METIS ASSOCIATES
strategic analysts

Risk Management Newsletter – 1st Edition.

Welcome to the first edition of the fire managers risk newsletter. This newsletter is aimed at sharing information between individuals and projects relating to the field of fire and risk management.

The audience that this is being distributed to includes individuals, organisations and projects in Australia, New Zealand, Canada, the United Kingdom, the United States and Italy.

The first edition will bring you a synopsis of two projects that are underway at present, one in New Zealand and one in Australia.

As this newsletter is being prepared on an ad-hoc and informal basis the editor would appreciate any comments that individuals have in relation to the newsletter (critical or positive).

Both projects whose summary is presented in this newsletter are willing to share their work to allow for peer review, wider understanding and critique. Please send your replies directly back to the editor and they will be forwarded to the individual or project managers and will also be prepared as part of subsequent newsletters.

Please feel free to pass this newsletter to colleagues who may appreciate its content or may wish to become subscribers. It is also requested that if you know of projects that are occurring to please put the editor in touch with them so that their work may be able to be included in subsequent newsletters.

It is hoped that this forum will be able to communicate some of the work and issues that fire risk related projects are facing and that this group may be able to assist the progression of work in this field.

Yours faithfully,

Brett Shields.

Late Release

The Victoria Dept of Justice (Australia), under the guidance from the Office of the Emergency Services Commissioner is undertaking a review of "a model of fire cover for Victoria". A public discussion paper is calling for submissions by August 31st. Anyone interested in this can download a copy of the discussion paper from <www.justice.vic.gov.au>.

New Zealand Wildfire Threat Analysis Project
New Zealand National Rural Fire Authority

1 Introduction

There have been several approaches to analysing New Zealand's wildfire threat in recent years. In 1966 the then New Zealand Forest Service introduced the Forest Fire Risk Grading score. In 1991 the National Rural Fire Authority introduced the Rural Fire Management Code of Practice. This has a more comprehensive fire threat assessment, based on a range of fire environment factors and values, incorporated into it. However, neither provided a detailed spatial overview of fire threat and in 1998 the National Rural Fire Authority initiated a project to develop a Wildfire Threat Analysis System for New Zealand.

2 Objectives

The objectives of the Project are to:

- Develop a systematic approach to quantifying wildfire threat appropriate to New Zealand conditions and requirements.
- Test and refine the methodology through a pilot study project.
- Introduce the System to Rural Fire Authorities.
- Assist Rural Fire Authorities with the implementation of the Wildfire Threat Analysis System.

3 Process

The National Rural Fire Authority achieved stakeholder buy-in early in the process through a series of workshops run by overseas experts, then conducting a scoping study. This improved the knowledge and understanding of wildfire threat analysis amongst New Zealand rural fire managers, and enabled them to broadly identify their requirements. Key stakeholder involvement (i.e. the New Zealand Forest Owners Association, the Local Government Association and the Department of Conservation) was further cemented by their representation on the Consultative Team that guides the Project Manager.

The process was planned in three phases– Analysis, Design and Implementation. The Analysis phase was completed in October 1999 with a Report detailing the Bibliography, the Literature review and the datasets required. The Design phase is almost complete (as at May 2001), with the last pilot study to finish and some validation work to do before peer review. Implementation is expected to be a phased process, dependent on Rural Fire Authority resources.

In recognition of the importance of the project, the National Rural Fire Authority has contracted a Project Manager specifically to manage it. The first, Bert Borger finished last January to work in South Sumatra. Geoff Cameron replaced him.

4 Progress

Work has concentrated on the three modules (Hazard, Risk, and Values) that will form the New Zealand Wildfire Threat Analysis model. At this stage, suppression capability will not be part of the system. These modules are being mapped in each of the different pilot study areas.

