Welcome to the FIREMAGIS Workshop

September 24, 2008

Workshop Objectives:

- Introduce the tool FIREMAGIS (a work in progress)
- Comments & suggestions
- Ideas for how it can be used in the fuel treatment planning process
- Interested in developing a project
- Interested in suggestions for how to deliver this tool to end users

FireMAGIS: A tool for optimizing spatial and temporal fuel treatments

Joint Fire Science Project: 06-3-3-14

Investigators:

- Greg Jones, RMRS
- Woodam Chung, UM
- Janet Sullivan, RMRS
- Kurt Krueger, RMRS
- Pablo Aracena, UM
- Carl Seielstad, UM
- Hans Zuuring, UM (retired)

Problem: While many models address various aspects of the fuel treatment planning problem, no one model considers all the following:

- Both the spatial and temporal changes of fuel treatment effects on a landscape
- Economics of maintaining fuel treatment objectives over time
- Resource and operational constraints

Examples:

- **FARSITE and FlamMap model fire behavior on landscape, TOM spatially schedules treatment**
  - * Not temporal – does not address effects over time
  - * Limited capability for resource or operational constraints (Are treatment locations feasible?)

- **FVS-FFE models stand level vegetation and fuel dynamics**
  - * Not spatial
  - * No fire spread logic

- **MAGIS spatial and temporal treatment scheduling that accommodates constraints**
  - * No fire behavior logic for evaluating fuel treatment effectiveness


Prescribed
Treatment
Data
Fuel
Unit
Thin
Road
Effects
Flow
Streamside
Habitat
Contract
FVS-FFE
Fire
Loss
Undesirable
Function
Map
Stewardship
Probability
FVS-Keyword
GIS
Comparison
Report
Management
FVS-Ready
Links
Thinning
Timber
Optimization
Acres
Behavior
Expected
Minimization
Restoration
projects
Polygon
Zone
Haul-traffic
Wildlife
Schedule
Value
Weather
FLAMMAP

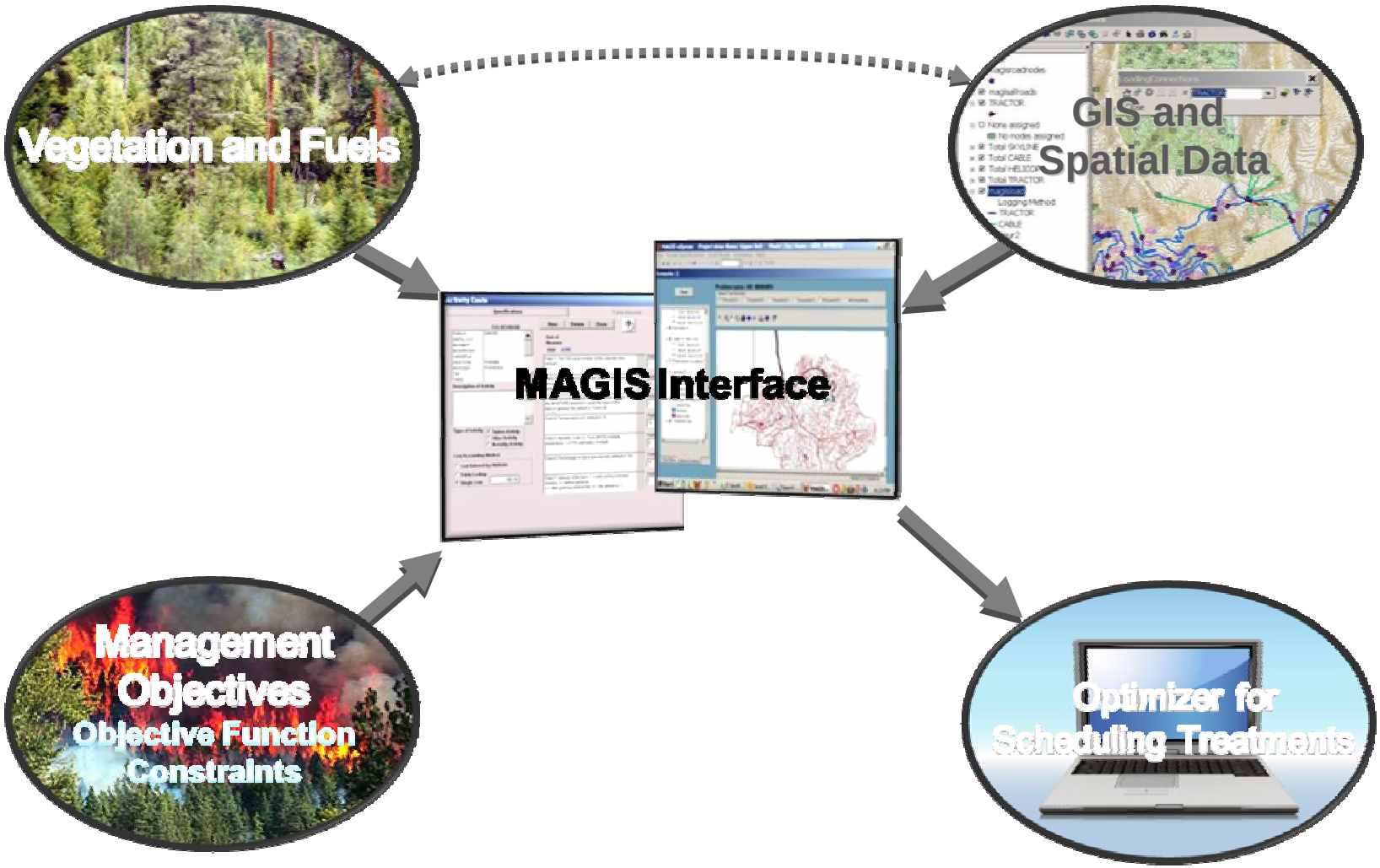
Project Objectives

1. Integrate existing fire behavior, vegetation simulation, and land management planning tools into a system (FIREMAGIS) that supports spatial and temporal fuel treatment planning.

2. Develop two field applications of FIREMAGIS to test and validate the system

3. Deliver FIREMAGIS to end users

System Components



Management Objectives Component

Objective for driving treatment placement and scheduling: Minimize expected loss to wildland fire over time.

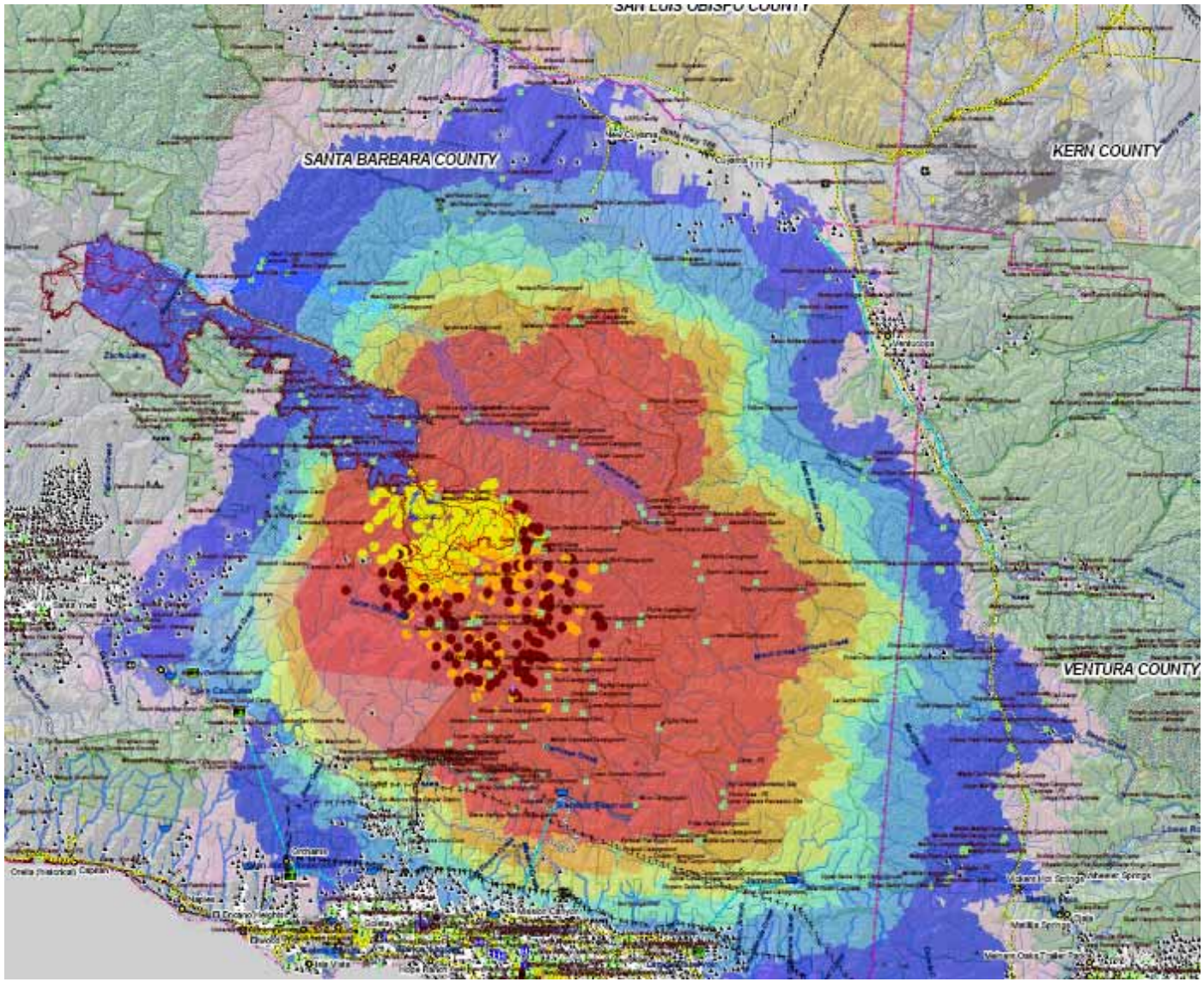
Model capabilities:

