The Wildfire Project: An integrated spatial application to protect Victoria's assets from wildfire

Flett, Hine and Stephens describe the Victorian Identification and Consequence Evaluation (Wildfire) Project that draws upon statewide data sets to support integrated fire management planning.

Abstract

This paper provides an overview of the Wildfire Project undertaken by Victoria's Office of the Emergency Services Commissioner (OESC) in collaboration with Spatial Vision Innovations Pty Ltd, the Country Fire Authority (CFA), the Department of Sustainability and Environment (DSE) and the Municipal Association of Victoria (MAV).

The Wildfire Project provides an opportunity to bring together the best quality statewide datasets to identify, classify, quantify and value the state's economic, environmental and social assets to assist fire management planners to enhance their capability to plan for, respond to and recover from wildfire, using a standard set of online statewide spatial information products.

Introduction

Geographic information systems (GIS) play a major role in emergency management, by providing the capability to rapidly gather and summarise data about geographic features and locations. By combining spatial data with asset related information in a modern, service-oriented architecture, a particularly powerful geospatial solution can be created—one that provides shared understanding and enables decision-makers across a range of stakeholders to make better-informed decisions (IBM, 2007).

The Wildfire Project products will enable fire management planners to view assets in a geospatial context, so they can more easily visualise the spatial relationships between managed assets and other mapped features around them, enabling levels of awareness and insight not provided by figures in tables. Consolidation of a wide range of asset-related data will support both GIS specialists and non-GIS users in their decision-making. Duplication of data will be avoided via this unified view of asset and geospatial data.

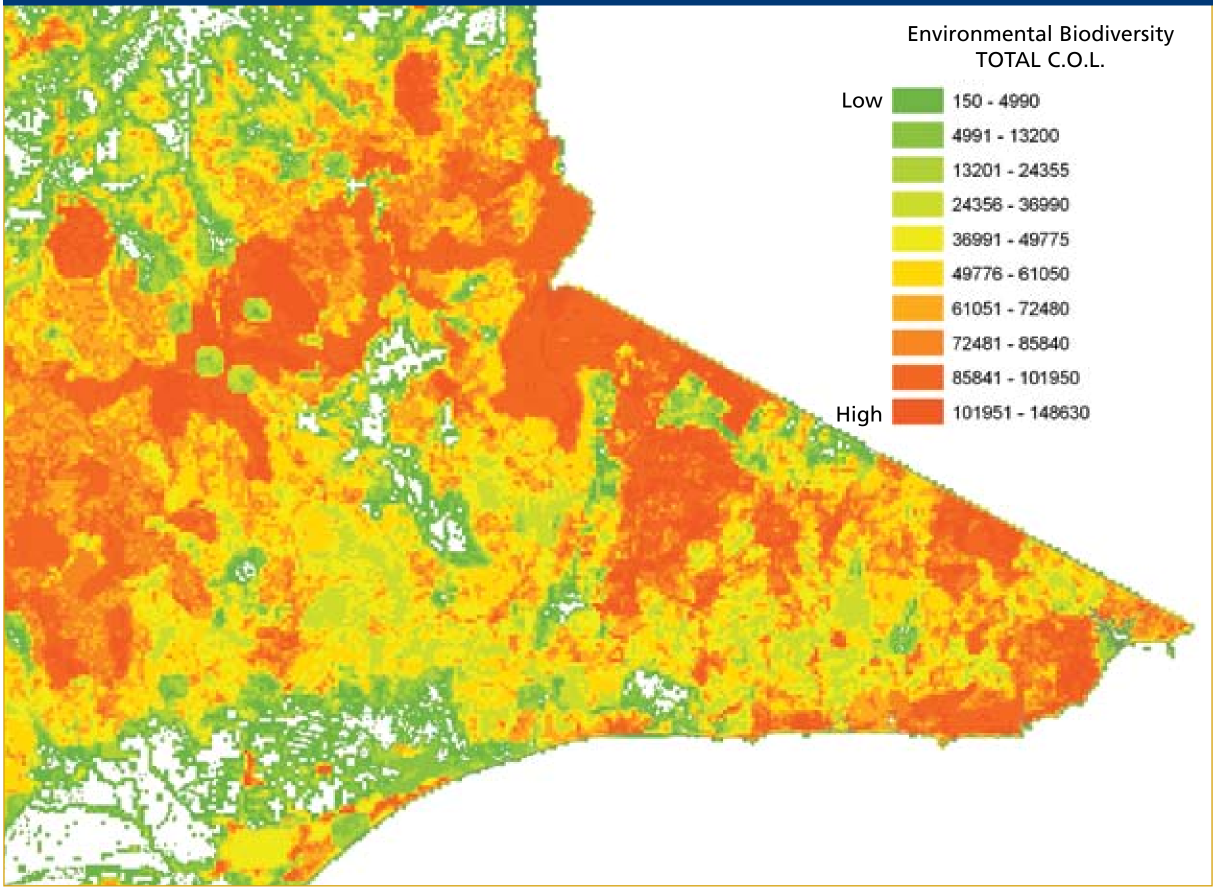
Improving our knowledge of where assets are located improves and supports integrated strategic planning and decision-making. Visualisation through mapping enables planners to view and understand the landscape more holistically. Maps provide an intuitive, visual framework, allowing people to conceptualise and understand the environment, and make more informed and considered decisions regarding wildfire risk (IBM, 2007). Figure 1 provides an example of the spatial representation of the Wildfire Project consequence of loss in relation to environmental biodiversity assets.

