New Zealand Wildfire Threat Analysis

workbook documentation

for

national rural fire authority

Created by:	Karl Majorhazi	Updated by:	Andrew Hansford
Created date:	24 Feb 2002	Update date:	14 November 2011

FITNESS FOR PURPOSE STATEMENT

The purpose and intent of a Wildfire Threat Analysis is to provide fire managers and planners with a strategic planning tool for fire management activities. Inappropriate use and application of Wildfire Threat Analysis information could result in liability issues for Rural Fire Authorities.

The scale and resolution of the analysis makes Wildfire Threat Analysis unsuitable for large-scale applications such as identifying threat levels for individual properties. Therefore a clear statement is required on the Wildfire Threat Analysis' fitness for purpose.

For organisations wishing to do so, the following statement should be included on all Wildfire Threat Analysis output:

"Wildfire Threat Analysis is developed as a strategic fire management and planning tool for use at scales of 1:50,000 or smaller. The authors claim no liability for any uses of this information at larger scales."

VERSION HISTORY

Release	Date	Author	Change Reason
1.0	24 Feb 2002	Karl Majorhazi	Initial release following Consultative Team input.
1.1	25 Mar 2002	Karl Majorhazi	Revision of recreation values.
1.2	30 Apr 2002	Karl Majorhazi	Updated risk land use scores to rangeland and pastoral agriculture after discussions with Tony Teeling.
1.3	19 June 2002	Karl Majorhazi	Additions from Wildfire Threat Analysis CT meeting on the 18^{th} of June.
1.4	3 July 2002	Karl Majorhazi	Additions following the validation exercise in Southland
1.5	10 July 2002	Karl Majorhazi	Added metadata for HV powerline buffers. Changed document name from "Technical Document" to "Workbook"
1.6	13 Mar 2003	Karl Majorhazi	Fixed typos and calculation errors
1.7	25 Mar 2003	Karl Majorhazi	Added fitness for purpose statement. Awaiting Rotorua DC to confirm the legality of the statement.
1.8	23 June 2003	Karl Majorhazi	Added advice for raster processing. Updated metadata and images
1.9	18 Aug 2003	Karl Majorhazi	Removed reference to "any subsequent fire suppression activities" from cultural values definition.
1.10	18 May 2004	Karl Majorhazi	Added standard field definitions for vector data. A request from the Wellington Wildfire Threat Analysis project.
2.0	March-April 2005	Karl Majorhazi/ WTA Reference Group	Changes following a review of completed regional projects during a workshop held in Rotorua on 8-9 March 2005.
2.1	21 Oct 2005	Karl Majorhazi	Updated HAZARD layer and scoring system. WTA versioning.
2.2	22 May 2006	Karl Majorhazi	Added RGB colours for R, H, V, and T maps and updated the examples. Also removed the words "DRAFT" from the title and headers.
2.3	3 July 2003	Karl Majorhazi	Minor additions suggested by Southern Rural Fire Authority project team. Updated metadata.
3.0	3 June 2011	Andrew Hansford	Significant update to the WTA layout and removal of layer definitions from workbook, references made to 2010 data layer
3.1	13 July 2011	Andrew Hansford	Finalising Updates and converting to PDF

Table of Contents

INTRODUCTION

The National Rural Fire Authority has developed a Wildfire Threat Analysis methodology for New Zealand. Wildfire Threat Analysis has been defined as:

"A systematic method of identifying the level of threat a particular area faces from wildfire. The level of threat is generally related to a combination of ignition potential, potential fire behaviour and the values threatened. These factors may themselves be derived from other combinations of factors, for instance, potential fire behaviour can be determined from a combination of climate, topography and fuels". 1

In Wildfire Threat Analysis ignition potential is described as RISK, potential fire behaviour is described as HAZARD, and values threatened is described as VALUES.

The results of a Wildfire Threat Analysis can have multiple uses for a Rural Fire Authority's fire management activities such as prevention, mitigation and resource allocation. It can also be used to establish benchmarks for determining appropriate fire control measures.

The approach taken has been to treat Wildfire Threat Analysis as a GIS-based spatial analysis project. The large number of factors (or layers) makes the manual overlaying of maps impractical. Geographic Information Systems (GIS) have been purposefully built to process multiple overlays of this nature. This involves the combination of a number of overlays and the scoring, weighting and subsequent accumulation of factors that contribute to risk (ignition potential), hazard (potential fire behaviour) and values, and as a result, to overall threat.

TERMINOLOGY

When capitalised, the terms ***RISK, HAZARD, VALUES*** and ***THREAT*** refer to the high level modules of the Wildfire Threat Analysis structure.

Wildfire Threat Analysis is comprised of both a ***methodology*** for carrying out the analysis and a ***structure*** to represent the data. The methodology contains instruction on the collection, processing and accumulation of data.

RISK, HAZARD, VALUES and **THREAT** are referred to as ***modules***, indicating that they are an accumulation of data providing an overview of its particular theme.

1 Taken from the "Wildfire Threat Analysis Definition of Key Terms" published at http://www.fire.org.nz/rural/publications/wta/DOT.htm

Components are input data layers to each module. They have been identified as the most significant contributors to Wildfire Threat.

Each component has a different ***weighting*** to indicate its relative contribution to each module. For example, land use has a higher weighting within RISK than natural occurrences reflecting the relatively low instances of naturally occurring fires to the large number of fires caused by escaped land-clearing burns or careless recreational users.

Different areas within each component will be ***scored*** differently depending on its value. For example mature plantation forest nearing harvest has high commercial values and will be given a higher score to represent the relative importance for protection and management in relation to newly planted forest.

The Purpose of This Document

This document provides developers and users wishing to carry out a Wildfire Threat Analysis with the technical information necessary to participate in a nationally consistent approach.

The information included in this document are:

- The data required,
- The scoring system,
- The weighting system,
- Cartographic (mapping) standards,
- Documentation (metadata) on supplied data.

The audience for this document are:

- GIS operators and analysts.
- Fire managers.

GIS operators should be able to refer to this document when performing a Wildfire Threat Analysis.

Fire managers should be able to understand and use this document in order to work with and advise the GIS operators or contractors. An understanding of the process will also give fire managers confidence in the process and the information to deflect any criticism of the results.

FEEDBACK

As Wildfire Threat Analyses are carried out, a significant amount of "ground truthing" will be done. The results of this will provide additional information that will improve the Wildfire Threat Analysis methodology. This document is considered a "living document" and will be updated periodically as ongoing work is carried out and feedback is received from users.

Any comments or suggestions relating to this document should be made to:

Spatial Intelligence Team on Behalf of National Rural Fire Authority

New Zealand Fire Service

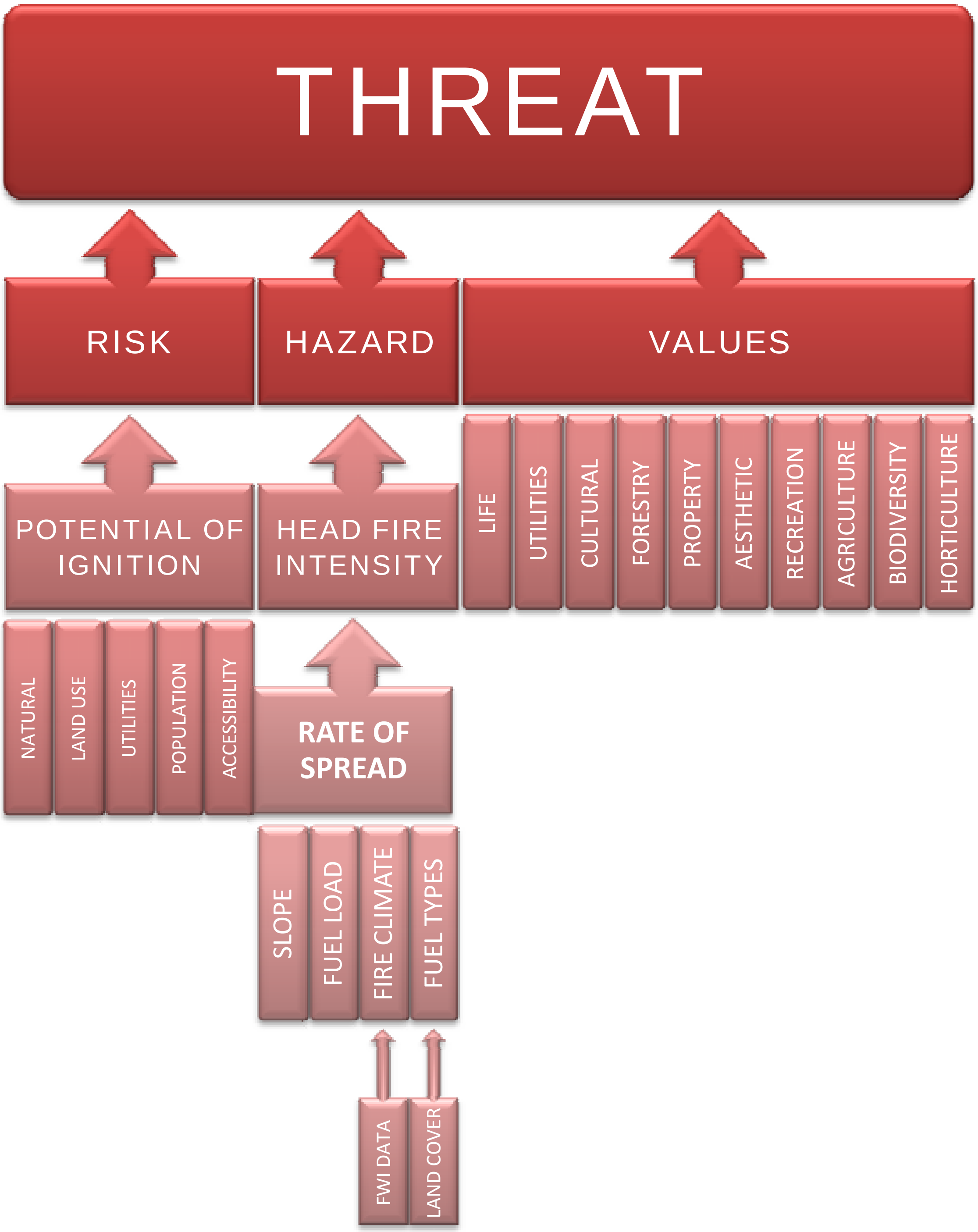
Phone: (04) 496 3600

E-mail: DSI-Support@fire.org.nz

WILDFIRE THREAT ANALYSIS STRUCTURE

The structure of the Wildfire Threat Analysis is outlined below. This has been the result of successive iterations involving discussion, research and analysis on the most important factors influencing wildfire threat. These have been balanced against the data sets that can be practically acquired and used in a national system.

It is important to note that not every possibility has been included in this methodology, only those that are considered significant.



Definitions of Risk, Hazard, and Values

Risk

Risk is defined as ignition potential which is simply the probability of a fire starting and spreading. In New Zealand, fires are mainly caused by people and their activities. This differs from other countries such as Canada or the USA where lightning is the major fire starter.

In this Wildfire Threat Analysis, greater weightings have been assigned to population (usually resident density and transient) and where they have access to (accessibility). People will not generally walk very far to start fires (either accidentally or maliciously).

Some land use activities such as land clearing, stubble burning and harvesting operations are the other major cause of fires.

The potential for an ignition to grow into a fire is incorporated in this model by the dryness of fine fuels (such as litter and grass) depicted by the Fire Weather Index Fine Fuel Moisture Code. Wetter areas may have the same potential for ignitions, however there is a greater probability that these will not grow into incidents.

Hazard

Hazard has been defined as the potential fire behaviour. Areas of significant hazard are those that have an abundance of flammable vegetation (high vegetation fuel loads) such as scrub and tussock, and have a dry and/or windy climate.

New Zealand’s fire climate has been defined and modelled spatially by Landcare Research and Forest Research in conjunction with the National Rural Fire Authority. Using the Fire Weather Index System, climatic layers were developed and combined with the Land Cover Database fuel-types and fire intensity equations to generate both the Rate of Spread and Head Fire Intensity. Head Fire Intensity is measured in kilowatts per meter of flame length. This ranges from zero to 40,000Kw/m.

Values

The New Zealand Wildfire Threat Analysis system requires the quantification of the values that are being protected from wildfire. Some of the components of the values module are easily measured and quantified (for example property values) due to the existence of a market price for these values. Others, such as aesthetics, recreation and historic/cultural values, are more difficult to quantify because no viable market exists for them and therefore there is no easily measured monetary value. These values non-the-less are of importance to the community and must therefore be incorporated in the values module.

Threat

Threat is the accumulation of the Risk, Hazard and Values modules providing an overview of wildfire threat to fire managers. The formula is quite simple:

How to carry out a Wildfire Threat Analysis

Wildfire Threat Analysis involves overlaying a set of discreet maps where each map depicts, in a polygon, a factor that has some influence on wildfire threat. Each polygon in a map is allocated a number that indicates its value and importance compared to other polygons. Each map is then allocated a weighting indicating the degree to which it influences the overall result.

Because there are so many maps involved in Wildfire Threat Analysis, a GIS is the only practical tool for manipulating the maps.

Wildfire Threat Analysis involves:

1. COMPILING the base maps required such as population density and property values.
2. SCORING the polygons of each map using the system set out in this document.
3. COMBINING each of the maps using GIS.
4. PRESENTING the results in the form of maps.
5. APPLYING the results to fire management.

Project Management

A regional Wildfire Threat Analysis project involves bringing together many different organisations working together toward a common goal. Good project management is essential.

Before you start you will need:

☑ ***A sponsor, champion and project manager***

☑ ***Organisational commitment***

☑ ***A defined study area***

☑ ***The scale and/or resolution for the desired outputs***

☑ ***A defined set of deliverables from the project***

☑ ***An approach and delegation of tasks***

☑ ***A budget and funding source***

The Sponsor, Champion and Project Manager

Every project needs to have some level of leadership. For Wildfire Threat Analysis project this should come from the project sponsor, champion, and project manager. The project sponsor is ultimately responsible for the project outcomes. This would normally be the Regional Rural Fire Committee Chairperson. The project champion would normally be the person who first sees the benefit of the project and rallies support for it amongst the region. The project manager is appointed, normally by the sponsor, to plan and organise and

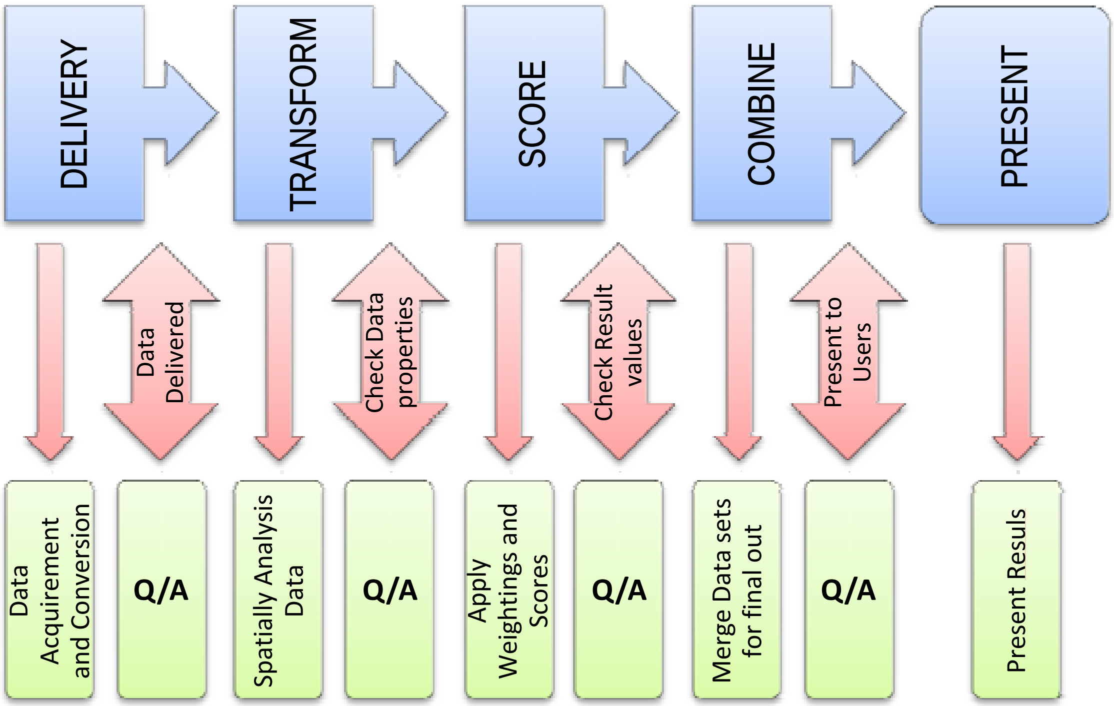
Versioning the analysis

Revisions of the Wildfire Threat Analysis methodology now mean that some Wildfire Threat Analysis projects will have been carried out using different versions of the methodology. The version of the workbook that was followed should be mentioned in publications, metadata and other documentation describing the project.

Spatial Information Operations

The following advice offers guidance on the practises and techniques that have been found to be most efficient for a project of this nature. It is not intended to be platform-specific but describes the general workflow and data management. The approach advocated for Wildfire Threat Analysis is to capture data as polygon features and to convert them to raster for calculation.

Workflow



Data Capture

Many of the data layers required for Wildfire Threat Analysis have been developed and supplied as part of the project. Additional data must be acquired through organisations supplying their data to the project. Some conversion and/or manipulation may need to be performed if the data supplied is not immediately ready for use. These operations can include conversion, reclassification, aggregation, re-projection, and generalisation.

Begin with a study area polygon that can be used to clip polygon datasets or be used as a mask when calculating rasters.

For data layers that do not exist in a GIS format, such as transient population areas, these may need to be manually entered. Using transient population as an example, local experts may be asked to define the areas where people congregate during the summer (motor camps, holiday resorts etc.) on a hard-copy map. The scores for each of these areas can then be allocated using the criteria set out in this document. The boundaries of these areas must then be digitised to create the layer for the GIS.

Calculation and Normalisation

In this methodology, each polygon is given a numeric VALUE according to specific criteria. This value is then multiplied by the WEIGHT applied to the layer to give a final SCORE to the polygon. The weighting reflects the influence the layer contributes to THREAT. The higher the weighting, the more important the layer is to the threat. The value and score should be stored in separate fields within the layer.

Since the number ranges of the scores vary between the RISK, HAZARD and VALUES modules, it is necessary to normalise the scores in each module so that the modules can be compared. For example, polygons the RISK module can have scores up to and over 138 whereas scores in the HAZARD module can score over 60,000. Comparing these two layers to identify the extent of elevated RISK and HAZARD would be quite difficult. Normalisation compresses or expands these number ranges so that they can be viewed on the same scale. More details on the Wildfire Threat Analysis normalisation process are outlined in the "Module Normalisation" section.

NAMING CONVENTIONS

A data layer may be compiled by several different people and organisations in a regional project. In order to make it easier to combine these parts into a single seamless layer, a standard naming convention for layers and fields is provided for efficiency. Each GIS software platform has its own constraints on naming conventions. For example, ESRI Grids have a 13-character limitation, coverages must conform to directory conventions whereas Shape Files are split into a number of separate files with the same name but different suffix.

Data will be several different states depending on where it is in the workflow:

- Raw: data as supplied or captured.
- Transformed: any operation that transforms the data into the study area's framework. These include operations such as format conversion, re-projection, clipping and reclassification.
- Scored: data that has the scoring and weighting applied.
- Combined: into either RISK or VALUES. Note that the RISK layer has an extra step where the initial combined layer (subtotal) is multiplied with the POI layer before RISK is complete.
- Normalised: with the final weighted values are normalised to a common scale before being combined into THREAT.
- Final: The finished dataset.

Some of these states may be represented in additional fields in a polygon dataset as opposed to producing a discrete version of the dataset. The choice of technique is left to the operator.