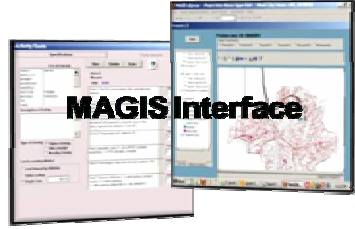
- Budget constraints
- Estimate quantity and value of products produced by treatments
- Limit treatment options by zones (treatment exclusion, treatment priority, treatment type)
- Require road access for treatments that remove product
- Schedule road construction, upgrades

Minimize expected loss to wildland fire over time including: 1) structure loss and, 2) forest loss

Fire Spread Probability

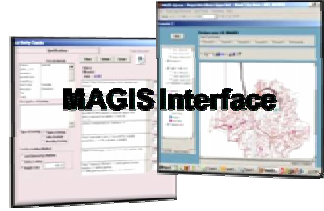
- >80%
- 60-80%
- 40-60%
- 20-40%
- 5-20%
- 1-5%
- <1%





MAGIS Output

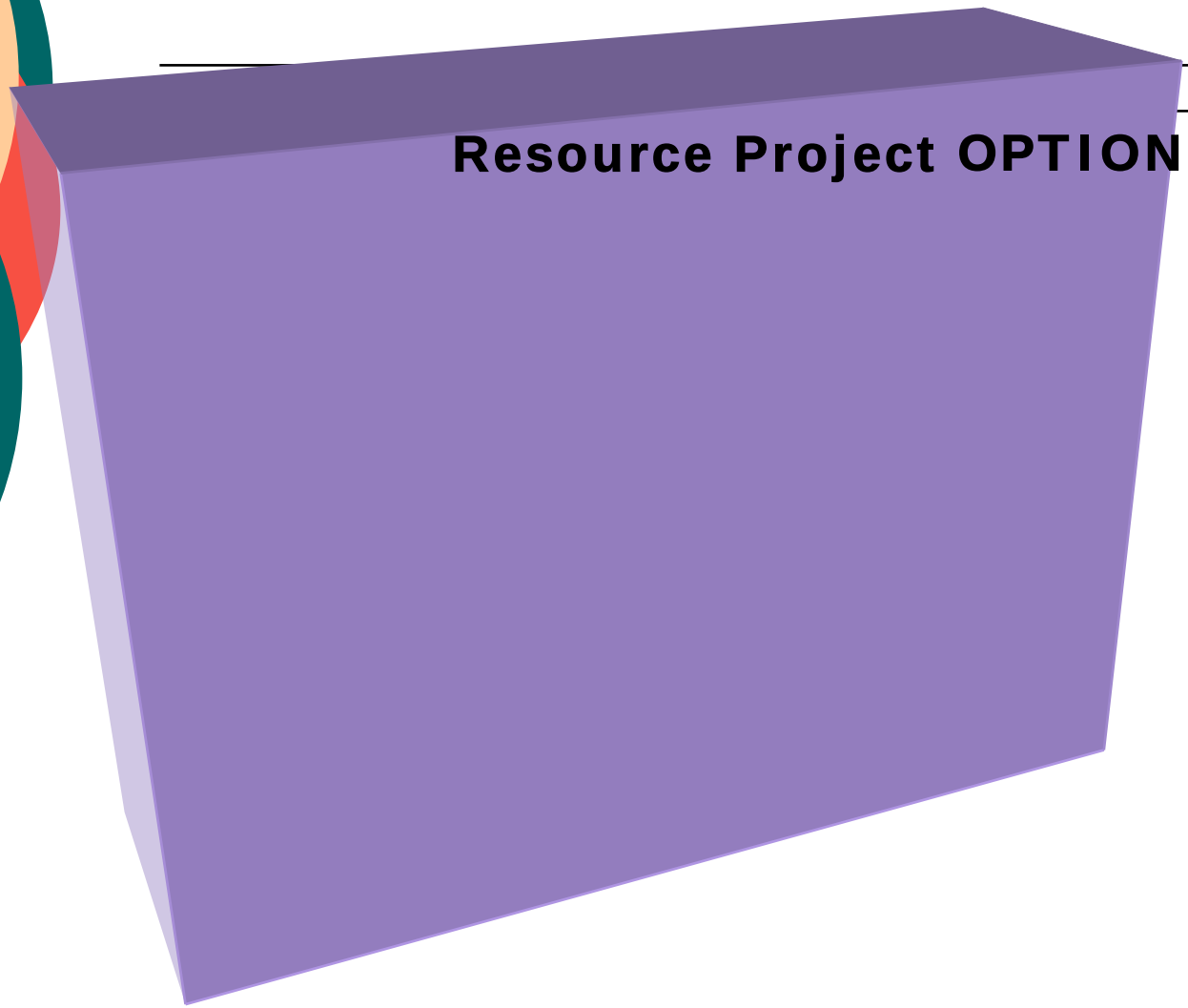
- Optimal Schedule of treatments
  - Map of treatment schedule
  - Unit by Unit report
- Schedule of road projects
  - Maps of road projects, Haul-traffic Flow
  - Link by Link report
- Values, Quantities, Effects
  - Map Display by unit
  - Report Summary
- Comparison Report of values (as Excel© file)



