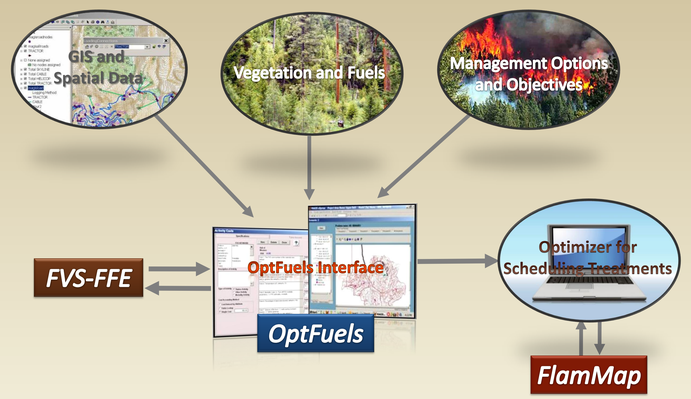
Spatial and Temporal Optimization of Fuel Treatments

Woodam Chung, Greg Jones, Janet Sullivan, Kurt Krueger, and Pablo Aracena

OptFuels *by Joint Fire Science Program*



Objective: Minimize expected loss to wildland fire over time

$$Minimize \sum_{t\in T}\sum_{c\in C}\sum_{f\in F} Loss_{f,c,t} \times Y_{f,c,t} \times P_{c,t}$$

Where
f is an index of flame length category,
c is an index of grid cells,
t is a time period,
$Loss_{f,c,t}$ is an expected loss value of grid cell *c* at flame length category ***f*** in time period ***t***,
$Y_{f,c,t}$ is a binary variable indicating the flame length category of cell ***c*** in period ***t***, and
$P_{c,t}$ is a probability of cell c being burn by given fire scenarios in time period ***t***.

WHY Forest managers faced with limited budgets, limited prescription-burning days, air quality issues, and effects on other critical forest resources must determine priorities for **where, when, and how** to apply and maintain hazardous fuel reduction treatments.

WHAT This study integrates existing fire behavior, vegetation simulation, and land management planning tools into a system for optimizing fuel treatments in time and space, given resource constraints (such as wildlife or hydrologic effects), management constraints (such as budgets), and operational feasibility of treatments.

HOW Combine existing application systems with new solution processor to take advantage of previous investments and efficiencies.

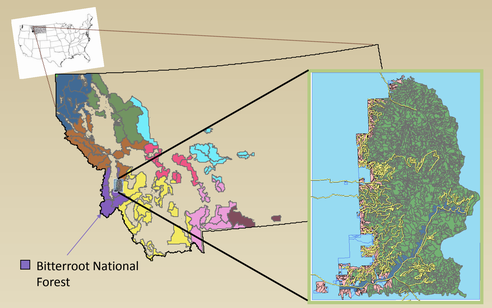
WHO **Woodam Chung and Pablo Aracena**, The University of Montana; **Greg Jones, Janet Sullivan, and Kurt Krueger**, Forest Service Rocky Mountain Research Station; **Mark Finney and Elizabeth Reinhardt,** Forest Service

For more information, contact Woodam Chung at woodam.chung@umontana.edu or Greg Jones at jgjones@fs.fed.us

Challenges

- ❑ Lack of spatial data for individual polygons: Important to support development of landscape GIS vegetation coverage with FVS ready inventory data (in addition to Landfire's current fuels coverage) to be able to project vegetation growth into the future both with and without treatment for each polygon
- ❑ Lack of appropriate fuel models that can represent resulting fuel characteristics after treatments
- ❑ Considerable computation time required
- ❑ Importance of developing workforce skills with the models employed by OptFuels

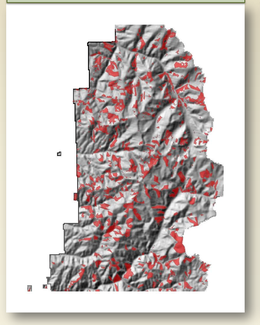
OptFuels Application



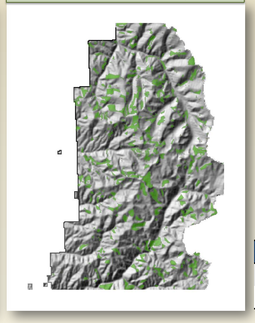
Land Types	Acres
FS, roadless	52,744
FS, accessible	30,939
FS, WUI	9,817
Right-of-way	3,830
State & Private	6,358
TOTAL	**103,688**

Treatment Types	Polygons
LP Clear Cut	309
PP, DF Thinning	807
Prescribed Fire	1319
No action only	775
TOTAL	**3,210**

Treatment locations – 1st period



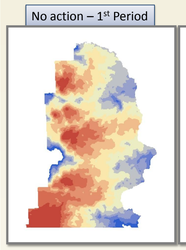
Treatment locations – 2nd period



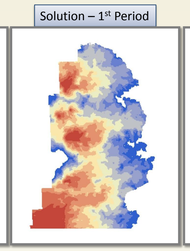
Area constraints: 20% and 15 % of total area

