and a numberof animal habitat features. This composite approach to the analysis of the data set produced a dichotomous key to the floristics at any site. Thus for example where the inventory showed the hectare cell to contain a woodland formation on a lateritic soil type, the following key would identify the site as having one of 8 floristic associations:

1	Trees over 5m tall	2
	Otherwise	3
2	Wet aspects (E,SE,S slopes ...	Association 1
	Otherwise	Association 2
3	Overstorey age > 12 years	4
	Otherwise	6
4	Plateau tops and ridges	Association 5
	Otherwise	5
5	Wet aspects (E,SE,S slopes) ...	Association 3
	Otherwise	Association 4
6	Plateau tops and ridges	Association 8
	Otherwise	7
7	Wet aspects (E,SE,S slopes) ...	Association 6
	Otherwise	Association 7

A total of 39 Associations were recognized during the data analysis and sorting, and were keyed out in this fashion. Each association was then characterised by up to 30 plant species (see Appendix 1).

The Fuels Module was developed by calibrating fuel dynamics curves using real data derived from field sampling. Two types of field data were collected:

a) monthly litterfall for 20 selected sites at Tutanning over a period of 2 years;

b) assessments of standing crops of fuels from a further 18 sites of known fire history.

The Fire Behaviour Module utilized the tables of Sneevwjagt and Peet (1979) for the Northern Jarrah (Eucalyptus marginata) Forest for calculations of rate and scorch height. Experience of field staff suggested that these tables provide a reasonable estimate of behaviour for some of the vegetation types at Tutanning but they are less useful for others, particularly the Dryandra shrublands. Thus a caution to PREPLAN users was included in the programme (see Appendix 1).

The other modules of PREPLAN which were described earlier have yet to be implemented for Tutanning, but work is in hand to do this. At the same time, additional field data are being collected to strengthen aspects of the existing modules, particularly the Plants Module. This process of continuing development is a necessary part of the modelling at this early stage. The data base for the Tutanning PREPLAN barely surpassed the critical threshold - the minimum amount of data required for development of such a model - so that the many gaps in the existing data base have been highlighted and now demand attention.

A further innovation in the development of a PREPLAN system that is currently being examined involves the use of a digitised GIS rather than the manually coded inventory used at Tutanning. Digitising is probably only slightly quicker overall than manual coding, but the data base so generated is much more flexible and useful.

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Edited by A. Heislers*, P. Lynch† and B. Walters*

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* National Parks Service, Victoria

† Rangelands Research Centre, CSIRO, Deniliquin, N.S.W.

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