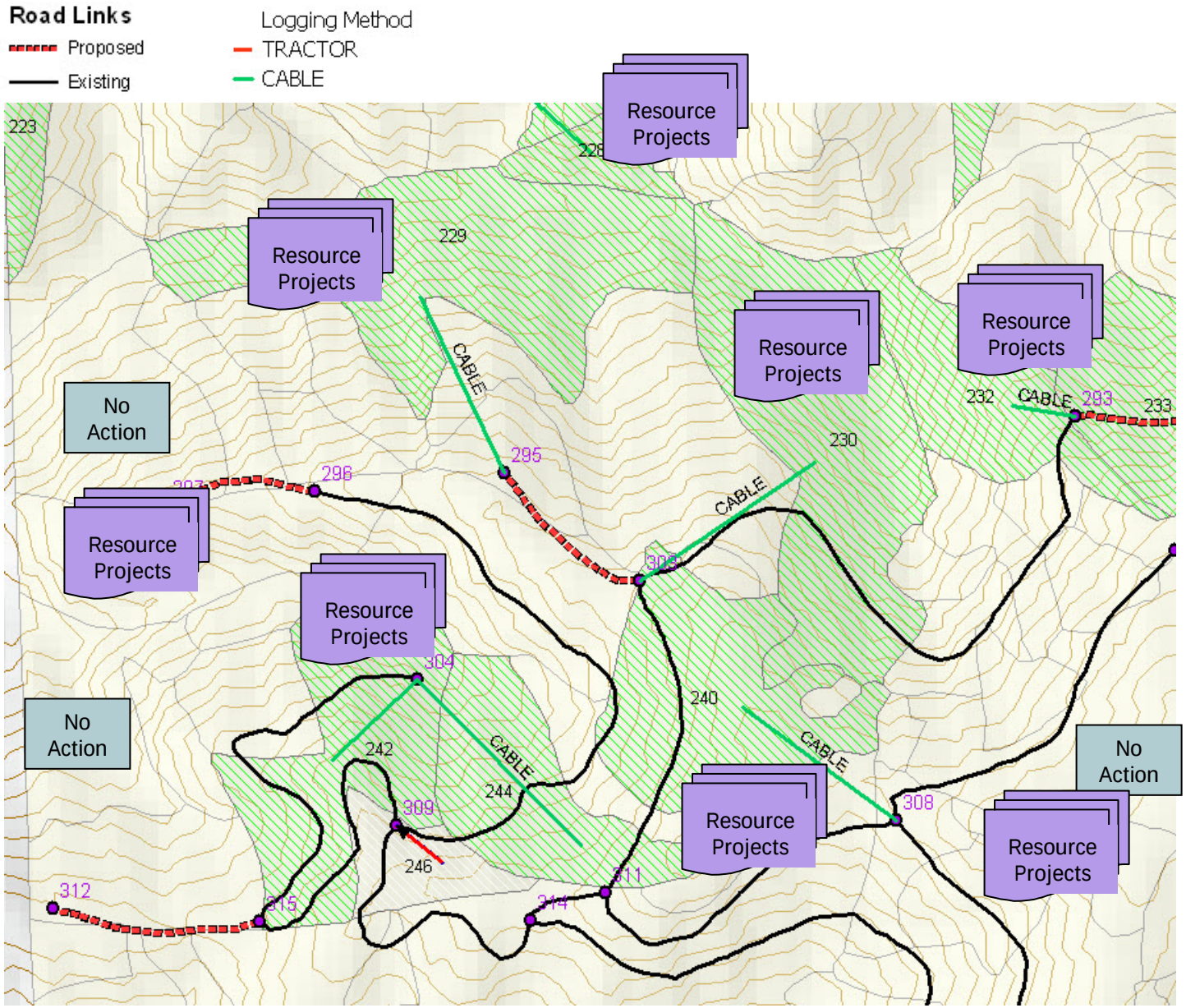
Fire-MAGIS Additions

- Optimal Schedule based on Minimization of Expected Loss & Constraints
- Map of Predicted Loss by planning period
- Standard FLAMMAP output layers
  - Post-treatment lcp for each planning period
  - No-Action lcp for each planning period
- Acres burned by flamelength (by probability contour)
- FVS outputs – no action and treatments are stored by polygon
- View in SVS

Building Blocks



OPTIONS


Road Links
Proposed
Existing
Logging Method
TRACTOR
CABLE
Resource Projects
Resource Projects
Resource Projects
Resource Projects
Resource Projects
Resource Projects
Resource Projects
Resource Projects
No Action
No Action
No Action
223
229
230
232
233
240
242
244
246
CABLE
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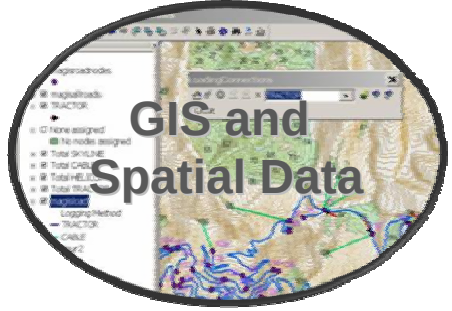
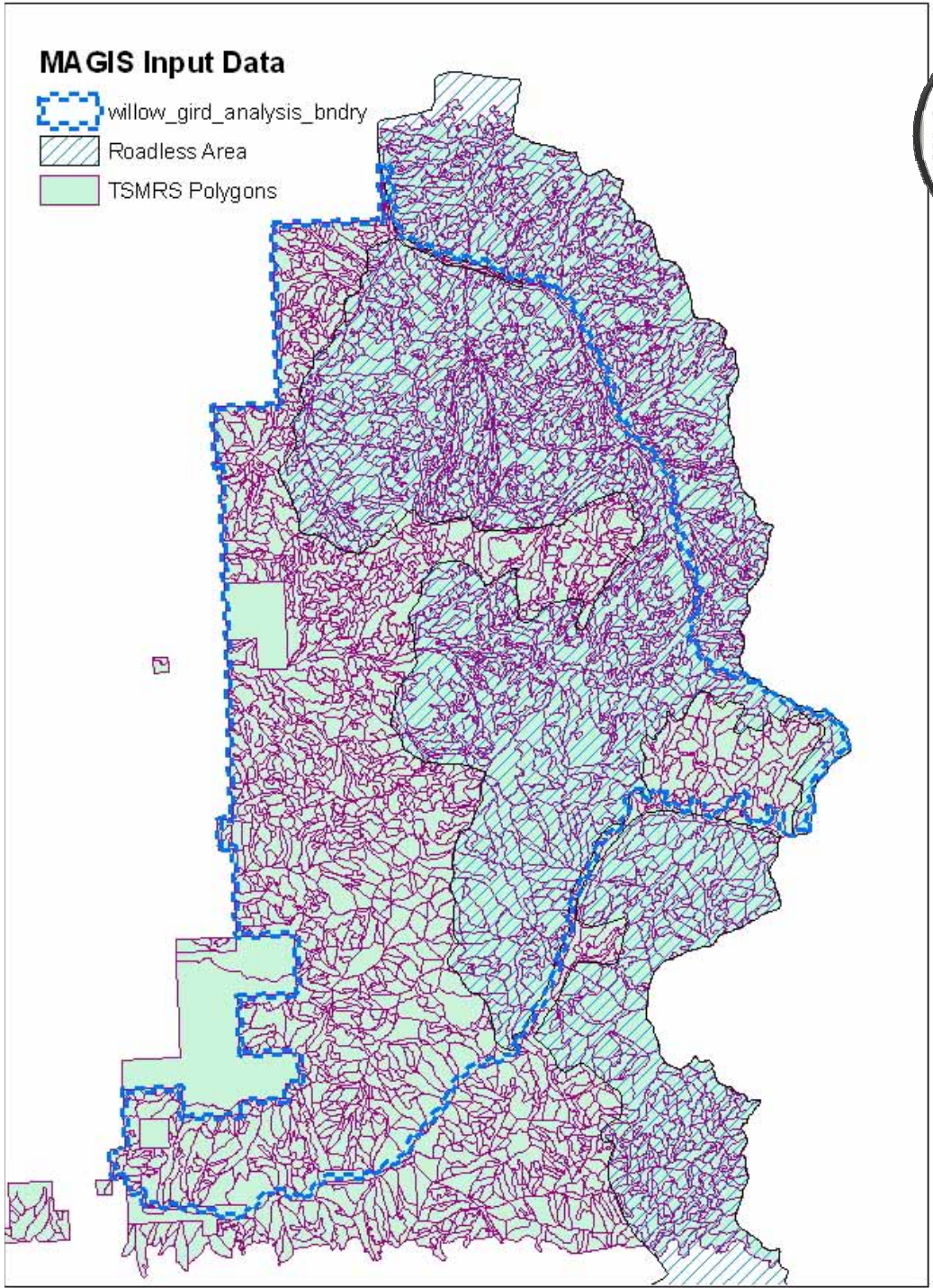
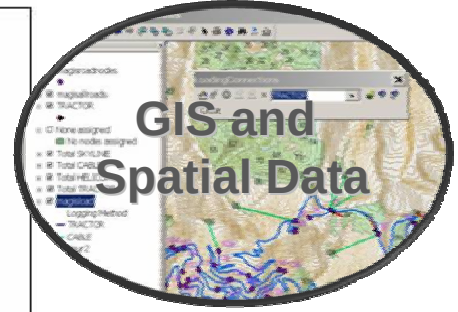
Spatial Data

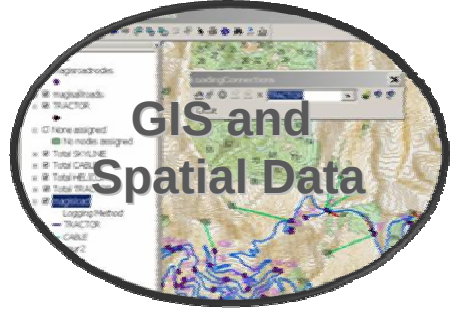


- Polygon Input Layers - Vegetation GIS Data
  - Wall-to-Wall stand polygons
  - FVS-Ready data crosswalked to polygons
  - Management Zones, History, Etc
- Rasters (for fire behavior)
  - Elevation, Slope, Aspect
- Road Input Layer - Optional
  - Existing & Proposed links
  - Construction/Upgrade costs
  - Variable Costs (haul cost)
  - Loading Nodes

