Evaluating Severe Wildland Fire Danger and Prioritizing Treatments

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Goals

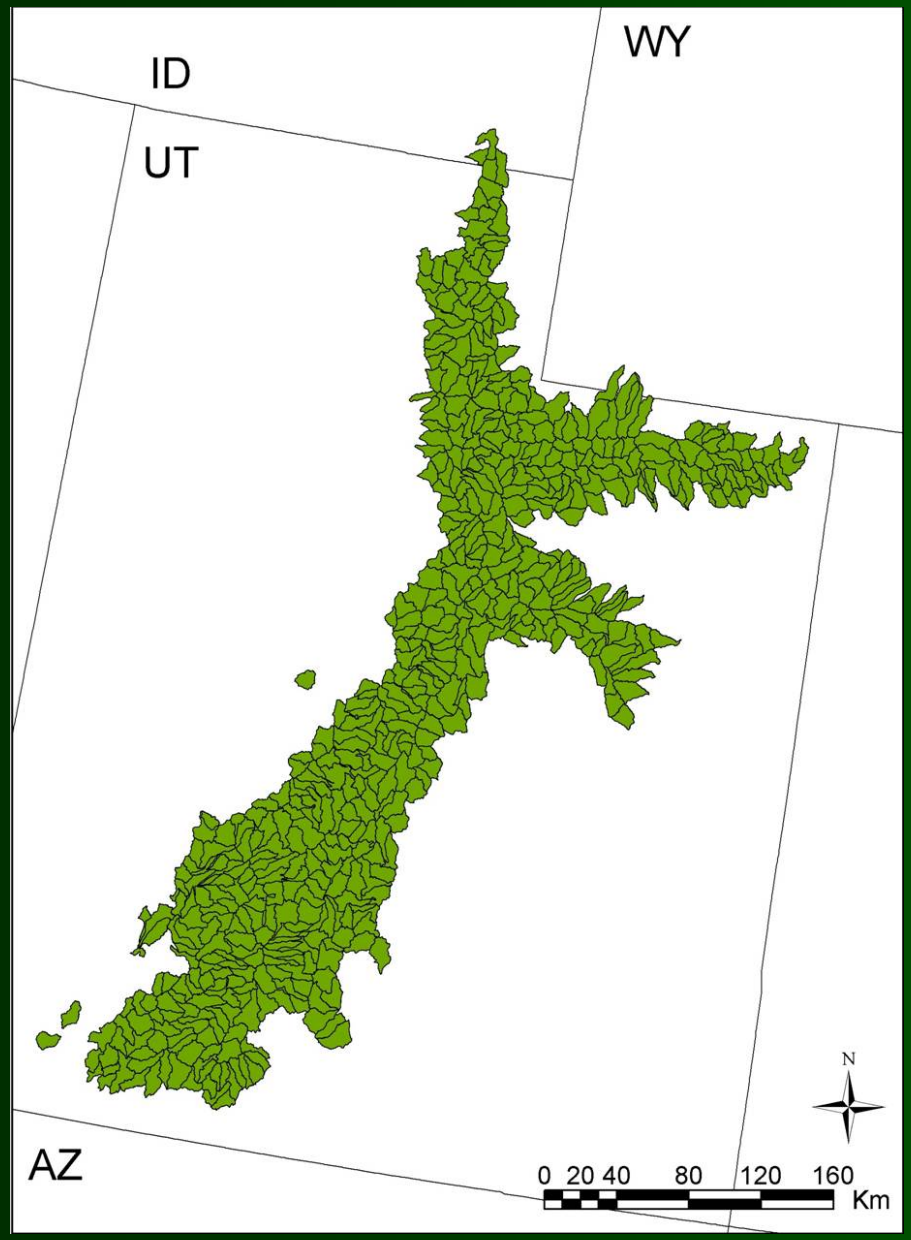
Present a DSS for evaluating severe wildland fire danger and prioritizing watersheds for vegetation and fuels treatment

Demonstrate the use of the DSS with an example from the Rocky Mountain region in Utah.

Show that the DSS can be expanded for regional and national scale landscape analysis and prioritization.

Broad Outline

1) DSS consists of logic and decision models.
2) Logic model evaluates danger as a function of three 1° topics: fire hazard, fire behavior, & ignition risk.
3) Primary topics have 2° topics where data are evaluated.
4) Logic model shows each watershed state wrt/ fire danger.
5) Decision model places fire danger conditions in the context of the amount of associated WUI.
6) Logic and decision models executed in EMDS in ArcGIS; NetWeaver (logic), CriteriumDecisionPlus (decision).
7) We show that decision criteria (e.g., relationship to WUI) can influence decisions determining treatment priorities.
8) We conclude with showing extensions of the logic and decision modeling work for a new regional DSS.

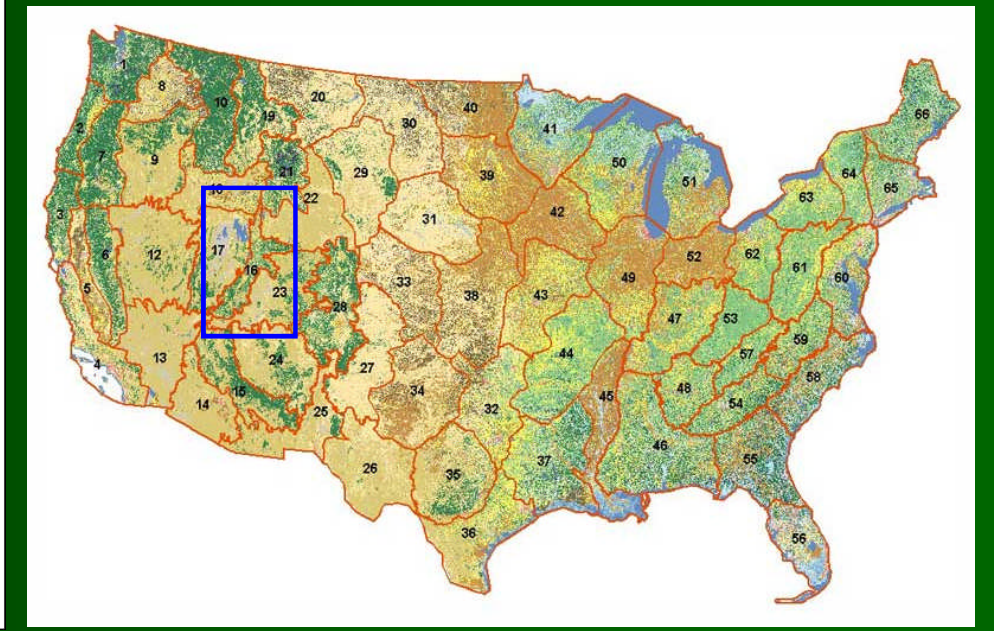


Subwatersheds: evaluation unit

575 subwatersheds in MZ 16.

