



FOFEM 5

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FOFEM 5 is...

- A computer system to calculate first-order fire effects from simple inputs.
- A Windows program with a graphical user-interface; also has a batch mode
- A fire effects calculator that can be linked to GIS or other software

First order fire effects are the **immediate** consequences of fire, whether direct or indirect.



FOFEM 5 contains...

- scientific information from many research studies
- heuristic information to bridge gaps and to select best data and equations
- an extensive set of default inputs



FOFEM 5 predicts...

- Fuel consumption
- Smoke production
- Tree mortality
- Soil heating



FOFEM 5 applies in...

- Most U.S. forest types
- Some rangeland vegetation types
- Areas managed by different agencies



FOFEM 5 is used for...

- Conducting environmental assessments
- Developing fire and silvicultural prescriptions
- Assessing fire severity



Fuel databases

- Users can describe fuels in detail. If, however, they do not have fuels data, they can describe the vegetation type to use default fuels data.
- Three keys
 - SAF/SRM
 - NVCS
 - FCC (needs to be updated)



Fuel databases

- Default loadings provided for
 - Litter, duff
 - Woody fuel by size class
 - Herbs, shrubs and canopy fuels
- Adjustment factors (light, typical, heavy)



FOFEM 5: Fuel consumption

- FOFEM 5 predicts consumption of...
 - Duff and litter
 - Surface woody fuels by size class, sound and rotten
 - Live fuels and canopy fuels
- FOFEM 5 uses Burnup, a theoretical model for predicting woody fuel consumption



FOFEM 5: Fuel consumption

- Duff and live fuel consumption are predicted using rules and regression equations based on
 - cover type
 - region
 - moisture
 - season.
- BURNUP predicts woody fuel consumption by simulating
 - heat transfer between fuel particles
 - combustion rate
 - resulting fire intensity



Burnup Assumptions

- Fuelbed consists of randomly oriented cylinders
- Small dry pieces are initially ignited
- Their consumption produces heat that dries and heats larger, wetter pieces which may subsequently be ignited.
- Intensity initially increases as more particles are ignited, then decreases as the smallest particles burn up.
- At some point intensity will drop below a threshold and combustion will cease.



Burnup Assumptions

- Intensity varies at a small spatial scale
- Flaming and smoldering combustion occur simultaneously during a burn, depending on local intensity
- Duff burns at a constant rate.



FOFEM 5: Fuel consumption

- **Inputs needed:**
 - Fuel load by size class
 - Fuel moisture
- **Outputs generated:**
 - Fuel consumption by size class
 - Post-burn fuel load



FOFEM 5: Smoke production

- Predicts fuel consumption rate, emission production rate, and fire intensity over time for both surface and crown fires
- Simulates the proportion of flaming and smoldering combustion
 - Combustion efficiency and emission factors vary with fuels and moisture.
- Estimates production of PM_{10} , $PM_{2.5}$, CO , CO_2 , CH_4 , NO_x , SO_x



FOFEM 5: Smoke production

- Smoke production is estimated by multiplying fuel consumption by emissions factors
 - FOFEM uses separate emissions factors for flaming and smoldering combustion
 - Flaming and smoldering combustion can occur simultaneously, in relative amounts depending on fuel moisture, fuel particle size class, and fire intensity.
 - Emission production is estimated in time intervals from ignition until combustion ceases.



FOFEM 5: Smoke production

- **Inputs needed:**
 - Fuel load by size class
 - Fuel moisture
- **Outputs generated:**
 - Smoke production over time for each emission species
 - Combustion efficiency and emission factors





Smoke emissions: outputs

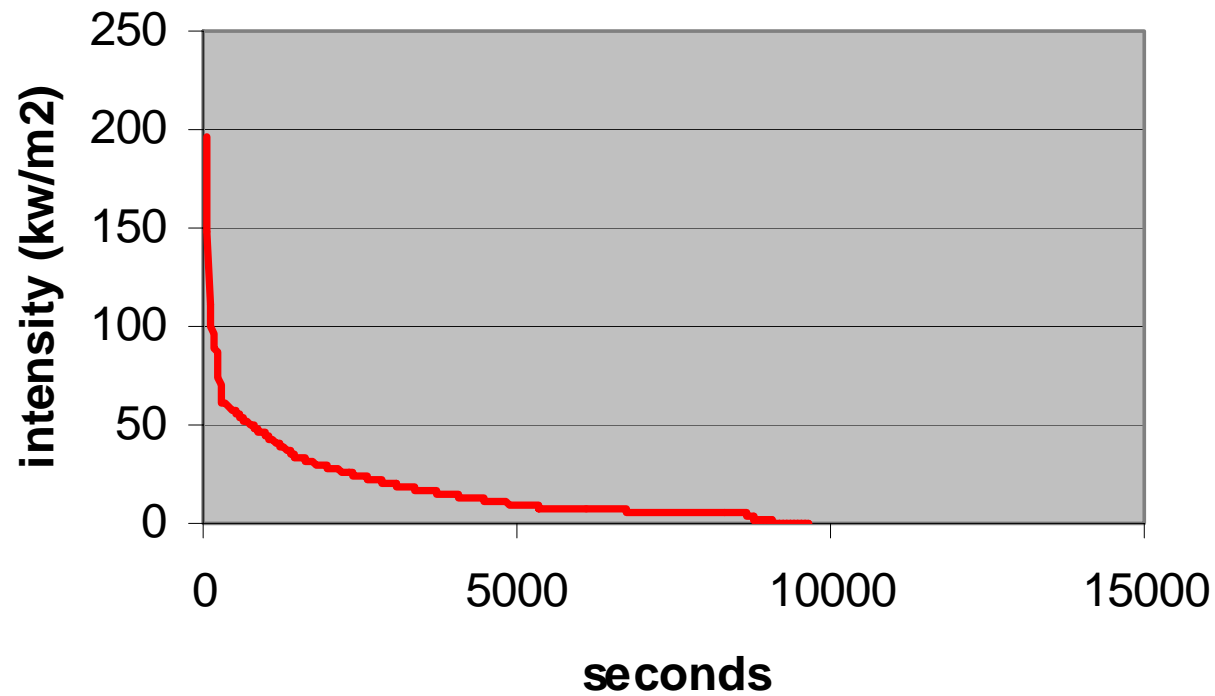
- Can save emissions and intensity history for use in smoke dispersion model (NFS-PUFF, SASEM, SIS).