4.1 Hazard

Hamilton-based scientists from Landcare Research Ltd, a Crown Research Institute, developed a Hazard surface that shows the potential Head Fire Intensity for existing fuel in a fire climate derived from long run average weather station data. To arrive at this point, they analysed all the fire season (October to April) weather records for the country, and summarised those that exceeded the 80 percentile to produce average fire weather components (Fine Fuel Moisture Content, Duff Moisture Content, Drought Code). These figures were weighted by length of weather station record (in years). Figures from three weather stations were excluded because they badly skewed the results. The result is a reliable long-run average value for the components of Fire Weather Index over the worst 20% of fire seasons since records were kept.

This data layer was combined with layers showing fuel type obtained from the public domain Land Cover Data Base, slope, and given generalised Degree of Curing percentages. The appropriate fuel type equation and slope correction factor were calculated (using Byram's Theory) to produce predictions for Head Fire Intensity and Rate Of Spread for the whole country. This data will now be tested in the pilot studies. Once tested, it is expected to provide a consistent representation of hazard for the whole country with a given fire climate.

4.2 Risk

Landcare Research attempted to model fire risk by analysing a number of causal factors, including the frequency of fire occurrence (from historical records), population factors, and climate and existing vegetation. The idea was to produce a national model that could have been used in association with the hazard module to ensure consistency of approach across the country in these two areas. Unfortunately that did not eventuate. Statistics on rural fire starts, fire cause and size of fire have been difficult to obtain, and so the project team had to go back to first principles and develop a basic risk profile based on the five key parameters of: population density, accessibility, land use, utilities (rail and electricity), and natural occurrence. These were defined, ranked in order of perceived importance, and sub-divided into suitable categories. Numerical scores were assigned. Team members are now mapping those risk profiles for the pilot study areas.

The accumulated risk score was multiplied by a factor that took account of the requirement that an ignition required other circumstances to become a fire. To transform the risk of fire ignition into an actual fire incident requires the existence of the appropriate fuel and the right conditions for it to ignite. In this case the Fine Fuel Moisture Content layer that formed part of the Hazard layer was used. The Team acknowledged that it was not the ideal parameter, but was an interim solution.

4.3 Values

A number of Values threatened by wildfire have been identified and given numerical scores based on their importance, and perceived frequency of loss. Where possible, assignment of particular sites into a value category or ranking has been done using existing objective methodology, so that land managers are not forced into a new system. So far this has proved very useful.