Context of Wildfire Project

Emergency services have long been recognised for their ability to respond to rapid impact events that threaten human safety, often under extreme circumstances. The traditional approach is to deliver action based treatments, what Crondstedt (2002) describes as a focus on hazard rather than vulnerability. Salter (1998) identified the emergence of a shift in emergency management from the traditional internal agency (response) focus to a community centred (risk management) focus. He described this as the emergency management community reinventing itself, to better meet the needs of communities. In Salter's view, such a paradigm shift would be evidenced by focusing on vulnerability via proactive multidisciplinary approaches in collaboration with communities. This trend has also been identified by Gabriel (2002) which he described as reconceptualising emergency management.

The emergency riskscape is changing and there is an increasing expectation that emergency managers are preparing for the impacts of urbanisation, climate change, pandemics, terrorism and energy, fuel and water security. Such preparedness requires much more than the traditional focus on competent rapid response. Success will ultimately depend upon long term integrated community planning (Handmer & Dovers, 2008). Ten years after Salter published his observations, emergency management in Victoria still has some way to go in developing the integrated, community based strategic planning capability to adequately fulfil this essential future requirement.

Figure1. Spatial Representation of consequence of loss in relation to environmental biodiversity assets.



The Victorian Department of Justice's strategic priorities include a commitment to developing an integrated long term strategic plan for the state's emergency services sector. The Future Horizons Discussion Paper (OESC, 2007) identifies a certain lack of imagination in emergency management planning, which has traditionally been based upon historical events. The paper indicates that such an approach is inadequate for future challenges and proposes a new approach based upon the following layers of thinking:

- strategic: There is significant potential within Victoria's emergency management arrangements to adopt sector-wide, whole of government approaches across a range of strategic outcomes. The main constraints to this are the complexity of the existing administrative arrangements and the lack of capacity to initiate change within these;
- imaginative: The need to anticipate previously unanticipated hazards has been underscored by the emergency management experience of the past decade;
- flexible: Changing scenarios and threats will continue to demand a more flexible approach within the sector to delivering outcomes. Some of the traditional constraints may demand to be revisited; and
- community-focused: The need to engage the community across a range of outcomes in emergency management – including service delivery – will continue to inform all processes within the sector.

The Wildfire Project is a practical step down the path of this new approach. The project is part of Victoria's fire safety strategy, Fire Safety Victoria (FSV) which provides the framework for a whole of government approach to fire safety. It is based upon comprehensive triple bottom line considerations that incorporate local knowledge and adopts a risk management approach to improving local planning and coordination. The strategy's objectives are based around community engagement and understanding (OESC, 2006).

Wildfire planning

The role wildfire plays on public land is complex. As well as being a potential seasonal threat to life and property, fire also plays an integral role in the maintenance of much of Victoria's environmental biodiversity. Considerable work is required to improve understanding of wildfire and develop integrated approaches which can be applied uniformly across the state.

Planning for the management of wildfire involves an analysis of wildfire risk. The Wildfire Project develops approaches, principles and tools (in the form of both spatial and aspatial data) to develop a shared statewide understanding of the consequences of wildfire in relation to assets. It does not produce a range of products encompassing the full risk management spectrum, but rather focuses on the 'consequence' as opposed to the likelihood characteristic of the risk management equation.