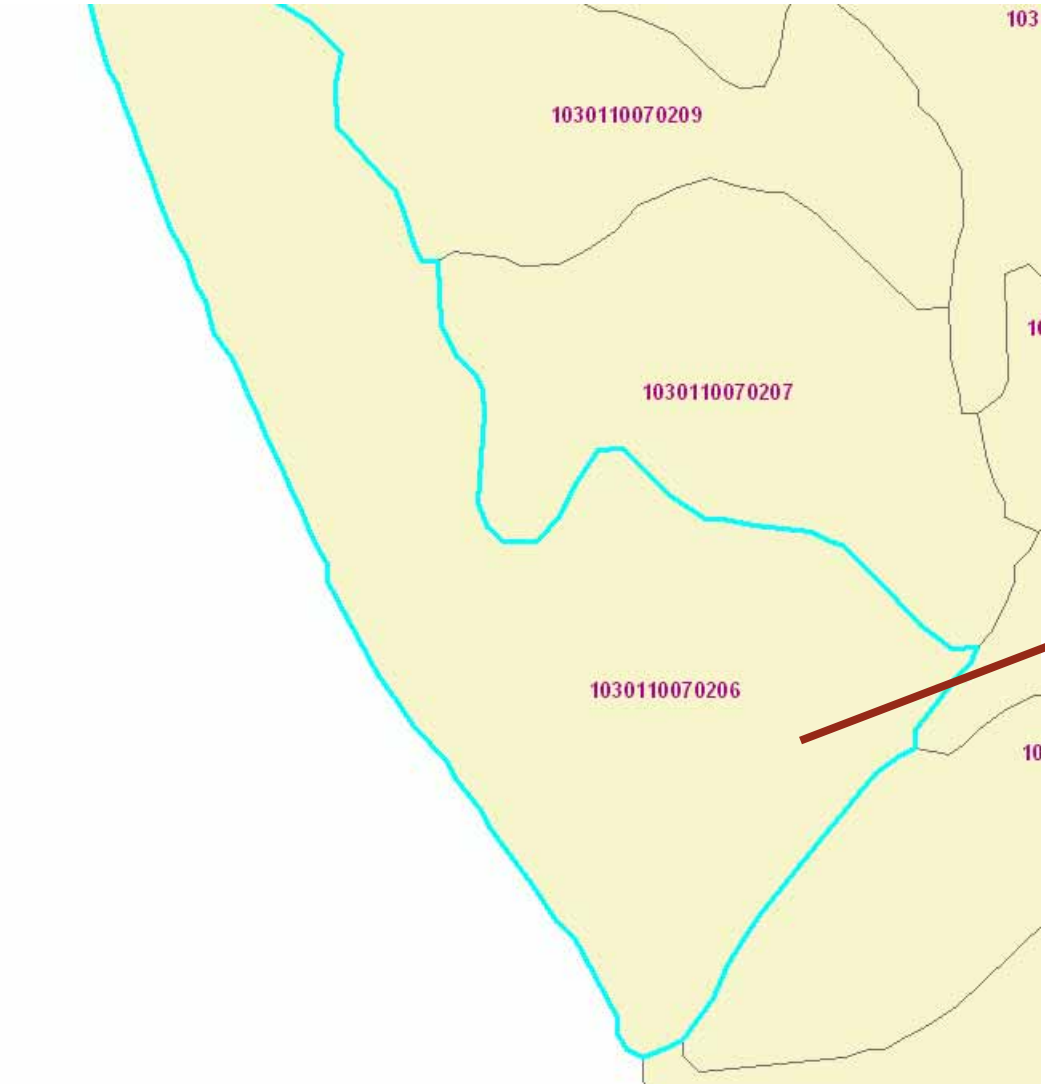
Polygon Layer







Stand Polygons

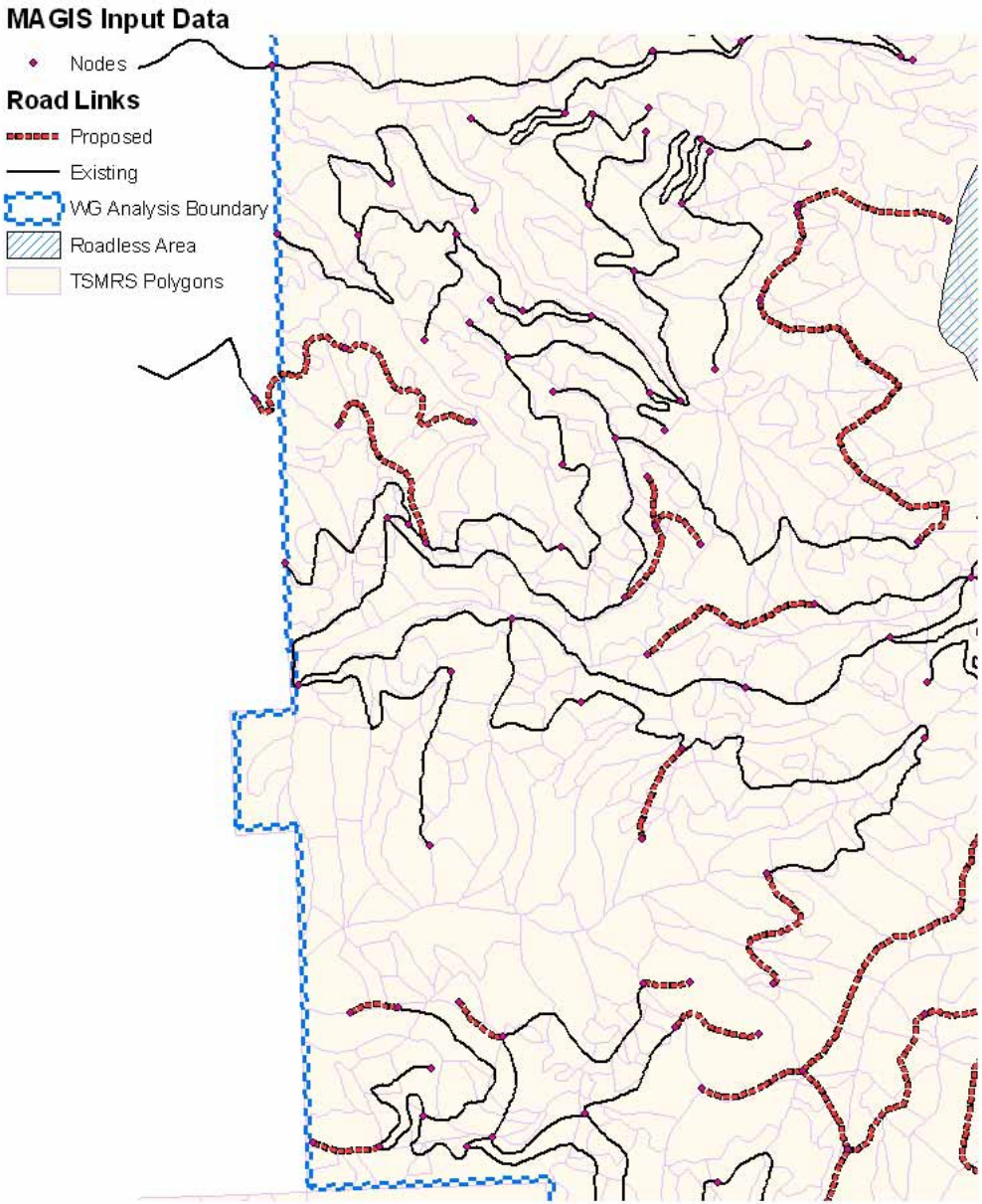


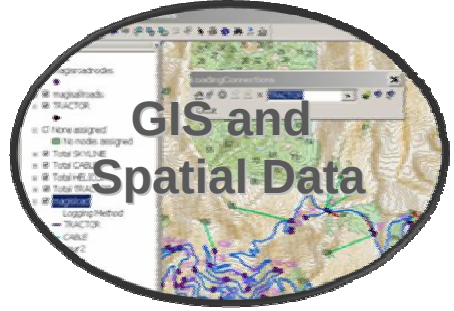
FVS-Ready Data

Stand Information Table
*1030110070206

Tree records table

Road Layer


MAGIS Input Data
Nodes
Road Links
Proposed
Existing
WG Analysis Boundary
Roadless Area
TSMRS Polygons


GIS and
Spatial Data

Vegetation – Fuels Data

- Vegetation – Fuels Data
  - FVS and FFE keywords
    - Prescribed Fire
      - SIMFIRE
      - PILEBURN
    - Mechanical Treatments
      - THINBBA, THINBTA
    - Commercial Harvest
      - THINBBA + RMCUFT (etc)

