A framework for modelling coarse woody debris dynamics, and a case study from Tasmania

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Coarse woody debris (CWD) is an important structural component in most forest systems. To understand the effects of different forms of management on CWD, on dependent biodiversity and on carbon, we need to understand its dynamics. **CWD dynamics** can be summarised as: "*how CWD volume, mass, diameter class distribution and decay class distribution change over time [at different spatial scales] as decay progresses and in response to different disturbance events or management interventions.*" Here we outline an approach for modelling CWD in forests subjected to periodic stand-replacing disturbance events such as wildfire or clearfelling. The modelling framework has been implemented for CWD in Tasmanian wet *Eucalyptus obliqua* forests using the Simile® visual modelling environment.

Growing the trees that give rise to the dead wood

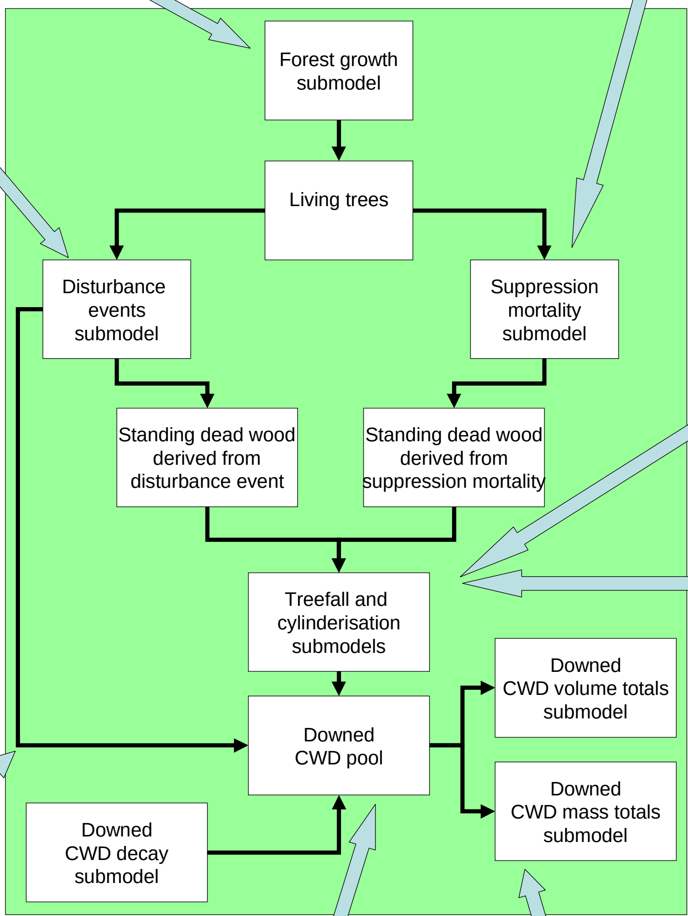
A growth model developed by Forestry Tasmania was adapted for this modelling framework. For a given site index, it first predicts the distribution of DBHob in the growing stand at yearly intervals in 1 cm diameter-classes. It then calculates the distribution of tree heights that can account for the predicted DBHob distribution, and uses this to calculate wood volumes assignable to 1 cm DBHob diameter-classes.

Generating standing dead wood from living trees through suppression mortality

A suppression mortality function developed by Forestry Tasmania was adapted for this modelling framework. It describes the number of stems per hectare dying through suppression mortality for a given stand age and site index. This is converted to volume based on the average DBHob for the given stand age and on the average tree height calculated for trees of that DBHob.

Generating standing dead wood from living trees through a disturbance event

Before disturbance mortality can reduce living trees to downed woody debris in this modelling framework, those trees must first become standing dead wood, even if only fleetingly. This is accomplished by transferring the volume of living trees into the 'standing dead wood derived from disturbance event' compartment, in the time-step (year) immediately following the disturbance event. The timing and frequency of disturbance events can also be set. At this stage, losses to standing dead wood caused by the disturbance event can be modelled. For instance, wildfire or timber harvesting can be modelled as removing (combusting and/or harvesting) a certain percentage of the volume before it enters the 'standing dead wood derived from disturbance event' compartment. Losses can be apportioned at different rates to different diameter-classes to represent the differential effects of the disturbance event in relation to tree diameter. When a disturbance event occurs, the age of the growing stand is reset to zero.



Simulating treefalls

For clearfelling, the volumes of wood in the 'standing dead wood' compartments are transferred to the downed CWD pool in the year of the disturbance event to represent the residual harvest residue. For wildfires and for suppression mortality, dead trees are modelled as falling over at rates proportional to their DBHob. Trees that take many years to fall over are modelled as entering the downed CWD pool in decay-class 2 rather than in decay-class 1.

'Cylinderising' the standing dead wood subjected to treefalls

Cylinderisation reallocates the volumes of standing dead wood from DBHob classes to 1 cm diameter-classes, using pre-established taper equations developed by Forestry Tasmania. Cylinderisation allows for a better representation of the diameter-class distribution of downed CWD. For instance, not all small-diameter CWD is derived from trees with a small DBHob (some comes from the tops of trees with large DBHob), while some CWD is of a diameter greater than the trees with the largest DBHob (because a sizeable proportion of a tree's volume resides in its butt).

Allowing a disturbance event to impact on pre-existing downed woody debris

This is accomplished by triggering a change to the downed woody debris pool in the same time-step as the disturbance event. For instance, wildfire or timber harvesting can be modelled as removing (combusting and/or machine crushing and/or fuelwood harvesting) a certain percentage of the volume in the pool. Losses can be apportioned at different rates to different diameter-classes or decay-classes to represent the differential effects of the disturbance event in relation to downed CWD diameter and decay stage.

Decaying CWD in the downed CWD pool

This requires modelling decay-class transitions, and modelling cylinder diameter-class transitions. Decay-class transitions are achieved using a Markov chain approach, where the transition from one decay-class to the next is specified as the inverse of the residence time of downed CWD in that decay-class. Several 'streams' of decay can be modelled, to allow for different rates of decay for downed CWD in different cylinder diameter-classes. Additionally, the model allows downed CWD to transit from one diameter-class 'stream' to another if it loses sufficient diameter (through decay) to trigger a need for this transition.

Aggregating and outputting CWD data

These functions allow data from the model to be output as mass or volume, in tabular or graphical form, aggregated by diameter-class or decay-class (or a combination of the two) if required. CWD mass is calculated based on relationships between decay-class, diameter and wood density that were established for this modelling framework.

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