To assess vulnerable elements within communities effectively, planners need to understand the community and the assets potentially at risk from the impact of wildfire. Commonly a subjective approach, it is predominantly focussed on the elements of 'life and property' which is not sufficiently comprehensive to ensure that communities are well prepared and resilient.

How can we understand what the consequences would be in terms of economic, environmental and social impacts to local communities and in fact, Victoria as a whole? Without fully understanding these triple bottom line consequences, how can we effectively plan asset protection regimes based upon identified vulnerability rather than potential hazards?

The Wildfire Project aims to establish an evidence-based product to support a consistent statewide approach to wildfire planning and decision-making. It enables the consequences of wildfire on assets to be classified, quantified and mapped in a uniform way across the state, meeting the needs of a range of stakeholders involved in wildfire planning, irrespective of organisational or geographical boundaries.

Project scope

In Victoria, responsibility for wildfire planning and response correlates to public (DSE/Parks Victoria), private; and CFA and Metropolitan Fire and Emergency Services Board (MFESB) land boundaries. The interests of people living in wildfire prone areas of Victoria can be assessed in the context of the economic, environmental and social wellbeing on both public and private land. The need to develop integrated management approaches across administrative, organisational and land tenure boundaries, is increasingly recognised.

The Wildfire Project was developed with two primary objectives:

- *to develop a methodology that identifies, classifies, quantifies, evaluates and summarises the consequences of wildfire on assets throughout Victoria; and*
- *to develop statewide wildfire consequence maps and datasets derived from existing primary source datasets, presented in a uniform and accessible format that supports integrated wildfire planning and decision making across DSE, CFA and Local Government.*

The Wildfire Project is 'tenure blind' and makes no distinction between public and private land in wildfire planning. It has developed integrated spatial products that identify assets at risk from wildfire on both public and private land and attempts to demonstrate the significance of the consequence of asset loss on both.

The project focuses on community assets that are typically static - those that do not alter frequently. The products can be used not just for wildfire, but applied to a range of emergencies such as floods, major landslides or earthquakes.

Methodology framework

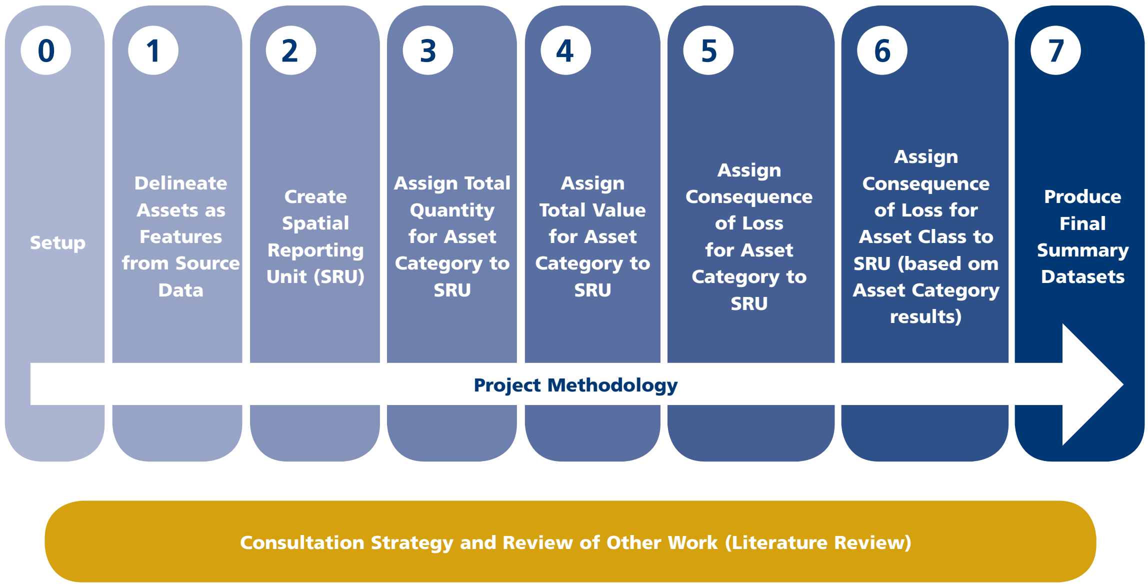
OESC engaged geospatial and information technology company, Spatial Vision and its team comprising Beca, RMIT Centre for Risk & Community Safety and Ecology Australia, to undertake the project and develop the project methodology.