FVS-FFE in FIRE-MAGIS

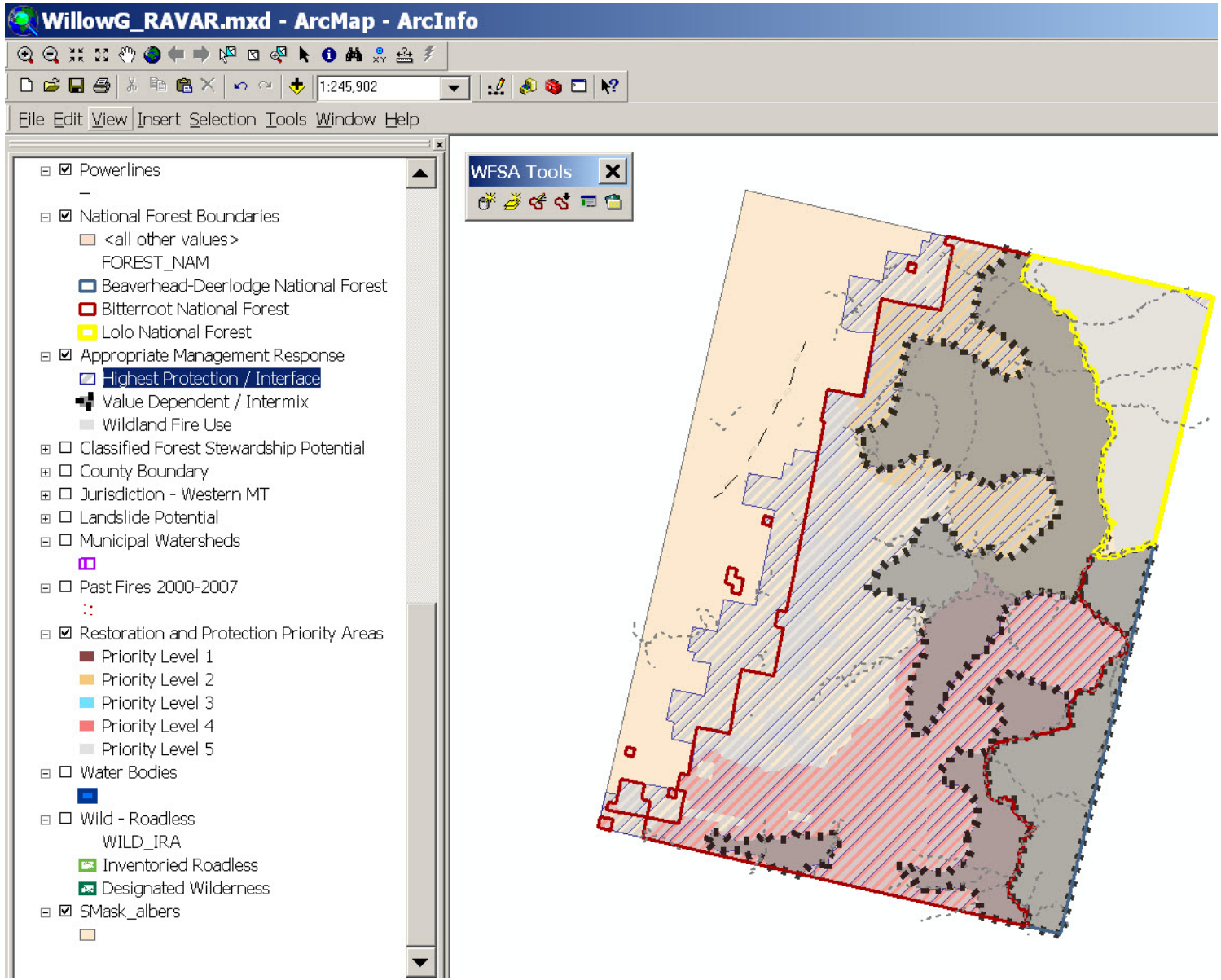
- Run FVS No Action
  - FFE Fuels for No Action
  - Determine Management Regime Assignments → Resource Projects
- Run FVS on Resource Projects
  - Calculate post-treatment FFE fuels
  - Calculate Outputs (Timber, Biomass)

Loss Function Editor

- Use GIS layers
- Create VALUE Categories
  - Timber
  - Residential Structures
  - Habitat etc
- Assign Loss values to FLAMELENGTH categories for each VALUE category
- Assign MGT areas to VALUE categories

Data available: WFDSS - RAVAR

?



Scenario Builder

- Fire Scenario
  - Ignition Point(s)
  - Flammap input variables
- Constraints
- Timing

FLAMMAP Data

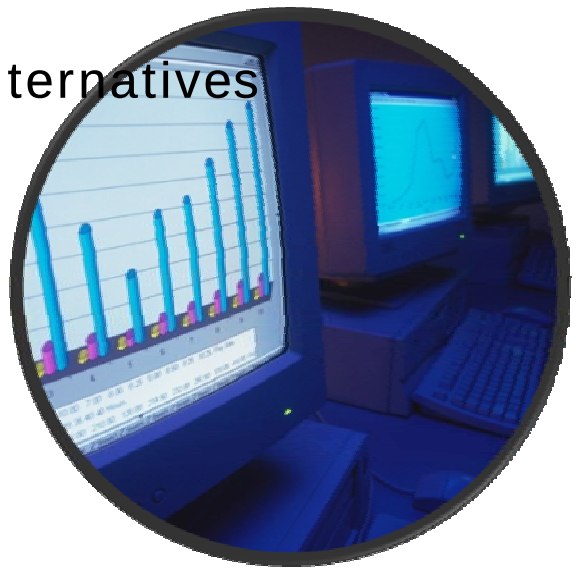
- LCP
  - Automatically Built by FIREMAGIS using FFE outputs
- Fuel Moisture file (*.fms)
  - Alternative: fixed fuel moisture
- Ignition shapefile
  - Use ArcMAP
- Optional files
  - FM conditioning
  - Wind grids
  - Custom fuel model

Discussion Topics

- System Detail Questions
  - FVS use details
  - Expected Loss
- Should FireMAGIS be Used in Planning
- How can FireMAGIS be used in Planning
  - Data collection
  - Model building
  - Results Analysis
  - Use of model information
- Changes / additions / reductions you'd like to suggest
- Modeling in Planning Process
  - how well does it work
  - how well could it work
  - what are the benefits?
- Who / How to use the model (s)
  - model support needs (local, RMRS, ...)
  - Data and other obstacles
- Projects you are ready to start ...?
- FireMAGIS (Your Name Here?)

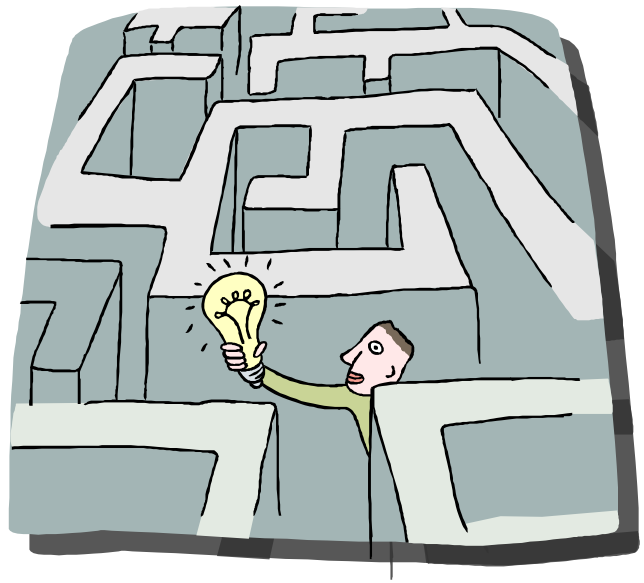
What is it?

- Heuristic optimizer in Fire-MAGIS is the optimization engine of the system that
  - uses an iterative method to generate a large number of alternative solutions (i.e., fuels treatment schedules)
  - evaluates the alternatives based on given objective function and constraints, and
  - selects the best solution among alternatives



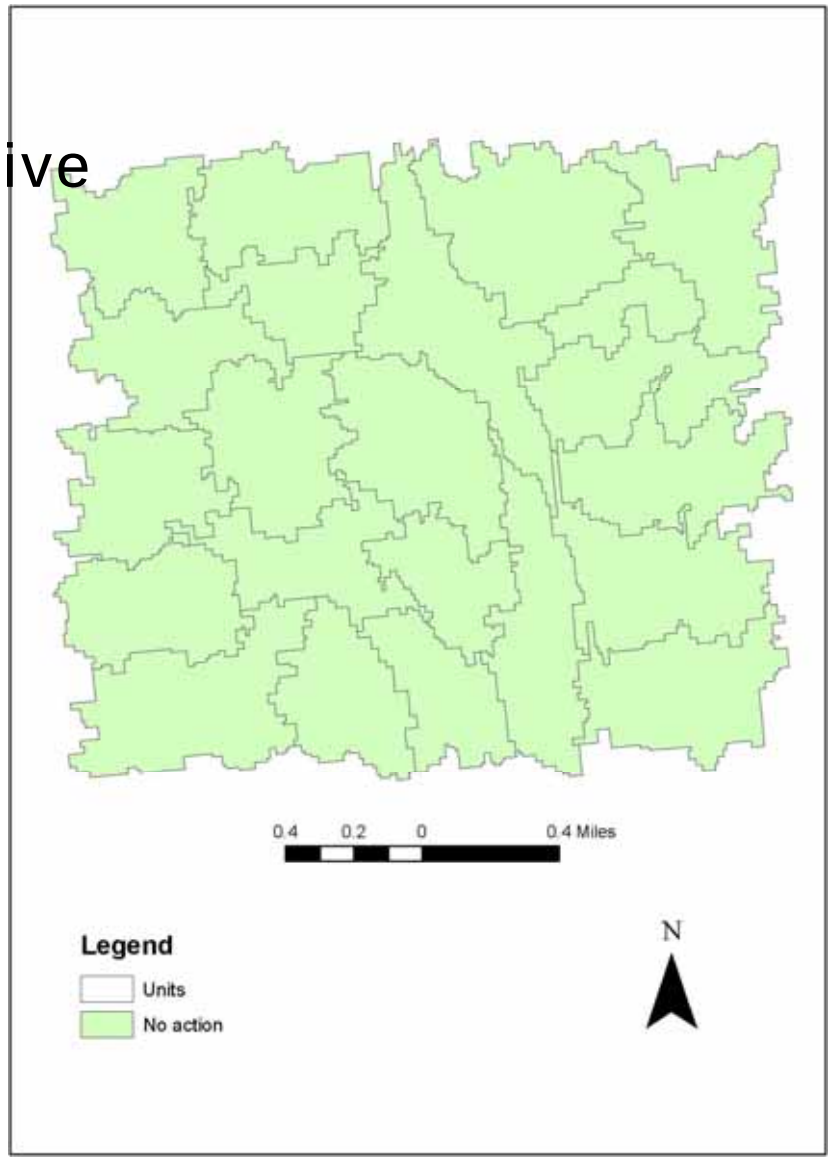
What is it?