Layer/File Names

Component	Raw	Transformed	Scored	Unnormalised	Final
RISK			**R_Subtot2**	**R_Unnorm**	**RISK**
POI	R_POI_R	R_POI_T			Risk_POI
Natural	R_NAT_R	R_NAT_T	R_NAT_W		Risk_Natural
Land Use	R_LU_R	R_LU_T	R_LU_W		Risk_LandUse
Powerlines	R_POW_R	R_POW_T	R_POW_W		Risk_Power
Railways	R_RAIL_R	R_RAIL_W	R_RAIL_W		Risk_Rail
Population	R_POP_R	R_POP_T	R_POP_W		Risk_Pop
Trans. Pop.	R_TPOP_R	R_TPOP_T	R_TPOP_W		Risk_Tpop
Accessibility	R_ACC_R	R_ACC_T	R_ACC_W		Risk_Access
HAZARD	**HFI**	**HAZ_T**		**HAZ_Unnorm**	**HAZARD**
VALUES				**V_Unnorm**	**VALUES**
Life	V_LIFE_R	V_LIFE_T	V_LIFE_W		Value_Life
Powerlines	V_POW_R	V_POW_T	V_POW_W		Value_Power
Railways	V_RAIL_R	V_RAIL_T	V_RAIL_W		Value_Rail
Comms	V_COMM_R	V_COMM_T	V_COMM_W		Value_Comms
Cultural	V_CUL_R	V_CUL_T	V_CUL_W		Value_Culture
Forestry	V_FOR_R	V_FOR_T	V_FOR_W		Value_Forest
Property	V_PRO_R	V_PRO_T	V_PRO_W		Value_Prop
Aesthetic	V_AES_R	V_AES_T	V_AES_W		Value_Aes
Recreation	V_REC_R	V_REC_T	V_REC_W		Value_Rec
Agriculture	V_AG_R	V_AG_T	V_AG_W		Value Ag
Biodiversity	V_BIO_R	V_BIO_T	V_BIO_W		Value_Biodiv
Horticulture	V_HOR_R	V_HOR_T	V_HOR_W		Value_Hort

Field Names for Polygon Analysis

The following field names can be used as a starting point for the analysis. Note that these are defined for polygon datasets or geo-relational databases, as raster datasets do not contain user-defined fields, however the field names could be used as image names for the raster datasets.

The field name is made up of three components separated by an underscore, the module, the component and whether it is a raw or weighted value. The first letter, indicating the module, is R, H, or V for RISK, HAZARD and VALUES. The next three (or two in some cases) letters are the component, such as population or accessibility. The last letter indicates whether it is the raw score (R) or the weighted score (W). This is an important distinction to make for two reasons. Firstly, it maintains a record of workflow and secondly, it allows for any changes in component weighting to be incorporated easily. The weighted value fields are all calculated using the raw field and weighting factor. Also note that these are the final fields for the dataset. Other fields will exist within the

2 The RISK subtotal is the result of combining all of the weighted layers. The subtotal is then multiplied by the POI layer to make the unnormalised layer.

layer as working fields, particularly if the layer is made up of many sources, such as land use. Retain these fields as well.

Component	Raw Score	Weighted Score
RISK		**RISK**
Unnormalised RISK3		RISK_U
RISK Subtotal		R_SubTot
POI		R_POI
Natural	R_NAT_R	R_NAT_W
Land Use	R_LU_R	R_LU_W
Powerlines	R_POW_R	R_POW_W
Railways	R_RAIL_R	R_RAIL_W
Trans. Population	R_TPOP_R	R_TPOP_W
Population	R_POP_R	R_POP_W
Accessibility	R_ACC_R	R_ACC_W
HAZARD	**HFI**	**HAZARD**
VALUES		**VALUES**
Unnormalised VALUES		VALUES_U
Life	V_LIFE_R	V_LIFE_W
Trans. Population	V_TPOP_R	V_TPOP_W
Powerlines	V_POW_R	V_POW_W
Railways	V_RAIL_R	V_RAIL_W
Communication Sites	V_COMM_R	V_COMM_W
Cultural	V_CUL_R	V_CUL_W
Forestry	V_FOR_R	V_FOR_W
Property	V_PRO_R	V_PRO_W
Aesthetic	V_AES_R	V_AES_W
Recreation	V_REC_R	V_REC_W
Agriculture	V_AG_R	V_AG_W
Biodiversity	V_BIO_R	V_BIO_W
Horticulture	V_HOR_R	V_HOR_W

PERFORMING SPATIAL OVERLAYS TO COMBINE LAYERS

Once the component data layers have been compiled and scored, they must be combined and the scores for all overlying polygons added to give the final module score. This can be using either the polygon overlay function "**UNION**" or by converting the data to raster format and calculated using map algebra.

Polygon overlays are combined using a **UNION** operation. **UNION** combines all of the features in two polygon layers to produce a new layer containing the merged polygons and both sets of feature attributes.

Since **UNION** only uses two layers at a time, there will need to be repeated operations until all of the layers have been combined. For example, Accessibility must be combined with Population to create a temporary layer. The temporary layer must then be combined with Utilities

3 Created by multiplying the RISK subtotal by POI to make the unnormalised RISK layer.

to produce a second temporary layer and so on. Before starting this process make sure that unique field names are used in each layer.

Note that when compiling the **RISK** module that an extra step is required for the **POI** (Probability of Ignition) component. Instead of adding this to the total risk score, the total risk score must be **MULTIPLIED** by a value between 1 and 2 using the value in the **POI** polygon to give the final total.

An alternative to this and perhaps more efficient is to convert the base data to rasters and calculate the outputs using map algebra. This method is easier than the polygon overlay method and also makes it easier for the analysis to be re-run with updated data. There are however certain constraints when working with raster data. For example, the resolution, or cell size, must be fixed at the maximum resolution expected for the output data. Processing capabilities must also be considered if the grid is large and/or high-resolution.

PROCESSING REQUIREMENTS

In order to carry out this form of Wildfire Threat Analysis, GIS software is required that is able to:

- Create and edit spatial data.
- Perform polygon overlay functions.
- Display raster data.
- Produce cartographic output.

The resource capability required is dependent on the size and complexity of the Wildfire Threat Analysis study area. Most Wildfire Threat Analysis datasets can be manipulated using Desktop PC GIS systems, however the processing required to calculate the Risk, Hazard, Values and Threat layers may present some limitations. For example, the multiple overlays necessary to create the module layers can create a large and complex dataset that contains many polygons. The large number of polygons created can cause computational problems on some systems with minimal configurations. It is recommended that final processing be carried out on workstation systems4 when these computational limits have been reached.

4 These are manufactured by companies such as Sun Microsystems, Silicon Graphics, and Hewlett Packard and usually run some form of UNIX operating system.

Outputs/Deliverables

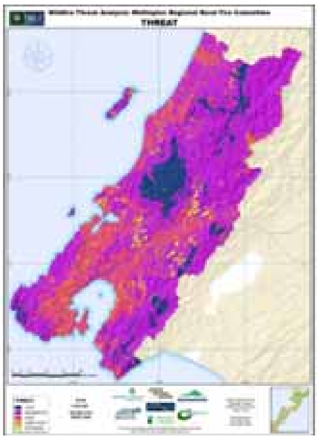
Maps

There are five primary maps that form part of the output of Wildfire Threat Analysis. These are:

- The Study area, including Rural Fire Authority jurisdiction.
- The Module maps (Risk, Hazard and Values)
- The Threat map

The examples below have been taken from the Wellington region project.

THREAT

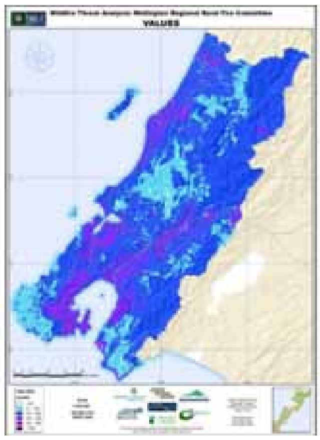


STUDY AREA

RISK

HAZARD

VALUES



There may be many different forms and formats of maps. They may be produced in hard copy, JPEGs (as above), or Adobe PDFs. Scales will vary according to the study area. Some areas will be large necessitating a series to be produced over a number of sheets. Individual jurisdictions may produce their own products based on their internal standards.

Data

The data can be distributed to all stakeholders either on a disk or through an online system. It is important to provide documentation with the data to inform any future users not familiar with the Wildfire Threat Analysis lineage. Of course, stakeholders are free to use the data as they wish, whether it be updating data or undertaking research, however it is important to recognise the data as a regional asset and any improvements should be fed back into the master datasets.

There are no restrictions on distribution except where a supplier's confidentiality is to be maintained. As a convention, it is appropriate that the modules, RISK, HAZARD, VALUES and THREAT be put into the public domain. Although there is no reason to withhold the underlying components, they should remain in the keeping of the stakeholders for analysis.

Applications

Once all of the underlying data has been collected, some users may request additional applications to automate the decision support process. Simple tools can be developed to allow users to view the layers in a GIS-type environment with functions to zoom in and out and turn layers on and off. More sophisticated tools can be developed to automate some analyses.

Training

Technical documentation of the data alone does not provide users with sufficient instruction on the use and interpretation of the data. A useful process is to have the technical staff introduce and explain each dataset with some local interpretation. These can be followed up with more focussed planning sessions.

COMPILING AND SCORING THE DATA

INTRODUCTION

This section outlines the data required for Wildfire Threat Analysis and the scoring scheme used to allocate numbers to each polygon.

Details of the Data Sets, their sources and scoring are described in the tables below.

A number of databases have already been supplied as part of this project. These are:

- Population density.
- Fire Climate (including FFMC and Head Fire Intensity).
- Probability of Ignition (POI)
- Accessibility.
- Tranzpower High Voltage Powerlines (utilities).

THE SCORING AND WEIGHTING SYSTEM

Applying the scoring and weighting system is simply the process of:

1. Assigning each ***COMPONENT*** a ***VALUE*** to a polygon in the GIS using the ***MEASURE*** as a guide,
2. Multiplying the ***VALUE*** by the ***WEIGHTING*** to give the final ***SCORE***,
3. Adjusting (normalising) all of the ***SCORES*** for **RISK** and **VALUES**[5] modules so that each factor can be measured on the same numeric scale,
4. Calculating the overall **THREAT** by adding the **HAZARD**, the normalised **RISK** and normalised **VALUES** layers together.

The weight indicates the influence that each component contributes to threat.

5 Note that the HAZARD layer is already normalised when supplied. However if it is being created, the Head Fire Intensity values will need to be normalised to the 0-500 HAZARD range of values.

RISK

COMPONENT	VALUE	MEASURE	WEIGHT	SCORE
Population Density	0	Unpopulated	5	0
	1	Low density rural and urban population		5
	2	Rural and suburban population		10
	3	Urban/rural population		15
Accessibility	0.04	Motorways	4	0.16
	0.05	Minor roads and vehicular tracks		0.2
	0.15	Major roads.		0.6
	0.67	State highways and walking tracks.		2.68
	3	Urban arterials.		12
Land Use	1	Horticulture/viticulture and “other” land uses.	3	3
	2	Residential		6
	3	Recreation, ecological and Intensive Pastoral Farming (<500Ha)		9
	4	Plantation forestry		12
	5	Cropping and Rangeland Pastoral Farming (>500Ha), Lifestyle blocks		15
	6	Illegal activities, Military live fire areas, open-cast coal mines.		18
Recreation	1	Recreation use from VALUES 0-2	3	3
	2	Recreation use from VALUES 3-5		6
	3	Recreation use from VALUES 6-8		9
Powerlines	1	High voltage powerlines.	2	2
	1.5	Local powerlines		3
	5.5	High-risk powerline segments with long spans, low clearances, localised winds or a history of ignitions.		11
Railways	2	Railway lines	2	4
	6	High-risk railway segments with high grades, curves, cold starts or a history of ignitions. Include tracks that carry steam trains.		12
Transient population	1	Low (Infrequent use &/or low numbers)	1	1
	3	Moderate (Infrequent use & large numbers, or Frequent use with low numbers)		3
	5	High (Frequent use &/or large numbers)		5
Natural Occurrence	0	Water Features	1	0
	1	No lightning or volcanic fires		1
	2	Naturally caused fires recorded		2
SUB TOTAL				84
Probability of sustained ignition	1	Multiply the sub total RISK layer by the value to give the final score.	1	84
	1.2			100.8
	1.4			117.6
	1.6			134.4
	1.8			151.2
	2			168
TOTAL		Maximum Score for RISK		168

Values

COMPONENT	VALUE	MEASURE	WEIGHT	SCORE
Life (usually resident population density)	0	Unpopulated (0 people/km^2)	25	0
	1	Low Density Rural (0-10 people/km^2)		25
	2	Rural (10-100 people/km^2)		50
	3	Urban/Rural (100-750 people/km^2)		75
	4	Suburban (750-2000 people/km^2)		100
	5	Urban (>2000 people/km^2)		125
Transient life	1	Low (Infrequent use &/or low numbers)	1	1
	3	Moderate (Infrequent use & large numbers, or Frequent use with low numbers)		3
	5	High (Frequent use &/or large numbers)		5
Property (improved values)	1	$0-5000.	15	15
	2	$5-15,000 per hectare.		30
	3	$15-30,000 per hectare.		45
	4	$30-50,000 per hectare.		60
	5	$50-75,000 per hectare		75
	6	$75-105,000 per hectare.		90
	7	$105,000 per hectare.		105
Plantation Forestry (5 age classes)	1	0-5 years	18	18
	2	5-10 years		36
	3	10-15 years		54
	4	15-20 years		72
	5	> 20 years		90
Plantation Forestry (optional alternative 3 age classes)	2	0-10 years	18	36
	4	10-20 years		72
	5	> 20 years		90
Biodiversity		Score as per matrix	20	
	1	1-2		20
	2	3-4		40
	3	5-6		60
	4	7-8		80
	5	9-10		100
Powerlines	1	Local lines	9	9
	3	Power feeder lines		27
	5	HV lines		45
Railways	4	Railway lines	9	36
Communication Sites	2	Communication sites	9	18
Agriculture	1	Extensive farming (> 500 hectares)	10	10
	4	Intensive farming (< 500 hectares)		40
Horticulture	7	The presence of any orchards, vineyards etc.	10	70
Recreation		Score as per matrix	15	
	1	1		15
	2	2		30
	3	3		45
	4	4		60
	5	5		75
Cultural		Score as per matrix	20	

	1	0-8		20
	2	9-16		40
	3	17-24		60
	4	25-32		80
	5	> 33		100
Aesthetic	0	Water features	13	0
	1	Entire area		13
	2	Special areas		26
TOTAL		Maximum score for VALUES		871

Module Normalisation

The risk and values modules have scoring systems developed to make the process of allocating scores as simple as possible. Because the number ranges for those modules differ, they need to be stretched or compressed in order for their values to be compared.

The scores for each of the modules are fitted into the following classification scheme:

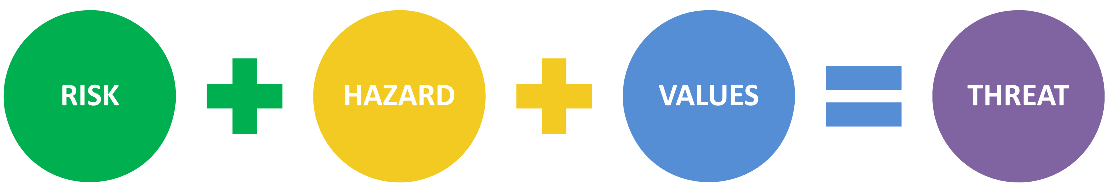
- 100 (LOW)
- 200 (MODERATE)
- 300 (HIGH)
- 400 (VERY HIGH)
- 500 (EXTREME)

When calculating the final module scores, use the following calculations:

MODULE	NORMALISATION
RISK	Multiply score by 2.98
VALUES	Multiply score by 1.1

Calculating Threat

If using raster techniques, use the map algebra tools to calculate the following:



If using polygon analysis techniques, use the **UNION** operation to combine the **RISK**, **HAZARD** and **VALUES** modules into a **THREAT** layer. To allocate a score to **THREAT**, add a new field to the **THREAT** layer and calculate the **THREAT** score.

The creation of this layer may be computationally intensive creating many small polygons. A **DISSOLVE** operation may be performed to reduce the number of polygons by merging adjacent polygons with similar values.

Assigning Cultural Values

The New Zealand Historic Places Trust (HPT) has developed a methodology, which is used to assess sites that are proposed for HPT registration. These can be used for scoring other values such as forests including indigenous and established forests. This methodology assesses three categories each with its own set of descriptors and values.

The three categories and the descriptors are:

- Historic significance

  The reason a place existed or was established. This takes account of the relevant importance of individual assets (outstanding, representative or rare); the association with historic events, persons and ideas; the potential to provide knowledge of history and the date of settlement.

- Physical significance

  The past relevance physically and the current condition of the asset. This comprises the relevant importance of individual assets (outstanding, representative or rare); the archaeological, scientific, architectural, technological values; technical design or accomplishment; and current condition of historic aspects.

- Community significance

  The perceived view of the place or asset by communities today. This comprises cultural, traditional, spiritual, social, aesthetic/landscape values; tangata whenua values; community association or public esteem; symbolic or commemorative values and public education opportunities.

These factors are assessed independently and summed to assign a historic/cultural value to a specific site.

Assistance may be required from people with historic knowledge to identify/locate and score the historic sites to determine the historic/cultural scores for sites within their areas. This process may be better suited to a regional analysis rather than a localised one. The NZHPT maintains a register of historic places and sites, including wahi tapu sites. Some of these sites have NZMS 260 grid reference locations, other have street addresses. This data is supplied by NZHPT to local authorities on a regular basis.

The following steps should be used to determine the cultural/historic score for individual sites.

Step 1 – Identify the historic/cultural sites.

- Identify all historic/cultural sites within the study area and plot these on a map.
- Decide whether the site must be included in the WTA. When evaluating whether a site should be included in the analysis, consider whether the historic/cultural values at a site may be adversely effected by a wildfire. Where no negative impacts are expected the site does not need to be included in the analysis.

Step 2 – Site scoring

- Use the tables below to score each site.
- That the criteria may not be applicable for all sites. Only assign scores based on applicable criteria.
- The highest possible score for a site is 42, the lowest 0.

RANKING		
1	**Historical Significance Descriptors**	**Score (max)**
1.1	Representative (1 mark); Outstanding (2 marks); Rare (3 marks).	**3**
1.2	Association with important events, persons, and ideas: marks from 1 to 5 are determined by the mix of important events, people, achievements, recognition, and ideas.	**5**
1.3	Potential to provide knowledge of history: to either a wide audience over a range of ages (2 marks) or to a selected audience (1 mark).	**2**
1.4	Dating from early settlement periods: Pre 1800 (5 marks); 1800 to 1850 (4 marks); 1851 to 1900 (3 marks); 1901 to 1950 (2 marks); 1951 to 1969 (1 mark).	**5**
	Total marks: Historic Significance	**15**

RANKING		
2	***Physical Significance Descriptors***	**Score (max)**
2.1	Representative (1 mark); Outstanding (2 marks); Rare (3 marks).	**3**
2.2	Archaeological, scientific, architectural, technological values: a summed combination, eg. If an asset has scientific and technological values it would receive a mark of 2; if four values it would receive a mark of 4.	**4**
2.3	Technical design or accomplishment: ie. If an asset design is typical of the era it receives 1 mark because it is not unique nor of higher accomplishment than another. If an asset design is unique and/or of high accomplishment it	**2**

2.4	receives a mark of 2. Condition of historic asset: Poor condition (1 mark); Fair condition (2 marks); Moderate condition (3 marks); Good condition (4 marks); Very good condition (5 marks).	**5**
	Total marks: Physical Significance	**14**

RANKING		
3	**Cultural/Community Significance Descriptors**	**Score (max)**
3.1	Cultural, traditional, spiritual, social, aesthetic/landscape values, a summed combination, eg. If an asset has cultural and social values it would receive a mark of 2; if four values a mark of 4.	**5**
3.2	Tangata whenua and Maori values. An assumption is made here about these values and in all instances needs to be confirmed with iwi. High values (3 marks); Medium values (2 marks); Low values (1 mark).	**3**
3.3	Community association or public esteem: a summed combination, eg. If an asset has both it receives 2 marks and if one it receives 1 mark.	**2**
3.4	Symbolic or commemorative values. This applies to assets or places that are marked as symbolically or commemoratively significant by a plaque or monument. The score is 1 mark for having this value. Otherwise no mark are allocated.	**1**
3.5	Public education: potential to educate either a wide audience over a range of ages (2 marks) or to a selected audience (1 mark).	**2**
	Total marks: Cultural/Community Significance	**13**

Step 3 – Assign site scores to score groups

For each site, add all historical, physical and cultural scores and allocate all scores into a group using the following:

- Assign 0 to cultural values of 0
- Assign 1 to cultural values of 1-8
- Assign 2 to cultural values of 9-16
- Assign 3 to cultural values of 17-24
- Assign 4 to cultural values of 25-32
- Assign 5 to cultural values of 33 and above

Assigning Recreational Values

There is no consistent system used by all Territorial Authorities for scoring recreational values. The Department of Conservation however has a system for determining recreational site scores called the Visitor Site Scoring System. A modified version of this system is used as an input to the proposed WTA recreational value.

Three factors are assessed independently and combined to assign a recreation value to a specific area. The factors are:

1. Visitor numbers.
2. Length of visit.
3. Uniqueness of the recreation opportunity.

The assumption has been made that the number of visitors that use a recreational site is a robust indication of the value of the site to the local community. Therefore high visitor numbers equate to a high recreational score.