4.4 Pilot Studies

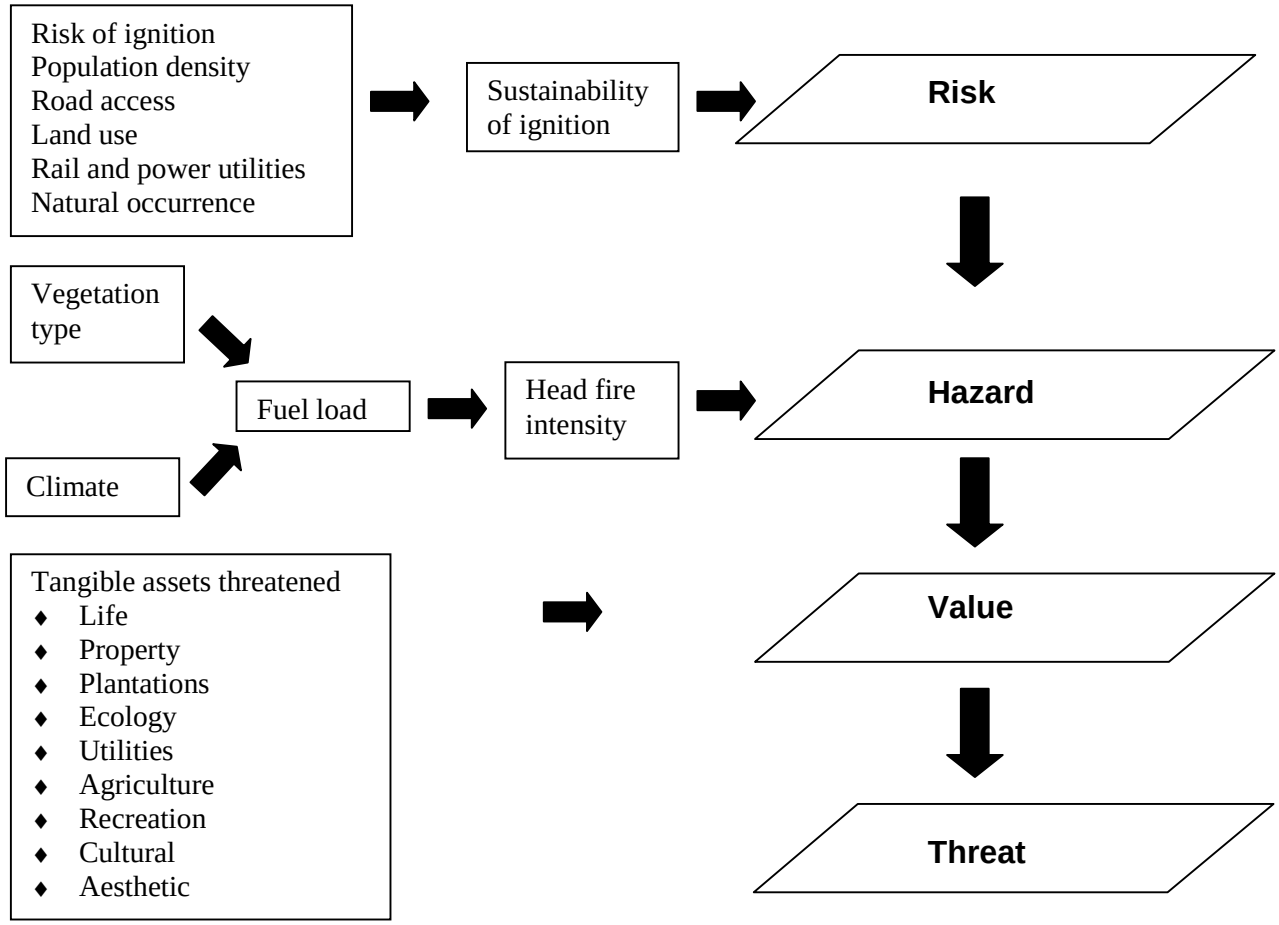
Three pilot studies were planned to test the model, particularly the categorisation of the different module components, and how they would be represented on a map. The study areas were representative of a commercial forest area, the rural area of a City Council, and an area of Department of Conservation land in the South Island high country. This work is well underway, and has demonstrated that some Rural Fire Authorities may have difficulty in gathering the base data. Hence the Team is considering creating more national datasets.

5 Future Work

Over the next few months work will concentrate on:

- Manipulation and validation of the pilot study results
- Peer review of the process and documentation
- Development of an implementation schedule.

Longer term, the project will look at the next version that will have new data layers, a more refined fire climate layer, and a risk module. The following diagram is a representation of the project linkages.



A Review of Rural Fire Risk Modelling

A joint initiative between the University of Melbourne and the Department of Natural Resources and Environment, Victoria.

The Forest Science Centre is a joint research group between the University of Melbourne and the Department of Natural Resources and Environment, Victoria. The following report is a summary of the first phase undertaken to review and prepare a management oriented risk modelling process for rural fire managers in Victoria.

The project will discuss some of the existing models and the underlying principles behind the models to allow for constructive criticism. This understanding coupled with a user needs analysis will be directed toward the development of a risk model in an environment of increasing sophistication of requirements from managers of fire.

Existing GIS Risk Models

Some of the earliest GIS based risk modelling was carried out in Western Australia, and was quickly followed by the United States, Canada, South Australia, Victoria and New South Wales.

The first development of these models followed on the heels of GIS technology. The GIS technology provided for the first time an ability to integrate large amounts of spatial data into a manageable system that could display that data on a map.

