THE VALIDATION OF DYNAMIC FIRE SPREAD MODELS: METHODS FOR COMPARING THE PERFORMANCE OF PERIMETER SPREAD PREDICTIONS

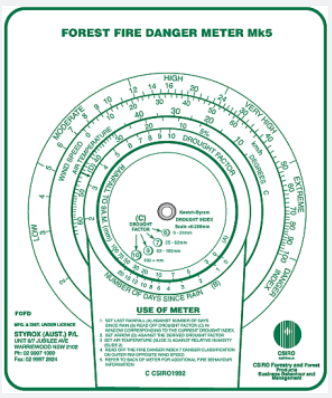
Dr Thomas J. Duff[1], Dr. Kevin G. Tolhurst[2], Derek Chong[1] and Dr. Peter G. Taylor[3]

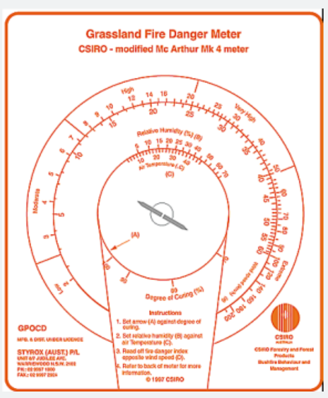
[1] Department of Forest and Ecosystem Science, University of Melbourne, Burnley, Victoria [2] Department of Forest and Ecosystem Science, University of Melbourne, Creswick Victoria [3] Department of Mathematics and Statistics, Faculty of Science, The University of Melbourne, Parkville

Simulation of fire spread

Dynamic, spatially explicit fire spread models enable the simulation of fire spread through time in complex landscapes. This allows risks to be evaluated, management scenarios to be assessed and impacts to be forecast in emergency situations.

Spatially explicit spread models are typically based on static physical or empirical models. These estimate spread rates as a function of fuel, weather and topography. As observed fire spread is the combination of range of inherently complex environmental influences, it can be difficult to determine the causes of poor model performance. Fire behaviour varies greatly through space and time, and to date, there has been little focus on the development of methods for the evaluation, validation or calibration of spread predictions in complex environments.





Validation of dynamic fire spread models

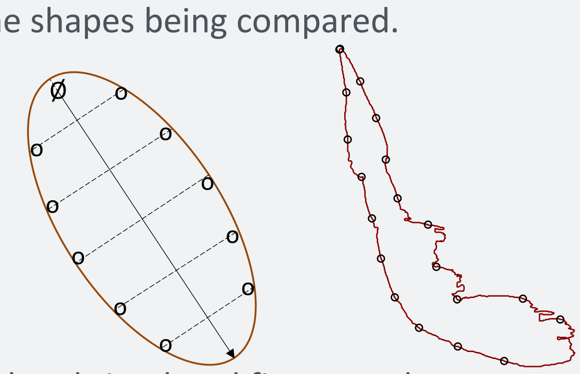
Dynamic fire spread models produce discrete shapes as outputs. There are few methods which can be used to objectively assess 'goodness of fit' for free-form spatial predictions.

Effective objective methods of validating spread models are important for:

- model development
- targeted data acquisition
- calibration
- model comparison
- systematic improvement

Generating landmarks on perimeters

"Landmark"-based methods of shape comparison require analogous references, i.e. point x in one time period moves to point x in the next time period (landmarks), on the shapes being compared.



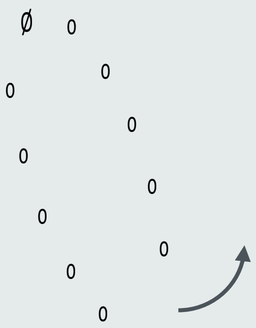
Actual and simulated fire spread patterns are unlikely to have true analogous features. However, the patterns will share an ignition point will and have an axis in the predominant (wind driven) spread direction. These can be used as references to generate 'pseudo-landmarks' to enable the use of landmark based analysis methods.

Procrustes metrics to discriminate sources of error

Procrustes metrics quantify differences in location, orientation, size, and shape. As observed and simulated fires share an ignition point, differences in location are not considered.

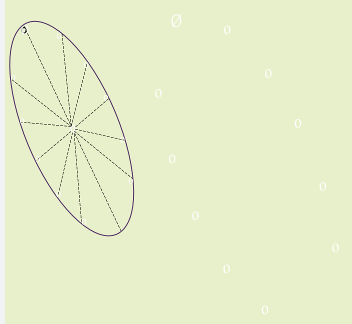
Orientation

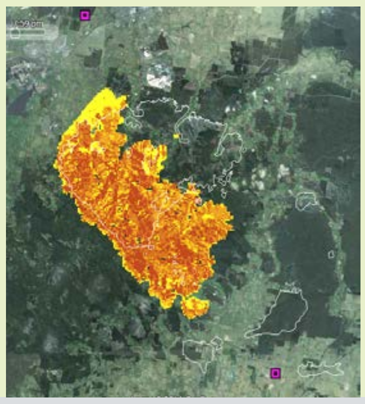
Bushfires are predominantly wind driven; differences between observed and predicted wind trajectories manifest as variation in fire orientation. These can be determined by assessing shape rotation.



Size

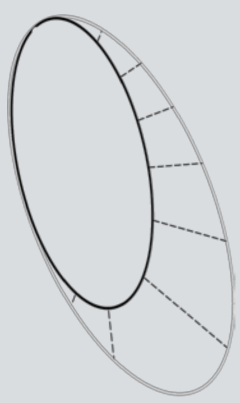
Differences in the size between actual and simulated fires can be indicative of erroneous estimates of wind speed, fuel conditions or fire spread mechanisms. Size can be compared using distances to centroids





Shape

Distances between analogous points can be used to provide an index of similarity of perimeter shape. Where perimeters are highly congruent, differences can be compared in terms of fire travel path vectors. Sampling fire travel paths between perimeters can provide a spatially explicit indication of error. The location, direction and length of these paths can be used to determine input specific biases for model calibration and the isolation of error sources.



Further information:

Thomas J. Duff, Derek M. Chong, Peter Taylor, Kevin G. Tolhurst (2012)

Procrustes based metrics for spatial validation and calibration of two-dimensional perimeter spread models: A case study considering fire

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tjduff@unimelb.edu.au
kgt@unimelb.edu.au

http://www.forestscience.unimelb.edu.au/people/staff/kevin_tolhurst/index.html
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