The length of visit has been included in the overall score to ensure that longer visits to a site equate to a higher recreation score. This is based on the premise that the longer visitors spend at a site the higher they value the recreational opportunity available at the site.

The use of the factor "uniqueness of the recreational opportunity" is based on the premise that the loss of a site (whether long or short term) is more significant if there are few sites offering similar experiences for visitors. So lack of substitutability equals a high uniqueness score.

Rural fire managers should be able to determine the recreational scores within their areas with input from local recreation planners. This process is better suited to a regional analysis rather than a localised one.

The following steps should be used to determine the recreation score for individual sites.

Step 1 – Identify the recreational sites.

- Identify all recreational sites on a map.
- A recreational site is defined around existing facilities and services that are managed for recreational purposes, in most cases for a primary visitor group.
- When evaluating whether a site should be included in the analysis, consider whether the recreational opportunities at a site could be impacted by a wildfire. Where no negative recreational impacts are expected (eg stock car track, trail bike area) the site should not be included in the analysis.

- Aim to keep the total area of individual high intensity recreational sites (for example peri-urban picnic sites, camp grounds and high use recreational reserves) to less than 1,000 ha.
- Low intensity recreational sites (for example national and regional parks) should be split into blocks no larger than 50,000 ha. The division into blocks should reflect the approximate recreational usage, for instance areas designated "wilderness" should be separated from high use tramping tracks.

STEP 2 – ESTIMATE VISITOR NUMBERS AND LENGTH OF VISIT

- Determine the primary visitor group for individual sites. Primary visitor groups are based on the length of visit. Three lengths of visits are used:
  1. Short-stop (up to one hour)
  2. Day visit (more than one hour and up to a day, without staying overnight).
  3. Overnight (staying within the recreational site at least one night)
- At sites that are used for multiple visit duration types, scores for each visit duration type are determined and added together. For example, a site catering predominantly for overnight visits, with 1,000 overnight visits per year and 500 day visits per year, will score 2 (overnight) plus 1 (day visit); a total of 3.
- Visits to visitor centres should be treated as short stops. This is because the visitor centres are predominately located beside roads and the visit is usually of less than one-hour duration.
- The highest score for a site is 24.

Use the table below to score recreational sites according to the annual number of visitors to a site and the visit duration.

Score	VISIT DURATION		
	Short stop (< 1 hour)	Day visits	**Overnight visit**
8	>200,000	>40,000	>10,000
7	150,001-200,000	30,001-40,000	7,501-10,000
6	110,001-150,000	22,001-30,000	5,501-7,500
5	80,001-110,000	16,001-22,000	4,001-5,500
4	50,001-80,000	10,001-16,000	2,501-4,000
3	30,001-50,000	6,001-10,000	1,501-2,500

2	10,001-30,000	2,001-6,000	501-1,500
1	2,001-10,000	401-2,000	101-500
0	2,000 or less	400 or less	100 or less

Step 3 – Determine uniqueness of the site

- The uniqueness score is based on the number of sites within the region that offer similar recreational opportunities.

Use the table below to determine the uniqueness score for each recreational site.

SCORE	DESCRIPTION
3	Similar recreational opportunities to those offered at this site are not available elsewhere within the region.
2	Similar recreational opportunities to those offered at this site are available at one or two other sites within the region.
1	Similar recreational opportunities to those offered at this site are available at three or more other sites within the region.

Step 4 – Calculate recreational score

- For each site multiply the score from the visitor use table with the score from the uniqueness table to determine the overall recreational score.

Assign scores to polygons using the following classification scheme:

- **Assign 1 to recreation values of 0-1**
- **Assign 2 to recreation values of 2-4**
- **Assign 3 to recreation values of 5-10**
- **Assign 4 to recreation values of 10-20**
- **Assign 5 to recreation values of 20-72**

Comments

Determining the boundary of individual sites, and by extension the size of each site, has a significant impact on the recreational score. To maintain consistency it is therefore recommended to keep the site size similar to that of other individual sites of a similar recreational nature.

Assigning Biodiversity Values

Biodiversity values are best represented by the Department of Conservation work on scoring these values. This brings together the two terrestrial components of biodiversity. First is a **botanical** values score based on a 6-level scale ranging from "Nationally Important" to "Has Potential". The second scores **wildlife** values in the same way. The two are brought together in an objective scoring matrix, which generates 5 categories. Where this matrix covers most of the land defined as having ecological values, the categories can be assigned on that basis. But where the ecological areas are not on DoC land, categorisation can be into low, moderate and significant on the basis of an established (and written) local system.

Step 1 – Botanical score

The botanical score is based on a scoring method by Shaw[6] and is used by the Wellington Conservancy of the Department of Conservation. The criteria are arranged in a six level scale ranging from the highest score for 'nationally important' (6) to the lowest score for 'potential' (1). Use the table below to assess the botanical score for individual sites.

SCORE	DESCRIPTION
6 Nationally important	Contains a nationally threatened vegetation type or plant species which is endemic to the ecological district. The best representative of a nationally uncommon vegetation type in the country.
5 Exceptional	Contains good examples of nationally uncommon vegetation types, successional sequences or mosaics. Contains vegetation types of great conservation value, for example largely unmodified by introduced plants, browsing animals or other human influences. Sites where a vegetation type, or more than one plant species, reaches a geographic limit. Contains threatened plants in the endangered or vulnerable category which are not endemic to the ecological district. Contains a vegetation type which is endemic to the ecological district. Contains communities which are to a significant degree representative of the natural character of the ecological district.
4 Very high	The last, or one of a few remaining examples of a vegetation type which was once more widespread in the ecological district. The example retains most of its natural character. Contains regionally uncommon vegetation types in good condition and forming part of a larger tract of native vegetation for example, sub-alpine and alpine areas surrounded by a large tract of forest. An example of the vegetation of an ecological district that forms a continuous ecological or altitudinal sequence across a district and not better represented elsewhere in the ecological district.

6 Shaw, W. 1994. Botanical ranking for nature conservation. Science and Research Series no.72. Dept of Conservation, Wellington. 17 pp.

	The last, or one of the few remaining examples of secondary succession that has developed following disturbance to the vegetation in pre-European or early European times. Good quality examples, or the only example of a secondary succession that has developed following a large disturbance such as mass ground movement, storm damage or fire. Nationally uncommon ecosystems or vegetation types which have been degraded by, for example, fragmentation, weeds, burning, browsing animals. Large (over 300 ha) example of secondary vegetation where there is relatively little (e.g., less than 5%) of an ecological district remaining in native vegetation.
3 **High**	Good quality, moderately large (300-1000 ha) example of native vegetation typical of an ecological district where there are other better quality or larger (over 1000 ha) examples present in the ecological district. The last, or one of the few remaining examples of a vegetation type within an ecological district which, although in a modified condition, still retains the main elements of composition and structure. An example of the native vegetation of an ecological district that now forms part of a culturally interrupted ecological and/or altitudinal sequence. Areas where individual species or vegetation types reach the limits of their geographical distribution. Regionally uncommon vegetation types, either intact or relatively unmodified, but completely or largely surrounded by a highly modified landscape, for example, small urban reserves. Contains a rare species or two or more threatened species in 'local' category. Nationally uncommon ecosystems or vegetation types, with a conspicuous element of exotic plant species that will eventually be replaced by native plant species. Early successional vegetation not presently representative of the natural cover of the ecological district but with the potential to develop so, and where there are very few or very small remaining other examples of natural vegetation in the ecological district.
2 **Moderate**	Substantially modified native vegetation types that retain their main elements of composition and structure (for example selectively logged, lightly burnt, grazed, weeds present), but are better represented at other sites in the ecological district. Small example of native vegetation type where there are larger or better examples elsewhere in the ecological district.
1 **Potential**	Mosaic(s) of native and exotic vegetation where the former are small and of no particular interest. Small areas of exotic vegetation surrounded by large areas of native vegetation. Early successional vegetation where there are better examples in the ecological district. Early successional vegetation dominated by exotic plants. Contains native vegetation but essentially recently human-made.

Botanical Score – Alternative Method.

The following table was developed by Paul Hughes from Department of Conservation during the Wellington Regional Project. During the project an update of the Land Cover Database was completed so a method of deriving botanical values was developed using the improved LCDB2. The examples cited are from the Wellington region.

SCORE	DESC. NO.	DESCRIPTION	DATA SOURCE	ISSUES
1	1a	Mosaic(s) of native and exotic vegetation where the former are small and of no particular interest.	Unable to define	What is a mosaic?
	1b	Small areas of exotic vegetation surrounded by large areas of native vegetation.	Pines/grass/exotic scrub <5ha. totally within Indigenous Scrub/Indigenous Forest – LCDB V2	Could only deal with areas totally within.
	1c	Early successional vegetation where there are better examples in the ecological district.	Indigenous Scrub – LCDB V2	
	1d	Early successional vegetation dominated by exotic plants.	Gorse and Broom or Mixed Exotic Shrubland – LCDB V2	
	1e	Contains native vegetation but essentially recently human-made.	Restoration and native plantations – None mapped, too numerous, small and difficult	Mana Island plantings not mapped.
2	2a	Substantially modified native vegetation types that retain their main elements of composition and structure (for example selectively logged, lightly burnt, grazed, weeds present), but are better represented at other sites in the ecological district.	Indigenous forest logged >5ha.Forest Typing for logged & LCDB V2 for indigenous forest 69 - sustainable forestry sites not used	Used forest typing "N" & "PF" & "TI" for logged
	2b	Small example of native vegetation type where there are larger or better examples elsewhere in the ecological district.	Native forest & alpine grassland <5ha. – LCDB V2	
3	3a	Good quality, moderately large (300-1,000 hectares) example of native vegetation typical of an ecological district where there are other better quality or larger (over 1,000 hectares) examples present in the ecological district.	Indigenous Forest & Tall tussock Grassland in LCDB V2 within the area thresholds specified	Kaitawa, Mt Wainui, West Akatarawa, Pakuratahi.

	3b	The last, or one of the few remaining examples of a vegetation type within an ecological district which, although in a modified condition, still retains the main elements of composition and structure.	Dunes - east of Karori Stm mouth, Makara Beach, Pencarrow to Turakirae. Saltmarshs - Pauatahanui, Makara & Waikanae. Kohekohe forest in Wellington ED - Colonial Knob. Lowland totara/matai - Te Marua Bush. Black Beech in Hutt Valley - Atkinson/Druce/Stephenson. Wetlands - Mangaroa Swamp, Mackays Crossing swamp, Pekapeka wetlands. Manuka/Kanuka.	
	3c	An example of the native vegetation of an ecological district that now forms part of a culturally interrupted ecological and/or altitudinal sequence.	Mt Hawtrey to coast Paraparaumu SR up to Maunganui	
	3d	Areas where individual species or vegetation types reach the limits of their geographical distribution.	Brachyglottis kirkii at Eastbourne. Libertia edgariae at Eastbourne. Kohekohe at Colonial Knob. Whau at Paekakariki. Atriplex buchanii at Miramar Peninsula. Chionochloa beddiei at Turakirae. Melicytus aff obovatus at Kapiti I. Aciphylla dissecta at Alpha.	
	3e	Regionally uncommon vegetation types, either intact or relatively unmodified, but completely or largely surrounded by a highly modified landscape, for example, small urban reserves.	Indigenous forest within urban or grassland in all ED except Tararua Wetlands on Foxton and Manawatu Plains ED's.	
	3f	Contains a rare species or two or more threatened species in 'local' category.	Threatened Plants database nationally Range Restricted or Sparse.	Ref. Hitchmough for classifications.
	3g	Nationally uncommon ecosystems or vegetation types, with a conspicuous element of exotic plant species that will eventually be replaced by native plant species.	Nil	
	3h	Early successional vegetation not presently representative of the natural cover of the ecological district but with the potential to develop so, and where there are very few or very small remaining other examples of natural vegetation in the ecological district.	Cook Strait shrubland	

4	4a	The last, or one of a few remaining examples of a vegetation type which was once more widespread in the ecological district. The example retains most of its natural character.	Paekakariki dune forest. Colonial Knob kohekohe. Bartons Bush. Te Marua Bush. Otari.	
	4b	Contains regionally uncommon vegetation types in good condition and forming part of a larger tract of native vegetation for example, sub-alpine and alpine areas surrounded by a large tract of forest.	All alpine grassland and subalpine shrubland	
	4c	An example of the vegetation of an ecological district that forms a continuous ecological or altitudinal sequence across a district and not better represented elsewhere in the ecological district.	Kapiti Island Indigenous Forest. Unlogged indigenous forest and subalpine schrublands and Tall tussock grassland, contiguous in the Forest Parks.	
	4d	The last, or one of the few remaining examples of secondary succession that has developed following disturbance to the vegetation in pre-European or early European times.	Nil	
	4e	Good quality examples, or the only example of a secondary succession that has developed following a large disturbance such as mass ground movement, storm damage or fire.	Turakirae Head (only below the 1855 uplift line)	
	4f	Nationally uncommon ecosystems or vegetation types which have been degraded by, for example, fragmentation, weeds, burning, browsing animals.	Dunes and wetlands including estuaries	LCDB V2 10,45,46, 47.
	4g	Large (over 300 hectares) example of secondary vegetation where there is relatively little (e.g., less than 5%) of an ecological district remaining in native vegetation.	Nil	
5	5a	Contains good examples of nationally uncommon vegetation types, successional sequences or mosaics.	Eastbourne Hills indigenous forest. Kohangapiripiri Lake catchment. Taupo Swamp. Turakirae to Barneys - mosaic. Porirua SR.	
	5b	Contains vegetation types of great conservation value, for example largely unmodified by introduced plants, browsing animals or other human influences.	Kapiti Island indigenous forest. Proposed Ecological Areas	
	5c	Sites where a vegetation type, or more than one plant species, reaches a geographic limit.	Kohekohe at Colonial Knob. Various plant species at Eastbourne Hills.	

	5d	Contains threatened plants in the endangered or vulnerable category which are not endemic to the ecological district.	Threatened plants database - nationally critical endangered or vulnerable	
	5e	Contains a vegetation type which is endemic to the ecological district.	Turakirae Head - uplifted beaches	
	5f	Contains communities which are to a significant degree representative of the natural character of the ecological district.	Recommended Areas for Protection (RAP's) (Only available for Foxton & Manawatu Plains Ecological Districts) Makara & Karori Stm Dunes, EA's. Eastbourne Hills indigenous forest. Kapiti Island indigenous forest. Hemi Matenga indigenous forest. Colonial Knob kohekohe.	
6	**6a**	Contains a nationally threatened vegetation type or plant species which is endemic to the ecological district.	No types known nationally & Nil species	
	6b	The best representative of a nationally uncommon vegetation type in the country.	Turakirae Head raised beaches.	

Step 2 - Wildlife score

The following criterion is based Elliot & Ogle7 and is used by the Wellington Conservancy of the Department of Conservation. The criteria are arranged in a six level scale ranging from the highest score for 'nationally important' (6) to the lowest score for 'potential' (1) value as habitat for native animals. Use Table 2 to assess the wildlife score for individual sites.

7 Elliot, G. & Ogle, C. C. 1985. Wildlife and wildlife habitat values of Waitutu forest, western Southland. Fauna Survey Unit report no. 39. 108 pp.

SCORE	DESCRIPTION
6 **Nationally important**	▸ Contains animal species endemic to or best represented in, this ecological district.
5 **Exception al**	▸ An endangered, rare, or restricted endemic species breeds in the unit. ▸ The management unit is essential to endangered, rare or restricted species for purposes other than breeding ▸ The management unit is vital to internationally uncommon species (breeding and/or migratory). ▸ The management unit is vital to internally migratory species with very limited distribution or abundance. ▸ Largely unmodified ecosystems or examples of original habitat not represented elsewhere; of large size and containing viable populations of all or most animal species typical of such ecosystems.
4 **Very high**	▸ Site containing a native animal species which has declined significantly as a result of human influence. ▸ One of a few, or the only breeding area, for a non-endemic native species of limited abundance. ▸ Habitat of an uncommon, discontinuously distributed species not adequately represented in a particular ecological district. ▸ Example of a largely unmodified site which is not represented to the same extent elsewhere in the ecological district and is used by most native animal species which are typical of that habitat in that ecological district. ▸ Supports a species of an endemic family which is of limited abundance nationally although adequately represented in one ecological district but whose habitat is at risk.
3 **High**	▸ Supports a species which is still widely distributed but whose habitat has been reduced. ▸ Contains large numbers of breeding or moulting birds or where breeding or moulting areas are of inter-regional significance. ▸ Large and fairly unmodified site which is represented elsewhere in the ecological district and contains all or most native animal species typical of that habitat for that ecological district. ▸ Contains widespread native animal species that is noteworthy at this site for its abundance or behaviour.
2 **Moderate**	▸ Not heavily modified and supports good numbers of native animal species typical of the habitat in the ecological district.
1 **Potential**	▸ Small, heavily modified site that could be more valuable to native animals if left to regenerate, or managed and developed for their benefit.

Step 3 – Assign site scores to score groups

		BOTANICAL CRITERIA SCORE					
		1	**2**	**3**	**4**	**5**	**6**
WILDLIFE CRITERIA SCORE	**1**	1	1	3	5	7	9
	2	1	2	4	6	8	10
	3	3	4	5	7	8	10
	4	5	6	7	8	9	10
	5	7	8	8	9	9	10
	6	9	10	10	10	10	10

- Assign 1 to biodiversity values of 1-2
- Assign 2 to biodiversity values of 3-4
- Assign 3 to biodiversity values of 5-6
- Assign 4 to biodiversity values of 7-8
- Assign 5 to biodiversity values of 9-10

UPDATING THE HAZARD DATA SET

The HAZARD layer is created nationally for the Wildfire Threat Analysis project using national fuel data from the Land Cover Database (LCDB) project, fuel and fire behaviour models from the fire researchers, and national fire climate data from the National Rural Fire Authority. However, in some areas of New Zealand, the HAZARD is not reflected as accurately using these national datasets and they could be with the incorporation of local data. For example, the satellite-derived fuel data over commercial forest areas is not likely to incorporate the changing forest management activities, nor accurately assess the age, and therefore fuel load, of the forests.

Note: *Any changes at this level are the responsibility of the Rural Fire Authority (RFA) or Regional Committee managing the WTA Project. This must be carried out with active participation of Landcare Research Ltd to ensure consistency across the country and Data and Spatial Intelligence Team should be informed.*

The recent version of the HAZARD layer was created with a 25 meter cell size using the LCDB2 as the basis for the fuel model.

The HAZARD layer is derived from the Head Fire Intensity fire climate layer. The reclassification table is below.

HFI (kw/m)	HAZARD
0	0
1 - 500	50
501 - 1000	100
1001 - 2000	200
2001 - 4000	300
4001 - 10,000	400
> 10,000	500

Any local/regional updates to the HAZARD layer must follow the methods from Briggs et al. in their publication **Spatial Prediction of Wildfire Hazard across New Zealand: A Significant Upgrade**

Further reading and the background material necessary can be found in the following papers:

Briggs, C., Price, R., Pearce, H G. **2005** *Spatial Prediction of Wildfire Hazard across New Zealand: A Significant Upgrade.* Landcare Research Contract Report: LCR 0506/014.

Borger, B H and Pearce, H G. **2000.** *Fire behaviour models for the Hazard module of the NZ WTA model*

***Forestry Canada Fire Danger Group*. 1992.** *Development and structure of the Canadian Forest Fire Behavior Prediction System*. Forestry Canada, Science and Sustainable Development Directorate, Ottawa, Ontario. Information Report ST-X-3. 63 p.

***Leathwick, J.R., Briggs, C.M.* 2001.** *Spatial Prediction of WildFire Hazard Across New Zealand.* Landcare Research Contract Report: LCR 0001/081.

***Van Wagner, C.E.* 1977**. *Effect of slope on fire spread rate.* Canadian Forestry Service. Bi-monthly Research Notes 33: 7-8.

DATA COMPILATION TABLES

The tables below outline the method for collecting, compiling and acquiring the GIS data for each of the factors

GUIDE TO THE TABLES

Data Set Title	THE REFERRED NAME OF THE DATA SET
Description	A short description of the Data Set.
Sources	Where the data can be obtained. Some may be supplied, some may require local knowledge and some might exist in local organisations such as power companies.
Operations	Any operations that need to be performed on the data. NOTE: Where datasets are to be buffered, use either the nominated value or ½ the cell size of the output data – whichever is the greater.

RISK MODULE

Data Set Title	NATURAL OCCURRENCE
Description	There are few fires in New Zealand that are attributed to natural causes. Natural fires are those caused by weather, tectonics or spontaneous combustion that are not connected to human activities. These are more common overseas (particularly lightning) but anecdotal evidence suggests that such occurrences are rare. Research is needed to quantify the relationship between ignitions and lightning strikes as there are many unidentified fire causes that may be attributed to lightning strikes. This could be carried out as part of a regional project.
Sources	MetService lightning strike data. Local knowledge.
Operations	Cluster actual lightning strike data or manually digitise polygons defined by fire managers.