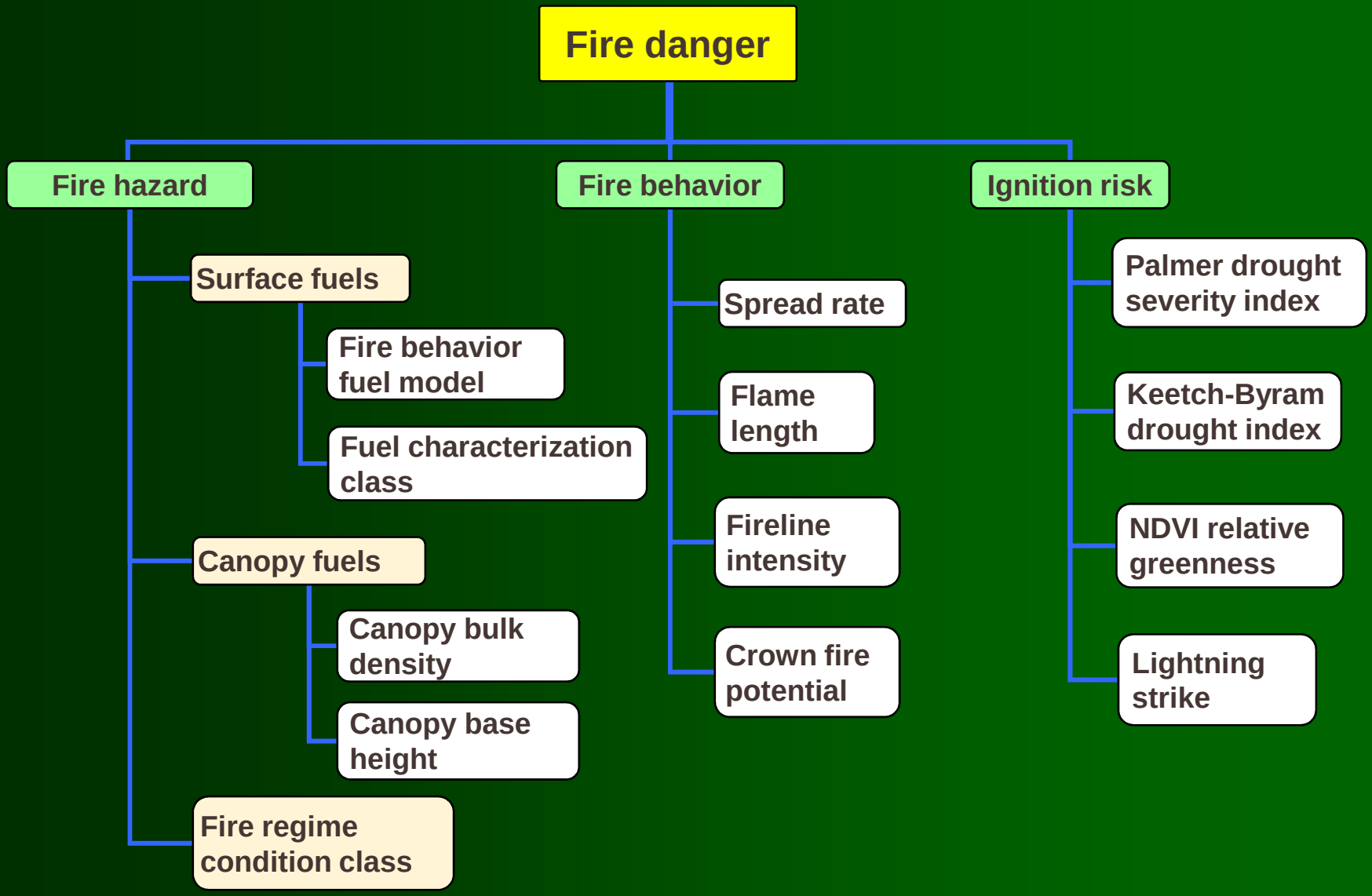
Average size: 8, 274 ha

Total area: ~ 4.8 million ha.



Map Zones: Broad biophysical land units defined by similarity of landforms, land cover, natural resources

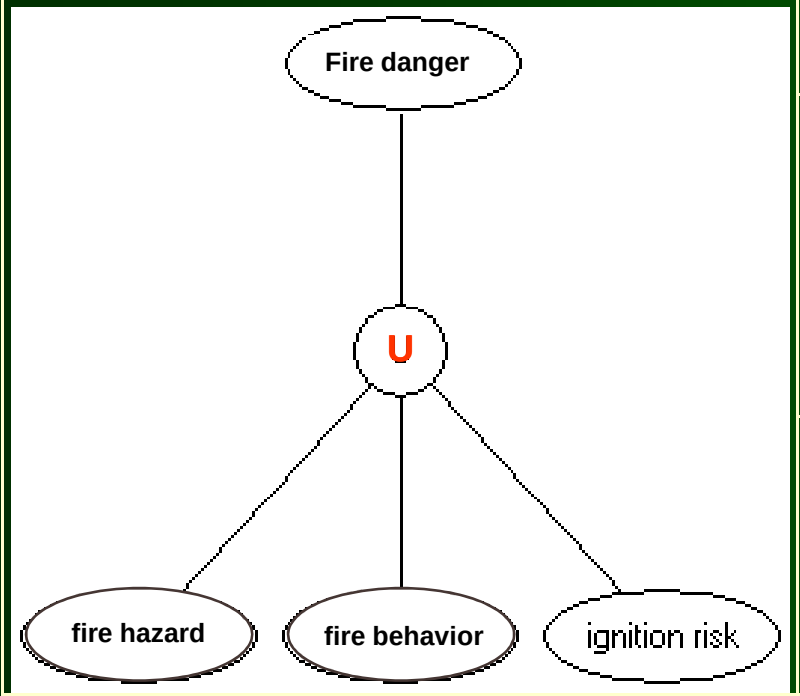
Fire danger topics -- outline of the logic model



Level 1 Evaluation – Propositions (all take the null form)

Fire danger

• Danger of a severe wildfire **is low**.



fire hazard

• vegetation and fuel conditions within the watershed **do not support** a severe wildfire.

fire behavior

• expected fire behavior within the watershed **is not severe**.

ignition risk

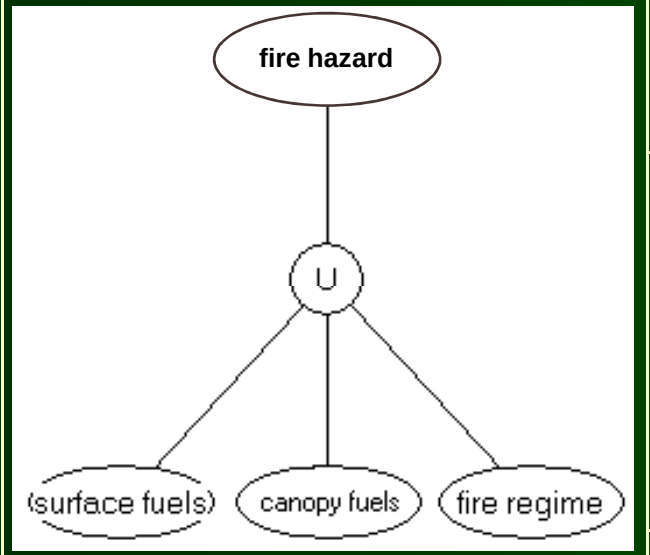
• likelihood of a wildfire ignition within the watershed **is low**.

Topic synthesis is performed with the UNION operator. Low strength of evidence for the proposition of one topic can be compensated for by strong evidence from others.

