Enhancement of Fire Behaviour Models for Use in Risk Assessment and Decision Support Tools

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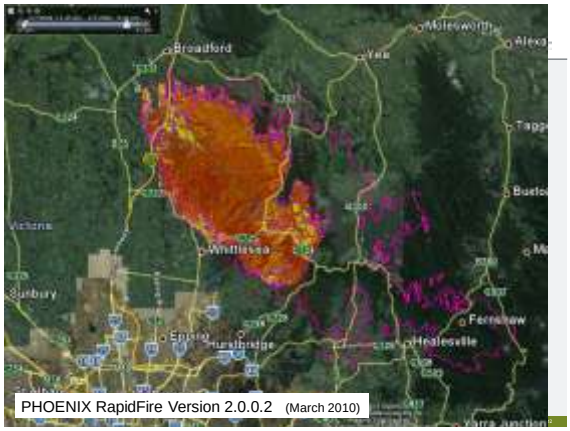
Program: "Understanding Risk"
Project: "Fire Impact and Risk Evaluation - Decision Support Tool (FIRE-DST)"

OUTLINE

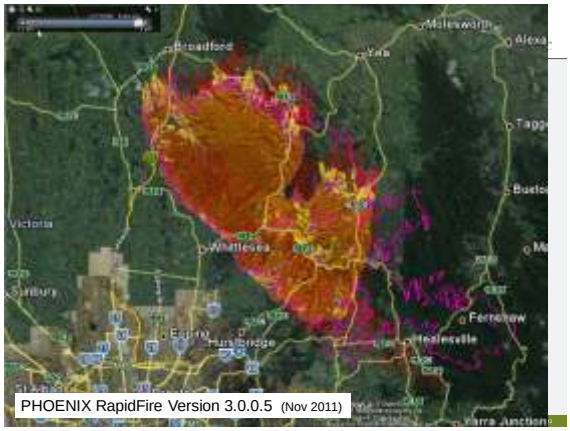
1. Advances in PHOENIX RapidFire - BCRC round 2
2. Progress in Case Study 1 – Black Saturday (Kilmore)
3. Extension (Technology Transfer)
4. Future work

ADVANCES

1. PHOENIX RapidFire 2.0.0.2 (March 2010)
   a) Problems with spotting implementation at low and extreme behaviour
2. Developments
   a) Automatically start fires when FDI > 23 or at peak FDI (Grid Analysis)
   b) Incorporated and improved Stuart Matthews' fuel moisture model for spotfire ignition
   c) Ember density with bimodal distribution (Weibull function)
   d) Ability to incorporate grass curing layer from MODIS (CRC project)
   e) Calculation of heat segments and convective centres to drive spotting
   f) Suppression resources in relative time rather than absolute time
   g) Onboard zip function to improve compatibility across operating systems
   h) New WindNinja code and process incorporated
   i) Added simulation log file for operational use
   j) Convection added as an output
   k) New potential house loss function developed including convection strength
   l) Added input parameter sensitivity option
   m) Added fire impact direction to outputs for input to Justin's model
   n) Developed a convection strength and height function with bubble graphics

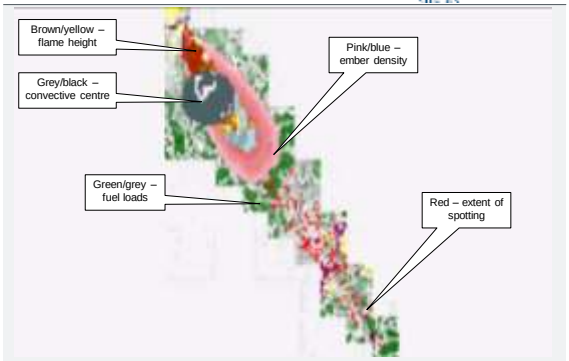


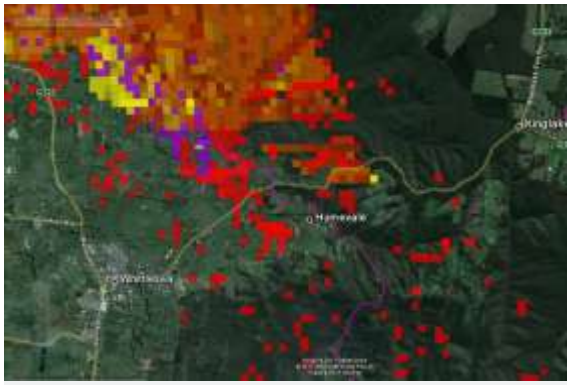
PHOENIX RapidFire Version 2.0.0.2 (March 2010)



