

On Correlating Mixed Forest Fuel Bed Fire Spread Data

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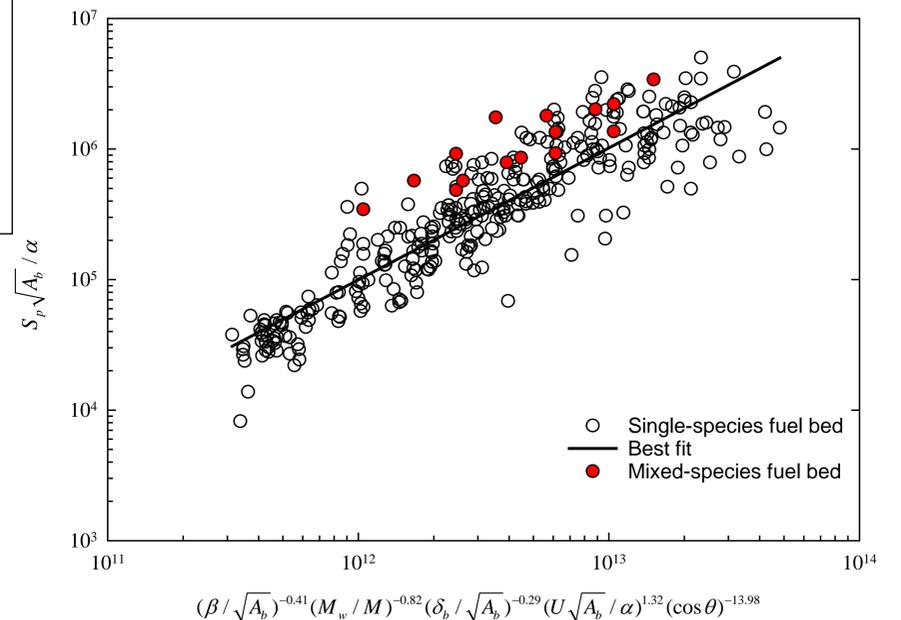
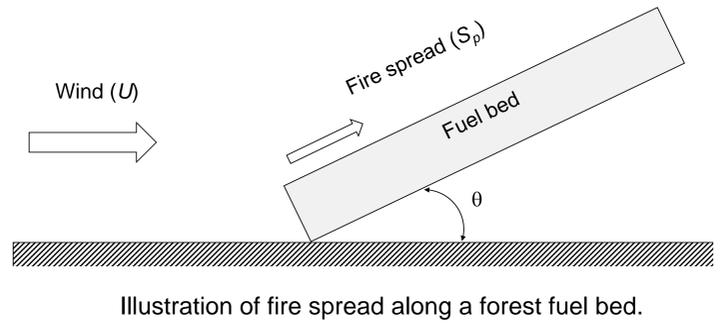
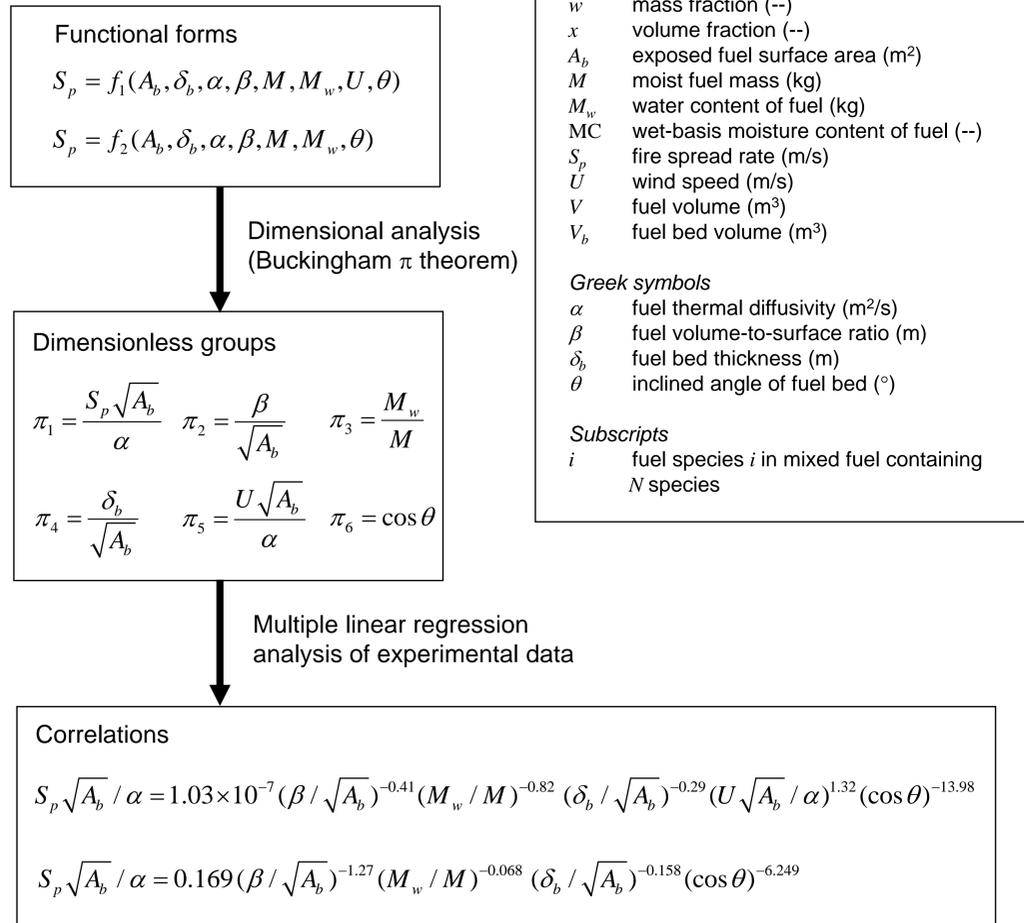
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Introduction

Fire spread along forest fuel beds is an important aspect in the study of wildland fire dynamic behavior. Most, if not all, of the previous experimental studies have been focused on fire spread along a homogeneous fuel bed. The experimental parameters examined mainly included fuel type, fuel bed compactness, applied wind speed, and the orientation of the fuel bed. Very few studies employed mixed forest fuel bed.