Level 2 Evaluation – Propositions (null form)

Fire hazard

- surface fuels
- canopy fuels
- fire regime



***** Data layers (30-m pixel resolution) from LANDFIRE project at *www.landfire.gov*

surface fuels

Condition of surface fuels not conducive to severe wildfire in the watershed

- fire behaviour fuel model (FBFM)*; H is FM>9
- fuel characterization class (FCC)*; H is fuel loading > 56 Mg/ha

canopy fuels

Condition of crown fuels not conducive to severe wildfire in the watershed

- canopy bulk density (CBD)*; H >0.15 kg/m^3
- canopy base height (CBH)*; H < 3.1m

fire regime

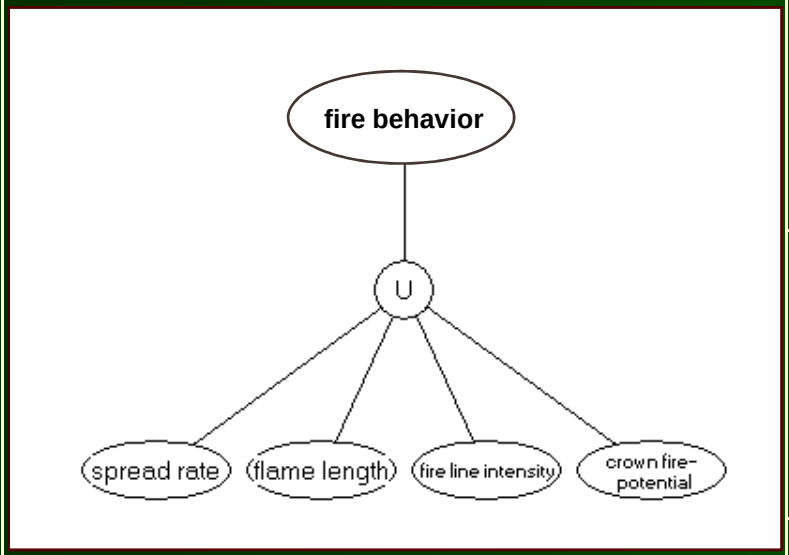
Current fire regime and vegetation structure and composition within the watershed do not depart significantly from pre-management era conditions

- fire regime condition class (FRCC)*; H > Class 2

Level 2 Evaluation – Propositions (null form)

Fire behavior

- spread rate
- flame length
- fire line intensity
- crown fire potential



***** Data layers from LANDFIRE via the FIREHARM model

spread rate

Likelihood of high spread rate of ground fire within the watershed **is low**.

Probability of a SR* > 4.8 kph

flame length

Likelihood of high flame length within the watershed **is low**.

Probability of a FL* > 2 m

fireline intensity

Likelihood of high fire line intensity within the watershed **is low**.

Probability of a FLI* > 400 kW/m

crown fire potential

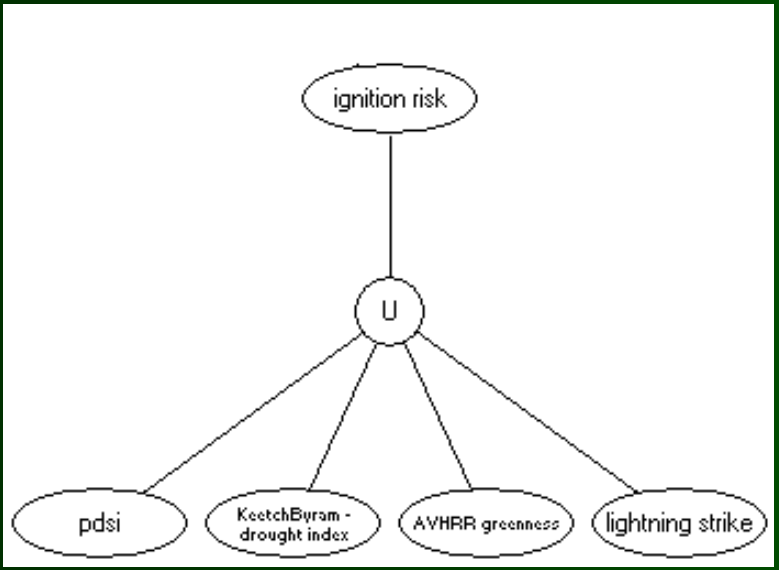
Likelihood of high crown fire spread potential within the watershed **is low**.

Probability of a CFP* > 7

Level 2 Evaluation – Propositions (all null form)

Ignition Risk

- PDSI
- KBDI
- NDVI
- Lightning strike



***** Data layers from LANDFIRE/FIREHARM, NCDC, EROS, NLDN

Palmer drought severity index

Likelihood of a long term drought within the watershed **is low**.

Probability of summer PDSI* < -2

Keetch-Byram drought index

Likelihood of a short term drought within the watershed **is low**.

Probability of a KBDI* > 400

NDVI

Relative plant greenness **is high**.

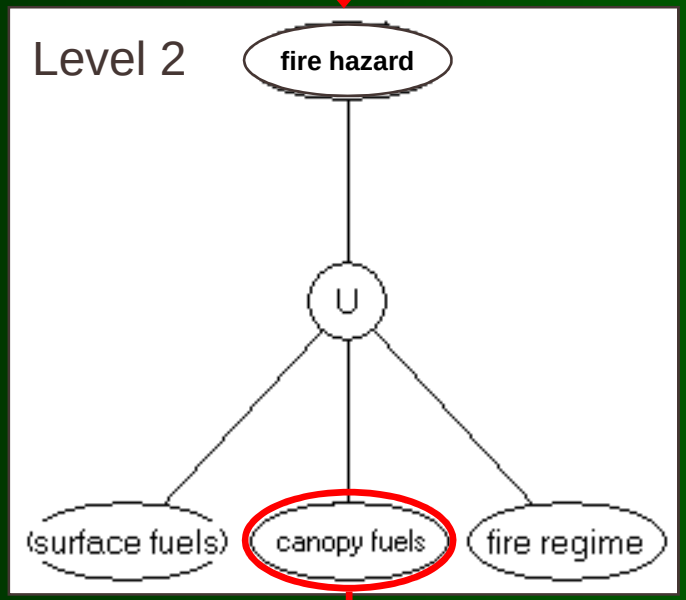
NDVI* on Julian day 152 (June1st)

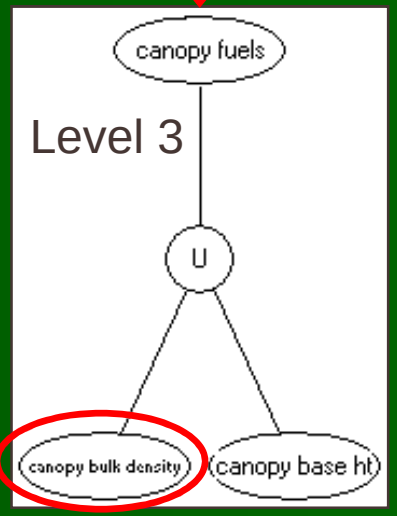
Lightning strike probability

Likelihood of cloud to ground strike within the watershed **is low**.

Probability of a strike last 15 years*

The **fire hazard** topic is evaluated as the synthesis of two metrics applied to each elementary topic





