

Dynamic calculations of fire Disturbance Matrices for GCBM including fire severity

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Global Variables

Certain variables, like the fractionation of CO₂:CH₄:CO, are constant throughout ecozones, but vary by flaming vs smouldering. They are defined in a global variables table:

Duff Consumption

To be expanded later, but duff consumption can be calculated annually using the median hotspot Drought Code and de Groot's FFFC equations, as applied to median FFFL values. Could also be done per fire using fire-specific DC and mapped FFFC values as well. Need to compute this above for use below.

Constructing fire DMs from abstractions

First, a generic template for a fire DM is loaded, that can represent any ecozone. It comes in two parts: (1) a list of variables, some biophysical and not relating to fire severity (such as the portion of live branchwood that falls into the smaller size fraction); or (2) severity-specific variables (such as Crown Fraction Burn) for a severity class. The template is loaded, and replicated across the list of ecozones (or any spatial unit) desired. Other processes, such as the analysis of field data, can then be used to fill in ecozone-specific variables in severity classes.

An example of the variable definition template is as follows:

| Ecozone | Pool | Plain.Language.Name | Variable.Name | Value | SeverityClass | InterimValue |
|---------|--------|--|----------------------------|-------|---------------|--------------|
| LA | Branch | Softwood small branch fraction of total branchwood | SW.SmBranch.frac.of.tot.BW | 0.5 | NA | TRUE |
| TP | Branch | Softwood small branch fraction of total branchwood | SW.SmBranch.frac.of.tot.BW | 0.5 | NA | TRUE |
| TSW | Branch | Softwood small branch fraction of total branchwood | SW.SmBranch.frac.of.tot.BW | 0.5 | NA | TRUE |
| BSW | Branch | Softwood small branch fraction of total branchwood | SW.SmBranch.frac.of.tot.BW | 0.5 | NA | TRUE |
| BP | Branch | Softwood small branch fraction of total branchwood | SW.SmBranch.frac.of.tot.BW | 0.5 | NA | TRUE |
| P | Branch | Softwood small branch fraction of total branchwood | SW.SmBranch.frac.of.tot.BW | 0.5 | NA | TRUE |

| Ecozone | FluxID | Source | Sink | ProcessSynonym | Pseudocode | Notes | SeverityClass | Value | InterimValue |
|---------|--------|-----------------------|-----------------------|---------------------------------|------------------|----------------|---------------|-------|--------------|
| LA | 1 | Softwood Merchantable | Softwood Merchantable | Survival rate of large conifers | 1-mortality rate | Ellen provides | Low | 0.8 | TRUE |
| TP | 1 | Softwood Merchantable | Softwood Merchantable | Survival rate of large conifers | 1-mortality rate | Ellen provides | Low | 0.8 | TRUE |
| TSW | 1 | Softwood Merchantable | Softwood Merchantable | Survival rate of large conifers | 1-mortality rate | Ellen provides | Low | 0.8 | TRUE |
| BSW | 1 | Softwood Merchantable | Softwood Merchantable | Survival rate of large conifers | 1-mortality rate | Ellen provides | Low | 0.8 | TRUE |
| BP | 1 | Softwood Merchantable | Softwood Merchantable | Survival rate of large conifers | 1-mortality rate | Ellen provides | Low | 0.8 | TRUE |
| P | 1 | Softwood Merchantable | Softwood Merchantable | Survival rate of large conifers | 1-mortality rate | Ellen provides | Low | 0.8 | TRUE |

A plain language name for each variable is provided right in the data, as well.

A second template defines each flux in a Disturbance Matrix, with Source and Sink defined as precise character variables, and a plain language summary (“Process Synonym”) included to tie this flux back to language used in the fire science literature. Pseudocode and notes are included in each flux, which is repeated for each fire severity class and ecozone. There are 3900 total fluxes, though many do not have sufficient information to describe differences between ecozones. Many of these are computed automatically, tying back into variables such as Crown Fraction Burned.

With both generic ecozone variables as well as severity-specific variables defined and the pseudocode for each flux included, actual DM values are computed as references to tables, subset by ecozone and severity class:

```
# SourceSink$Value[SourceSink$Ecozone == ecozone &
# SourceSink$FluxID == 1 & SourceSink$SeverityClass ==
# 'Low'] <- 1 - (VarDefs$Value[VarDefs$Variable.Name ==
# 'SW.CFB' & VarDefs$Ecozone == ecozone &
# VarDefs$SeverityClass == 'Low'])
```

Note that rather than defining softwood crown fraction burned as a variable called “SW.CFB” for each ecozone, there is a row in the VarDefs table that represents SW.CFB in each ecozone and for each severity class, thus avoiding the creation of large lists of manually entered variable names and values in the R environment. Instead, these values can be programmatically entered via external analysis of plot data (not covered here).

In a final step, a classical tabular DM is shown, with row and column names precisely matching those in the Sink and Source columns in the SourceSink table:

Table 1: Example moderate severity DM in Boreal Plains

| | Softwood Mer- chantable | Softwood Stem Snag | Black Carbon | Softwood Foliage | Above Ground Very Fast soil C | CO2 | CH4 | CO |
|----------------------------------|-------------------------------|-----------------------|-----------------|---------------------|--|------|-------|------|
| Softwood Merchantable | 0.5 | 0.5 | 0 | NA | NA | NA | NA | NA |
| Softwood Stem Snag | NA | NA | NA | NA | NA | NA | NA | NA |
| Black Carbon | NA | NA | NA | NA | NA | NA | NA | NA |
| Softwood Foliage | NA | NA | NA | 0 | 0.45 | 0.45 | 0.005 | 0.05 |
| Above Ground Very Fast soil C | NA | NA | NA | NA | NA | NA | NA | NA |
| CO2 | NA | NA | NA | NA | NA | NA | NA | NA |
| CH4 | NA | NA | NA | NA | NA | NA | NA | NA |
| CO | NA | NA | NA | NA | NA | NA | NA | NA |