- Heuristic optimizer employs a simulated annealing and a heuristic network algorithm to efficiently produce near-optimal solutions



How does it work?

- Generating alternative solutions



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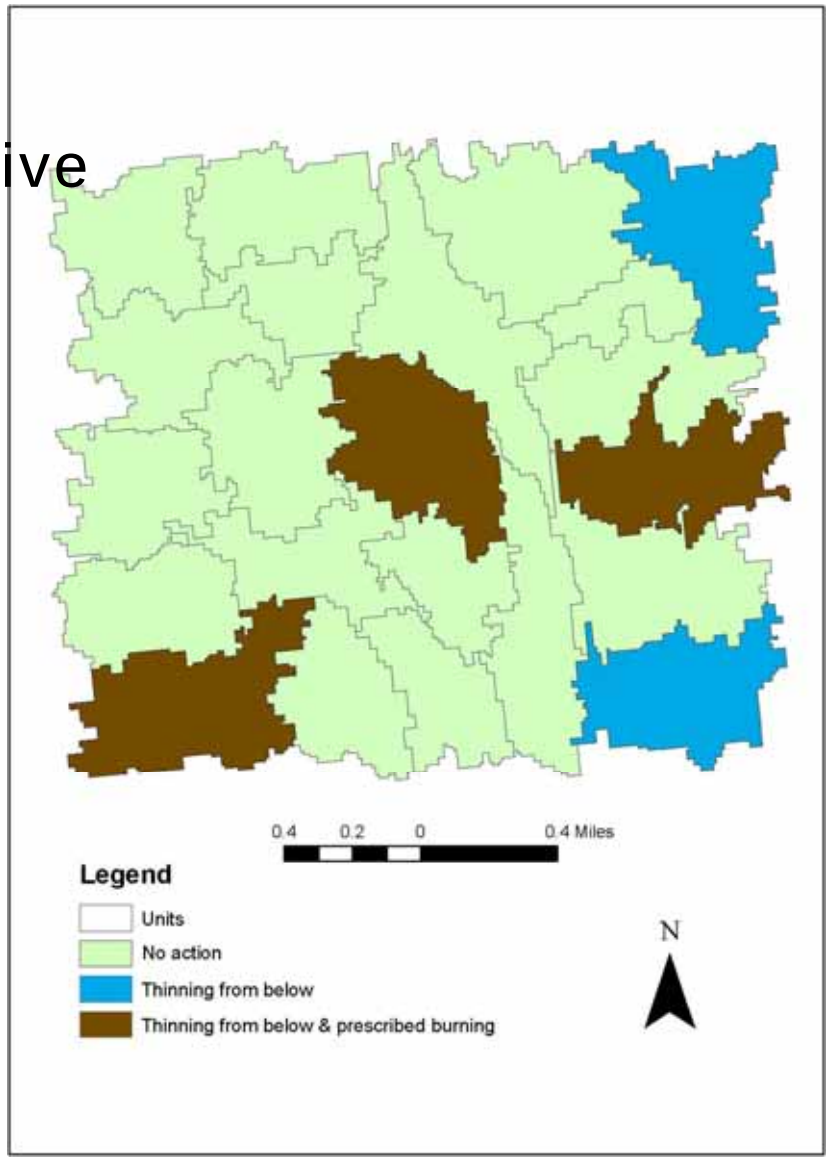


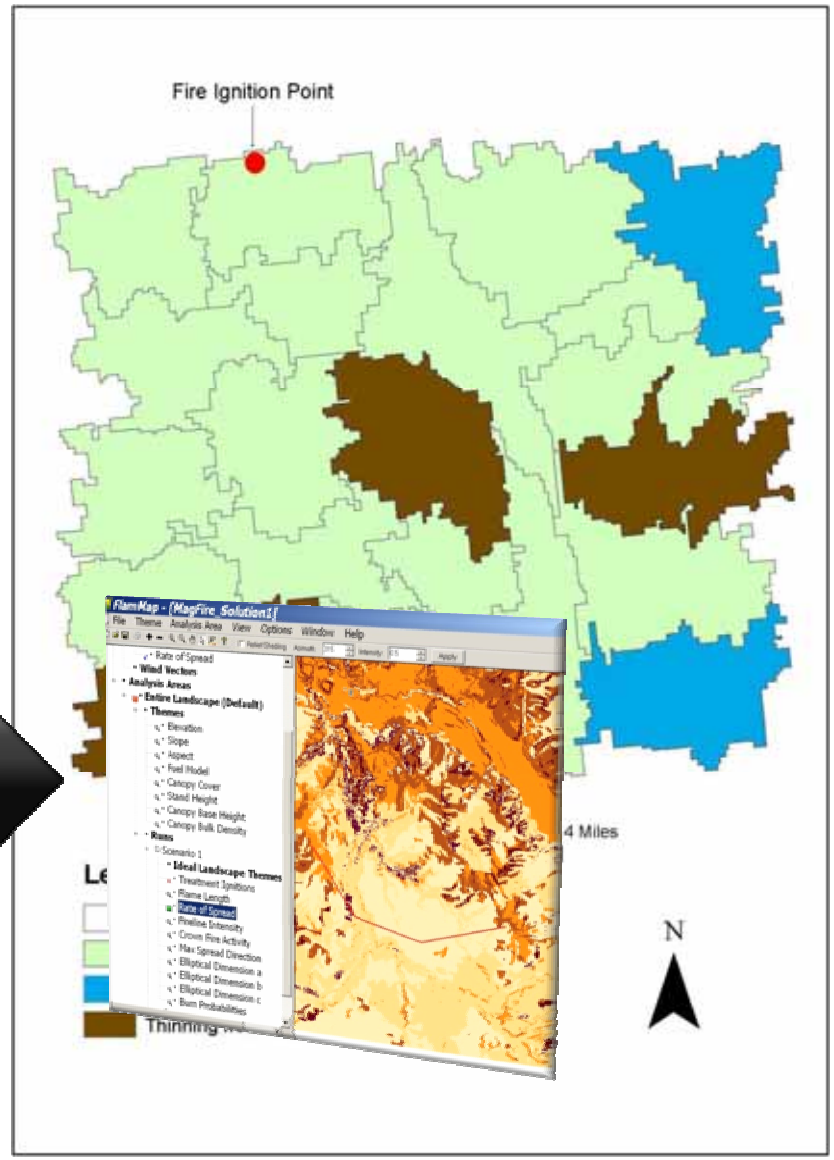
How does it work?

Wind direction & speed

- Evaluating each candidate solution

LCP file generator
mf_ffe_mgt.txt,
mf_ffe_noaction.txt,
mf_objectivevalues.txt,
aspect.txt, elev.txt, slope.txt, etc.