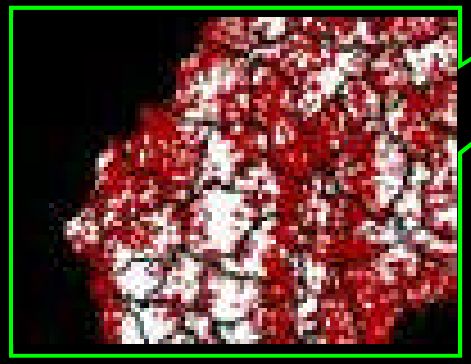
Class metrics -- PL and AI *

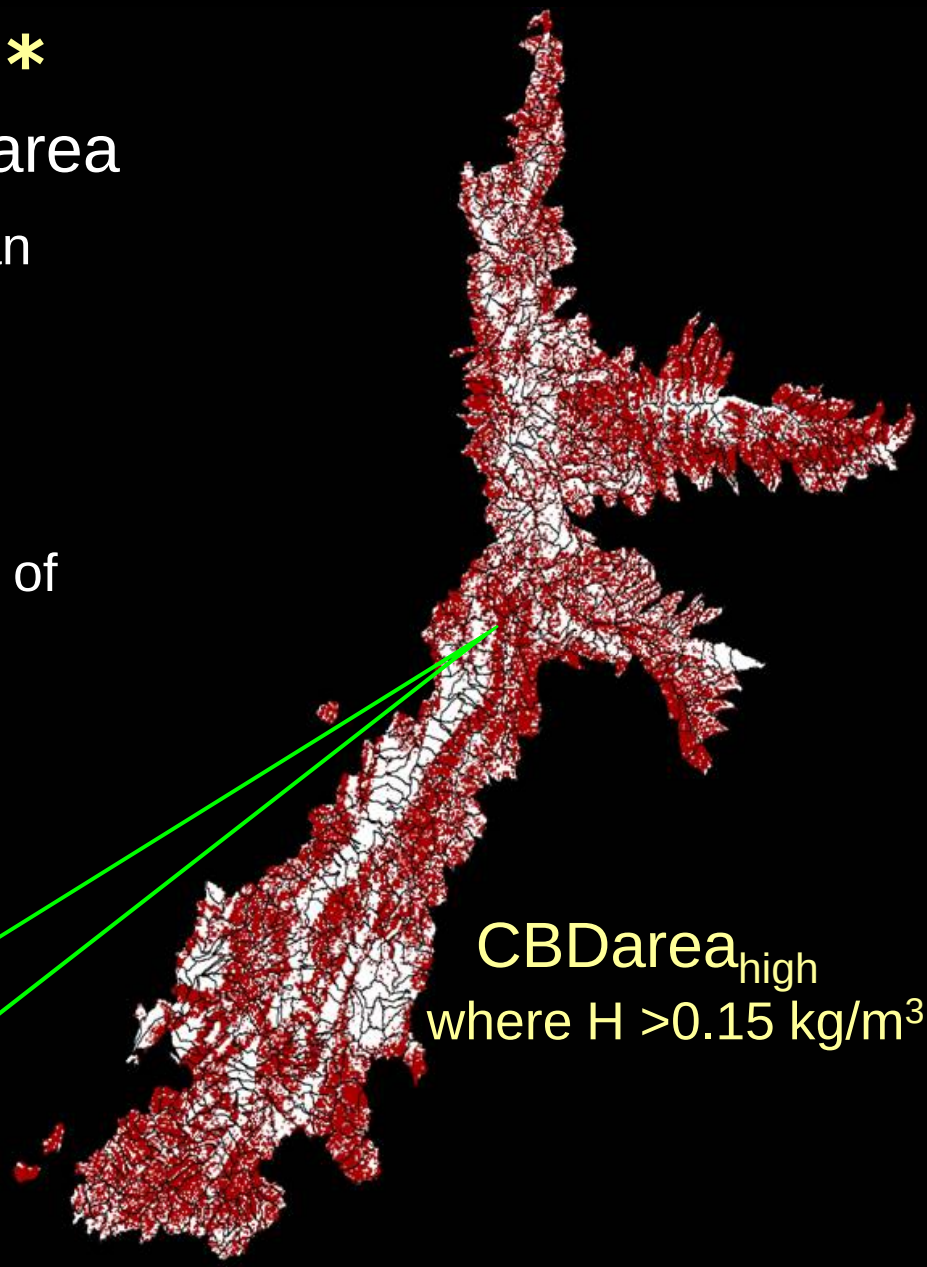
Percentage of the landscape area

Calculates % area of class “high” of an attribute in the subwatershed

Aggregation Index

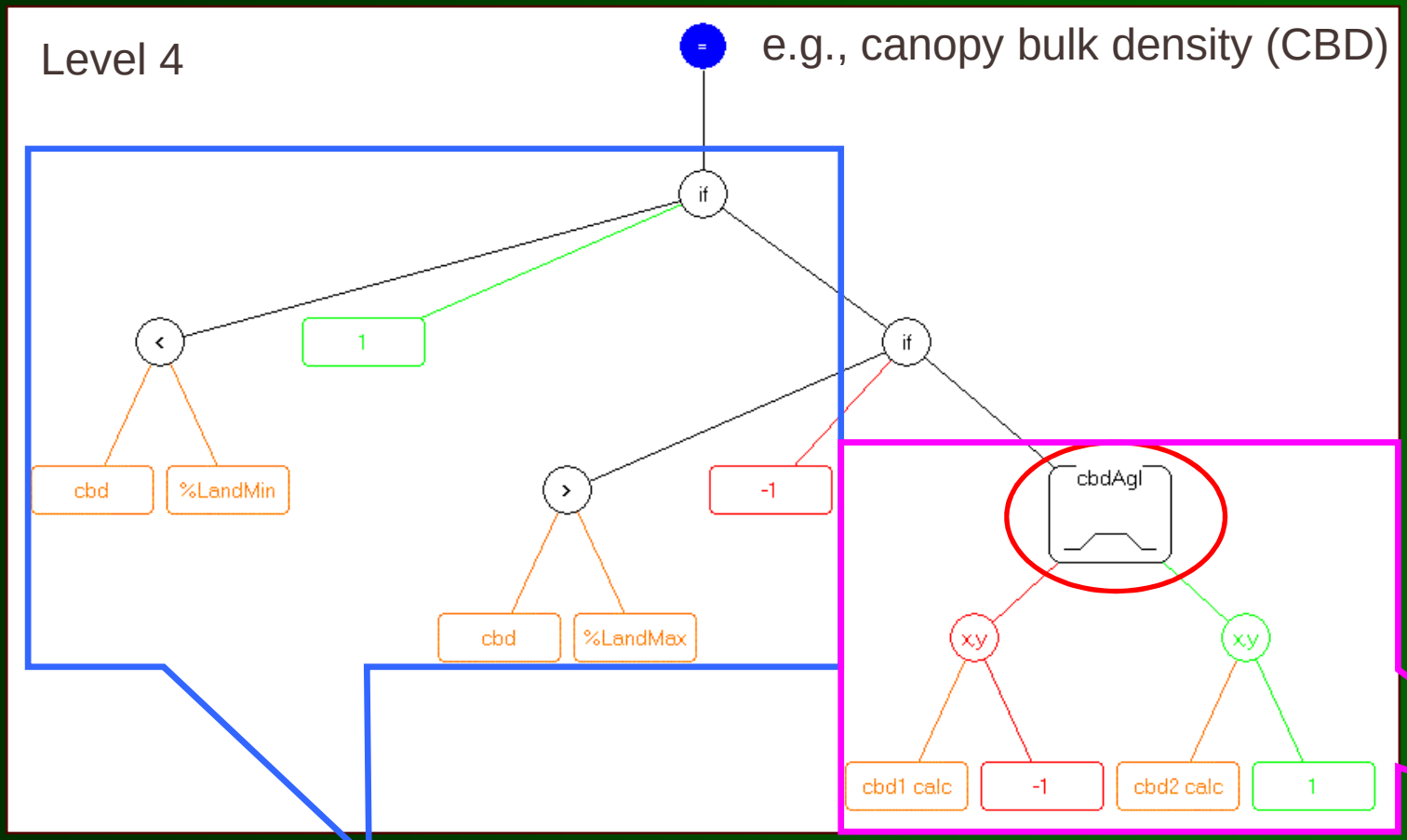
Calculates the degree of aggregation of the class “high” of an attribute in a subwatershed