Data Set Title	LAND USE
Description	The primary activity such as recreation and types of farming on a piece of land that is likely to cause a fire.
Sources	Residential: Population density (urban, suburban classification). LCDB2 classes 1 and 2. Plantation Forestry: LCDB2 classes 64-67. More detailed information may be held by forest companies and would provide the most accurate information. MAF Age Classes derived from LCDB1 imagery (supplied), Rangeland Pastoral Farming: Agribase farms over 500 hectares. Not all farms are represented in Agribase (contributions are voluntary). In instances where there are known gaps, use the land parcel framework as a base for adding additional farms. Intensive Pastoral Farming: Agribase farms less than 500 hectares. In instances where there are known gaps, use the land parcel framework as a base for adding additional farms. Cropping: LCDB2 classes 30, 31 and 32 MINUS Agribase parcels. Horticulture/Viticulture: Land Cover Database Primarily Horticulture classification. NZ TOPO

	Orchards. Supplement with local knowledge. Lifestyle Blocks: A category of farm run by former urban dwellers with little exposure to rural fire management activities. These can be defined as agricultural land within parcels less than 50 ha. Illegal activities: based on local knowledge where such activities are a potential source of ignition. Military Live Firing Areas: New Zealand Defence Force.
Operations	Separate and merge the individual Data Sets. The cropping data set will need to be clipped using the pastoral farms data set. Lifestyle bocks could be derived by overlaying the cropping and horticulture/viticulture layer with the cadastral layer, extracting parcels inside that layer less than 50 ha then removing all parcels within the Agribase dataset.

Data Set Title	RECREATION
Description	Recreation areas as defined in the VALUES module using the use, or visitor numbers to set the score.
Sources	Local/Regional Authority databases, forest companies, DoC Visitor Asset Management System (VAMS). Supplement with local knowledge.
Operations	None.

Data Set Title	POWERLINES
Description	A key utility that has the potential to cause fires. This dataset can be also used in the VALUES module.
Sources	Powerlines: High Voltage – Tranzpower (supplied), local feeder lines – individual power companies. Where no data exists for local lines, the road network can be used to represent lines. Use local knowledge to remove any lines that are known not to exist alongside roads or add where they are known to exist (eg across forests).
Operations	Create a 500-metre buffer for high voltage lines. Create a 20-metre buffer for local lines. Note: the data sources may have to be generalised in order for smooth buffers to be created.

Data Set Title	RAILWAYS
Description	A key utility that has the potential to cause fires. This dataset can be also used in the VALUES module.
Sources	Railways: NZ TOPO
Operations	Create a 20-metre buffer for railway lines.

Data Set Title	POPULATION
Description	Represents the usually resident population (i.e. where people live). A model of 5 classes of population density – urban, sub-urban, rural, low-density rural and unpopulated.
Sources	Supplied as part of the project however will be updated for each new census an supply of address points.
Operations	None required, however, not all Local Authorities will be represented in the Data Set as they have not supplied their address points to Land Information New Zealand. For these areas,

	Statistics New Zealand meshblocks will have to be used.

Data Set Title	TRANSIENT POPULATION
Description	There are temporary periods where the population around certain locations and facilities grows during the summer. These include resorts, hostels, camps and recreation areas. This dataset can be also used in the VALUES module.
Sources	Local knowledge, Local Authority district plans, Regional Council statistics, NZ TOPO, TUMONZ Campsites, Tourism New Zealand, Department of Conservation park maps.
Operations	Manually digitise polygons. Include a suitable buffer around facilities to reflect human accessibility.

Data Set Title	ACCESSIBILITY
Description	Represents the extents of the influence of fires starting near roads or tracks. Fires are rarely started far from easily accessible places. The weightings to access types have been determined through a study of incident locations and road types. The buffer widths from the road centreline are as follows: Motorway – 100m State Highway – 500m Urban arterial – 500m Major Road – 100m Minor road – 50m Vehicular Tracks – 50m Walking Tracks - 50m
Sources	LINZ data is supplied as part of the project including buffers. Walking tracks can be sourced from DoCs Visitor Asset Management System (VAMS) track data.
Operations	Buffer walking tracks and combine with the supplied data with the supplied data taking precedence.

Data Set Title	PROBABILITY OF SUSTAINED IGNITION
Description	In addition to the various factors that contribute to the likelihood of ignitions, one of the keys is having an environment (climate and fuel) that turns an ignition into an incident. This is referred to as a "sustained ignition". This "Probability of Ignition" layer (POI) differentiates areas that may have potentially the same number of ignitions but climatic conditions may prevent those ignitions from growing and spreading from those where ignitions are more likely to grow and spread into fires. For this project, the Fine Fuel Moisture Code (FFMC) component of the Fire Weather Index (FWI) system is used to determine the potential for sustained ignition. The FFMC is defined in the Rural Fire Management Glossary of Terms as: "A numerical rating of the moisture content of litter and other cured fine fuels. This code is an indicator of the relative ease of ignition and flammability of fine fuel." The FFMC ranges from 0 to 101 with a value of 86 indicating high level of dryness and 92

	extreme. POI has been define as: FFMC < 85 multiply risk score by 1 FFMC 85-86 multiply risk score by 1.2 FFMC 86-87 multiply risk score by 1.4 FFMC 87-88 multiply risk score by 1.6 FFMC 88-89 multiply risk score by 1.8 FFMC > 89 multiply risk score by 2.
Sources	Supplied as part of the project.
Operations	Multiply the RISK subtotal layer with the POI layer.

Hazard Module

Data Set Title	HAZARD
Description	The potential fire behaviour measured by the Head Fire Intensity. The units are kilowatts per metre of flame length.
Sources	Supplied as part of the project. It is the Head Fire Intensity layer from the Landcare Research spatial fire climate work and represents the average summer peak conditions (the average of the top 20th percentile). The dataset has been created on a 25m grid. May be re-created if more detailed fuel type and loading exists. The HFI layer is reclassified as follows HFI (kw/m) — HAZARD 0 — 0 1 - 500 — 50 501 - 1000 — 100 1001 - 2000 — 200 2001 - 4000 — 300 4001 - 10,000 — 400 > 10,000 — 500
Operations	None required if using the supplied layer.

Values Module

Data Set Title	LIFE
Description	Life is one of the key values identified by the Forest and Rural Fires Act, and so has the highest possible value. Statistics show that the likelihood of life being adversely affected by vegetation fire is very low, with very few lives lost in vegetation fires.
Sources	Supplied as part of the project as population density and scored differently to the RISK interpretation.
Operations	None.

Data Set Title	COMMUNICATION SITES
Description	A key utility that may be damaged by fire.
Sources	Telecommunications companies.
Operations	Create a 50-metre buffer around the sites.

Data Set Title	CULTURAL
Description	This applies only to items of cultural value that may be damaged by fire. For example, fire cannot damage sites that have no built component remaining. Cultural values may vary from place to place in New Zealand. Sites include those listed under the Historic Places Act, and those listed in District Plans (including trees). Other cultural values may include forest areas, landmarks etc.
Sources	Local Authority district plans, local knowledge.
Operations	Manually create polygons and assign appropriate buffers to point features.

Data Set Title	PLANTATION FORESTRY
Description	The valuation of plantation assets for market purposes is a complex procedure with a number of assumptions and variables. To keep the process manageable, the Consultative Team decided that plantation values are best linked to age class for this exercise.
Sources	RISK: Land Use plantation forestry classification.
Operations	For the following age classes assign the scores: 0-5 years – score 1. 5-10 years – score 2. 10-15 years – score 3. 15-20 years– score 4. > 20 years – score 5. If using the three age classes, score the following: 0-10 years – score 2. 10-20 years – score 4. > 20 years – score 6.

Data Set Title	PROPERTY
Description	Improved values in monetary terms.
Sources	Valuations, Local/Regional Authority databases.
Operations	For each parcel: ▸ Calculate the improved value (capital value minus land value) for each parcel. ▸ Calculate the improved value per hectare Classify the dataset into the following ranges, dissolve and assign the scores: $0-5000 – score 1. $5-15,000 – score 2. $15-30,000 – score 3. $30-50,000 – score 4. $50-75,000 – score 5. $75-105,000 – score 6. $105,000 – score 7.

Data Set Title	AESTHETIC
Description	An assessment of whether an area has an important aesthetic (visual) value that must be preserved.

Sources	Local Authority district plans, regional landscape plans, local knowledge.
Operations	Manually create polygons.

Data Set Title	BIODIVERSITY
Description	Some ecological values are fragile, easily modified and so are virtually irreplaceable. Fire is a common cause of modification.
Sources	Local/Regional Authority databases/District Plans. Department of Conservation classifications.
Operations	Score as per the methods above. Consider the alternative option for scoring the botanical values.

Data Set Title	RECREATION
Description	A combination of uniqueness and level of use determines recreation value. Fire can damage fixed recreational assets and the "experience" of using recreational tracks and areas.
Sources	Local/Regional Authority databases, forest companies, DoC Visitor Asset Management System (VAMS). Supplement with local knowledge.
Operations	Score as per the workbook methodology above.

Data Set Title	AGRICULTURE
Description	Grazed land.
Sources	RISK: Land Use
Operations	Extract the rangeland and intensive pastoral farming and the lifestyle block classification from RISK: Land Use

Data Set Title	HORTICULTURE
Description	High value land use, but infrequent damage given the intensive and often irrigated nature of it.
Sources	RISK: Land Use
Operations	Extract the horticulture/viticulture and cropping classification from RISK: Land Use

CARTOGRAPHIC GUIDELINES

INTRODUCTION

Maps are the main products of Wildfire Threat Analysis and it is therefore important to apply some standardisation to them. The reasons for this are:

- Maps are the most efficient way to communicate Wildfire Threat Analysis information. Standardisation offers the ability for the user to compare different areas.
- Quality maps give Wildfire Threat Analysis information the impact required for presentation and understanding.
- Standardised maps give this Wildfire Threat Analysis its identity.
- Standardised maps can impart trust in the process in the minds of the reader.

The methodology is one that is to be applied nationally for comparative purposes. This should also be applied to the presentation of the maps. For example, if two studies in different extremes of threat use the same colour schemes, but scale their data differently their maps could potentially look similar. This will give the viewer the impression that the two areas face a similar threat.

This paper describes the standard elements and colour schemes that are to be used to depict risk, hazard, values and threat.

DEVELOPMENT OF THESE STANDARDS

The initial work for this standard was completed at a meeting of Wildfire Threat Analysis pilot study GIS Analysts on the 6th of July 2001. A series of experimental maps were produced to develop the right "look and feel" for the Wildfire Threat Analysis maps. Involved in this process was:

- Dean Strachan (Department of Conservation Canterbury Conservancy)
- Mark Day (Department of Conservation Southland Conservancy)
- Ingrid Brunclikova (Manukau City Council)
- Karl Majorhazi (National Rural Fire Authority)

Look and Feel

It is important to maintain a consistent look and feel to the maps. Below are examples of the maps of risk, hazard, values, threat, and study area. Their specifications will follow.

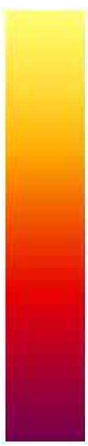
Colours and Ranges

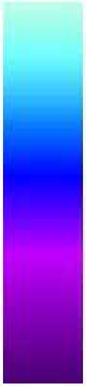
Each of the modules should have their own distinct colour-ramp for easy identification and interpretation. The colours should also be used in maps of the individual components.

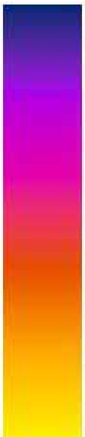
For the component maps, the colour-ramps can still be used even if there are only two values in the layer, as in Natural Occurrence.

The tables below shows the colour ramp, class break-down and the RGB colour values used.

RISK		**RED**	**GREEN**	**BLUE**
	**0-50**	**255**	**255**	**191**
	50-100	**209**	**240**	**74**
	100-200	**87**	**217**	**0**
	200-300	**0**	**179**	**86**
	300-400	**27**	**111**	**128**
	400-500	**3**	**39**	**115**

HAZARD		**RED**	**GREEN**	**BLUE**
	**0**	**255**	**255**	**191**
	50	**255**	**255**	**66**
	100	**255**	**255**	**0**
	200	**255**	**170**	**0**
	300	**237**	**51**	**0**
	400	**191**	**0**	**35**
	500	**115**	**0**	**77**

VALUES		RED	GREEN	BLUE
	0-50	191	255	233
	50-100	79	223	255
	100-200	0	55	255
	200-300	132	0	255
	300-400	143	0	199
	400-500	77	0	155

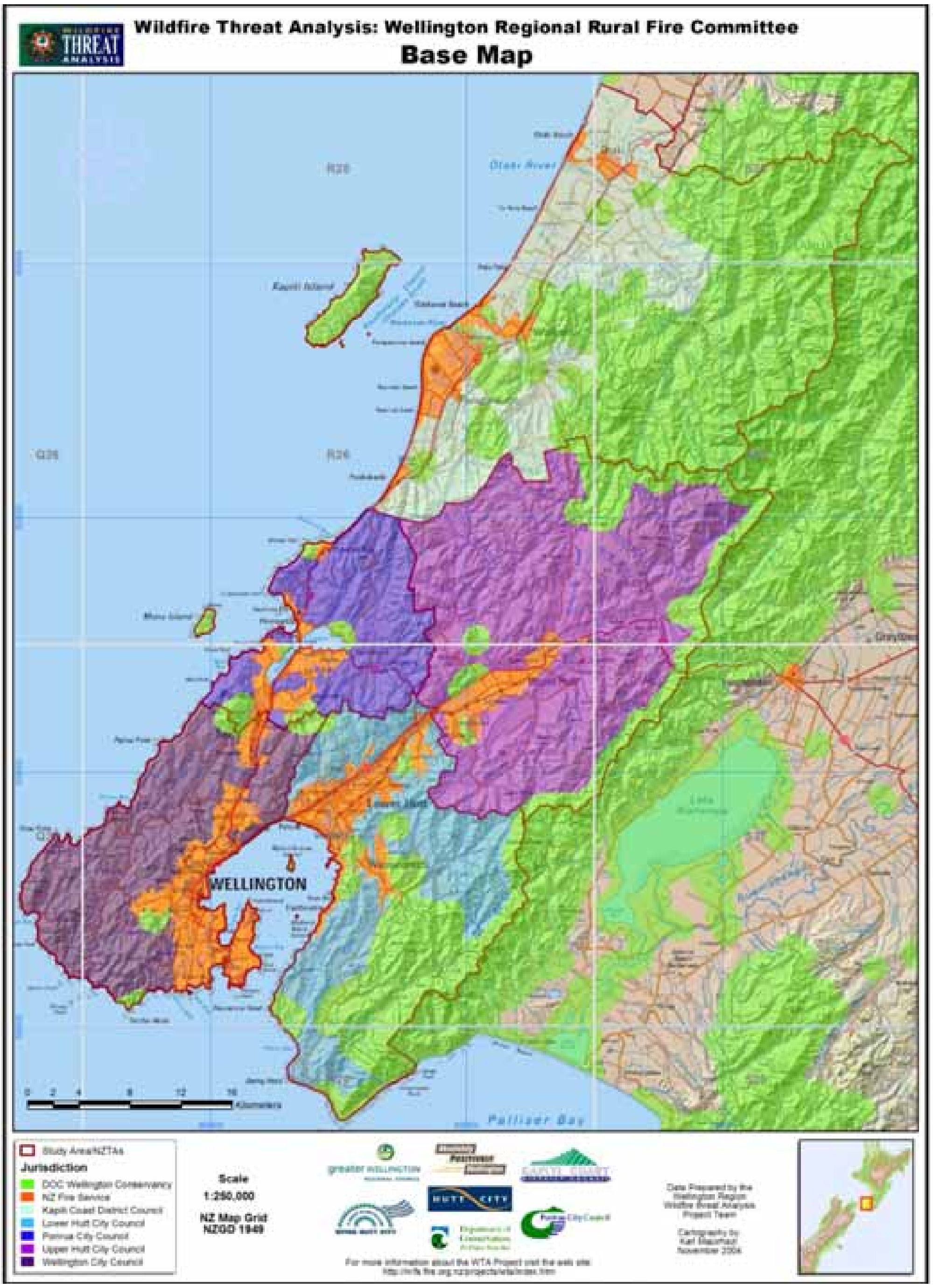
THREAT		RED	GREEN	BLUE
	0-150	0	38	115
	150-300	141	23	209
	300-450	214	0	186
	450-600	235	49	89
	600-750	237	103	0
	750-900	255	179	0
	900-1500	255	238	0

EXAMPLES

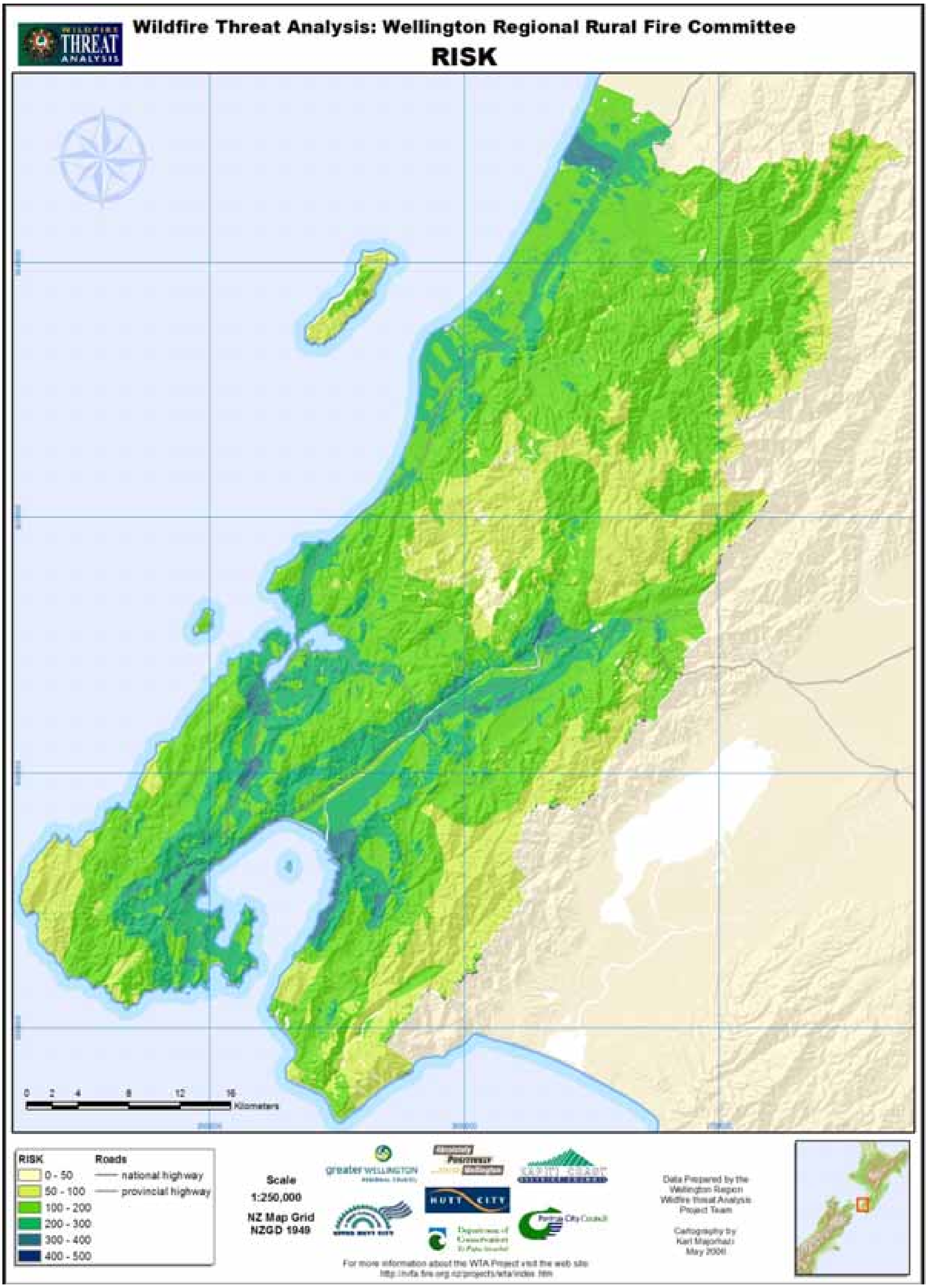
Here are some examples taken from the Wellington Regional Project.

BASE MAP/STUDY AREA

The first map to be produced, even before the data collection phase of the project is a map that defines the jurisdiction of each Rural Fire Authority. This defines the areas that each authority will need to provide data for.