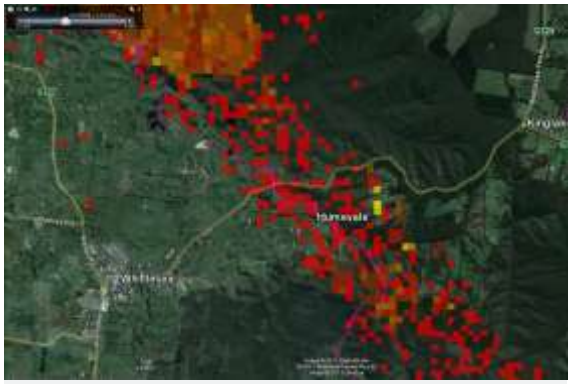
PHOENIX RapidFire Version 3.0.0.5 (Nov 2011)

CONVECTIVE CENTRES

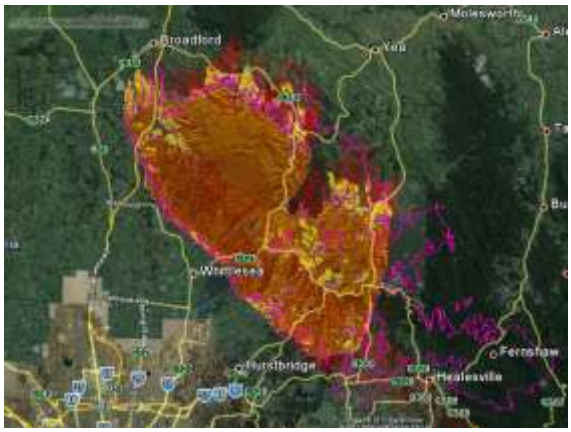




PHOENIX RapidFire Version 2.0.0.2



PHOENIX RapidFire Version 3.0.0.5



STUDY DATA (HOUSES)

	Lost	Survived	Total	Pr(Loss)
Churchill	225	146	371	0.61
Kilmore	1751	1836	3587	0.49
Murrindindi	664	400	1064	0.62
Stawell	14	46	60	0.23
Total	**2654**	**2428**	**5082**	**0.52**

PRINCIPAL COMPONENT ANALYSIS
(A STATISTICAL MODEL)

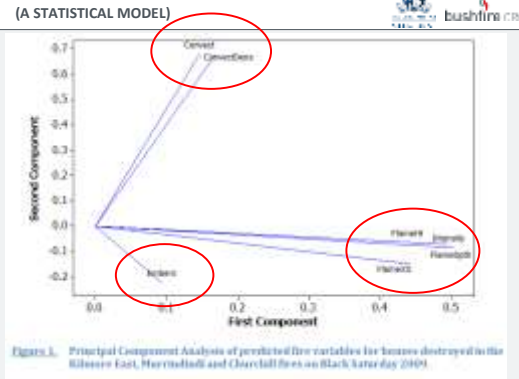


Figure 1. Principal Component Analysis of predicted fire variables for houses destroyed in the Kilmore East, Murrindindi and Churchill fires on Black Saturday 2009.

INTERACTIVE FACTORS (STATISTICAL MODEL)

Logistic equation 1.

Pr[Loss]=1-EXP(0.63076-0.0000021*ConvectDens-0.0002662*FlameXS-0.01832*Embers)/(1+EXP(0.63076-0.0000021*ConvectDens-0.0002662*FlameXS-0.01832*Embers))

Somers D = 0.51

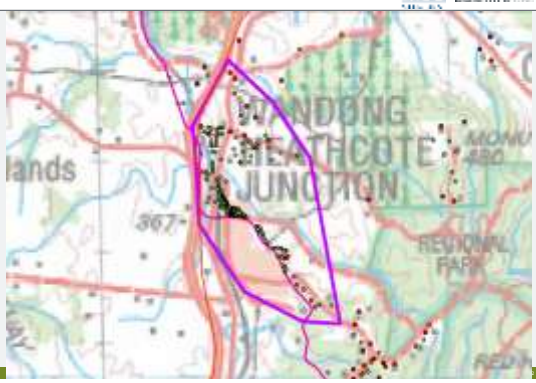
Logistic equation 2.