* Metric values computed in FRAGSTATS

Logic for synthesis over fire hazard attributes

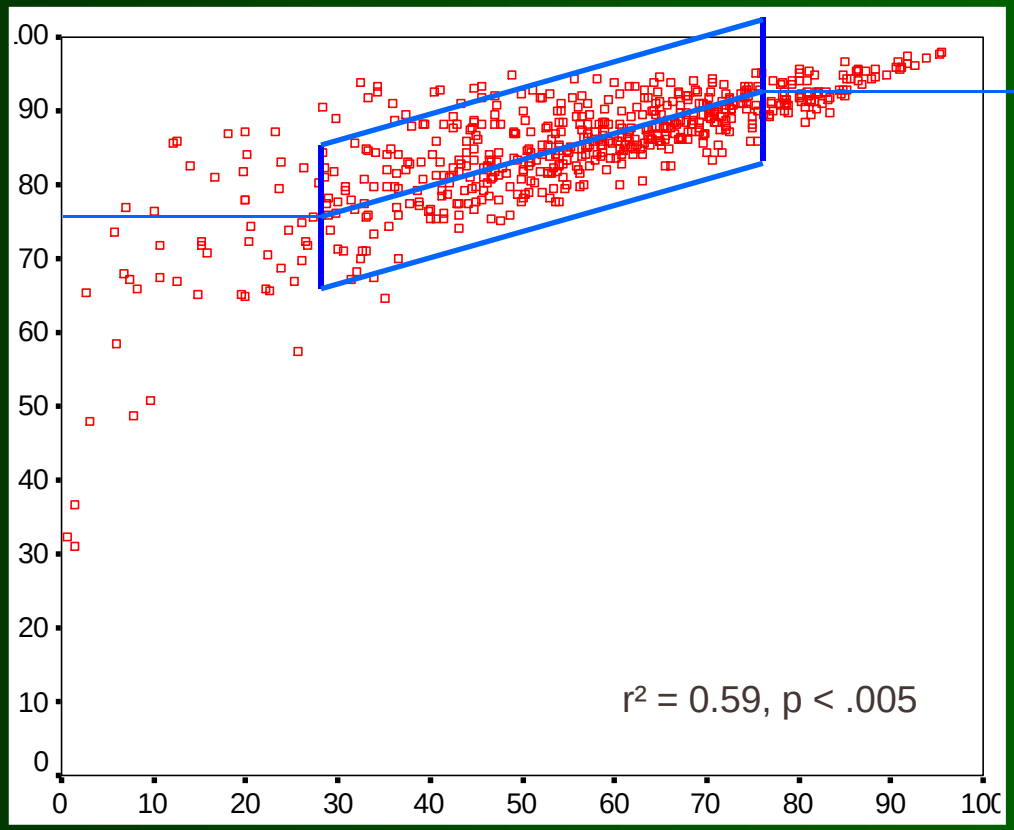


The evaluation 1st treats the class metric %Land of High separately, and then jointly with aggregation of High in a ramp function.

1st query: Are values below (full support)/above (no support) median 80% range of all 575 %Land values?

2nd query: Are values below (full support)/above (no support) 1 SD of all 575 AgI values?

Values above/below either MIN and MAX are interpolated from a ramp function of the associated regression



no support

Aggregation
μ ± 1 SD

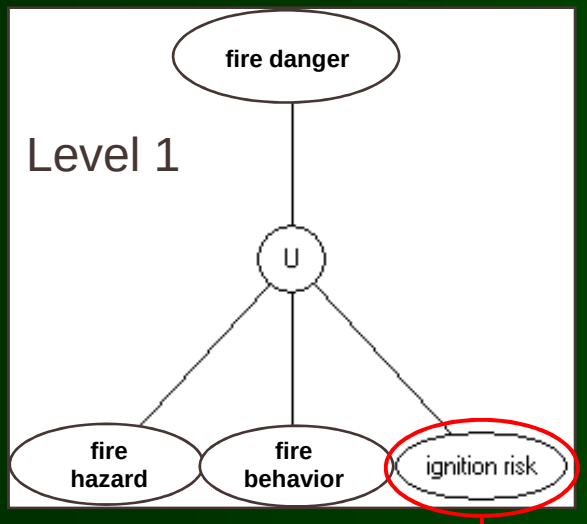
full support

Percentage of landscape area of High (canopy bulk density)

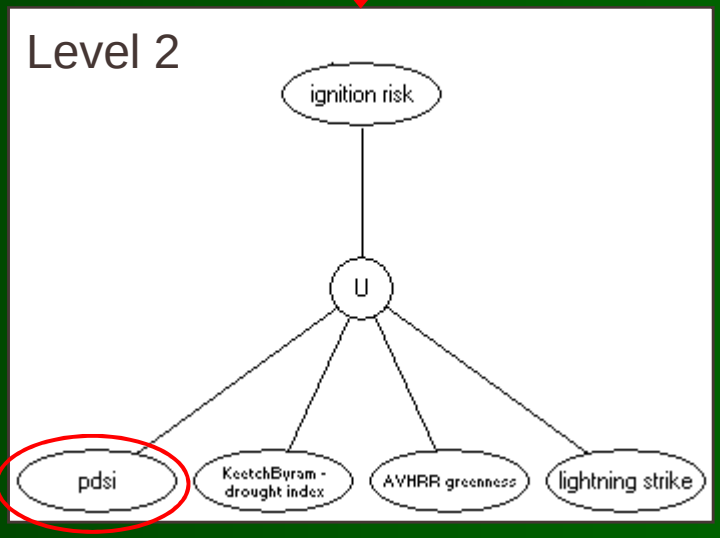
MIN High
(full support)