To provide a robust framework for the methodology, a process logic was developed for the methodology. In its simplest form, this involved:

- identifying and defining the assets - identifying existing, suitable spatial datasets that describe the asset;
- obtaining and incorporating the primary (source) spatial dataset(s) and supporting classification schema to represent the asset, into the methodology;
- assigning the primary spatial dataset (in which the asset is represented as a point, line, or area) to a 'reporting unit' (where the "amount" of the asset within the reporting unit is used to determine the quantity of the asset);
- translating the asset quantities into an asset value for each 'reporting unit';
- translating the asset value into an asset consequence of loss rating for the loss of the asset, or loss of the function the asset provides; and
- aggregating the Asset Category results for each Asset Class.

Seven key stages underpin the methodology and the approach to assessing the consequence of losing assets from a wildfire event, as shown in Figure 2.

Figure 2. Diagrammatic representation of the key steps in identifying, classifying and quantifying assets at risk from wildfire, and evaluating the consequences of their loss by wildfire.



Classification of assets

To classify the diverse range of assets, a three tier hierarchy was applied comprising asset groups, classes and categories.

Asset Groups: Three groups represent the contextual or thematic levels of environmental, economic and social. This comprises a triple bottom line approach in accordance with Government policy.

Asset Classes: Ten classes represent the level at which asset categories are summarised and reported on for the purposes of key project outputs. Eight of the ten classes have been applied as insufficient relevant data is currently available for two of the classes.

Asset Categories: 173 categories represent the level at which assets are defined for the purpose of assigning values, measures of disruption, and consequence of loss. They represent the lowest level of asset classification. This level of asset classification is required to accommodate the varied representations of assets in existing spatial datasets and to be able to classify types of assets (for example power stations of a certain size, or roads of a certain type).

A breakdown of the 173 Asset Categories implemented on the basis of the eight Asset Classes for which a consequence of loss rating was assigned, is presented in Table 1.

Table 1. Representation of the asset classification system.

Asset group (TBL Theme)	Asset Class	Number of Asset Categories
Environmental	Biodiversity	29
	Land	NIL
	Water	2
	Air	NIL
Economic	Economic production	24
	Infrastructure	37
	Property	19
Social	Cultural Heritage	12
	Social Infrastructure	40
	Human Life	10
Total		173

Many spatial datasets have an existing classification schema or attributes on which a classification of the asset types can be made. For example, many environmental assets are classified by a conservation rating, while for infrastructure the asset category may be based on physical parameters, like road surface, school or hospital type. Other assets may have a value related to production capacity (for example, agricultural capacity or power station capacity), which may be used as the basis for grouping assets for the purpose of assigning asset value. Other assets (for example land value, or gross timber value produced) have a dollar value that can be used to group assets.