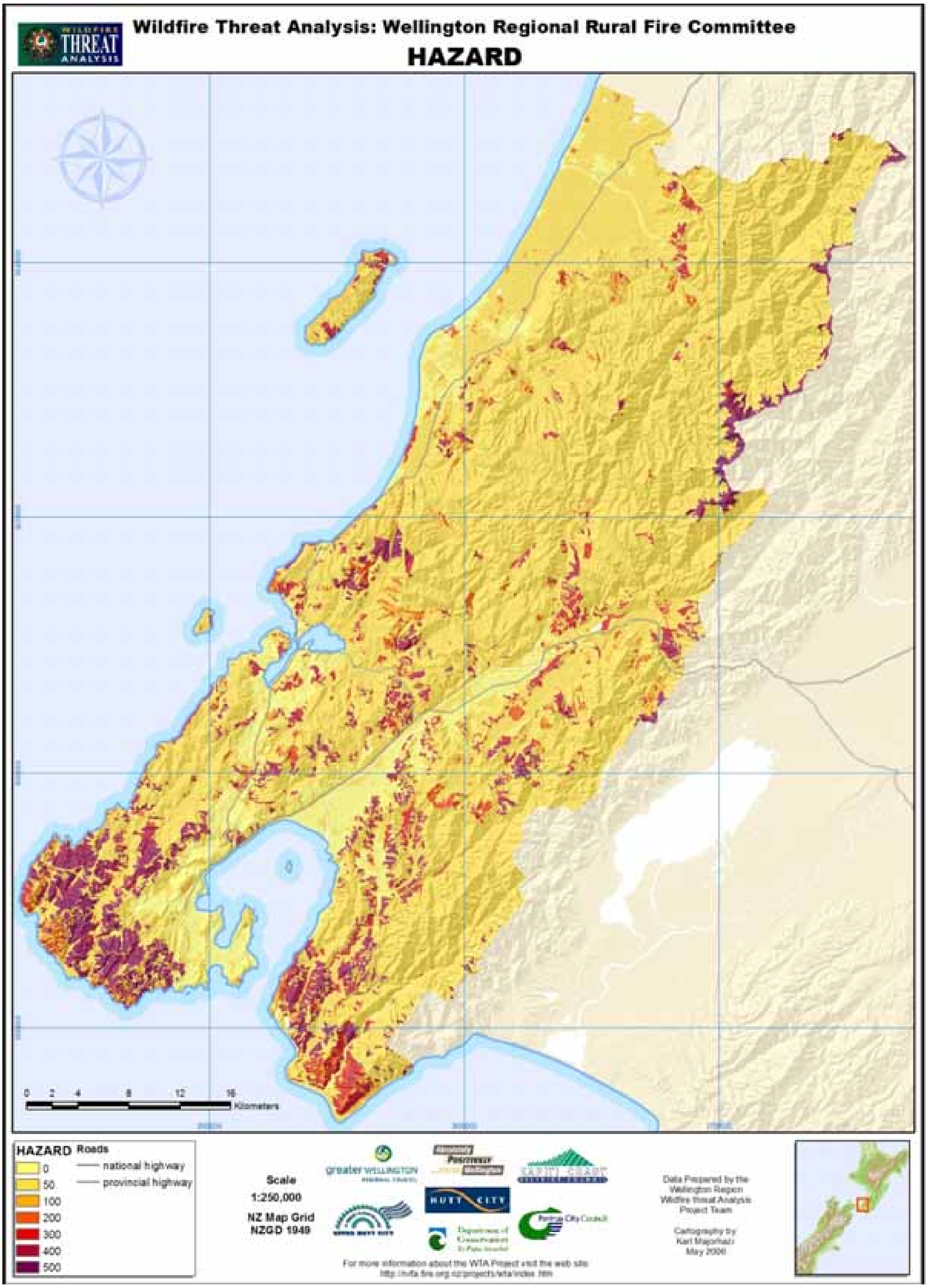


<u>*Risk*</u>

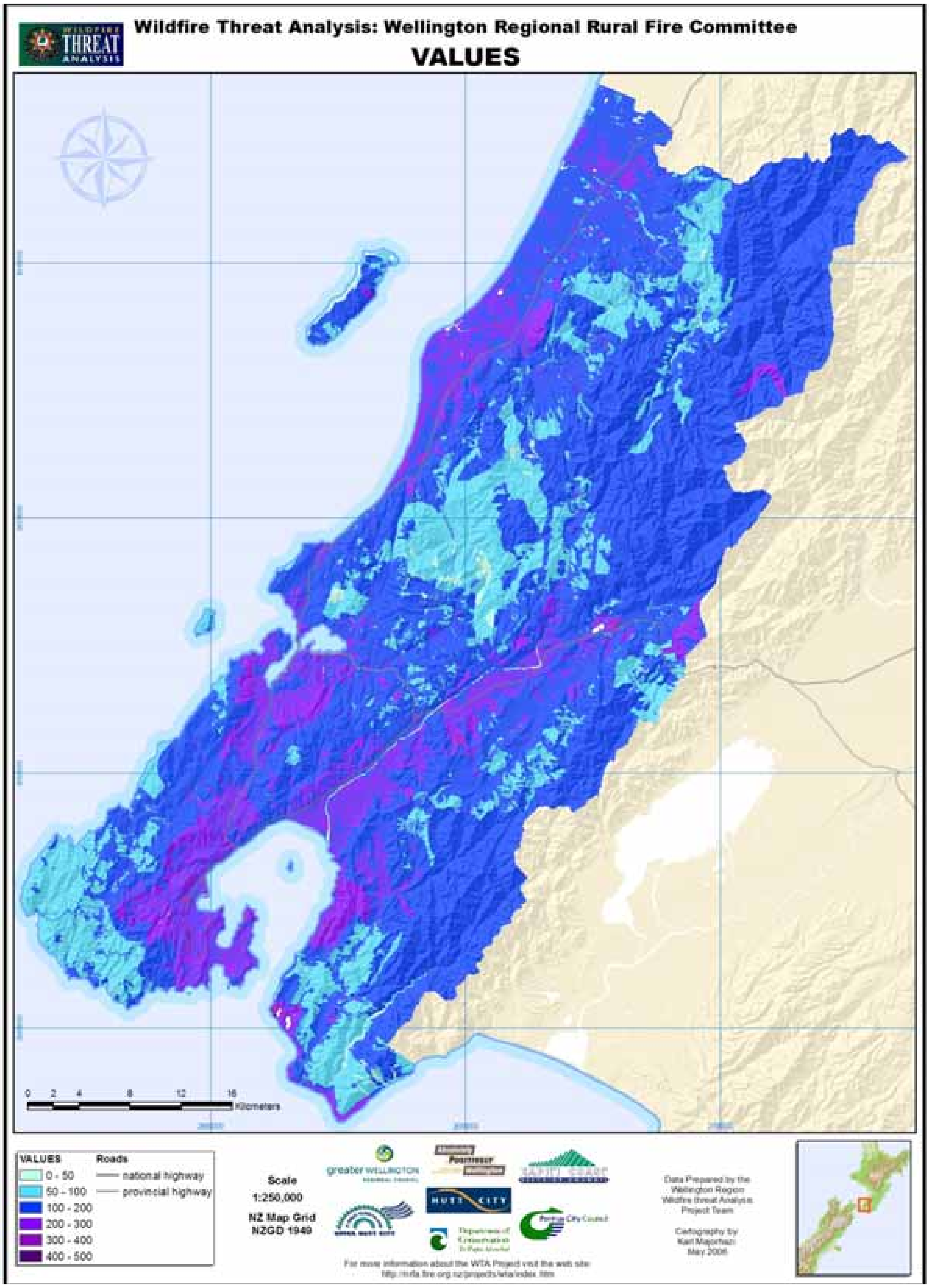


Wildfire Threat Analysis: Wellington Regional Rural Fire Committee
RISK
0 2 4 8 12 16
Kilometers
RISK
0 - 50
50 - 100
100 - 200
200 - 300
300 - 400
400 - 500
Roads
national highway
provincial highway
Scale
1:250,000
NZ Map Grid
NZGD 1949
HUTT CITY
Data Prepared by the
Wellington Region
Wildfire Threat Analysis
Project Team
Cartography by
May 2006
For more information about the WTA Project visit the web site:

HAZARD

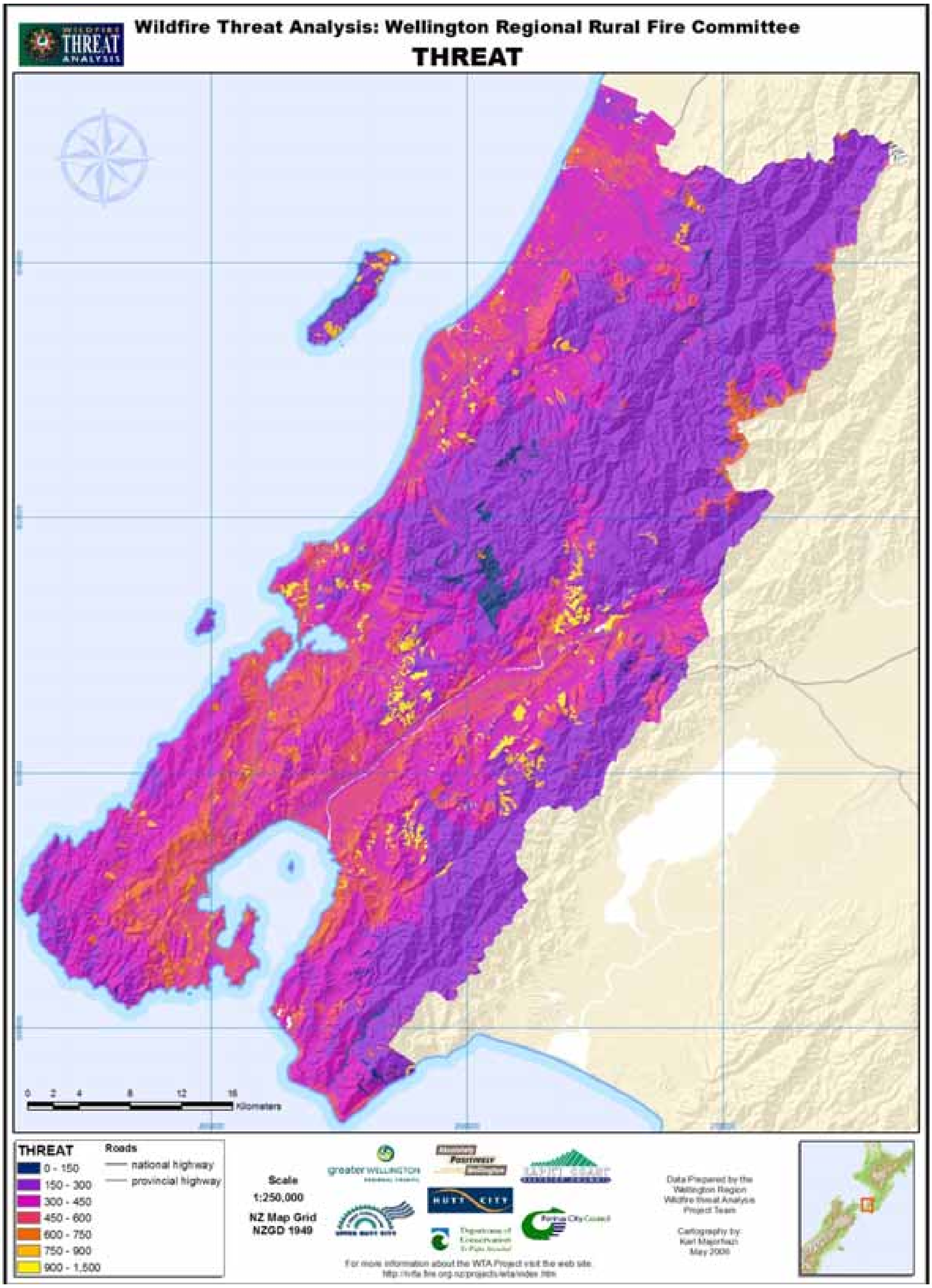

Wildfire Threat Analysis: Wellington Regional Rural Fire Committee
HAZARD
0 2 4 8 12 16
Kilometers
HAZARD
0
50
100
200
300
400
500
Roads
national highway
provincial highway
Scale
1:250,000
NZ Map Grid
NZGD 1949
Data Prepared by the
Wellington Region
Wildfire Threat Analysis
Project Team
Cartography by
Karl Majorhazi
May 2006
For more information about the WTA Project visit the web site:
http://nrfa.fire.org.nz/projects/wta/index.htm

VALUES



Wildfire Threat Analysis: Wellington Regional Rural Fire Committee
VALUES
0 2 4 8 12 16 Kilometers
VALUES
0 - 50
50 - 100
100 - 200
200 - 300
300 - 400
400 - 500
Roads
national highway
provincial highway
Scale
1:250,000
NZ Map Grid
NZGD 1949
Data Prepared by the
Wellington Region
Wildfire threat Analysis
Project Team

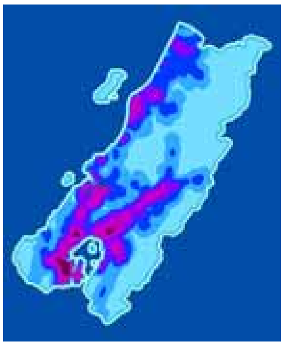
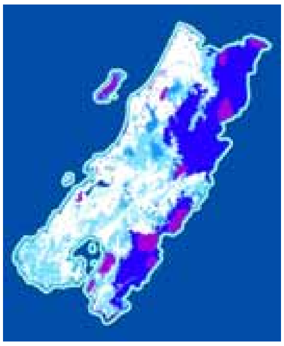
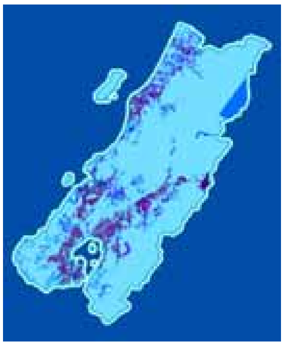
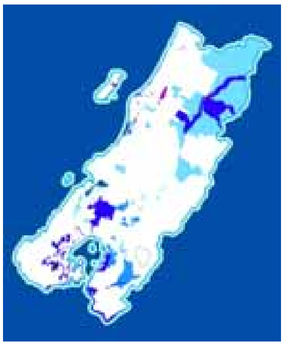
THREAT


Wildfire Threat Analysis: Wellington Regional Rural Fire Committee
THREAT
0 2 4 8 12 16
Kilometers
THREAT
0 - 150
150 - 300
300 - 450
450 - 600
600 - 750
750 - 900
900 - 1,500
Roads
national highway
provincial highway
Scale
1:250,000
NZ Map Grid
NZGD 1949
Data Prepared by the Wellington Region Wildfire threat Analysis Project Team
Cartography by:
May 2006

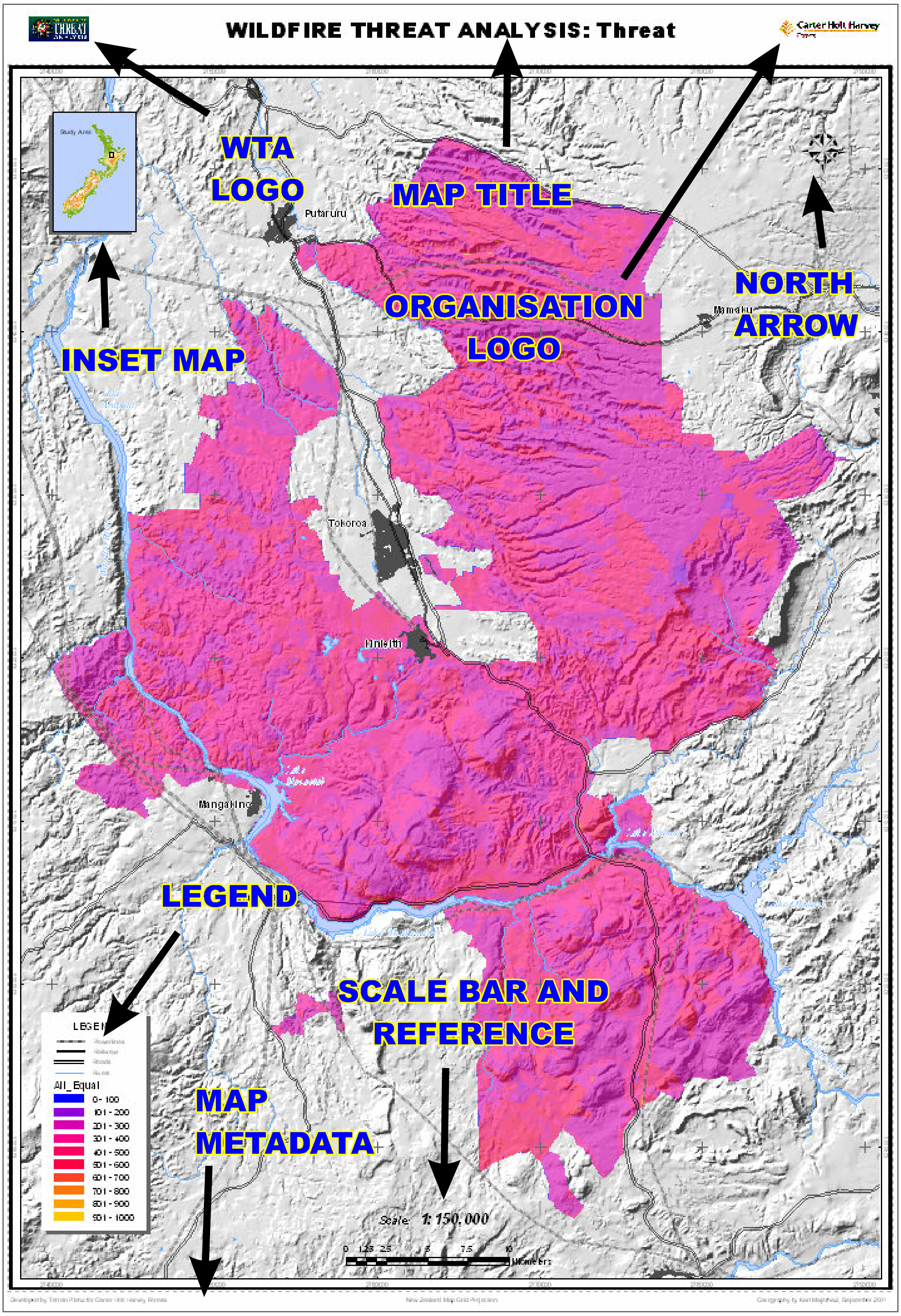
Components

Below are examples of maps made from the component datasets using the colour-ramps above. Note that HAZARD has already been created separately and many of the underlying components are not freely available. Some of these can be viewed at

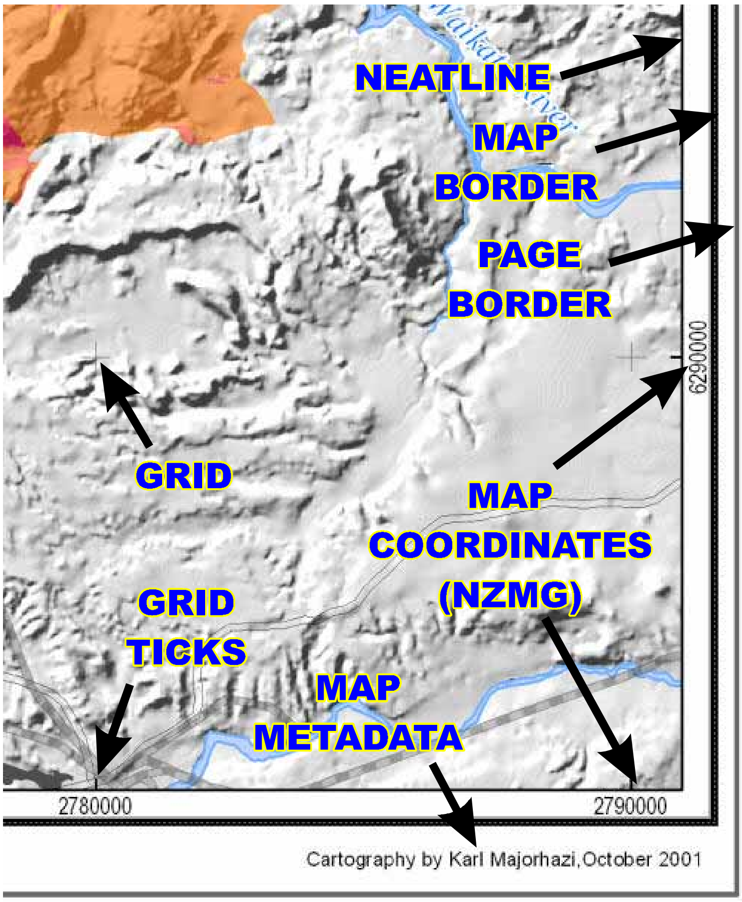
http://www.nrfa.org.nz/fire_weather/historical.htm.