Spatial risk models tend to use a design structure similar to the techniques applied in the insurance industry. The models incorporated a risk (probability of an event occurring) a hazard (the intensity or strength of the event once it had occurred) and a value (in either dollar or non dollar terms). In some cases the influence or impact of suppression resources was built into the model or the vulnerability to fire of particular assets was built in.

The output of these models were a series of interim maps that rated the risk or hazard or asset from high to medium to low with a single map at the end often referred to as a threat map. The threat map was an aggregated composite of the inputs and was also rated from high to medium to low. A list of the benefits and detractions of this model type is provided below.

Benefits of the Models

- Fire agencies and planning authorities can communicate the relative threat of wildfire.
- Education tool for fire agencies, planners, land managers and the public.
- Method to capture and display the experience of senior field staff.
- Could assist in the prioritisation of management decisions.
- Provision of some strategic / planning overview

Detractions of the Models

- Did not answer direct management questions, the answers had to be inferred.
- Concern with the overlay (aggregation) relationships between the datasets of risk, hazard and asset. The additive relationships and weighting factors are mostly subjective and untested, ie there were no interaction functions built in.
- Limited operational / tactical utility.

Discussion

The earlier models have had limited management and operational impact to date in most agencies. Following discussion with agencies who have previously conducted wildfire risk analyses it has been revealed that only two agencies have rolled out a model across their management area. This is British Columbia (Canada) and the Australian Capital Territory.

It is suggested that other agencies have not rolled out their models for one of four reasons:

1. The model outputs do not answer managers questions related to fire management but rather the answers have to be inferred from the output.
2. The agencies could not justify the time and expense cost without showing direct savings or efficiencies to be gained from the roll out of the model.
3. The data availability across many agencies sizeable land area makes the roll out phase an exceptionally large and costly project.
4. The actual aggregation of layers to deliver an output is not rigorous enough to be considered to be valid when compared to the field.

A test model developed by Natural Resources and Environment, Victoria.

In 1998 the Dept. of Natural Resources and Environment (NRE), Victoria, undertook to review and refine spatial wildfire modelling in Victoria. A model was developed to ask a question that was management oriented.

This was a significant shift from the previous models that did not ask a specific question but rather attempted to provide an overarching output that would filter management decisions.

The question asked by the Victorian model was “the probability of first attack being successful” given specific levels and conditions of detection, access, suppression resources, fuels, topography and weather.

The utility of this model today will hinge on its ability to reset the central question to a new scenario or new issue that has arisen within the organisation. Similarly the transfer of the model to another agency will hinge on the ability to answer different question(s) of importance to that agency.

The specific question set within the model was asked as it is considered a central issue to fire management in Victoria. It is often used as a key performance indicator and some prior research had been conducted to provide a probability curve against which first attack would be successful (under specific conditions).

Unlike the previous method of aggregating the spatial layers, the NRE model began to develop business rules that directed the GIS layers interaction and also placed boundaries on the layers interacting. Some of the layers were classified and ranked for ease of management and output, but the interaction following this step was completed via a series of business rules.

The output of this model is a map(s) showing probabilities of where first attack would be successful or not. This was a significant step away from a map output showing a relative rating. The inputs to this model could then be adjusted to alter the scenario to see how it affected the output. Such adjustments may include more or less resources, faster or slower travel times (based on changes to road surface types or locations) or changes to the fuel.

This built in a flexibility to adjust the quantity of the inputs to examine the probability of first attack success. This introduces the notion of scenario analysis within wildfire risk modelling. Scenario analysis as used here relates to the use of varying levels of input being applied to examine the question of first attack success.

If a sensitivity analysis was conducted on the outputs, as compared to the relative inputs, the manager for the first time could begin to determine the effects that changes in the inputs were having on the model output, i.e. their capacity to succeed in first attack.

This introduced an ability for managers to begin to target areas of management, say fuel or road maintenance that will reap the greatest rewards for their money and effort.