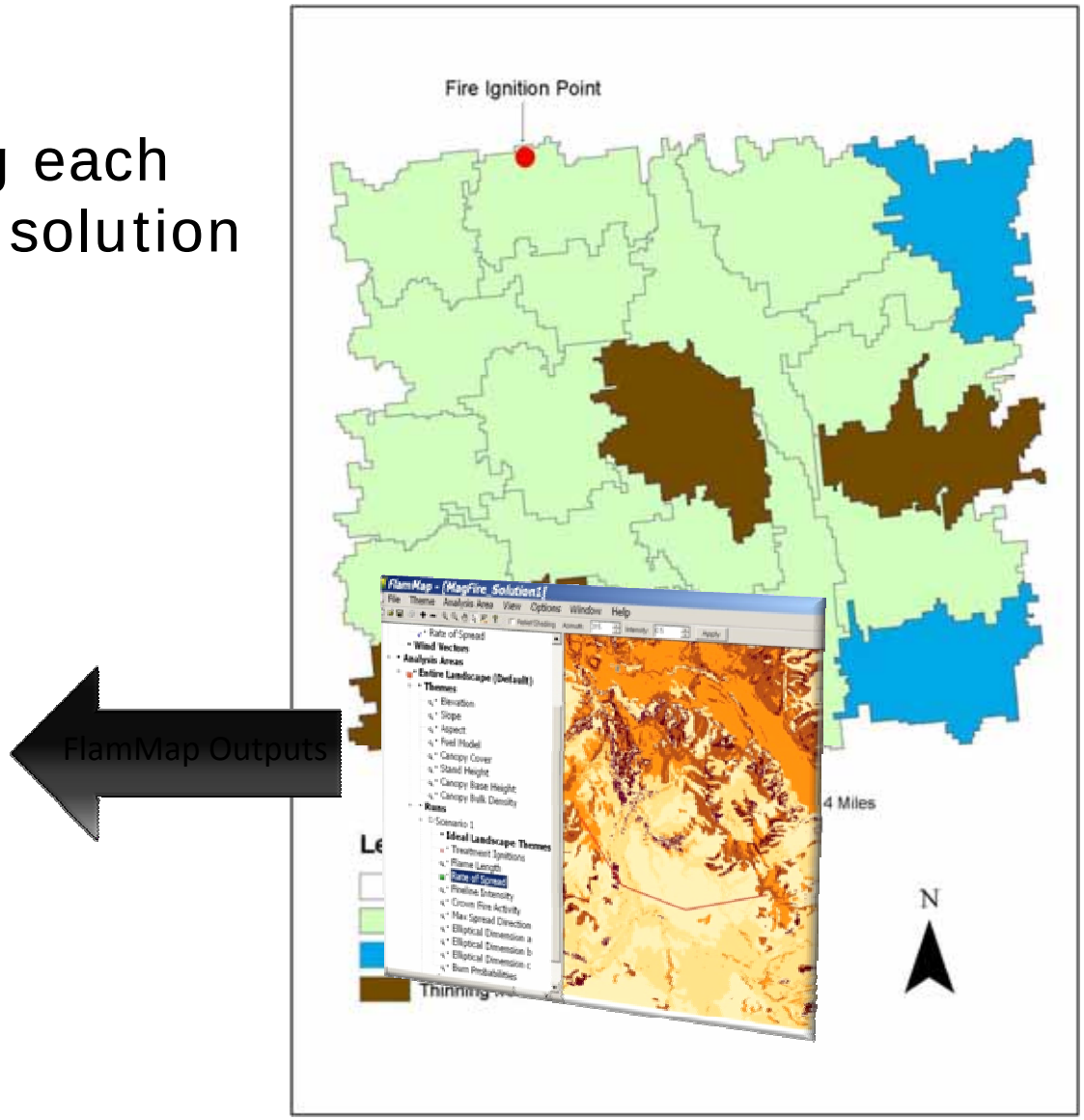
FlamMap DLL run



How does it work?

- Evaluating each candidate solution

Fire behavior characteristics
- Flame length
- Rate of spread
- Max. spread direction
- Ellipse dimensions



How does it work?

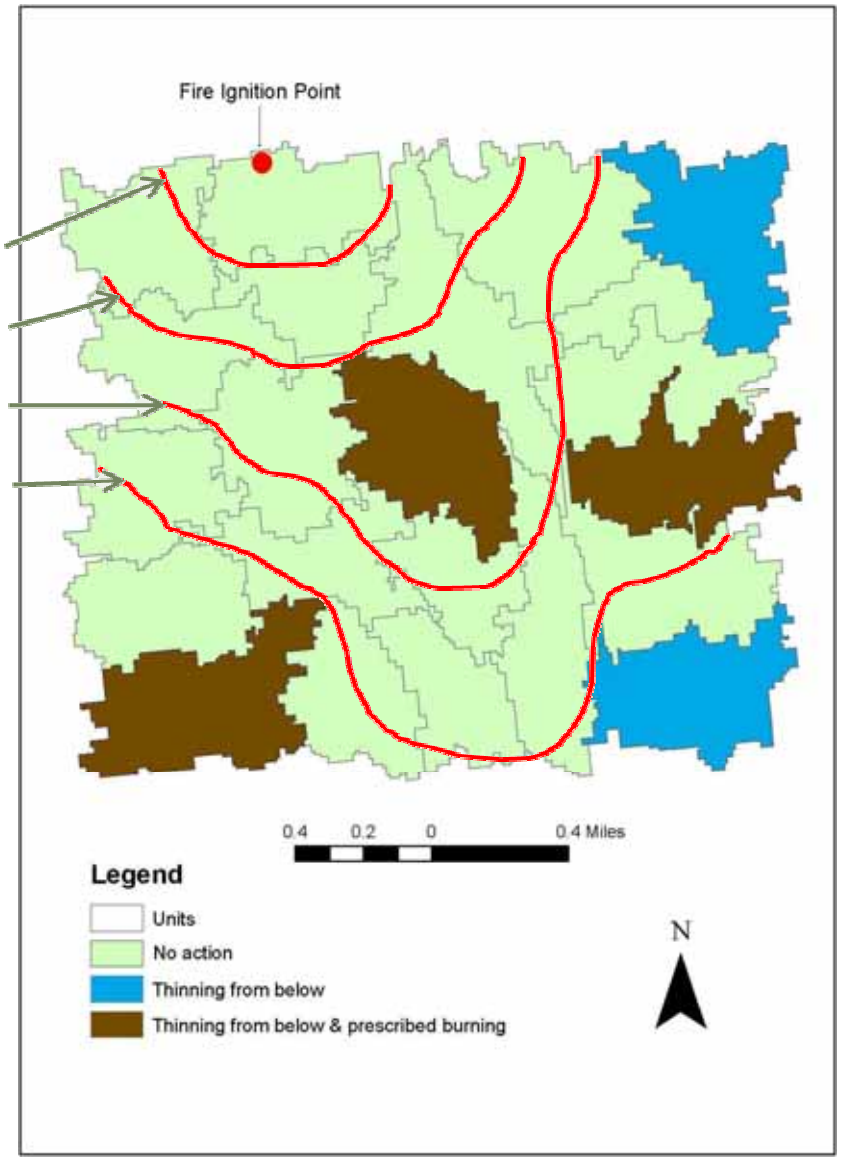
- Evaluating each candidate solution

1 day (95%)

3 days (70%)

5 days (50%)

10 days (10%)

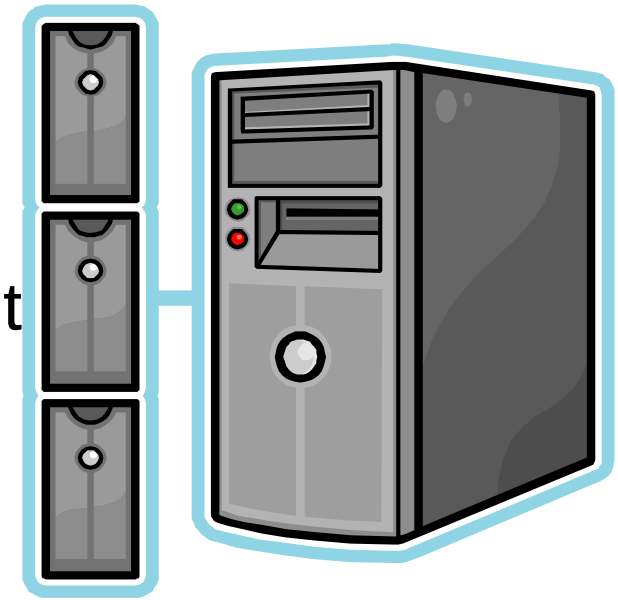


Why is the solver useful?

- Develop the best fuel treatment schedule that is cost-efficient and practically feasible (meets all given constraints)
  - Reduce undesired fire behavior over time
  - Deal with multiple time periods
  - Work with management units
  - Schedule road activities
  - Allow budget or acres constraints
  - ...