Period	Acres	Polygons
1	19,970	639
2	14,384	508

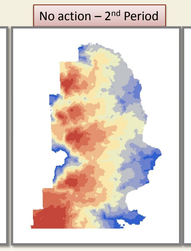
No action – 1st Period



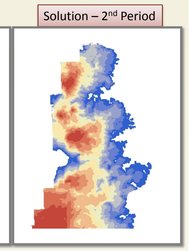
Solution – 1st Period



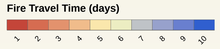
No action – 2nd Period



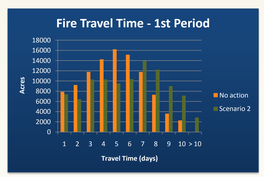
Solution – 2nd Period

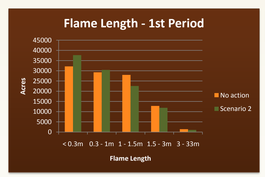


Fire Travel Time (days)

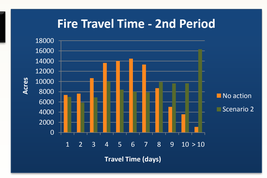


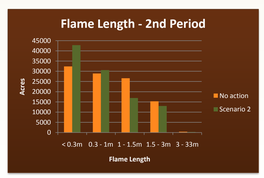
1st Period





2nd Period





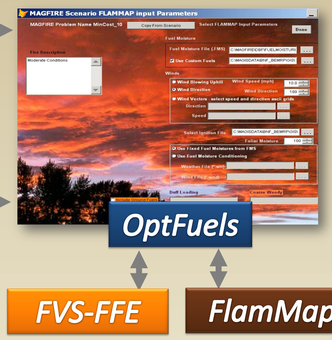
Decision Support System for Lake Tahoe Basin

FS WEPP

- ❑ Assess soil erosion potential after treatments
- ❑ Limit sediment loading to Lake Tahoe

Managers' Input

- ❑ Promote or sustain species of special concern
- ❑ Prioritize areas using Fire Regime Condition Classes (FRCC)



- ❑ LANDFIRE
- ❑ Fuel Characteristic Classification System (FCCS)

Project Objectives

- ❖ Develop an integrated decision support system built on the existing models that optimize fuel treatment locations in time and space to achieve multiple management objectives while meeting resource and operational constraints. Management objectives will be implemented in a flexible manner and can include the reduction of the probability of catastrophic fire, the reduction of sediment inputs into Basin streams, the promotion of species of special concern, among others. The decision support system will identify where, when, and how to treat fuels to maintain desired fuel reduction, forest restoration, and water quality goals at a landscape scale.
- ❖ Develop applications for the Lake Tahoe Basin. Working closely with land managers in the Basin, we will develop spatial and temporal fuel treatment schedules for the Lake Tahoe Basin that meet local resource management objectives. We will document the developed approach, experiences, and analysis results. We will also evaluate the system outputs in terms of the feasibility of implementation and improvement in treatment benefits.
- ❖ Deliver DSS to end users. Built on the existing OptFuels user interface, the decision support system will be immediately deliverable to land managers in the Basin. Managers will be able to construct planning models and conduct trade-off analyses between various management strategies through workshops, meetings, and working together with us during the project period.

Project Deliverables

Deliverable	Description	Schedules
Data transfer interfaces	Interface that facilitates automatic data transfers between MAGIS, FlamMap, FVS-FFE, and FS WEPP	Dec. 2009
Heuristic optimizer	Optimizer that integrates resource issues/economics with fire behavior projections for various treatment options	Mar. 2010
Interface for LMS	Decision support system that integrates MAGIS and LMS/ENVISION for enhanced solution display	Sep. 2010
Data collection	Input data collected for the support system	Dec. 2010
Lake Tahoe model	Application built from real data for testing, with input from local management for resource objectives and constraints	Mar. 2011
Workshop	Present our results at a workshop with field managers to ensure that our results are useful	Jun. 2011
Publication	Peer-reviewed journal manuscript describing the support system and its applications	Sep. 2011
Presentations	Present results at professional conferences	Sep. 2011
Applications report	Document on DSS and its applications in two national forests	Sep. 2011
DSS Technology transfer	Initial draft of Website and User Documentation with active tutorials.	Oct. 2011
DSS Distribution System	Installation package and software delivery system (ftp and website for downloads and updates)	Nov. 2011
System manual	Document describing how to use the support system	Nov. 2011
Workshop	Hold a workshop for demonstrating and teaching the new modeling system to potential users	Nov. 2011
DSS Technology transfer	Final Drafts of Website and User Documentation with active tutorials	Nov. 2011
DSS Distribution System	Installation package and software delivery system (ftp and website for downloads and updates)	Nov. 2011
Publication	Peer-reviewed journal manuscript describing tradeoffs of different fuels management strategies in the Lake Tahoe Basin	Dec. 2011
Forest Service technical report	Synthesis report describing the support system, applications, and analysis results	Dec. 2011