Benefits of the model

- The model has a management focused question
- The inputs can be adjusted to begin scenario analysis
- Introduced the ability to conduct sensitivity analysis

Detractors of the model

- Only a single question output is available
- Relationship between output and inputs based on empirical research.

Discussion

This model has shown a significant step in the development of managerial thinking behind the questions that the models are trying to answer.

The model enables outputs that include the cost of resources required to adequately provide for first attack success (dollar output), the number or type of resources required (quantitative output) to provide for first attack success, or the location of those resources in the field (geographic output).

This model has some significant benefits over it predecessors (direct management implication, notion of scenario analysis and the notion of sensitivity analysis) and some pitfalls (one question as the center of the model) in its use.

It will be shown that the utility of the model is overshadowed by the increasing sophistication of questions being posed by managers. The sophistication and

variation in questions required to be answered by fire managers cannot be fully catered for using a model that has only one central question as its output. Managers are now asking for multiple outputs (resource quantity, dollars, locations) from many different questions.

The NRE model has broached the next hurdle in the evolution of wildfire risk modelling, but in its current format is unable to fully meet the sophistication being asked of wildfire risk modelling. A new process and modelling technique is required to meet these needs.

User Needs Analysis

The conduct of a user needs analysis was done using a semi-structured interview with fire managers. The interview questions centered around the ideas and understandings of managers in relation to wildfire risk. Effort was made to draw out the underlying requirements of a wildfire risk model and the questions that it would need to answer to be of relevance to management.

The answers returned ranged in complexity and detail but have been able to be characterised into several different formats and understood through the following framework:

- Strategic through to Tactical
- Planning through to Operational

The output from each question was phrased to be represented in units of measurement that could be characterised as one of the following:

- Quantitative (number of resources)
- Time (travel time to a fire)
- Geographic (location of depots)
- Dollars (cost of suppression vs. prevention)
- Non dollar (protection of water catchment or air shed)

The questions unit of measure was phrased to provide one of the following actions for that unit of measure:

- Optimise
- Maximise
- Minimise
- Natural

Diagram 1 provides a visualisation of the separation of questions posed by the fire managers interviewed or contacted.