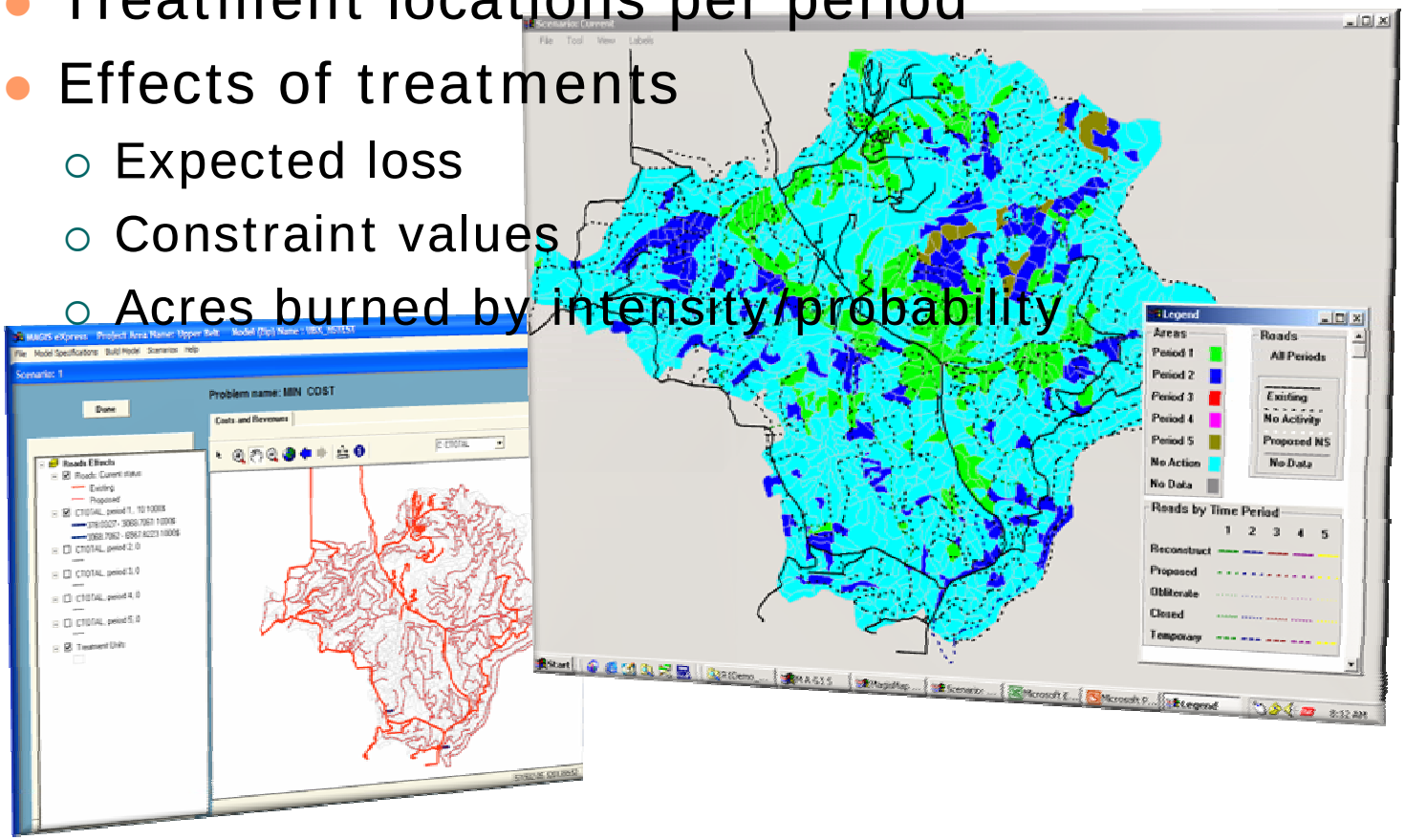
Challenges

- Considerable computation time is required
  - Parallel programming techniques
  - Multiple computers wit multiple processors

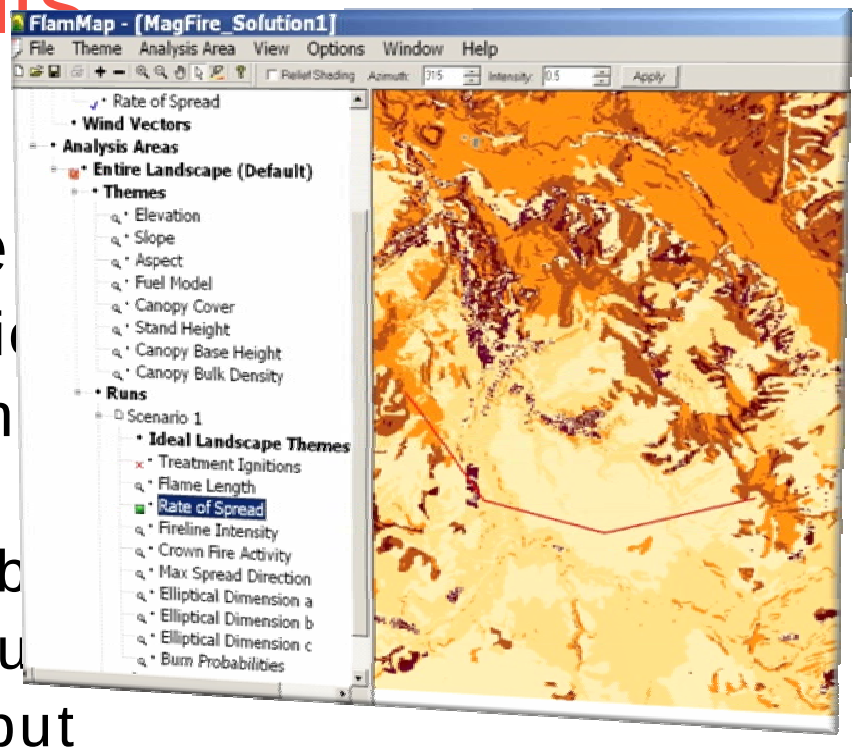


Displaying results

- Maps of treatment schedule
  - Treatment locations per period
  - Effects of treatments
    - Expected loss
    - Constraint values
    - Acres burned by intensity/probability



Displaying results



- Maps of treatme
  - Treatment locati
  - Effects of treatm
    - Expected loss
    - Acres burned b
    - Constraint valu
    - FLAMMAP output
      - No action vs. treatment by planning period
        - Crown fire potential
        - Rate of spread
        - Flame length
        - Etc.

Displaying results

- Tabular reports
  - Scenario details
  - Comparison reports

	int_	long_name	hs_sdv	mps_sdv	hs_constr	mps_const	hs_max2	mps_max
2	32	AcresLarge1	988.4	988.4	988.4	988.4	988.4	988.4
3	33	AcresLarge2	988.4	988.4	988.4	988.4	0	988.4
4	34	AcresLarge3	988.4	988.4	988.4	988.4	0	988.4
5	35	AcresLarge4	988.4	988.4	741.3	741.3	0	1235.5
6	36	AcresLarge5	1976.8	1976.8	1729.7	1729.7	0	1976.8
7	37	AcresMed1	988.4	988.4	988.4	988.4	988.4	988.4
8	38	AcresMed2	988.4	988.4	988.4	988.4	247.1	988.4
9	39	AcresMed3	1976.8	1976.8	1976.8	1976.8	247.1	1976.8
10	40	AcresMed4	1482.6	1482.6	1729.7	1729.7	494.2	1235.5
11	41	AcresMed5	494.2	494.2	741.3	741.3	494.2	247.1
12	27	AcresPole1	1976.8	1976.8	1976.8	1976.8	1976.8	1976.8
13	28	AcresPole2	1482.6	1482.6	1482.6	1482.6	247.1	1482.6
14	29	AcresPole3	741.3	741.3	494.2	494.2	4447.8	0
15	30	AcresPole4	247.1	247.1	0	0	4200.7	494.2
16	31	AcresPole5	247.1	247.1	0	0	4200.7	494.2
17	18	AcresSeedSap5	0	0	0	0	0	247.1
18	42	AcresVeryLarge1	988.4	988.4	988.4	988.4	988.4	988.4
19	43	AcresVeryLarge2	1235.5	1235.5	1482.6	1482.6	247.1	1482.6
20	44	AcresVeryLarge3	1235.5	1235.5	1482.6	1482.6	247.1	1482.6
21	45	AcresVeryLarge4	2223.9	2223.9	2471	2471	247.1	1976.8
22	46	AcresVeryLarge5	2223.9	2223.9	2471	2471	247.1	1976.8
23	2	NOACT1	4694.9	4694.9	4694.9	4694.9	0	4200.7
24	3	NOACT2	4694.9	4694.9	4694.9	4694.9	0	3706.5
25	4	NOACT3	4694.9	4694.9	4694.9	4694.9	0	3706.5
26	5	NOACT4	4694.9	4694.9	4694.9	4694.9	0	3459.4
27	6	NOACT5	4694.9	4694.9	4694.9	4694.9	0	3212.3
28	99	PNV	1309.7042	1310.898	548.1125	548.562	497.4196	1597.1243
29	47	NetValue1	1309.7042	1310.898	548.1125	548.562	497.4196	1578.5687
30	48	NetValue2	0	0	0	0	0	8.8956
31	49	NetValue3	0	0	0	0	0	0
32	50	NetValue4	0	0	0	0	0	8.1774
33	51	NetValue5	0	0	0	0	0	1.4826
34	52	Costs	1529.1058	1527.909	267.3175	266.868	4129.8604	1354.1877
35	58	Costs_1	1529.1058	1527.909	267.3175	266.868	4129.8604	867.7213
36	59	Costs_2	0	0	0	0	0	109.7124
37	60	Costs_3	0	0	0	0	0	0
38	61	Costs_4	0	0	0	0	0	318.9326
39	62	Costs_5	0	0	0	0	0	57.8214
40	68	AcresEvenAgeHarv1	247.1	247.1	0	0	0	0
41	69	AcresEvenAgeHarv2	0	0	0	0	0	0