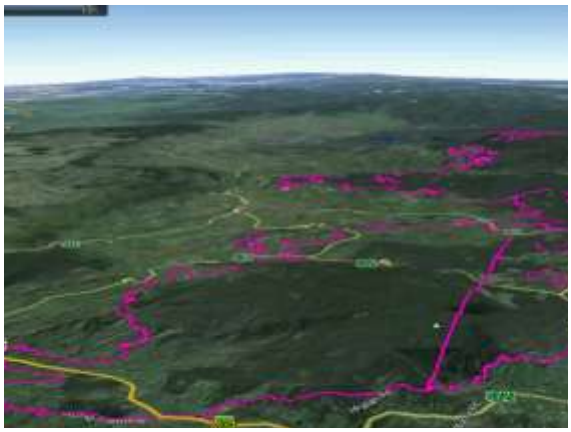
Pr[Loss] =1-EXP(0.2894-0.000487*FlameXS-0.02003*Embers-0.0000157*Convect)/(1+EXP(0.2894-0.000487*FlameXS-0.02003*Embers-0.0000157*Convect))

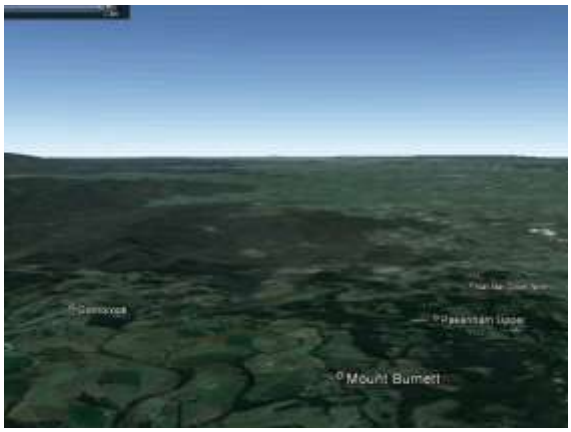
Somers D = 0.42

INTENSIVE INVESTIGATION AREAS – WANDONG

(188 HOUSES)







Bunyip Ridge fire (12:20 am start)

Comparison of Phoenix convection model (bubbles) with Laverton weather radar data looking side on.

Smoke as reflectance > 33 dBZ (pink rays)

PROGRESS ON CASE STUDY 1

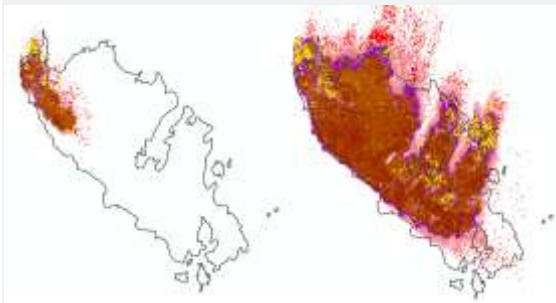
CSIRO SINGLE HOUSE VULNERABILITY MODEL

DATA
(CASE STUDY 1 – KILMORE 2009)

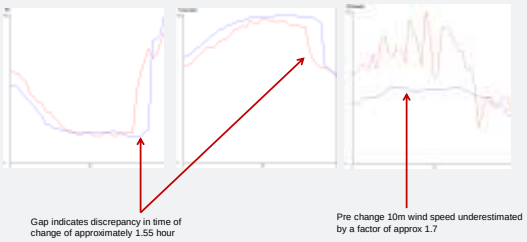
1. Fuel
   a) Vegetation – ok, but no detail around interface and rural residential areas.
   b) Veg to Fuel conversion – ok, but not validated
   c) Fire History pre-Black Saturday – ok.
   d) Interface fuel characterization (not yet, to be done in interface model).
2. DEM
   a) 30m, ok.
3. Disruptions
   a) Roads with widths, ok.
   b) Rivers with widths, ok.
   c) Firebreaks, cleared easements, no.
4. Houses
   a) Post-Black Saturday survey data, ok.