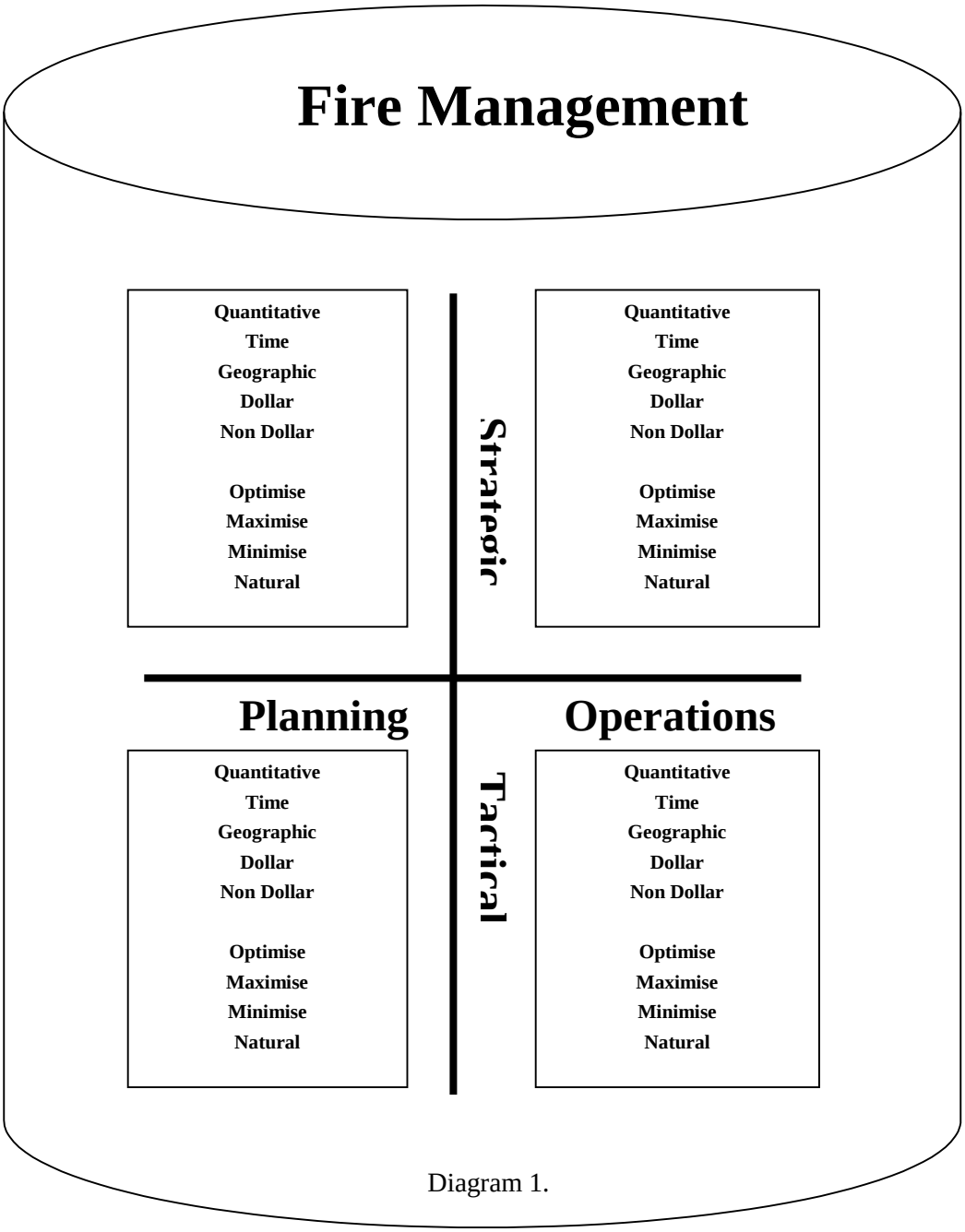

Fire Management
Quantitative
Time
Geographic
Dollar
Non Dollar
Optimise
Maximise
Minimise
Natural
Strategic
Quantitative
Time
Geographic
Dollar
Non Dollar
Optimise
Maximise
Minimise
Natural
Planning
Operations
Quantitative
Time
Geographic
Dollar
Non Dollar
Optimise
Maximise
Minimise
Natural
Tactical
Quantitative
Time
Geographic
Dollar
Non Dollar
Optimise
Maximise
Minimise
Natural

Diagram 1.

Outcomes to date

The outcomes from this initial phase has identified that there is no one model that can be developed to answer the management questions being asked. Rather it is an ongoing process that includes a series of scenarios with several outputs (strategic, tactical, planning and operations) that need to be adjusted to suit the user.

The first phase of this project identified that the existing models used by fire agencies were not able to answer the current questions being asked by fire managers.

The user needs analysis was able to characterise the areas into which the fire managers questions were directed.

Second Phase

GIS technology, like all technology, is rapidly evolving. The next evolution of GIS technology is the introduction of object oriented modelling. It is perceived that object oriented modelling may bring about several benefits to wildfire risk modelling.

The next phase of this project is going to examine the ability of object oriented GIS technology to answer multiple scenarios as represented by the user needs characterisation.

The second phase will also examine the ability of the model to be readily adjusted to meet changing scenarios, its ability to be integrated with existing organisation GIS capacities and the ability of the model to be used to conduct sensitivity analysis on the inputs as compared to the outputs. It is hoped that a sensitivity analysis may provide some understanding of where managers can gain the greatest fire management benefits for the least extra cost in terms of dollars or effort.

If this is successful a second report will be able to be prepared to identify the strengths and weaknesses of the process as compared to the existing models.