


# Conceptual Framework for Assessing Seasonal, Daily, and Hourly Landscape Moisture and Fuel Energy

Nic Gellie[1], Jeff Kepert[2,1], Kevin Tolhurst[3,1], Chris Rudiger[4,1] and Sarah Harris[5,1]

[1] Bushfire CRC, Melbourne
[2] The Centre for Australian Weather and Climate Research, Melbourne
[3] Department of Forest Ecosystem Science, Melbourne University,
[4] Department of Civil Engineering, Monash University, Melbourne
[5] School of Geography and Environmental Science, Monash University, Melbourne

## SCOPE

This paper proposes a framework to provide new process-based dead and live fuel moisture models that can be used to assess whole of landscape fuel moisture and fuel energy on a daily or weekly basis, and then at an hourly basis during wild and prescribed fires.

## AIMS

The principal aim of this project is to model fuel moisture of a representative range of dead and live fuel moisture elements in order to obtain realistic estimates of available fuel energy in any given vegetation-fuel bed within any landscape vegetation-fuel matrix in Victoria at any given time.

The resolution of the landscape moisture and fuel energy model would be at a resolution of 200–500 m to allow for some fine scale modelling of fuel moisture in narrow mountain gullies in a dissected forested landscape.

## BACKGROUND

Existing fuel and moisture predictive models and indices do not cover the high heterogeneity in the composition, arrangement, and live-to dead ratios in vegetation-fuel bed complexes and the resulting inherent variability in fuel moisture and fuel energy

A critical part of any fire danger rating system is the estimation of potential energy release. The Macarthur FFDI can approximate Byram's Head Fire Line Intensity (BHFI) using total fine surface and near-surface fuel loads. The limitation with the Macarthur FFDI is there no seasonal evaluation of the potential of all dead and live fuels to contribute to potential energy release. We propose to adapt the Energy Release Component from the United States Fire Danger Rating System to estimate reaction intensity (combustion rate) and residence time. These two components require fuel loads, surface ratio to volume ratios, bulk densities, and fuel moistures estimated for any vegetation–fuel bed complex.

## METHOD

This approach requires a range of input parameters, such as global and diffuse radiation, and weather parameters above and below the vegetation canopy, including temperature, vapour pressure deficit, and wind speed to get realistic fuel moisture estimates. An essential vegetation parameter is leaf area index (LAI) that needs to be estimated on a seasonal basis as eucalypt canopies are highly changeable to seasonal wetness and dryness (**Figure 1**).

The linked sub-projects in the framework are:

(a) Development of background datasets of direct and diffuse surface irradiance ($Q_S$) (**Figure 2**), precipitation, (P), and vapour pressure deficit (VPD) downscaled to a 200–500-m grid cell resolution using terrain algorithms (Bureau of Meteorology);

(b) Obtain seasonal spatio-temporal values of leaf area index (LAI) upper canopy foliage moisture content (UCFMC) on a seasonal half-monthly to a monthly basis (Monash University);

(c) Collection of field data on below canopy $Q_S$, VPD, and dead and live fuel moistures across the range of vegetation-fuel types in Victoria (Melbourne University and Department of Sustainability and Environment);

(d) laboratory determination of equilibrium moisture content (EMC) for characteristic fine fuel elements found in Victorian forests and grasslands under desorption and adsorption conditions;

(e) Development of models from data and knowledge gained from projects (a), (b), (c) and (d) (All members of consortium);

(f) Development of web-based system to map fuel moistures and available fuel energy (BOM, Melbourne and Monash University), and

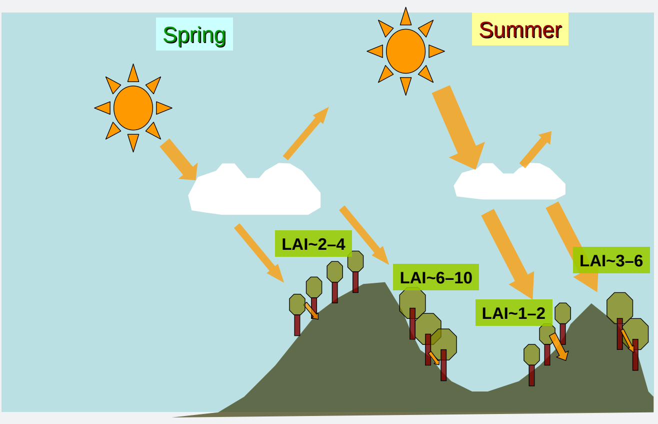


**Figure 1 Change in canopy LAI values in spring and summer**

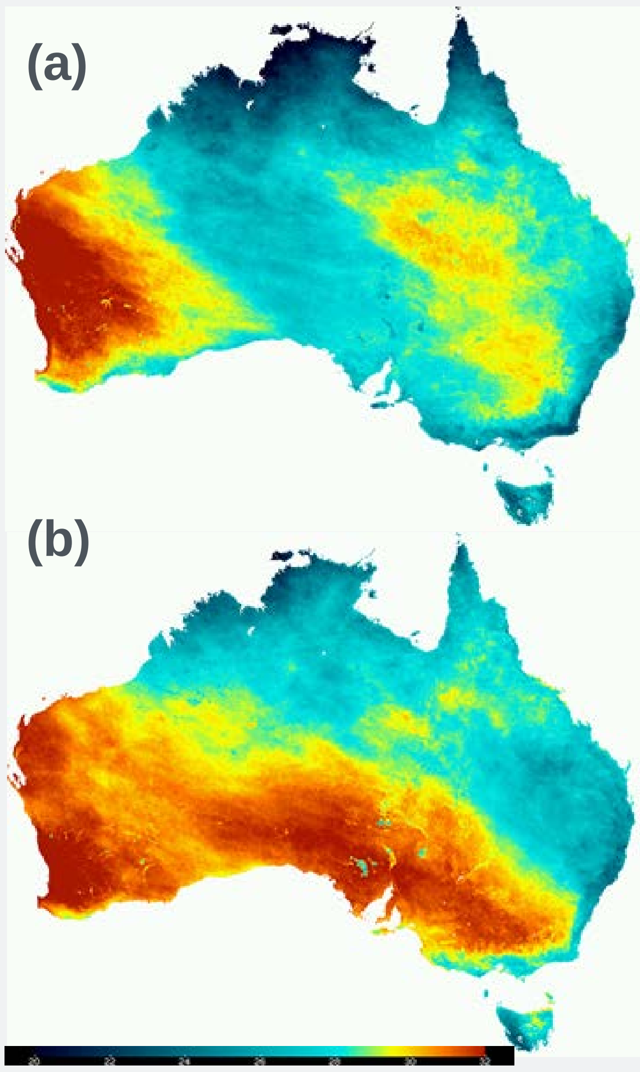


**Figure 2 Monthly mean global irradiance values modelled from satellite data for (a) Dec 2008 and (b) Dec 2009 (Bureau of Meteorology)**

(g) Ongoing Validation of model input parameters, moisture model processes, and outputs (Melbourne and Monash University)

## CONCLUSIONS

The proposed conceptual framework would provide up-to-date seasonal, daily, and hourly fuel moisture and fuel energy for evaluation of fire hazard, preparation of fire predictions, fire warnings, and simulation of prescribed burns and bushfires.

The system can easily be adapted to other Australian states that have appropriate terrain and vegetation–fuel datasets.

CRC

Australian Government
Bureau of Meteorology

The Centre for Australian Weather and Climate Research
A partnership between the Bureau of Meteorology and CSIRO

CSIRO

MONASH University