DATA

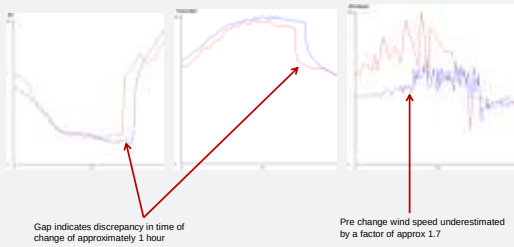
5. Weather
   a) Operational gridded forecast data (3km, hourly)
   b) AWS observations (Kilmore Gap AWS)
   c) Gridded reforecast (3600m, 1200m, 400m, 5 mins), not yet
   d) Grass curing (Modis image, experimental)
6. Fire Reconstruction
   a) Preliminary analysis only (Nic Gellie)
7. Other values and Assets
   a) Not considered this time.
8. Vulnerability models
   a) Houses – broadscale statistical model (paper published)
   b) Interface to single house model to be developed (Justin)



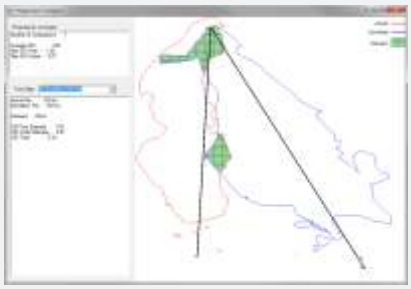
Raw ACCESS 5 minute data at 3600m compared to bias corrected wind speed (x1.7) with Time offset (1.55 hours) to match time of change at Kilmore Gap AWS



Raw ACCESS 5 minute data at 3600m (Blue) compared to Kilmore Gap AWS observations (Red) 9am to 10 pm 7th February 2009.



Raw ACCESS 5 minute data at 400m (Blue) compared to Kilmore Gap AWS observations (Red) 9am to 10 pm 7th February 2009.

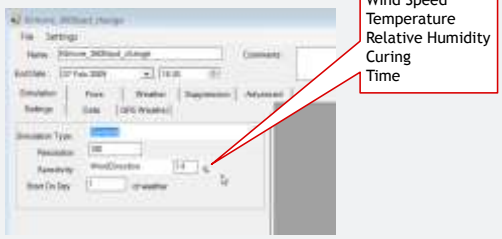


Implementation of a Spatial Deviation Index (*Cui and Perera 2010*) which allows complex fire shapes that including spot fires to be compared, and additional angular deviation measure Indicated by the black lines has also added based on *(Duff et al. 2012*)

Cui, W. and A. H. Perera (2010) "Quantifying Spatio-Temporal Errors in Forest Fire Spread Modelling Explicitly." Journal of Environmental Informatics **16(1): 19-26.**

Duff, T. J., et al. (2012). "Procrustes based metrics for spatial validation and calibration of two-dimensional perimeter spread models: A case study considering fire." Agricultural and Forest Meteorology **160**(0): 110-117.

ENSEMBLE AND SENSITIVITY RUNS



EXTENSION – TECHNOLOGY TRANSFER

1. NSW – RFS & Uni Wollongong (Case study 3)
2. SA – DENR (Case study 2)
3. Tas – NPWS Tasmania
4. WA – DEC
5. Vic – DSE/CFA (Case study 1)
6. Nationally – Fire Behaviour Analysts Course

SUMMARY

1. Significantly improved the dynamics of PHOENIX RapidFire with convection-driven spotting
2. Useful statistical model of house loss based on fire characteristics alone
3. Fire characteristics at the urban interface useful as input to "Single House Vulnerability" model
4. Ready to evaluate effects of temporal and spatial resolution of weather data on fire simulations
5. Ready to provide quantitative comparisons of simulated fire areas
6. Ensemble modelling will be needed in the future
7. Some preparation for Case studies 2 and 3 in place through knowledge transfer process