Bulk density

Definition:

Calculating the Target Crown Bulk Density.—Crown bulk density is a parameter that describes density of crown fuels or the mass of foliage and twigs within the volume of space occupied by tree crowns. Van Wagner’s (1977)

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| **Vegetation** | **Bulk density (kg/m3)** | **Technique** | **Source** |
| Pinus sylvestris | 0.13-0.14 | LiDAR | [1] |
| Grand fir, Douglas fir, Ponderosa pine | 0.10 (to sustain crown fire) | Emperical | [2] |
| Ponderosa pine (3200 trees/ha)  Douglas fir (3200 trees/ha)  Grand fir (3200 trees/ha) | 0.223  0.26  0.378 | Emperical | [3] |
| Pinus) Aleppo pine | 0.09-0.22 |  | [4] |
| Eucalyptus -Surface fuel bulk density | 44( sit 1) and 52 (site 2) | Field experiment | [Project vesta] |
| Pine forests | 0.23 |  | [3] |

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Calculated bulk desity of eucalyptus in AS3959

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| Component | Fuel load (kg/m2)  [given in AS3959] | Thickness of the fuel layer (m)  [given in AS3959] | Bulk density (kg/m3)  [Calculated as per Ioannis et al. 2007] |
| Canopy | 10 | 20 | 0.05 |
| Understorey | 2.5 | 10 | 0.25 |

1. Riano, D., et al., *Generation of crown bulk density for Pinus sylvestris L. from lidar.* 2004. **92**(3): p. 345-352.

2. Keyes, C.R. and K.L.J.W.J.o.A.F. O'Hara, *Quantifying stand targets for silvicultural prevention of crown fires.* 2002. **17**(2): p. 101-109.

3. Agee, J.K. *The influence of forest structure on fire behavior*. in *Proceedings of the 17th annual forest vegetation management conference*. 1996.

4. Mitsopoulos, I.D. and A.P.J.A.o.F.S. Dimitrakopoulos, *Canopy fuel characteristics and potential crown fire behavior in Aleppo pine (Pinus halepensis Mill.) forests.* 2007. **64**(3): p. 287-299.

3. A Guide to rate of fire spread models. Cruz et al.

Observations of the series of trail simulations

1. Bulk density of fuel results of the nature of the flame (tilting, coming out from the vegetation) and being a barrier to firebrands to come out

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Wind effect is higher because of lower CBD wind effect is lower because of higher CBD

Wind dominant Fire buoyancy dominant

1. Lower fuel consumption results lower flame height and flame temperature.

The density of firebrands and the elevation of firebrand inputting depend on this.

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| Tmax=1118 0C (at the center of the flame)  T ≈ 700 0C (at Canopy level:visually) | Tmax=968 0C (at the center of the flame)  T ≈ 500 0C (at Canopy level:visually) |

1. Initiating firebrands at higher elevations results longer spotting

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And,

the level of fireline is at the forest floor ---- > more likely buoyancy dominant

the level of fireline is at the canopy ---- > more likely wind dominant

Calculating the number density of vegetation particles

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Total fuel load (t/ha ) = 35

= 3.5 kg/m2

Understorey fuel load (t/ha ) = 25

= 2.5 kg/m2

Canopy fuel load(t/ha ) =35-25

=10 kg/m2

Thickness of canopy (m) =20

Thickness of understorey (m) =10

**MPV(bulk density) canopy** = (10 kg/m2)/20m

=**0.05 kg/m3**

**MPV(bulk density) understorey** =(2.5 kg/m2)/10m

=**0.25 kg/m3**

Volume of a single eu. Leaf (V) = L 🞨 W 🞨 t

=0.12 m 🞨 0.017 m 🞨 0.00065 m =1.326 🞨10-6 m3

Mass of a single eu.leaf (m) =V 🞨ρ

= (1.326 🞨10-6 m3) 🞨650 kg/m3

=8.619 🞨10-4 kg

Number of eu.leaves in a 1 m3 of canopy = Bulk density(canopy)/m

=(0.05 kg/m3)/ 8.619 🞨10-4 kg

=58.011 leaves/m3

**Number of eu. leaves in total canopy volume** =(58.011 leaves/m3) 🞨 130 m 🞨102 m 🞨20 m

=**1.5384615 🞨 107**

Number of eu.leaves in a 1 m3 of canopy = Bulk density(understorey)/m

=(0.25 kg/m3)/ 8.619 🞨10-4 kg

=290.05 leaves/m3

**Number of eu. leaves in total understorey volume**=(290.05 leaves/m3) 🞨 130 m 🞨102 m 🞨20 m

=**3.8461538 🞨 107**