Reporting construct

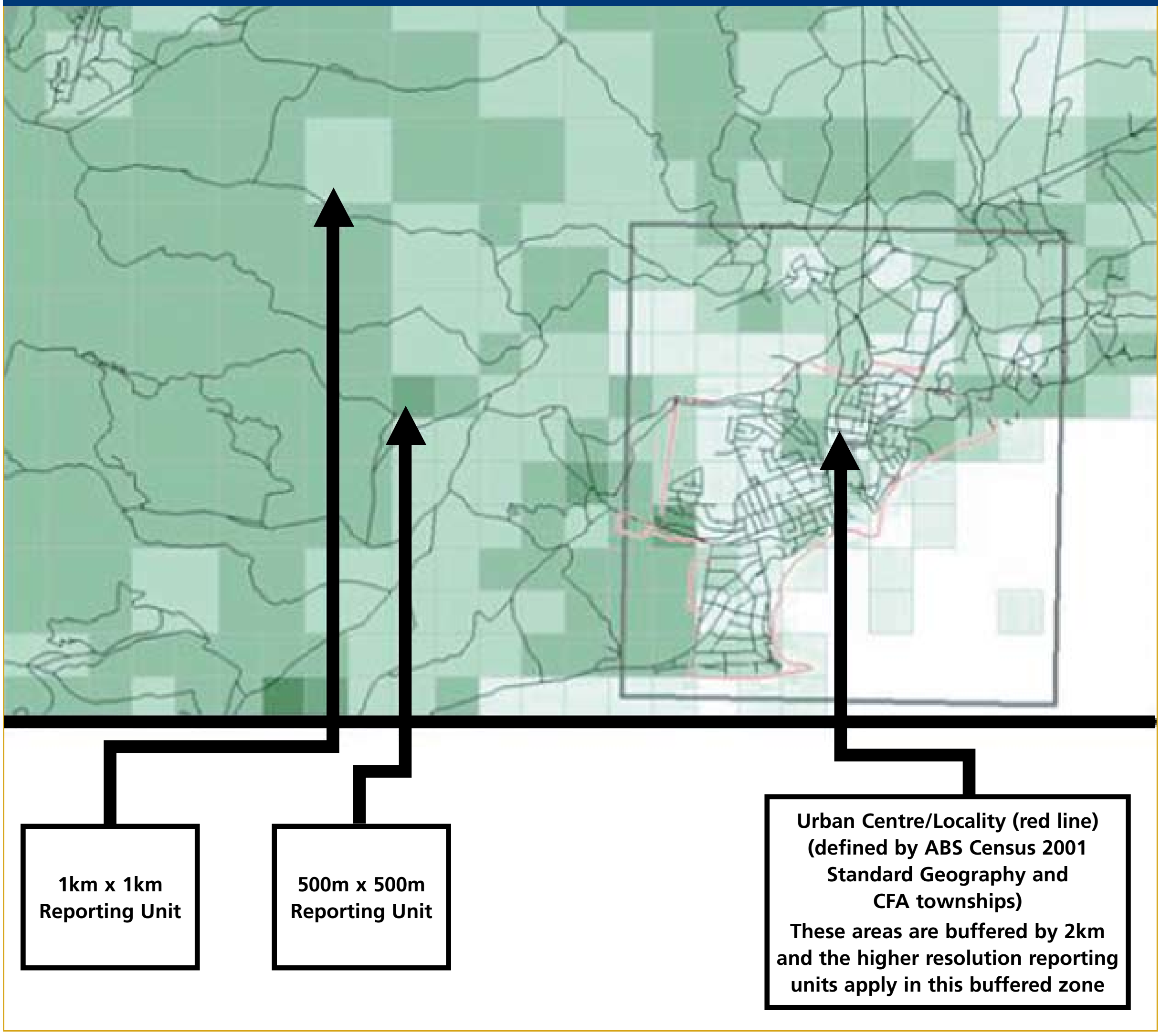
A key requirement of the project was to provide a tool for planners that take a large number of assets represented in a variety of ways (as spatial datasets) and create an informative and focused summary.

This is achieved by aggregating the assigned consequence of loss for individual assets on an area-based reporting unit. This can be thought of as the "reporting" resolution of the database containing asset information in summary form. The spatial reporting unit enables the aggregation of summary information related to a diverse range of physical features represented as lines, points and areas.

This approach provides planners with a concise summary of the consequences of asset loss in any particular area of interest. A key issue in deciding the appropriate resolution for the reporting unit is identifying at what resolution the information 'adds value' from a strategic perspective.

A reporting unit of 1km by 1km is adopted for the State and a reporting unit of 500m by 500m was adopted for towns and urban areas as represented in Figure 3. Spatially, this is represented by statewide grids for each asset class.

Figure 3. An example area of the statewide multi-resolution reporting unit template dataset.



Valuing assets

All assets are valued from a statewide perspective and in a strategic planning context. It was determined that assigning a 'relative value' to the assets was the most appropriate approach to valuing the assets. Understandably, there are many complexities involved in valuing all assets with an 'absolute' dollar value, particularly with respect to the environmental and social groups.

Environmental assets incorporate a number of statewide datasets that apply existing classification systems. Independent valuations are not readily available for assets. To overcome this, all assets for a particular Asset Category are assigned a relative statewide value between 1 and 100, where 1 is assigned to the asset type of least value and 100 to the asset type of most value.

Using biodiversity assets as an example, the value of 100 may be assigned to those assets of greatest value from a statewide viewpoint. For this project every hectare of old-growth forest is assigned a value of 100 and every rare and threatened species site a value of 100 per count (or site). In the case of native vegetation that has no conservation status rating, a value of 25 is assigned, based on it having a lower value. A cleared area may be assigned a value of 0 in relation to its contribution to biodiversity.

Consequence of loss

Consequence of asset loss is represented spatially using a colour ramp to indicate the level of consequence. The methodology assigns the consequence of loss to an Asset Category (for example, power stations of a certain size, or roads of a certain type). The underlying premise is that the consequence of loss of an asset is a combination of the damage to the asset and the potential disruption (or flow on effect) that occurs as a result of losing the function or service provided by the asset.