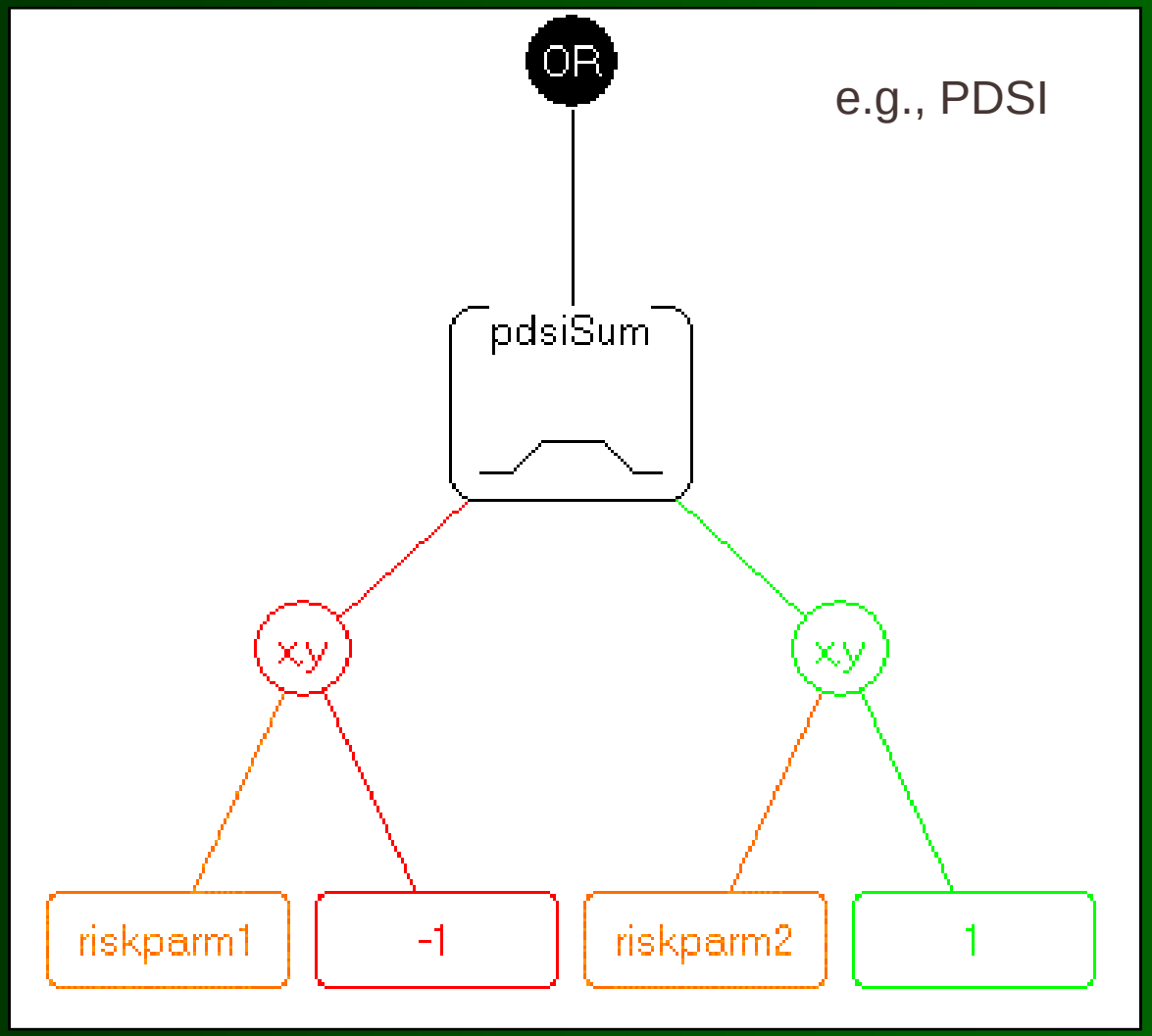
Median 80% range of PL of "High" CBD

MAX High
(no support)



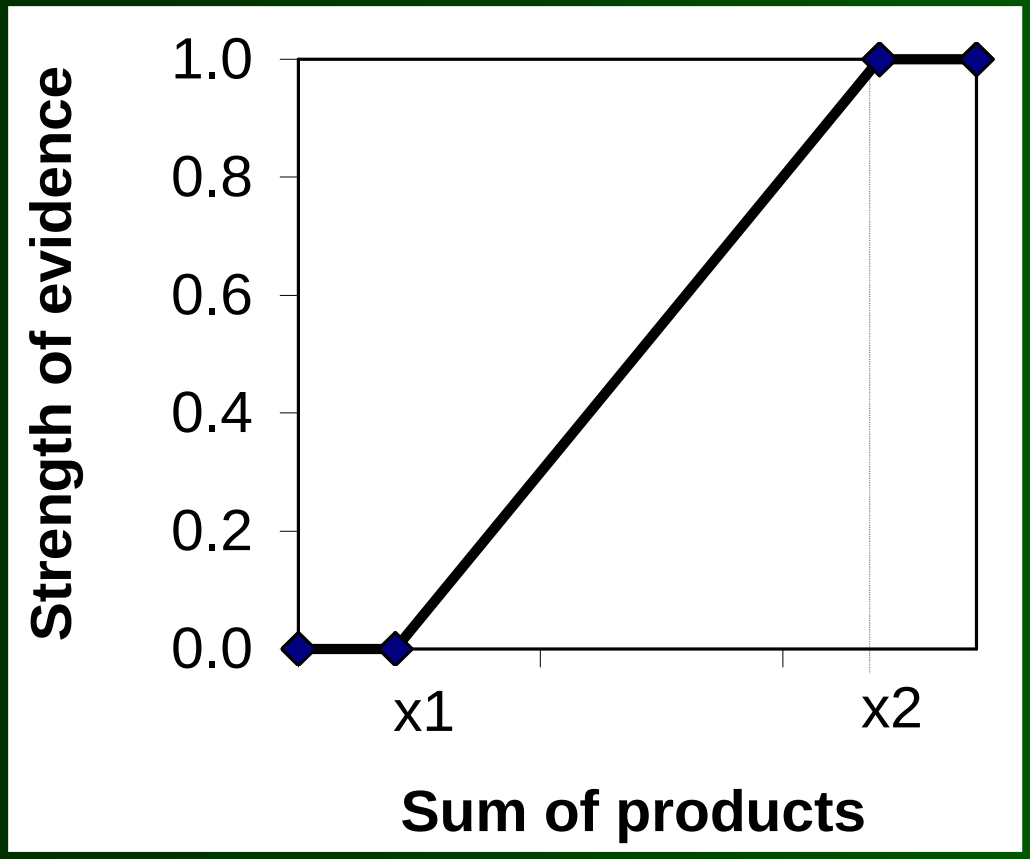
For fire behavior and ignition risk topics, likelihood is evaluated as the probability of a condition occurring relative to a threshold value. For example, 20 yr of PDSI data is evaluated to determine likelihood of a moderate drought.



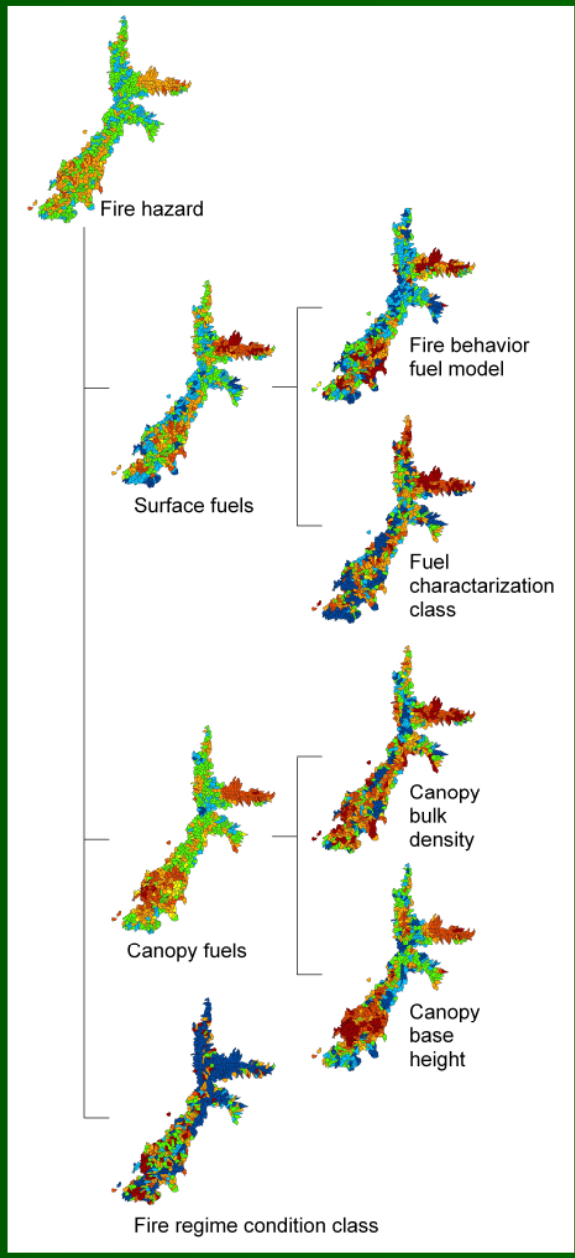


- The logic model asks what is the probability of a summer PDSI value< -2?
- For each watershed, the probability of a summer PDSI < -2 is calc'd from monthly continuous maps of summer PDSI for the last 20 yr.
- Values approximating 1 contribute to high likelihood of severe fire danger
- Values approximating 0 contribute to low likelihood