RISK			
POPULATION	TRANS. POP.	ACCESSABILITY	NATURAL
			
VALUES			
LIFE	BIODIVERSITY	PROPERTY	AESTHETIC
			

MAP ELEMENTS



BORDER DETAIL



TITLE

The map title should appear outside the map border on the top of the map. The title should read “Wildfire Threat Analysis: <NAME OF MAP8>”

REFERENCING SYSTEM

All of the data supplied for Wildfire Threat Analysis is in New Zealand Map Grid. All maps should be printed in this projection.

SCALE

The scale should be appropriate to the study area. Wildfire Threat Analysis has been developed for a 1:50,000 scale.

LEGEND

The legend should contain the following elements:

- The title “Legend”.
- The themes legend.

8 Where the name of the map is RISK, HAZARD, VALUES OR THREAT. This should also apply to component maps if they are to be published.

Use black text on a white background with a drop shadow (a dark rectangle offset and underneath).

The legend should be placed in an area outside the study area but within the neatline. If this is not possible, then it should be placed in a title panel between the map border and page border.

Orientation

All maps should show north at the top of the page.

Borders

The map and page borders should have the following characteristics:

- The page border should be at the extents of the printed page. The thickness should be 0.5mm and 50% black.
- The map border should be just outside the grid labels. The thickness should be 0.7mm with a 0.25mm .
- The neatline should be 50% black and 0.3mm width.
- The font for the grid labels should be a narrow san-serif font 8 point bold.

Hydrology

Major hydrographic features such as rivers, lakes and harbours should be coloured blue and labelled in an italic serif font if appropriate.

Inset location map

The inset should be placed in an area outside the study area but within the neatline. If this is not possible, then it should be placed in the border between the map border and page border.

Use a drop shadow to help differentiate the inset from the map.

Labelling

Only major features should be labelled in order to give the reader basic reference information. Labelling over the polygons should be kept to a minimum and used where the hill shading does not provide an adequate location reference.

Map Metadata

The map metadata should be arranged along the bottom of the map in between the map border and page border. The metadata should include:

- The author and/or cartographer.
- The date the map was produced

- The authority the map was produced under.
- The projection.
- The sheet number if there is more than one map covering the study area (eg. Sheet 1 of 2).
- The edition number. There may be different versions created.

Bibliographic Reference

A bibliographic reference will be necessary for references in documents. Maps may have similar bibliographic references to documents. References should be in a similar format to this example:

***Strachan, D.**, Taylor, B., Cameron, G,; 2001;* **Wildfire Threat Analysis for Department of Conservation Canterbury Conservancy: Pilot Study**; Wildfire Threat Analysis Project: Design Phase Report;

Acknowledgements and Credits

Documents and reports relating to the development of the maps should include acknowledgements to those who assisted production. These include reviewers, field checkers, and data sources.

Colour Schemes[9]

The graphic display of data plays a critical role in visualisation and exploratory data analysis. Appropriate use of colour for data display allows interrelationships and patterns within data to be easily observed. The careless use of colour will obscure these patterns.

The Wildfire Threat Analysis maps use a sequential colour class. Sequential data classes are logically arranged from high to low, and sequential lightness steps should represent this stepped sequence of categories. Low data values are usually represented by light colours and high values represented by dark colours. Transitions between hues may be used in a sequential scheme, but the light-to-dark progression should dominate the scheme. Terrain slope categories or population densities, for example, are well represented by sequential colour schemes.

The rainbow-type colour scheme used the fire danger signs are not to be used for any of the maps. There are two reasons for this:

1. The blue and green colours are not in sequence, that is green is depicted as the low value and blue is moderate. Maps created using this colour sequence produce flawed results.

[9] Colour Use Guidelines for Mapping and Visualization. Cynthia A. Brewer (http://www.essc.psu.edu/~cbrewer/ColorSch/SchHome.html)

2. The colours represent specific values of head fire intensity. For example, red represents values of 4000Kw/m and above and is considered **EXTREME** in the fire danger class. For example, since the hazard map has values ranging from 0 to 40,000Kw/m, maps drawn with this scale will consist mostly of red. If this map was re-scaled and red represented values of 30 - 30,000, the user would not consider those values between 4,000 - 30,000 to be extreme.

ZERO AND NO DATA

The legend should include a differentiation between zero and no data values where appropriate.

No data (or null) values occur in areas where no data exists and is therefore excluded from the calculations.

Zero values are areas that are included in the calculations, but have a final value of zero.

WILDFIRE THREAT ANALYSIS

BIBLIOGRAPHY

Anon. 1991. Rural fire hazard assessment in the A.C.T. Australian Capital Territory Rural Firefighting Service, Manuka, A.C.T. 32 p.

Anon. 1993. Fire risk rating for existing and planned wildland residential interface developments in Montana. Montana Department of State Lands. 18 p + appendices.

Anon. 1994. The assessment of the relative risk from wildfire in exotic plantation forests, New Zealand. Unpublished report prepared for Agricultural Risk Management (Pacific) Ltd. by the New Zealand Forest Research Institute. (Confidential).

Anon. 1997. Wildfire threat analysis. Fact Sheet. Department of Housing and Urban Development, Planning Division, Information and Data Analysis Branch, Geographic Analysis and Research Unit, Adelaide, S.A. 3 p.

Anon. 1997. Wildfire threat analysis in a GIS environment. Wildfire Threat Analysis Fact Sheet homepage. Department of Housing and Urban Development, Adelaide, S.A. 3 p.

Anon. no date. Fire hazard mitigation. Wellington City Council, Emergency Management Office. 3 p.

Bachmann, A.; Allgöwer, B. 1998. Framework for wildfire risk analysis. In Viegas, D.X. (editor). Proceedings, 3rd International Conference on Forest Fire Research and 14th Conference on Fire and Forest Meteorology, 16-20 November 1998, Luso, Coimbra, Portugal.

Beck, J.A.; Muller, C. 1991. The inception and development of decision support systems for forest fire management in Western Australia. In Daniel, T.C.; Ferguson, I.S. (editors). Proceedings of the US-Australia Workshop Integrating Research on Hazards in Fire-Prone Environments: Reconciling Biological and Human Values in the Wildland/Urban Interface. June 12-16, 1989, Melbourne, Victoria. The United States Man and the Biosphere Program, Washington, D.C. pp 94-100.

Beer, T. 1991. Modern developments in fire modelling and decision-support systems. In Daniel, T.C.; Ferguson, I.S. (editors). Proceedings of the US-Australia Workshop Integrating Research on Hazards in Fire-Prone Environments: Reconciling Biological and Human Values in the Wildland/Urban Interface. June 12-16, 1989, Melbourne, Victoria. The United States Man and the Biosphere Program, Washington, D.C. pp 46-51.

BLM; NPS; F&WS; BIA. no date. Wildfire Prevention Analysis and Planning. U.S. Department of the Interior, Bureau of Land Management, National Park Service, Fish and Wildlife Service and Bureau of Indian Affairs. 40 p.

Borger, B. 1999. Wildfire Threat Analysis Literature Summary. New Zealand Wildfire Threat Analysis Analysis Phase Report, Appendix F. http://nrfa.fire.org.nz/projects/wta/analysisreport/index.htm

***Borger, B.* 1999. Datasets Required for the New Zealand Wildfire Threat Analysis System.** New Zealand Wildfire Threat Analysis Analysis Phase Report, Appendix G. http://nrfa.fire.org.nz/projects/wta/analysisreport/index.htm

***Borger, B.* 1999. Desktop Comparison of the Proposed NZ WTA Model with the South Australian WTA.** New Zealand Wildfire Threat Analysis Analysis Phase Report, Appendix I. http://nrfa.fire.org.nz/projects/wta/analysisreport/index.htm

***Borger, B.* 1999. New Zealand Wildfire Threat Analysis Project: The Analysis Phase.** New Zealand Wildfire Threat Analysis Analysis Phase Report. http://nrfa.fire.org.nz/projects/wta/analysisreport/index.htm

***Borger, B.* 2000. Fire Risk Patterns in Exotic Forests of New Zealand: An Expert Survey.** New Zealand Wildfire Threat Analysis Project Report. http://nrfa.fire.org.nz/projects/wta/index.htm

***Cameron, G*. 2001. New Zealand Wildfire Threat Analysis Project: Report on the Design Phase**. New Zealand Wildfire Threat Analysis Project Report.

***Cameron, G*. 2002. New Zealand Wildfire Threat Analysis Project: Report on the Pilot Studies**. New Zealand Wildfire Threat Analysis Project Report.

***Chatto, K*. 1998. Development of a wildfire threat analysis model for south-eastern Australia**. In Viegas, D.X. (editor). Proceedings, 3rd International Conference on Forest Fire Research and 14th Conference on Fire and Forest Meteorology, 16-20 November 1998, Luso, Coimbra, Portugal.

***Dempster, W*.R.; Stevens, N.A. 1987. Risk management in forest planning.** Forestry Canada and Alberta Department of Forestry, Lands and Wildlife, Edmonton, Alberta. Canada-Alberta Forest Resource Development Agreement Project # B31444-18 Report. 38 p + appendices.

***Dovey, S*. 1995. Analysing bushfire threat in southern New South Wales.** Bushfire '95: Presented papers, Australian Bushfire Conference, 27-30 September 1995, Hobart, Tasmania.

***Fogarty, L.G*. 1993. Risk assessment and fire management using Geographical Information Systems: the Australian experience.** NZ FRI Project Record No. 3641.

***Forme Consulting*. 1997. Interface Fire Hazard Susceptibility: study area 1 - Wellington City.** Report prepared for the Wellington Regional Council, August 1997.

***Forme Consulting*. 1997. Recent urban interface wildfires in the Wellington region.** Report prepared for the Wellington Regional Council, August 1997.

***Garvey, M*. 1994. The use of Geographic Information Systems to analyse wildfire threat.** Online. Country Fire Authority of Victoria, Risk Management Department. http://www.vicnet.au/vicnet/club/cfa/garvey. 4 p.

***Garvey, M*. 1997. Wildfire Threat Analysis: GIS applications of the CFA.** Presentation to the NZ Fire Service, 14 November 1997, Wellington.

***Grigel, J.E*.; Lieskovsky, R.J.; Kiil, A.D. 1971. Fire hazard classification for Waterton Lakes National Park**. Canadian Forestry Service, Northern Forestry Research Centre, Edmonton, Alberta. Information Report NOR–X–7. 18 p.

Hawkes, B.; Beck, J. 1996. A wildfire threat rating system for McGregor Model Forest. Abstracts, 13th Conference on Fire and Forest Meteorology, 27-31 October 1996, Lorne, Australia. pp 19. (Abstract only).

Hawkes, B.; Beck, J. 1997. A Wildfire Threat Rating System. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre. Technology Transfer Notes 1 (July 1997). 6 p.

Hay, C. 1996. A wildfire hazard rating model for structures/parcels in the urban-wildland interface. Abstracts, 13th Conference on Fire and Forest Meteorology, 27-31 October 1996, Lorne, Australia. pp 20. (Abstract only).

Johnson, N. no date. A wildfire hazard identification and mitigation system for Boulder Counter, Colorado. WHIMS Project Summary. Boulder County Land Use Department, Boulder, Colorado. 4 p.

Kiil, A.D.; Lieskovsky, R.J.; Grigel, J.E. 1973. Fire hazard classification for Prince Albert National Park, Saskatchewan. Canadian Forestry Service, Northern Forestry Research Centre, Edmonton, Alberta. Information Report NOR-X-58. 26 p.

Leathwick, J, R, Briggs, C, M. 2001. Spatial Prediction of Wildfire Hazard Across New Zealand. Prepared for the New Zealand Fire Service Commission's Contestable Research Fund, 1999-2000. Landcare Research Contract Report: LCR 0001/081.

Majorhazi, K.1998. Wildfire Threat Analysis for New Zealand. Online. National Rural Fire Authority. http://nrfa.fire.org.nz/projects/wta/about/WTA.html

Majorhazi, K., Borger, B. 1999. Wildfire Threat Analysis: Meeting the Challenges of National Implementation. *National Rural Fire Authority, Wellington,* presented to the AURISA 99 Conference, Sydney, Nov 22-26 1999.

Majorhazi, K. 1999. Wildfire Threat Analysis Data Assessment. New Zealand Wildfire Threat Analysis Analysis Phase Report, Appendix H. http://nrfa.fire.org.nz/projects/wta/analysisreport/index.htm

Majorhazi, K. 2001. Risky Roads: An Initial Study of Incident Locations Adjacent to Roads. New Zealand Wildfire Threat Analysis Project Report.

Majorhazi, K. Brunclikova, I. 2002. A Population Density Model for New Zealand's Wildfire Threat Analysis. In preparation.

Majorhazi, K. 2002. Wildfire Threat Analysis Workbook. New Zealand Wildfire Threat Analysis Project Report.

Malcolm, I.; Smith, K.; Oh, T.; Collins, N. 1995. Wildfire threat analysis. Bushfire '95: Presented papers, Australian Bushfire Conference, 27-30 September 1995, Hobart, Tasmania.

McRae, R.H.D. 1995. Analysis of rural ignition patterns on Canberra's urban/rural interface. Landscape Fires'93: Proceedings of an Australian Bushfire Conference, Perth, Western Australia, 27-29 September 1993. Western Australian Journal of Conservation and Land Management, CALMScience Supplement 4. pp 93-100.

Morris, W.; Barker, J.R. 1981. Fire hazard mapping. Country Fire Authority of Victoria, East Kew, Victoria. 11 p.

***Muller, C*. 1993. Wildfire threat analysis - an effective decision support system for fire protection planning.** In The Burning Question: Fire Management in New South Wales, August 5-7, Coffs Harbour, NSW, Australia.

***Muller, C*. 1993. Wildfire threat analysis manual - for lands managed by the Department of Conservation and Land Management, Western Australia.** 23 p + appendices.

***Northland Forest Managers*. 1995. Wildfire Threat Analysis: Waitakere Rural Fire District.**

***NPS*. no date. Wildland Fire Prevention Analysis Handbook.** U.S. Department of the Interior, National Park Service. 47 p.

***NZ Forest Service*. 1966. Forest Fire Risk Grading.** New Zealand Forest Service, Fire Control Branch. 16 p.

***NZ Forest Service*. 1975. Forest fire risk grading**. 2nd edition. New Zealand Forestry Service, Wellington, New Zealand. 24 p.

***Olsen, A*. 2000. A Pilot Study to Identify Strategies to Assess Vegetation Fire Hazards.** Prepared for the New Zealand Fire Service Commission's Contestable Research Fund, 1999-2000.Social Sciences Department, Chilton Saint James School

***Salas, J*.; Chuvieco, E. 1994. Geographic Information Systems for wildland fire risk mapping.** Wildfire 3(2): 7-13.

***Smithies, C*. 1997. Development of a Wildfire Threat Analysis and Reporting System: scoping study**. National Rural Fire Authority. Draft 6, December 1997.

***Smithies, C.W.* 1998. Some notes on wildfire threat analysis development in New Zealand.** Discussion paper prepared for a meeting of the NRFA Wildfire Threat Analysis Consultative Team, 17 Sept. 1998, Wellington.

***Sneeuwjagt, R*. 1998. Application of wildfire threat analysis in south-western forest of Western Australia.** In Viegas, D.X. (editor). Proceedings, 3rd International Conference on Forest Fire Research and 14th Conference on Fire and Forest Meteorology, 16-20 November 1998, Luso, Coimbra, Portugal.

***Vodopier, J*.; Haswell, D. 1995. The application of wildfire threat analysis in forests of southwestern Australia.** Bushfire '95: Presented papers, Australian Bushfire Conference, 27-30 September 1995, Hobart, Tasmania.

ACCESSIBILITY

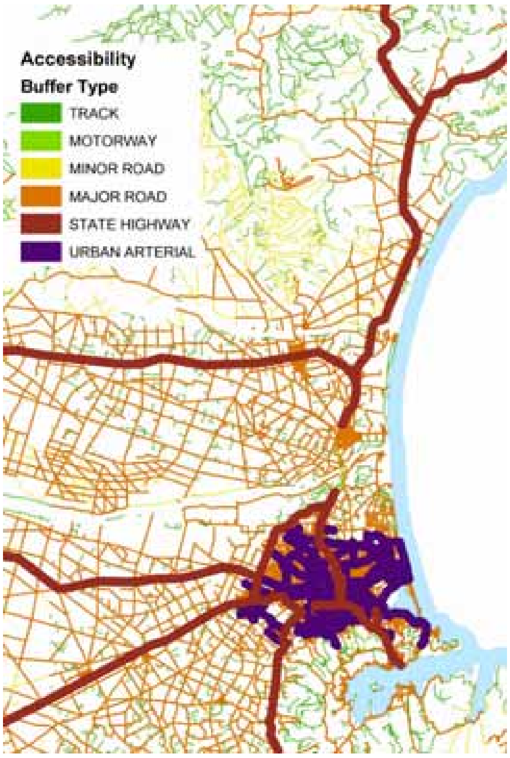
DATA SET

TITLE

Accessibility.

JURISDICTION

New Zealand



DESCRIPTION

ABSTRACT

Buffers for various types of roads were created to define the areas where there is a risk of fire ignitions for types of road. The road types were taken from the New Zealand Fire Service road network. The categories with buffer widths are Urban Arterial (500m), State Highway (500m), Major Road (100m), Minor Road (50m), Motorway (100m), and Tracks (50m). The order of this list is also the hierarchy for weighting. The value for intersecting polygons was taken as the highest in the hierarchy (not accumulated). Weightings were assigned according to the number of incidents per 100km of road.

SEARCH WORD(S)

Accessibility, roads, motorways, tracks, buffers.

GEOGRAPHIC EXTENT NAME(S)

New Zealand

GEOGRAPHIC EXTENT POLYGON(S)

DATA CURRENCY

BEGINNING DATE

March 2010.

ENDING DATE

December 2010.

DATA SET STATUS

PROGRESS

Current Accessibility Version has been completed. The Data Set should be regenerated when the road network is updated and/or further research is conducted on the size and nature of the buffer widths.

MAINTENANCE AND UPDATE FREQUENCY

Only when required for future versions of Wildfire Threat Analysis.

DESIRED MAINTENANCE AND UPDATE FREQUENCY

Only when required for future versions of Wildfire Threat Analysis.

Access

STORED DATA FORMAT(S)

POLYGON - ESRI Shape file and Coverage.

AVAILABLE FORMAT TYPE(S)

ESRI Shape file and Coverage.

ACCESS CONSTRAINT

None

DATA QUALITY

LINEAGE

Source Data:

Separate NZAM roads by Road Class

Exclude legal roads and walkways from NZAM Roads.

Use tracks from NZTOPO. NZAM tracks are incomplete.

Width and ranking as follows:

Road Class	Buffer	Ranking Order
Motorway	100m	2
State Highway	500m	5
Urban Arterial	500m	6
Major Road	100m	4
Minor Road	50m	3
Track	50m	1

Separate buffer coverages joined by UNION. Attributes modified.

Note: Alter “INSIDE” attribute to a unique name as each successive UNION will overwrite attributes of the same name.

UNION highway and urban_arterial to unioncover1

UNION unioncover1 and major_roads to unioncover2

UNION unioncover2 and minor_roads to unioncover3

UNION unioncover3 and motorways to unioncover4

UNION unioncover4 and tracks to unioncover5

COPY unioncover5 to editcover6

Add field "buffer_ty" to editcover6

Populate buffer_ty with the buffer with the highest ranking where inside attribute = 100 (ie if major_rd_inside = 100 and urban_art_inside = 100 then buffer_ty = "URBAN ARTERIAL")

Polygons DISSOLVED on buffer_ty <> ""

POSITIONAL ACCURACY

+_ 20 metres.

ATTRIBUTE ACCURACY

COMPLETENESS

100%.

CONTACT INFORMATION

CONTACT ORGANISATION

Data and Spatial Intelligence Team – New Zealand Fire Service

CONTACT POSITION

Spatial Intelligence Team Leader

MAIL ADDRESS 1

PO Box 2133

MAIL ADDRESS 2

SUBURB/PLACE/LOCALITY

STATE/LOCALITY 2

Wellington

COUNTRY

New Zealand

POSTCODE

TELEPHONE

+64 4 496 3600

FACSIMILE

+64 4 496 3731

ELECTRONIC MAIL ADDRESS

DSI-Support@fire.org.nz

METADATA DATE

28 September 2010

ADDITIONAL METADATA

POPULATION DENSITY

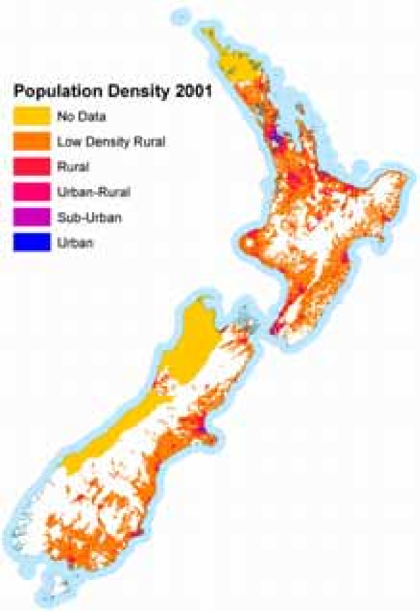
DATA SET

TITLE

Population Density - Version 2.