Consequence of loss is calculated as follows:

Consequence of Loss = DAMAGE + DISRUPTION

Where:

DAMAGE = total loss of asset value (based on replacement value and/or intrinsic value); and

DISRUPTION = impact from the loss of an asset (based on the loss of a function and/or service provided by the asset across disruption elements).

Although the two components are generally seen as closely related, in a wildfire context, they can be independent of each other. In the project methodology, it is assumed that the components are independent - for example, a power station or road may not be damaged by a wildfire, but the function or service it provides may be significantly disrupted by such an event.

Disruption

Disruption impacts arising from the loss of the service or function provided by an asset are often significantly greater than the replacement or intrinsic value of the asset itself. The approach taken in classifying assets accounts for this issue. Hence, the classification of power stations, or hospitals, or agricultural production capacity, for example, should include consideration of the level of disruption that their loss, or loss of service and/or function will cause, and not just their value.

In many cases, the classification of assets is not suitable for rating local disruption impacts such as in the case of certain roads. For example, a single road to an isolated township will have the same road type classification as many other roads in the state with the same basic parameters (sealed, single lane, major road). However, the disruption impacts caused if this only form of access was severely damaged or closed as a result of fire, would be significant to the community.

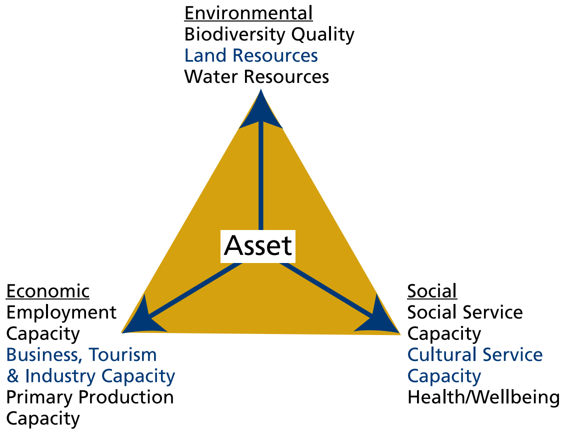
This is an example of where the classification available for statewide spatial data cannot always be used to assign meaningful disruption element ratings from a local perspective. It illustrates the limitations of what can be undertaken centrally through the Wildfire Project, and what must be undertaken at a regional or local level through the provision of local user interaction and the incorporation of local knowledge.

Disruption elements

Disruption is 'measured' using a set of elements that describe a range of disruptive impacts that can occur due to the loss of an asset type. Those that are relevant to an asset category are used in assigning a disruption rating or measure.

Nine disruption elements are identified and used in the methodology (Figure 4). The use of disruption elements allows the potential multiplicity of flow-on impacts associated with the loss of an asset to be clearly identified. It also provides planners with useful information on the drivers for the consequence of loss associated with particular asset types; and thereby it assists in planning treatments to minimise that consequence.

Figure 4. Disruption Elements (that relate to the loss of service or function of an asset), grouped on the basis of Asset Groups.



Project trial and delivery

The Wildfire Project underwent an evaluation trial by field users who applied the project methodology and spatial products in a number of areas throughout Victoria. This involved a range of agencies and local government areas across Victoria. Participants were able to share their experiences in using the outputs of the project.

The trial sought to validate and further refine the methodology and products. The methodology and format of the outputs delivered have been reviewed based on the feedback and key refinements implemented into the development of an application to make the final project outputs available to stakeholders.

To deliver the Wildfire Project outputs, OESC has partnered with the Cooperative Research Centre for Spatial Information (CRC SI) and other organisations in the National Data Grid (NDG) Project. The NDG project is a data access and modelling support tool being undertaken by the CRC SI as a research project. The NDG Project will provide a platform for updating, hosting and providing interactive access to identified use cases. A delivery application for the Wildfire Project will be developed as part of the NDG project.

Conclusion

In the planning context, the Wildfire Project will enable fire management planners to make shared decisions with the community - people who have not traditionally had a say in the decision making – people who are not necessarily fire or GIS specialists.

The ability to factor in local community knowledge is an important and unique feature of the project. This is important not only in appropriately determining likelihood, but also in considering the impact of disruption downstream. Disruption can only be realistically understood with the benefit of local knowledge. This approach empowers communities in this important decision making process.

The application of products from the Wildfire Project will enable a comprehensive, evidence based assessment of identified assets and the consequence of their loss resulting from wildfire. The Wildfire Project application will enable fire management planners to make better decisions about risk priorities in their planning and response strategies when facing wildfire threat.

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