Evaluating approaches to mapping burn probability: phase I

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OBJECTIVE

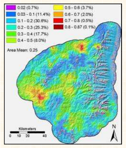
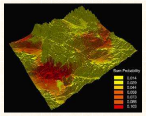
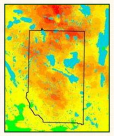
Evaluate and test 3 burn probability models and incorporate the approach into a quantitative risk assessment tool. In doing so, answer:

- Why and under what circumstances is one model better?
- What features make a landscape more/less susceptible to fire?
- How might expected loss/benefit be altered by fuels management?

Burn Probability is the likelihood that a location will burn within a defined time period. It depends on the spatial configuration and interaction of fuels, topography, weather (e.g., wind) and ignition location.

Burn Probability models combine the stochastic components of the fire regime (spatial ignitions, fire weather conditions) with deterministic fire spread based on the physical factors that control fire spread. The fire spread component allows these models to predict how burn probability is affected by landscape patterns.

Some of the Major Differences Among Models

	BurnPro	FlamMap-Randig	BURN-P3
			
Developer	US Forest Service (RMRS-ALWRI)	US Forest Service (RMRS-Fire Lab)	Canadian Forest Service
Spatial scale	10^4-10^7 km^2	10^1-10^4 km^2	10^4-10^7 km^2
Temporal scale	Entire fire season	Weeks	Entire fire season
Burning period	Length of fire season; frequency of rain	User defined	# hrs & days of burning in fire season
Fire growth	Minimum travel time, weighted by weather class	Minimum travel time using time series of weather	Prometheus fire spread model
Probability calculation	Weibull waiting time	Sum of occurrences	Sum of occurrences

OVERVIEW

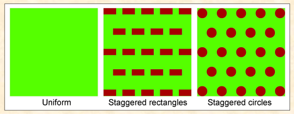
Predictive models of burn probability (BP) have enormous potential to support quantitative fire risk assessments. However, the task of estimating BP is not trivial, and we have only a fragmentary understanding of the controls on BP.

To better understand the factors affecting BP and to improve our ability to conduct quantitative risk assessments, **we are evaluating and comparing three independently developed approaches**, each of which simplifies the complexity of landscape fire in different ways to estimate BP. None have yet been fully tested or validated.

In Phase I of this project, we use a series of very simple, artificially generated landscapes to run controlled simulation experiments in which the effects of a single or few interacting variables can be distinguished. We employ a factorial design in which we vary some of the key factors including the spatial pattern of fuels, fuel flammability, ignitability, and fire size distributions.

Simulation experiments on simple, artificial landscapes to vary key factors like these:

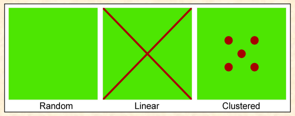
FUEL PATTERN
- **Patch shape**
- **Composition**



Colors represent different fuel types

2:1 rate-of-spread ratio between two fuel types.

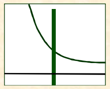
IGNITIONS
- **Random**
- **Patterned**



Colors represent different ignition point densities

10% of landscape with 10 times the ignition potential

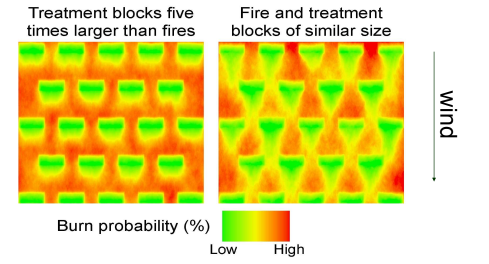
FIRE SIZE
- **Constant**
- **Variable**



Constant, uniform random, and negative exponential distributions

Two mean fire sizes = 1/20th & 1/100th of landscape.

Each of the three BP models produces BP maps for the artificial landscapes like the ones below. These provide an important verification of model behavior.



NEXT STEPS

After completing phase I model evaluations using simple artificial landscapes, BP model performance will be evaluated on artificial landscapes that are increasingly more complex (e.g., with topography) and finally on real landscapes. This will help us understand the spatial features that make a landscape more or less susceptible to fire and will help us identify the best approach for supporting quantitative risk assessments.

We will incorporate a BP approach into ArcFuels. ArcFuels is a a library of VBA (Visual Basic for Applications) macros within ArcMap that link and drive a number of models. The inclusion of a BP model in ArcFuels will provide an operational risk analysis tool for conducting risk assessments and evaluating fuels management alternatives.