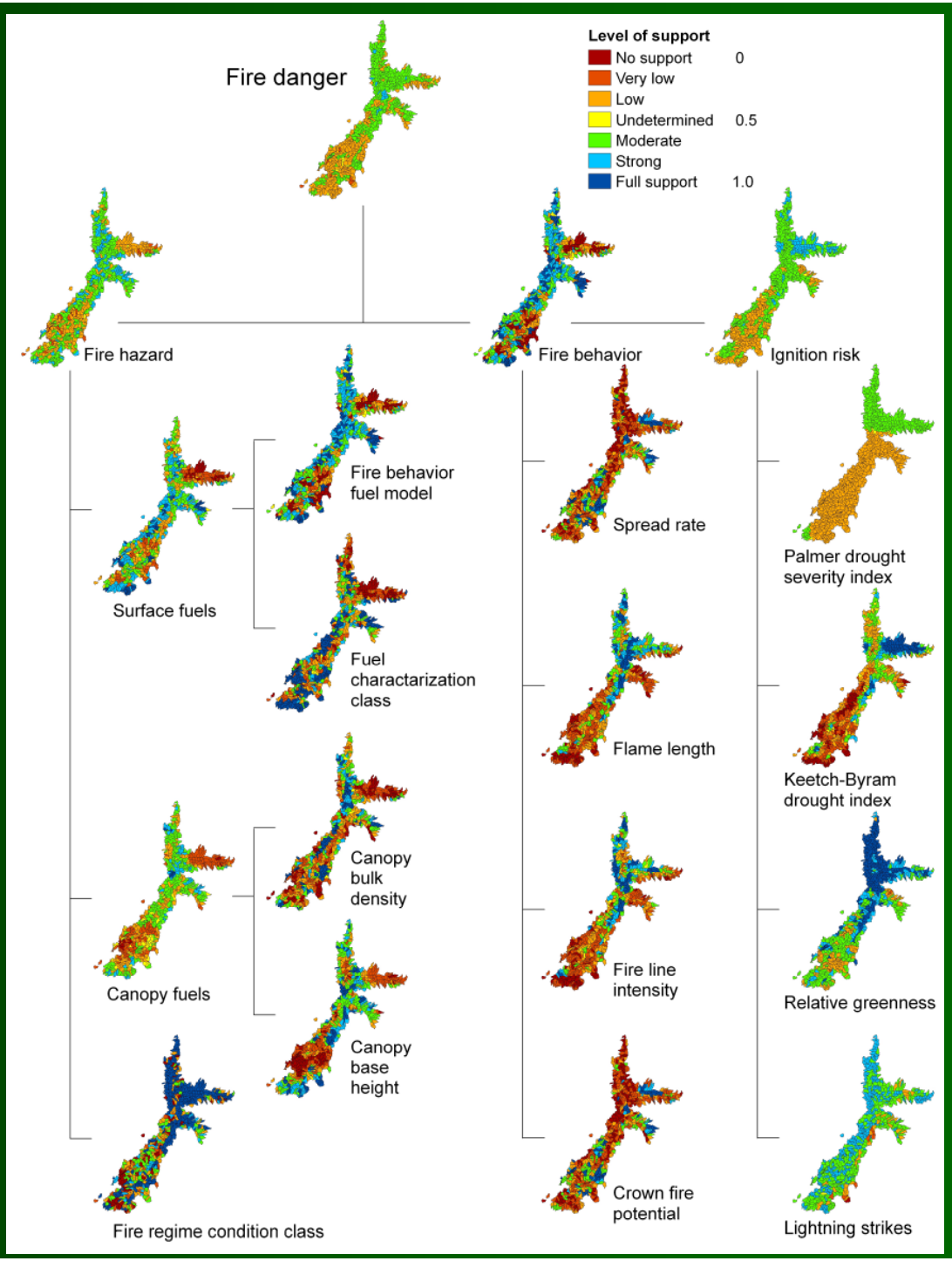
Weighing strength of evidence in support of propositions



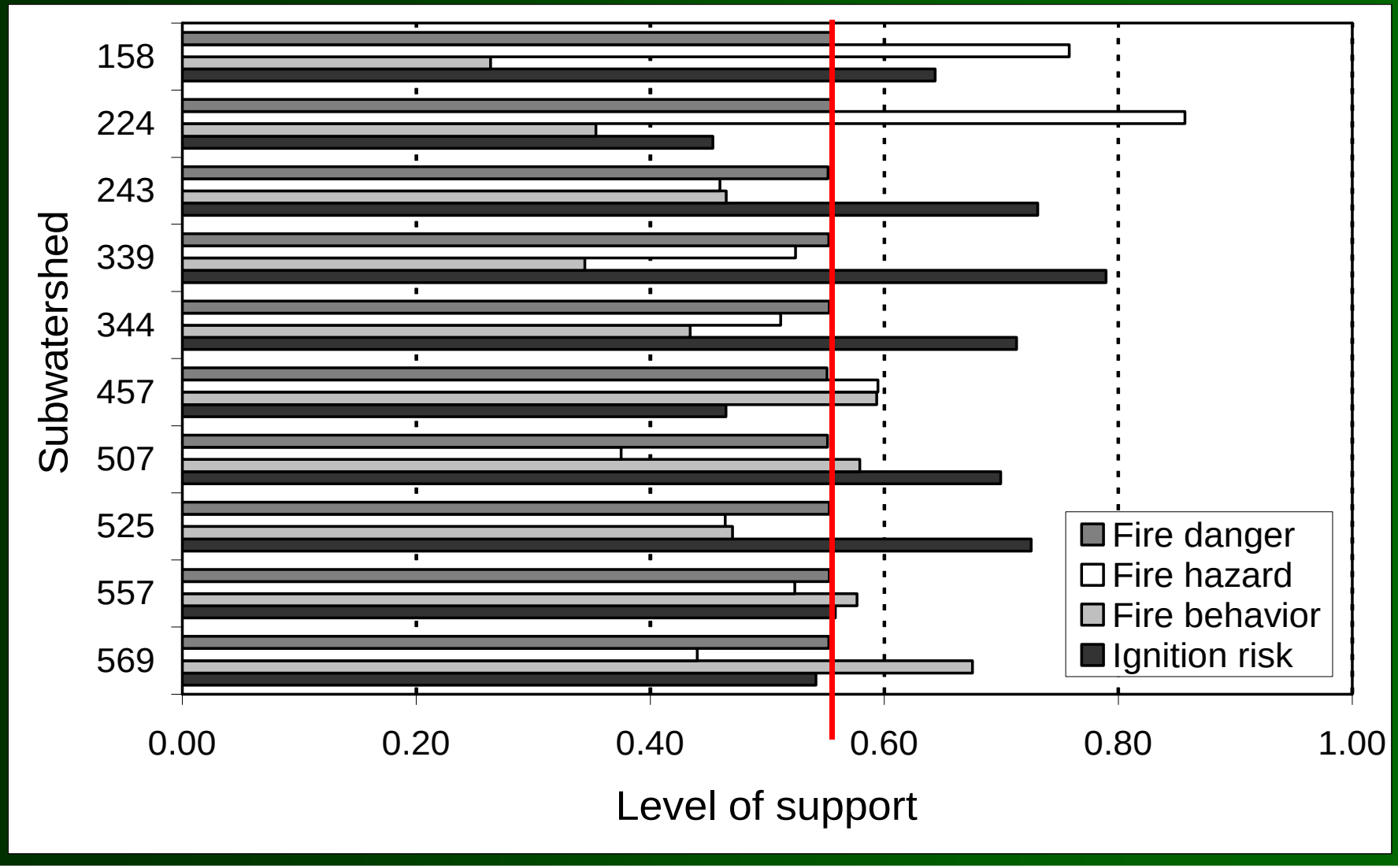
- Attributes incrementally contribute to support for a proposition.
- Evaluation by weighted sum of evidence
- Default weighting is 1.