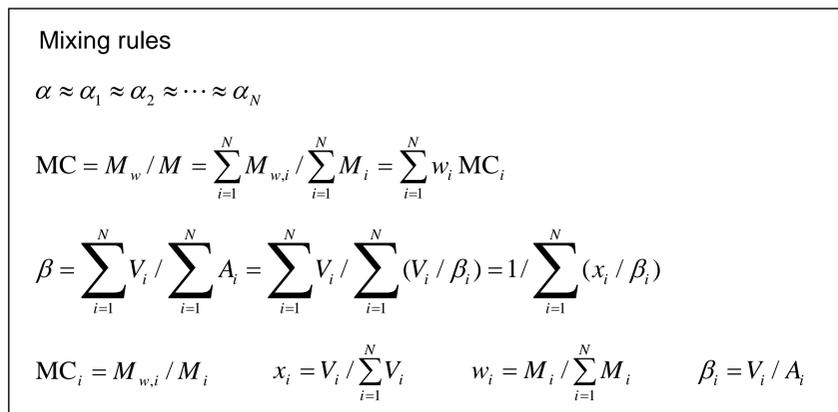
Recently, the author used dimensional analysis to correlate a large amount of experimental data of fire spread along a single-species forest fuel bed from the literature with some success [see *Canadian Journal of Forest Research* **48** (2018) 105-110]. The resulting dimensionless groups include dimensionless fire spread rate, dimensionless fuel particle size, fuel moisture content, dimensionless fuel bed depth or dimensionless fuel loading density, dimensionless wind speed, and angle of inclination of fuel bed.

Dimensional Analysis



In this work, we examine if the above two correlations for single-species fuel could be used for fire spread for mixed forest fuel bed by defining and deriving some empirical mixing rules (akin to mixing rules used in thermodynamics for mixtures) to treat mixed fuel species as a pseudo single fuel species.

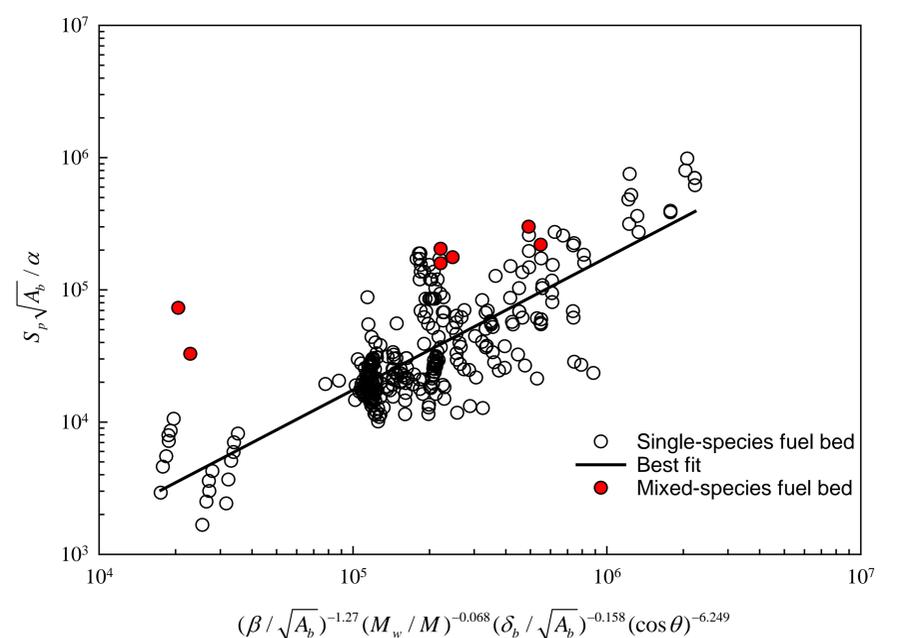
Two major assumptions are used in the analysis. One is to assume that the fuel species are *evenly distributed* (i.e., *well-mixed*) in the mixed fuel bed. According to some studies, many actual forest fuel beds can be found in configurations that correspond closely to this seemingly idealized fuel bed for mixed species. The other is to assume all the fuel species have *similar thermal diffusivity* (the thermal diffusivities for many selected wood species only decrease slightly with density and over a range of moisture contents typically used in experiments reported in the literature).



Conclusions

Based on a limited set of data on multiple-species fuel fire spread, the dimensionless correlations correlate the fire spread rates satisfactorily for single-species and multiple-species fuels in the light of the wide range of uncertainties associated with some of the estimated parameters used to obtain the dimensionless groups for the correlations. With proper mixing rules for the fuel bed properties to estimate the dimensionless groups, the correlations for the single-species fuel spreads could potentially be extended and directly applicable to mixed fuel spreads.

Dimensionless correlation for forest fuel fire spread under no wind conditions.



Data sources

Single-species fuel bed: *Canadian J. of Forest Research* **48** (2018) 105-110.
Mixed-species fuel bed: *International J. of Wildland Fire* **3** (1993) 45-57.