JURISDICTION

New Zealand



DESCRIPTION

ABSTRACT

In New Zealand, it is accepted that if there were no people, there would be few or no fires. The more people there are, the more fires are likely to occur. Population therefore is an important part of a Wildfire Threat Analysis. The only nationally available spatial dataset covering population are Statistic New Zealand meshblocks. Unfortunately, this is a very coarse dataset for use at 1:50,000 scale and does not have enough resolution for Wildfire Threat Analysis. A new population model had to be specially built for this Wildfire Threat Analysis.

This dataset is built around address points using the Statistics New Zealand meshblock values to assign a number of people per dwelling to create a surface that would be converted to polygons.

SEARCH WORD(S)

Population, density, rural, urban, suburban, census.

GEOGRAPHIC EXTENT NAME(S)

New Zealand

GEOGRAPHIC EXTENT POLYGON(S)

DATA CURRENCY

BEGINNING DATE

March 2010.

ENDING DATE

DATASET STATUS

PROGRESS

The Current Version has been completed using 2006 census information and address points current to 2010. The dataset should be regenerated when the address point database is updated and/or new census data is available.

MAINTENANCE AND UPDATE FREQUENCY

Required for future versions of Wildfire Threat Analysis.

DESIRED MAINTENANCE AND UPDATE FREQUENCY

Required for future versions of Wildfire Threat Analysis.

Access

STORED DATA FORMAT(S)

POLYGON - ESRI Shape file and Coverage.

AVAILABLE FORMAT TYPE(S)

ESRI Shape file and Coverage.

ACCESS CONSTRAINT

None

Data Quality

LINEAGE

1. Overlay and attach average number of people per household from the meshblock framework.
2. Create density surface from the point data using the number of people per household, a 2000m KERNEL interpolation radius and a 100m grid.
3. Reclassify and convert the grid to polygons. The units represent the number of people per square kilometre. Use the following classes:

   0=unpopulated,

   0-10=Low Density Rural

   10-100=Rural,

   100-750=Urban-Rural,

   750-2000=Sub-urban,
4. 2000=Urban.
5. Add a new field for density type and populate with the text description.
6. Union “No Data” polygons.
7. Dissolve on population density type.

Note: *The dataset has not been clipped to a coastline in order to allow users to clip to their own versions of the coastline.*

POSITIONAL ACCURACY

+_ 20 metres.

ATTRIBUTE ACCURACY

Classes are based on relative, not actual values.

COMPLETENESS

13 out of the 74 Territorial Authorities had incomplete address point data. Their areas were masked from the final dataset.

Contact Information

CONTACT ORGANISATION

Data and Spatial Intelligence Team – New Zealand Fire Service

CONTACT POSITION

Spatial Intelligence Team Leader

MAIL ADDRESS 1

PO Box 2133

MAIL ADDRESS 2

SUBURB/PLACE/LOCALITY

STATE/LOCALITY 2

Wellington

COUNTRY

New Zealand

POSTCODE

TELEPHONE

+64 4 496 3600

FACSIMILE

+64 4 496 3731

ELECTRONIC MAIL ADDRESS

DSI-Support@fire.org.nz

METADATA DATE

01 March 2010

ADDITIONAL METADATA

PROBABILITY OF IGNITION (POI)

DATA SET

TITLE

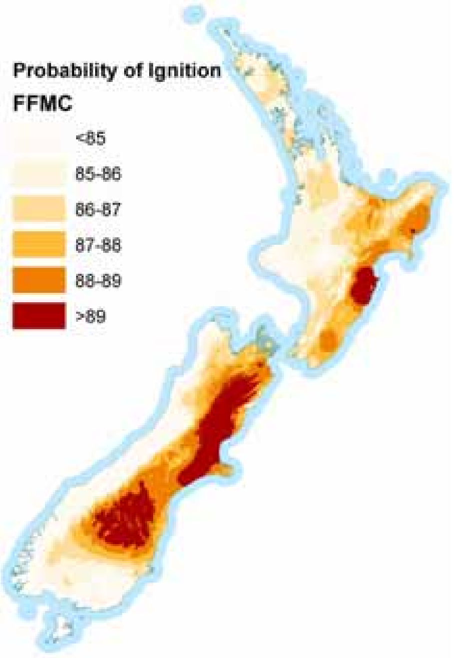
Probability of Ignition.

JURISDICTION

New Zealand.

DESCRIPTION

ABSTRACT



In addition to the various factors that contribute to the likelihood of ignitions, one of the keys is having an environment (climate and fuel) that turns an ignition into an incident. This is referred to as a "sustained ignition".

This "Probability of Ignition" layer (POI) differentiates areas that may have potentially the same number of ignitions but climatic conditions may prevent those ignitions from growing and spreading from those where ignitions are more likely to grow and spread into fires.

For the Wildfire Threat Analysis project, the Fine Fuel Moisture Code (FFMC) component of the Fire Weather Index (FWI) system is used to determine the potential for sustained ignition. The FFMC is defined in the Rural Fire Management Glossary of Terms as:

"A numerical rating of the moisture content of litter and other cured fine fuels. This code is an indicator of the relative ease of ignition and flammability of fine fuel."

The FFMC ranges from 0 to 101 with a value of 86 indicating high level of dryness and 92 extreme.

To create the POI layer, the FFMC grid was classified into a number of classes representing FFMC value ranges. These classes were:

- FFMC < 85
- FFMC 85-86
- FFMC 86-87
- FFMC 87-88
- FFMC 88-89
- FFMC > 89

These were converted into multipliers between 1 and 2 and applied to the risk module.

SEARCH WORD(S)

Probability of Ignition, POI, Sustainability of Ignition, Fine Fuel Moisture Code, FFMC.

GEOGRAPHIC EXTENT NAME(S)

New Zealand.

GEOGRAPHIC EXTENT POLYGON(S)

Data Currency

BEGINNING DATE

March 2010

ENDING DATE

March 2010

Data Set Status

PROGRESS

Complete.

MAINTENANCE AND UPDATE FREQUENCY

When new fire climate grids have been produced. This has not yet been determined.

DESIRED MAINTENANCE AND UPDATE FREQUENCY

As frequently as the climate grids are being produced.

Access

STORED DATA FORMAT(S)

ESRI shape file. One for the entire country.

AVAILABLE FORMAT TYPE(S)

ESRI shape file.

ACCESS CONSTRAINT

None.

Data Quality

LINEAGE

Reclassified and converted the FFMC grid to ungeneralised polygons.

POSITIONAL ACCURACY

The spatial resolution is 100 metre grid cells.

ATTRIBUTE ACCURACY

COMPLETENESS

Complete.

Contact Information

CONTACT ORGANISATION

Data and Spatial Intelligence Team – New Zealand Fire Service

CONTACT POSITION

Spatial Intelligence Team Leader

MAIL ADDRESS 1

PO Box 2133

MAIL ADDRESS 2

SUBURB/PLACE/LOCALITY

STATE/LOCALITY 2

Wellington

COUNTRY

New Zealand

POSTCODE

TELEPHONE

+64 4 496 3600

FACSIMILE

+64 4 496 3731

ELECTRONIC MAIL ADDRESS

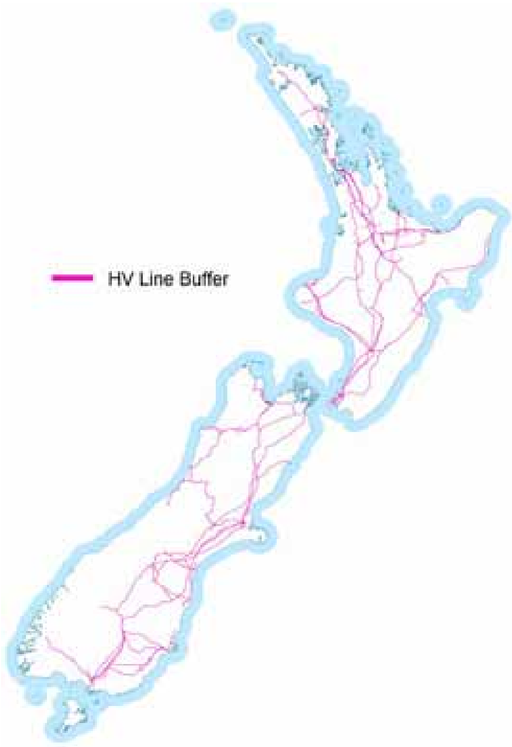
DSI-Support@fire.org.nz

METADATA DATE

March 2010.

Additional metadata.

High Voltage Powerline Buffers



Data Set

TITLE

High Voltage Powerline Buffers

JURISDICTION

New Zealand

Description

ABSTRACT

High voltage powerlines are both a RISK and a VALUE within the Wildfire Threat Analysis system. A buffer of 20 meters has been determined to be an applicable distance to apply to this linear feature.

SEARCH WORD(S)

High voltage powerlines, buffers.

GEOGRAPHIC EXTENT NAME(S)

New Zealand

GEOGRAPHIC EXTENT POLYGON(S)

Data Currency

BEGINNING DATE

November 2010

ENDING DATE

Data Set Status

PROGRESS

The current version has been completed. The Data Set should be regenerated when the powerline network is updated.

MAINTENANCE AND UPDATE FREQUENCY

Only when required for future versions of Wildfire Threat Analysis.

DESIRED MAINTENANCE AND UPDATE FREQUENCY

Only when required for future versions of Wildfire Threat Analysis.

Access

STORED DATA FORMAT(S)

POLYGON - ESRI Shape file and Coverage.

AVAILABLE FORMAT TYPE(S)

ESRI Shape file and Coverage.

ACCESS CONSTRAINT

None

Data Quality

LINEAGE

The original feature set was obtained from Tranzpower through Terralink who provide the data maintenance services. The original data consisted of a line feature set to depict the wires and a point feature set to depict the pylons. The buffers were created using only the line features.

There are some differences between this dataset and the powelines from NZ TOPO. According to Tranzpower, this was due LINZ not utilising the latest Tranzpower data. it was therefore assumed that Tranzpower held the authoritative source.

POSITIONAL ACCURACY

ATTRIBUTE ACCURACY

COMPLETENESS

100%.

Contact Information

CONTACT ORGANISATION

Data and Spatial Intelligence Team – New Zealand Fire Service

CONTACT POSITION

Spatial Intelligence Team Leader

MAIL ADDRESS 1

PO Box 2133

MAIL ADDRESS 2

SUBURB/PLACE/LOCALITY

STATE/LOCALITY 2

Wellington

COUNTRY

New Zealand

POSTCODE

TELEPHONE

+64 4 496 3600

FACSIMILE

+64 4 496 3731

ELECTRONIC MAIL ADDRESS

DSI-Support@fire.org.nz

METADATA DATE

10 July 2010

ADDITIONAL METADATA

HAZARD

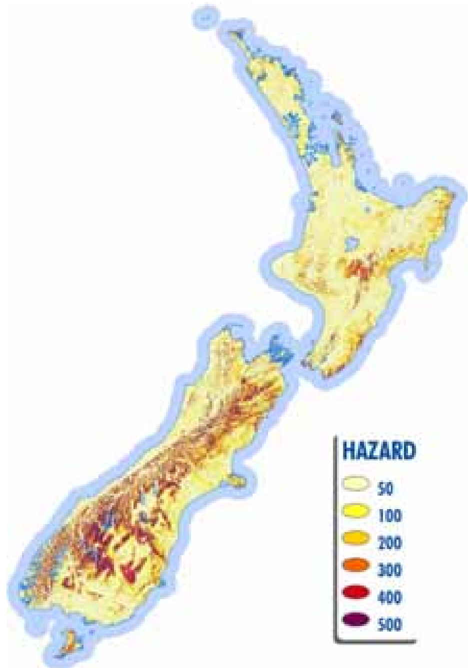
DATA SET

TITLE

Hazard

JURISDICTION

New Zealand



DESCRIPTION

ABSTRACT

The Hazard module of the Wildfire Threat Analysis System is derived from the measure of Head Fire Intensity. A spatial fire climatology was created by Landcare Research and the Forest Research fire research project using long-term averages using the National Rural Fire Authority's and NIWA's climate database.

Various surfaces have been developed for the Fire Weather Index system that calculates indices for vegetation moisture and potential fire behaviour.

Derived FWI Layers:

Fuel Load: indicates the dry weight of combustible materials per unit area, measured in kilograms per square metre (kg/m3) or tonnes per hectare (t/ha).

Slope Correction Factor: a dimensionless coefficient that indicates the effect of slope on fire rate of spread. Fire is assumed to travel more rapidly up slope due to heat convection and radiation.

Degree of Cure (DoC): indicates the degree of drying and is used in determining rate of fire spread in grass fuel types.

Rate of Spread (ROS): the progress per unit time of the head fire or another specified part of the fire perimeter, generally measured as metres per hour (m/hr).

Head Fire Intensity (HFI): the portion of a fire edge showing the greatest rate of spread and fire intensity (e.g., up slope).

The methodology is published as:

Landcare Research Contract Report: LC0506/014

Spatial Prediction of Wildfire Hazard across New Zealand: A Significant Upgrade

Craig Briggs, Robbie Price, and Grant Pearce

http://www.nrfa.org.nz/research/_docs/WildfireReport_Upgrade05_v2.pdf

SEARCH WORD(S)

Wildfire Hazard, Fire Climate, Fire Weather Indices, head fire intensity

GEOGRAPHIC EXTENT NAME(S)

New Zealand

GEOGRAPHIC EXTENT POLYGON(S)

DATA CURRENCY

BEGINNING DATE

January 1961 – the date of the first weather record.

ENDING DATE

January 2010 – the date of the last weather record.

DATA SET STATUS

PROGRESS

This data set has been completed.

MAINTENANCE AND UPDATE FREQUENCY

This data set will be updated when required. The previous version of the dataset was created in 2010.

DESIRED MAINTENANCE AND UPDATE FREQUENCY

Every 3 – 5 years

ACCESS

STORED DATA FORMAT(S)

ESRI Grid.

AVAILABLE FORMAT TYPE(S)

ESRI Shape file, ESRI Grid, ASCII grid.

ACCESS CONSTRAINT

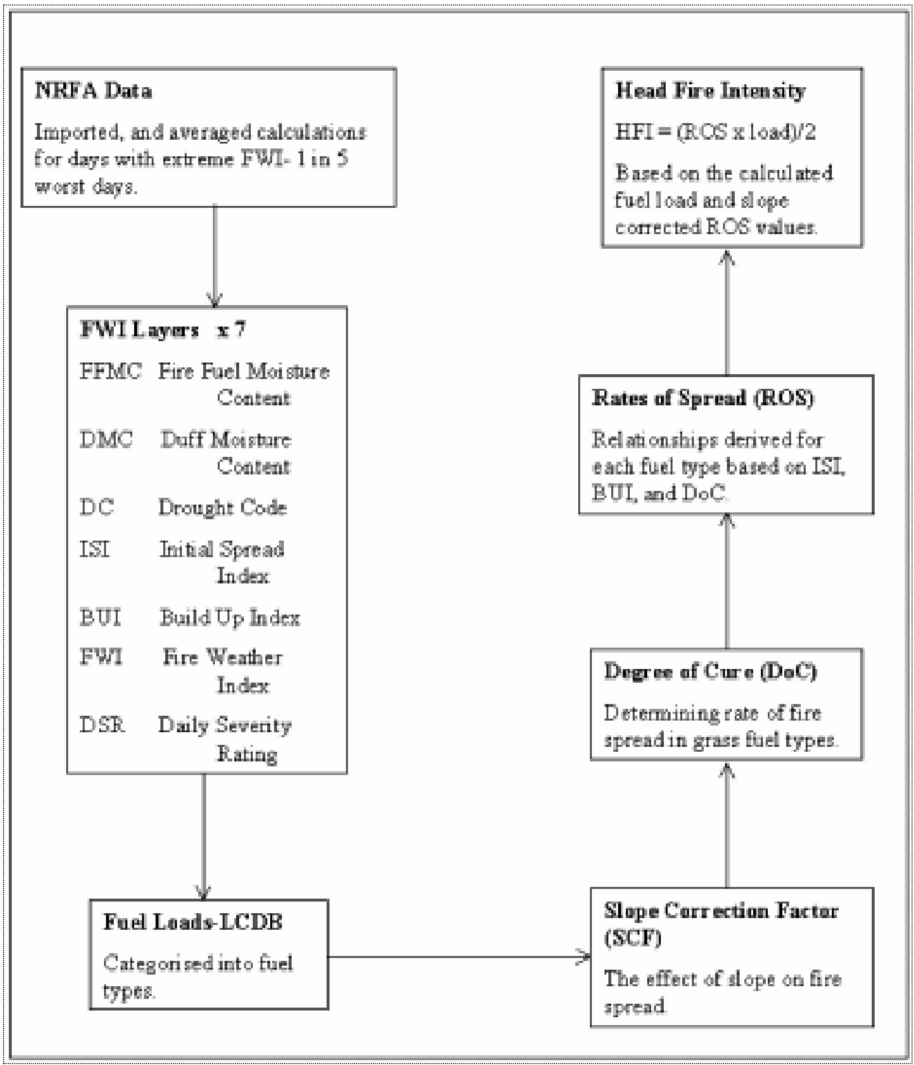
None

DATA QUALITY

LINEAGE

Weather data measured over time across the NRFA weather station network were used to calculate average fire hazard during the worst 20% of days in the fire season. Mathematical surfaces were fitted to these data to enable estimation of standard fire weather indices (FWI) across New Zealand. The resulting grid data layers (rasters) describing FWI indices were combined with data describing fuel loads and slope to derive additional data layers describing rate of fire spread and head fire intensity.

The process used is outlined below (from Leathwick and Briggs 2001):



POSITIONAL ACCURACY

The spatial resolution is 25 metre grid cells.

ATTRIBUTE ACCURACY

COMPLETENESS

This data set is complete.

CONTACT INFORMATION

CONTACT ORGANISATION

Data and Spatial Intelligence Team – New Zealand Fire Service

CONTACT POSITION

Spatial Intelligence Team Leader

MAIL ADDRESS 1

PO Box 2133

MAIL ADDRESS 2

SUBURB/PLACE/LOCALITY

STATE/LOCALITY 2

Wellington

COUNTRY

New Zealand

POSTCODE

TELEPHONE

+64 4 496 3600

FACSIMILE

+64 4 496 3731

ELECTRONIC MAIL ADDRESS

DSI-Support@fire.org.nz

METADATA DATE

November 2010

ADDITIONAL METADATA

DATA CONFIDENTIALITY AGREEMENT

The following can be copied and pasted into a document to create a formal agreement with a data supplier who wishes to keep their data out of the public domain.

Non-Disclosure Agreement

Between

____

(the supplier)

and

____

(the custodian)

for data supplied for the creation of Wildfire Threat Analysis information.

Definitions:

The **SUPPLIER** is the owner, steward and/or custodian of spatial data.

The **CUSTODIAN** is the holder of the supplied spatial data.

SPATIAL DATA are the digital representations of geographic features and associated attribute data.

WILDFIRE THREAT ANALYSIS is a national methodology published by the National Rural Fire Authority to highlight and quantify the level of threat regions face from vegetation fires.

In this agreement, the supplier agrees to supply spatial data for use in the creation of Wildfire Threat Analysis information. The custodian agrees not to distribute the supplied data or make that data viewable to any third party through any means.

The supplied data will be processed to create derivative datasets that will be further combined using the published Wildfire Threat Analysis methodology. As a result of processing, the derivative datasets **WILL NOT** retain any supplied attribute information but **MAY** retain its spatial representation.