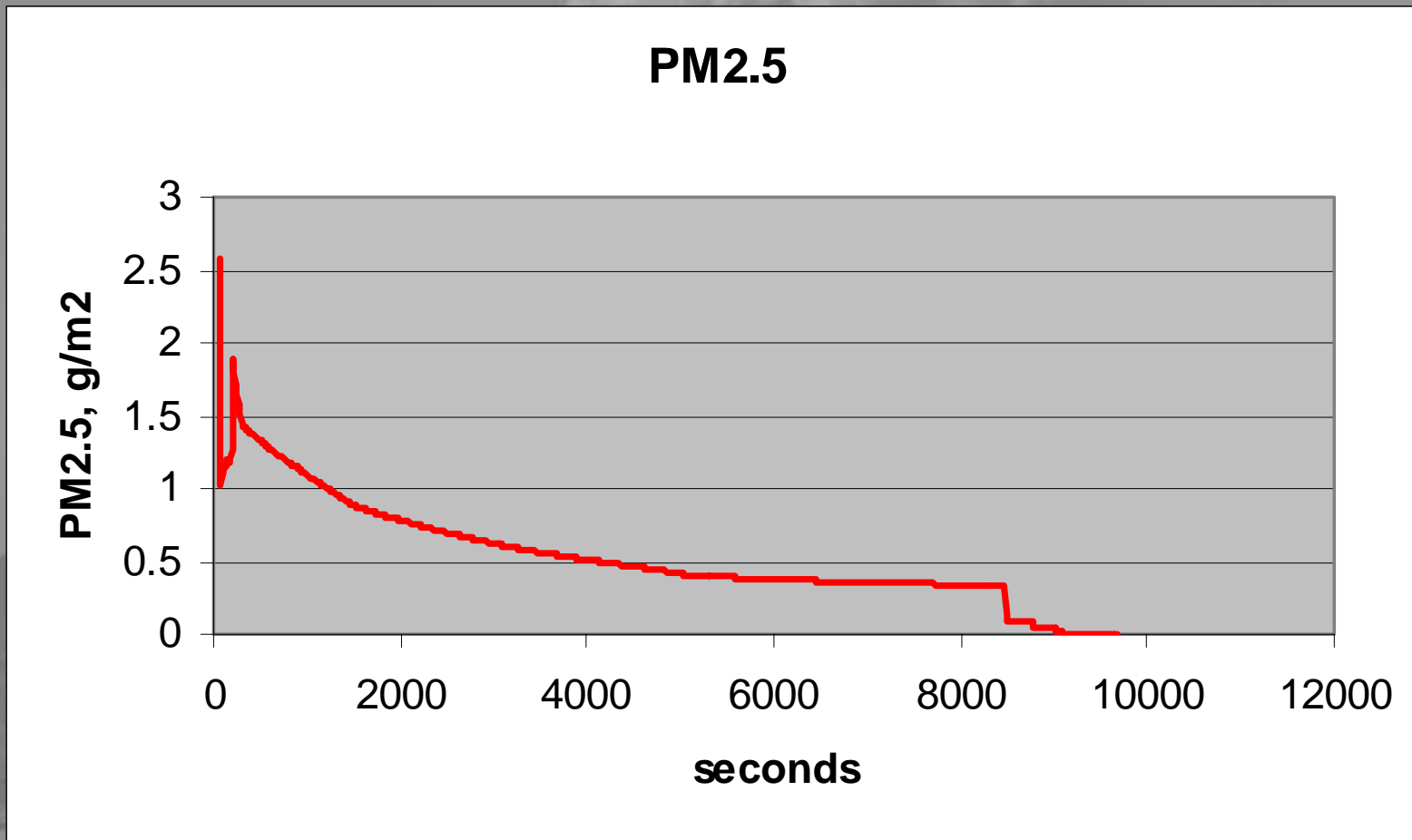
Smoke Output

Intensity over time



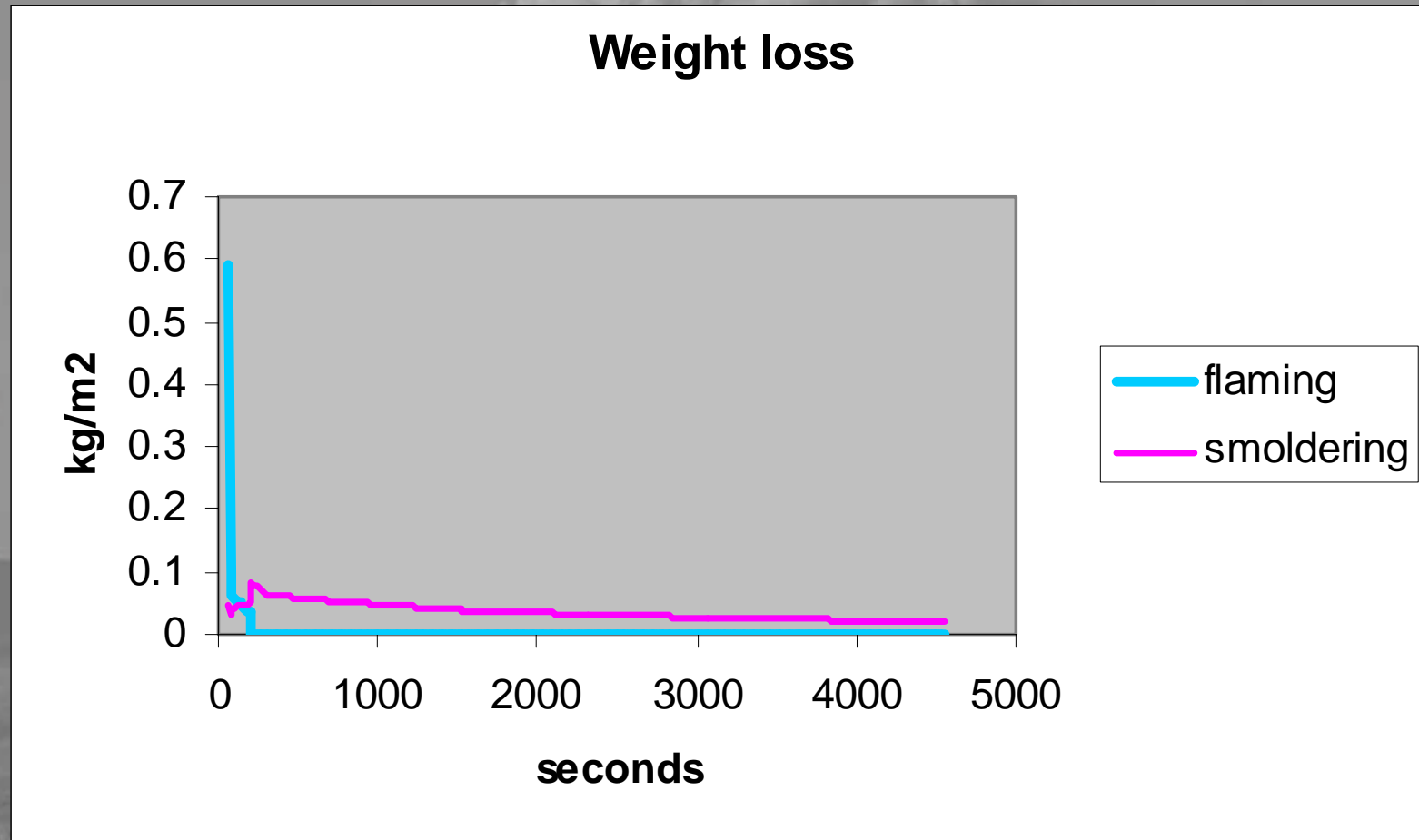


Smoke Output





Smoke Output





FOFEM 5 batch mode

- Some users need to make hundreds or even thousands of FOFEM runs
 - E.g., to simulate potential fire effects across a landscape or under a range of fuel moisture conditions
- A batch mode of FOFEM 5 allows you to bypass the user interface.



Linking FOFEM 5 to a GIS

- A GIS analyst can simulate the spatial distribution of fire effects by linking FOFEM 5 to a GIS
- The landscape is first divided into homogeneous units, then model inputs are set for each unit.
- Then the analyst simulates fire effects using a FOFEM batch run
- Finally, the FOFEM batch run output attributes are linked back to the original units, allowing the spatial display of effects such as probability of tree mortality, smoke production, fuel consumption, etc.



FOFEM library

- The FOFEM code is also available as a .dll that can be called from other software packages.



FOFEM 5: Strengths

- Simple, easy to learn and use
- Can be used for a variety of purposes
- Accommodates variable level of input detail
- Expandable structure
- Uses heuristic information to bridge research gaps