Description of the supplied data:

Citation

Abstract

Resource Format

Delivery method

Signed on behalf of the supplier	Signed on behalf of the custodian
Date	Date

ACKNOWLEDGEMENTS

Many people have been involved in this project over its duration. The main participants have been listed below. Others have been used as sounding boards or consulted with who deserve our gratitude. These are:

Brad Hawkes and Judy Beck (BC Forest Service, Canada)

Brett Shields

Mark Garvey (CFA)

Noreen Krusel (CFA)

Rick McRae (ACT)

Mark Chladil (Tasmanian Fire Service)

PARTICIPANTS IN THE WILDFIRE THREAT ANALYSIS DEVELOPMENT PROJECT

Bryan Cartelle (Manukau City Council)

Ingrid Brunclikova (Manukau City Council)

John Blythe (Manukau City Council)

Rod Farrow

Bob Cuff (Terrain Planz)

Rick Sampson (Terrain Planz)

John Leathwick (Landcare Research)

Craig Briggs (Landcare Research)

Tony Teeling (Department of Conservation)

Dean Strachan (Department of Conservation)

Norm Thornley (Department of Conservation)

Brian Taylor (Department of Conservation)

Mark Day (Department of Conservation)

Grant Pearce (Forest Research)

Greg Baxter

Bert Borger

Geoff Cameron

Colin Smithies (National Rural Fire Authority)

Karl Majorhazi (National Rural Fire Authority)

Thanks also to:

Sarah Cowell from LINZ for helping translate the ANZLIC metadata into a Wildfire Threat Analysis version of the New Zealand Geospatial Metadata Standard (NZGMS).

Joseph Montgomery, New Zealand Fire Service Legal Advisor for drafting the non-disclosure with fewer words than the authors first draft.

APPENDIX 1

DEFINITION OF FIRE MANAGEMENT TERMS

CONSEQUENCE: The outcome of an *event* or situation expressed *qualitative*ly or *quantitative*ly, being a loss, injury or gain.

CLIMATE: The prevailing atmospheric *phenomena* and conditions of temperature, humidity, wind etc., of a country or region.

COST: The cost of activities, both direct and indirect, involving any negative impact, including money, time, labour, disruption, goodwill, political and *intangible* losses.

DATA SET: A set or subset of data relating to a particular theme. In Wildfire Threat Analysis this would be any GIS data layer.

DEGREE OF CURING: An estimate of the proportion of dead material expressed as a percentage of the total volume of grass.

ECOSYSTEM: The interacting system of a biological community, both plant and animal, and its non living surroundings.

EVENT: An incident or situation, which occurs in a particular place during a particular interval of time.

EXTREME FIRE BEHAVIOUR: A level of fire behaviour that ordinarily precludes methods of direct suppression action. One or more of the following characteristics is usually involved:

- high rates of spread and fire intensity
- prolific crowning and/or spotting
- presence of fire whirls
- a strong convective column

Predictability can be difficult because such fires often exercise some degree of influence on their environment and behave erratically, sometimes dangerously.

FINE FUELS = LIGHT FUELS: *Fuel*s such as grass, leaves, dropped pine needles, fern tree moss, and some kinds of slash that ignite rapidly and are consumed rapidly when dry.

FIRE AUTHORITY: Means:

a) In relation to a rural fire district, the rural fire committee in which the administration of the district is vested or, as the case may be, the Minister of Conservation or the Minister of Defence.

b) In relation to a territorial area, the territorial authority having jurisdiction in respect of that area.

c) In relation to any State area, the Minister of Conservation.

d) In relation to the fire safety margin of any State area, the Minister of Conservation to the extent provided by section 14(5) of this Act.

e) In relation to any land or other *property* subject to any agreement or arrangement made pursuant to subsection (1) or subsection (2) of section 14 of this Act, the party thereby appointed to act.

Provided that the power and duties of that party as a Fire Authority shall extend only as far as is provided by that agreement or arrangement.

f) In relation to any land or other *property* in respect of which a local authority exercises the functions of a Fire Authority pursuant to section 9(b) of this Act, that local authority to the extent approved under that section by the New Zealand Fire Service Commission.

FIRE BEHAVIOUR: The manner in which *fuel* ignites, flame develops, and fire spreads and exhibits other related *phenomena* as determined by the interaction of *fuel*s, weather, and *topography*.

Fire climate: **THE COMPOSITE PATTERN OR INTEGRATION OVER TIME OF THE *FIRE WEATHER* ELEMENTS THAT AFFECT FIRE OCCURRENCE AND FIRE BEHAVIOUR IN A GIVEN AREA.**

FIRE DANGER: A general term used to express an assessment of both fixed and variable factors of the *fire environment* that determine the ease of *ignition*, rate of spread, difficulty of control, and fire impact.

FIRE DANGER CLASS: A segment of a *fire danger* index scale identified by a descriptive term (e.g. Low, Moderate, High, Very High, Extreme) and/or a colour code (e.g. blue, green, yellow, orange, red). The classification system may be based on more than one *fire danger* index.

FIRE DANGER RATING: The process of *systematic*ally evaluating and integrating the individual and combined factors influencing *fire danger* represented in the form of *fire danger* indexes.

FIRE DETECTION: A system for the act of discovering, locating, and

reporting *wildfire*s.

FIRE EFFECTS: Any change(s) on an area attributable to fire.

FIRE ENVIRONMENT: The surrounding conditions, influences, and modifying forces of *topography*, *fuel*, and *fire weather* that determine fire behaviour.

FIRE HAZARD: A general term to describe the potential fire behaviour, without regard to the state of weather-influenced *fuel* moisture content, and/or resistance to fireguard construction for a given *fuel type*. This may be expressed in either the absolute (e.g., “cured grass is a fire hazard”) or comparative (e.g., “clear-cut logging slash is a greater fire hazard than a deciduous cover type”) sense. Such an assessment is based on physical *fuel* characteristics (e.g., *fuel* arrangement, *fuel load*, condition of *vegetation*, presence of ladder *fuel*s).

FIRE HAZARD REDUCTION: Treatment of living or dead forest *fuel*s to diminish the *likelihood* of a fire starting and to lessen the potential rate of spread and resistance to control.

FIRE HAZARDOUS AREA: An area where the combination of *vegetation*, *topography*, weather, and the *threat* of fire to life and *property* create difficult and dangerous problems.

FIRE HISTORY: An historical record of the incidence and *consequence* of fire for a given area.

FIRE INCIDENCE: The average number of fires started in a designated area during a specified time.

FIRE MANAGEMENT: All activities associated with the management of fire-prone land, including the use of fire to meet land management goals and objectives.

FIRE PLAN: A statement compiled and issued by a *Fire Authority* defining policy, chain of command, and procedure, in relation to fire control by that Authority.

FIRE PREVENTION: Activities directed at reducing fire occurrence; includes public education, law enforcement, personal contact, and reduction of *fire hazard*s and *risk*s.

FIRE PROTECTION: All activities designed to protect an area (including human life, *property*, assets and values) from damage by fire.

Fire Report: **AN OFFICIAL RECORD OF A FIRE, GENERALLY INCLUDING INFORMATION ON CAUSE, LOCATION, ACTION TAKEN, DAMAGE, *COST*S, AND SO ON, FROM START OF THE FIRE UNTIL COMPLETION OF SUPPRESSION ACTION.**

FIRE RISK: The *probability* or chance of fire starting determined by the presence of activities or causative agents (i.e. potential number of *ignition* sources).

FIRE SUPPRESSION: All the work and activities connected with fire-extinguishing, or elimination operations, beginning with discovery and continuing until the fire is completely extinguished.

FIRE TRIANGLE: An instructional aid in which the sides of an equilateral triangle represent the three factors necessary for combustion and flame production (i.e. oxygen, heat and *fuel*).

FIRE WEATHER: Collectively, those weather parameters that influence fire occurrence and subsequent fire behaviour (e.g. dry-bulb temperature, relative humidity, wind speed and direction, precipitation, atmospheric stability, winds aloft).

FIRE WEATHER INDEX (FWI) SYSTEM: The FWI System provides numerical ratings of relative *vegetation* fire potential. The first three components are *fuel* moisture codes that follow daily changes in the moisture contents of three classes of forest *fuel* with different drying rates. The higher values represent lower moisture contents and hence greater *flammability*. The final three components are fire behaviour indices, representing rate of spread, amount of available *fuel*, and fire intensity; their values increase as *fire weather* severity worsens.

The system is dependent on weather only and does not consider differences in *risk*, *fuel*, or *topography*. It provides a uniform method of rating *fire danger* throughout New Zealand.

FIXED STANDARDS OF COVER: Means the standards as laid down in the Code of Practice with which all Rural Fire Authorities must comply regardless of time danger classification.

FLAMMABILITY: The relative ease with which a substance ignites and sustains combustion.

FREQUENCY: A measure of *likelihood* expressed as the number of occurrences of an *event* in a given period of time.

FRONTAL FIRE INTENSITY: The rate of heat energy release per unit time per unit length of fire front. Frontal fire intensity is a major determinant of certain *fire effects* and difficulty of control. Numerically, it is equal to the product of the heat of combustion, quantity of *fuel* consumed in the flaming front, and linear rate of spread. Measured in kilowatts per metre (kW/m).

Fuel: **ANY MATERIAL SUCH AS DEAD AND LIVE *VEGETATION* WHICH CAN BE IGNITED AND SUSTAINS A FIRE.**

FUEL BREAK: An existing barrier or change in *fuel type*.

FUEL LOAD: The dry weight of combustible materials per unit area. Measured in kilograms per square metre (kg/m^2) or tonnes per hectare (t/ha).

FUEL TYPE: An identifiable association of *fuel* elements of distinctive species, form, size, arrangement, or other characteristics that will exhibit characteristics fire behaviour under specified burning conditions.

GEOGRAPHIC DATA LAYER: A seamless map of information, usually stored in a *GIS*, representing to a single theme.

GEOGRAPHIC INFORMATION SYSTEM (GIS): A suite of computer programs designed to collect and store spatial (map-based) and non-spatial data, and to produce information from spatial queries.

GRID REFERENCE: A map number plus a six figure number (e.g. G46-304392) as a method of locating a particular point on a NZMS 260 series map from Eastings and Northings. The method of giving a map reference is generally shown on the map margin.

HARM: Hurt, injury, damage, mischief; and instance of this.

HAZARD: A source of potential harm or a situation with a potential to cause loss.

HUMAN CAUSED FIRE: A *wildfire* caused by human carelessness or

malicious use of fire.

Ignition: **THE BEGINNING OF FLAME PRODUCTION OR SMOULDERING COMBUSTION; THE STARTING OF A FIRE.**

INITIAL ATTACK: The action taken to halt the spread or potential spread of a fire, by the first fire fighting force to arrive.

Intangible: **NOT TANGIBLE; UNABLE TO BE TOUCHED OR MENTALLY GRASPED.**

LIKELIHOOD: A *qualitative* description of *probability* and *frequency*.

LITTER: The top layer of the forest floor composed of loose debris of dead sticks, branches, twigs, and recently fallen leaves and needles, little altered in structure by decomposition. (The litter layer of the forest floor).

METHODOLOGY: A body of methods used in a particular branch of study or activity.

NATURAL FIRE: Any fire of natural origin (ie. Caused directly by lightning or volcanoes).

NEW ZEALAND FIRE DANGER RATING SYSTEM: The national system of rating forest and rural *fire danger* in New Zealand. Includes all guides to the evaluation of *fire danger* and the prediction of fire behaviour such as the New Zealand *Fire Weather Index System*.

NZMS 260 SERIES: A national series of topographical maps drawn to a scale of 1:50,000 on the New Zealand Map Grid projection.

PHENOMENON: A fact or an event that appears or is perceived by one of the senses or the mind (plural phenomena).

PROBABILITY: The *likelihood* of a specific outcome, measured by the ratio of specific outcomes to the total number of outcomes.

PLANNING/INTELLIGENCE: The collection, evaluation, and dissemination of information related to the incident and the preparation and documentation of the Incident Action Plan.

PREPAREDNESS: (1) The degree to which an agency is prepared to respond to a potential fire situation. (2) A mental readiness to recognise changes in *fire danger* and to act promptly when action is appropriate.

PRE-SUPPRESSION PLAN: Those fire management activities in advance of fire occurrence concerned with the organisation, training and management of a fire fighting force and the procurement, maintenance and inspection of improvements, equipment and supplies to ensure effective *fire suppression*.

PROPERTY: Includes real and personal property, and any estate or interest in any real or personal property, and any debt, and any thing in action, and any other right or interest; and, without limiting the generality of the foregoing words, shall be deemed to include any public work (as defined by [the Public Works Act 1981]) situated within a district, and in particular any stop-bank so situated.

QUALITATIVE: Relating to or concerned with quality or qualities.

QUALITATIVE ANALYSIS: Identification of constituents present in a substance or *phenomena*.

QUANTITATIVE: Possessing a measurable quantity, magnitude or spatial extent.

QUANTITATIVE ANALYSIS: Measurement of the amounts of constituents present in a substance or *phenomena*.

RISK: The chance of something happening that will have an impact on objectives. Measured in terms of consequences and *likelihood*.

RISK ANALYSIS: A *systematic* use of available information to determine *risk management* priorities to determine how often specified *event* may occur and the magnitude of likely consequences.

RISK ASSESSMENT: The process used to determine *risk management* priorities by evaluating and comparing the level of *risk* against predetermined standards, target *risk* levels and other criteria.

RISK MANAGEMENT: A *systematic* application of management policies, procedures and practices to the tasks of identifying, analysing, assessing, treating and monitoring *risk*.

Risk Reduction: A selective application of appropriate techniques and management principles to reduce either the *likelihood* of occurrence or its consequences, or both.

Sieve Mapping: **The process of overlaying two or more *geographic data layers* and combining them to a single layer for analysis. This is the predominant method for computer-based *Wildfire Threat Analysis*.**

Sensitivity Analysis: Examines how the results of a calculation or model vary as individual assumptions are changed.

Systematic: Arranged or conducted according to a system, plan or organised method.

Threat: An indication of the approach of something unwelcome or undesirable; a person or thing regarded as a cause of *harm*.

Topography: **The land form or surface configuration of a region.**

Values at Risk: **The specific or collective set of natural resources and man-made improvements/developments that have measurable or intrinsic worth and that could or may be destroyed or otherwise altered by fire in any given area (includes social, economic, cultural and environmental values).**

Vegetation: Includes:

a) All plants and the produce thereof, live or dead, standing, fallen, windblown, cut, broken, pulverised, sawn, or harvested, natural or disturbed, in use or as waste, rubbish, refuse or debris, stump, stubble, or otherwise; and

b) Fossil *fuel* exposed at or lying within 20 metres of the surface of any land; and

c) Peat in any form.

But does not include wood forming part of a structure or otherwise in processed form.

Wildfire: An unplanned fire. A generic term which includes grass fires, forest fires and scrub fires be it man caused or natural in origin.

Wildfire Threat Analysis: **Is a *systematic* method of identifying the level of *threat* a particular area faces from *wildfire*. The level of *threat* is generally related to a combination of *ignition* potential, potential *fire behaviour* and the *values threat*ened. These factors may themselves be derived from other combinations of factors, for instance, potential fire behaviour can be determined from a combination of *climate*, *topography* and *fuels*.**

APPENDIX 2

SUPPLIED DATA SET DOCUMENTATION

INTRODUCTION

The Data Sets described within this document use the guidelines for metadata elements described in:

ANZLIC GUIDELINES: CORE METADATA ELEMENTS Version 1

Metadata for high level land and geographic data directories in Australia and New Zealand

http://www.anzlic.org.au/asdi/metaelem.htm

All supplied datasets have an associated XML file containing metadata developed in ArcCatalog 8.3 to the ESRI Metadata profile.

The Data Sets described are[10]:

- Accessibility
- Population Density
- Pastoral Farming
- Land Cover Database
- Forest Age Classes
- Fire Climate
- Rural Fire Districts
- Urban Fire Districts

GUIDE TO DATA DESCRIPTION ELEMENTS

DATA SET

TITLE

The title of the Data Set.

JURISDICTION

The area of authority for the data set.

DESCRIPTION

ABSTRACT

[10] Metadata for Tranzpower Power Lines is not available at this time.

A narrative explanation/description of the Data Set, including rationale, use and history.

SEARCH WORD(S)

A list of words that can be used to find the data set.

GEOGRAPHIC EXTENT NAME(S)

The name of the region that applies to the data set.

GEOGRAPHIC EXTENT POLYGON(S)

The bounding rectangle for the data set.

Data Currency

BEGINNING DATE

The date the Data Set was first generated.

ENDING DATE

The date the Data Set was last updated.

Data Set Status

PROGRESS

Whether the Data Set has been completed, is in a state of on-going improvement, is currently being generated or does not yet exist.

MAINTENANCE AND UPDATE FREQUENCY

How frequently the Data Set is being updated.

DESIRED MAINTENANCE AND UPDATE FREQUENCY

How frequently the Data Set should be updated to improve analysis results.

Access

STORED DATA FORMAT(S)

The data type (point, line, polygon) and GIS data format.

AVAILABLE FORMAT TYPE(S)

A list of all currently available formats.

ACCESS CONSTRAINT

Whether there are any restraints on use such as licensing and/or contracts.

Data Quality

LINEAGE

A description of how the Data Set was generated.

POSITIONAL ACCURACY

The spatial accuracy of the data eg. NZTOPO data = +_ 20 metres.

ATTRIBUTE ACCURACY

A description on how accurate the Data Set attributes have been defined.

COMPLETENESS

Data completeness at the time of the last update.

CONTACT INFORMATION

CONTACT ORGANISATION

The contact organisation for the Data Set.

CONTACT POSITION

The position title of the contact person

MAIL ADDRESS 1

The box number or street address

MAIL ADDRESS 2

SUBURB/PLACE/LOCALITY

The contact suburb/place or locality used in the address.

STATE/LOCALITY 2

The state or locality (city) use in the address.

COUNTRY

The country used in the address.

POSTCODE

The postcode used in the address.

TELEPHONE

The contact telephone number.

FACSIMILE

The contact fax number.

ELECTRONIC MAIL ADDRESS

The contact e-mail address.

METADATA DATE

The date the metadata description was completed/updated.

ADDITIONAL METADATA.

Additional descriptors that further describe this data set.

APPENDIX 3

UPDATES

19 June 2002: Changes suggested at WTA CT meeting on the 18th of June. Added "Water Features" to natural occurrence risk and aesthetic values with a score of 0.

Added "Feedback" section to Introduction. Include forest as a cultural value. Removed "mixed condition" from physical significance descriptors under Cultural Values and reduced the max score.

Updated processing requirements after feedback from DOC after they experienced computation and memory problems during the final stages of their validation project.

Updated Wildfire Threat Analysis structure.

Removed the "Most Significant Component" map from the list of maps.

This is a by-product and not necessary for the completion of the analysis.

3 July 2002: Added a new section "GIS Operations".

Added more detail on handling the utilities data. Rearranged the structure and definition sections.

10 July 2002: Added a metadata for powerline buffers.

5 September 2002: Updated POI scores in RISK after a calculation error was identified.

13 March 2003: Updated some scores due to an error in calculations.

25 March 2003: Added a "Fitness for Purpose" statement at the request of Rotorua DC. The purpose is to limit the authors liability in cases where the information has been used inappropriately.

23 June 2003: Added advice for raster processing. Experience has shown that this may be a more efficient way of combining the layers. Updated metadata and images associated with the data.

18 May 2004: The Wellington Wildfire Threat Analysis team requested standard field definitions to be included in this document. Since many of the data layers are produced separately, working to standard field definitions helps when merging the data together.

March-June 2005: Changes following the Wildfire Threat Analysis workshop on the 8th and 9th of March in Rotorua. There are enough changes to warrant a new version number, 2.0, and a change to the look of the document. This makes it easy to identify those working with the current workbook.

The structure diagram has been modified to clarify the role of the POI component (it is a multiplier applied to the sub total pf RISK layers).

The FFMC values have been removed from the POI scoring and weighting table for clarity.

Utilities have been split into powerlines and railways to provide a finite set of values for RISK.

Recreation has been separated from RISK:Land-Use to account for plantation forest used as a recreation area. Woodhill forest near Auckland was cited as an example of this.

The normalisation formulae have been altered because of the above. A new section on project management including GIS workflow. Layer/file name conventions and directory structure are added. Updated field names to include processed and unnormalised data fields. Added illegal activities, lifestyle blocks and military live fire areas to land use. Included walking tracks in the accessibility layer and given the same score as State Highways.

21 October 2005: Landcare Research have completed the update of the fire climate layers. From their Head Fire Intensity layer, a new HAZARD layer was produced. Improvements include: increased resolution to 25m cells, update fuel model from LCDB2, fire behaviour models and climate data.

22 May 2006: At user's request, the RGB colour values were added as part of the cartographic guidelines. The completion of the Southern Rural Fire District project prompted the THREAT map classification to be reviewed.

3 July 2006: Included open-cast coal mines and railways that carry steam trains as high risk components. Updated the HAZARD metadata to reflect the 2005 version of the dataset. Removed metadata for obsolete datasets – LCDB1, Rural and Urban fire districts. Fire districts are being superseded by a new fire jurisdiction database.

1 September 2010: Updated datasets supplied to NZFS Data and Spatial Intelligence Team.

11 May 2011: Updating the WTA workbook to reflect data for 2010. Adding and removing information.