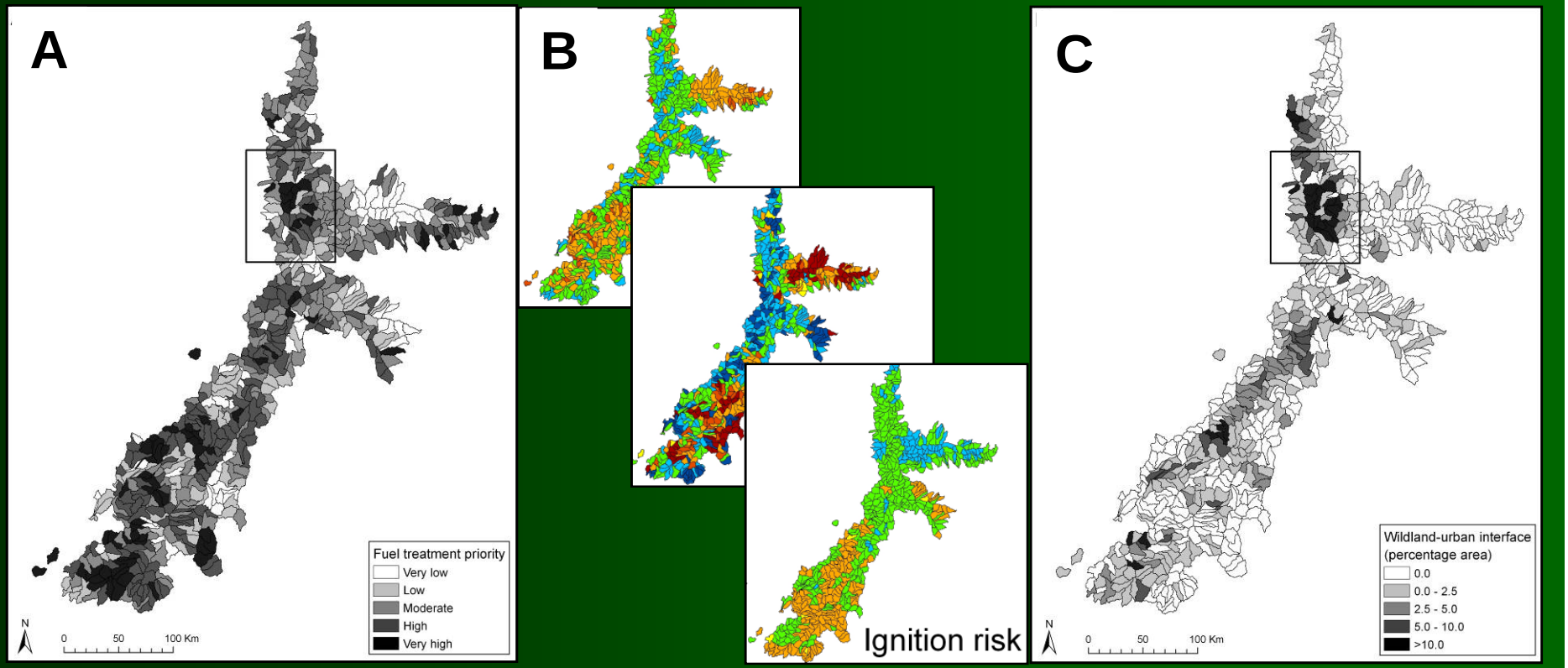
Fire danger result and evaluation components



Comparing 10 subwatersheds in MZ 16, each displaying moderate support (strength of evidence = 0.56 in the interval [0,1]) for the proposition of low fire danger. Note that level of support varies by primary topic.



Decision model: Considering treatment priority in the context of the amount of associated WUI



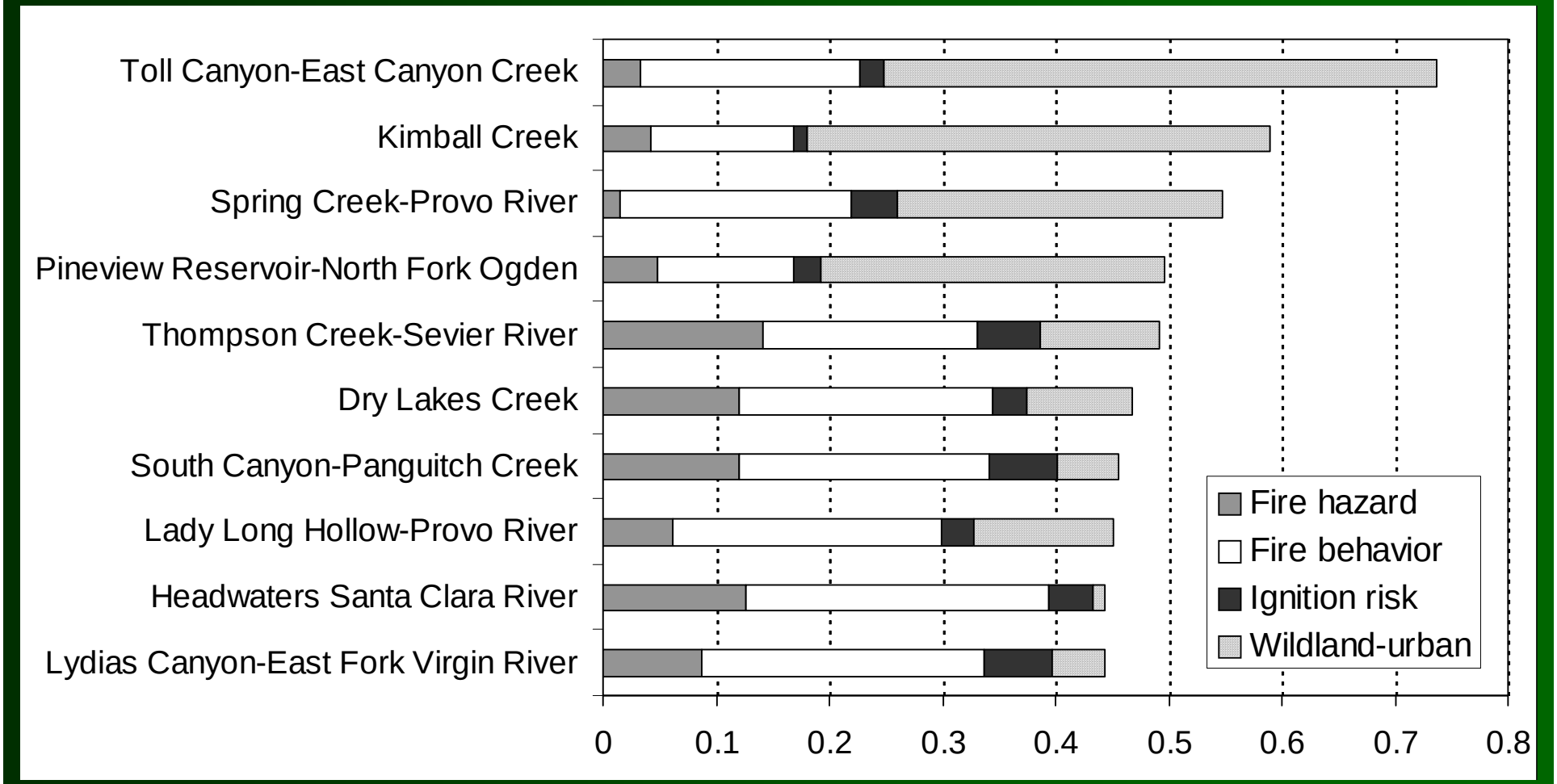
Fire hazard (0.15)*
Fire behavior (0.27)*
Ignition risk (0.08)*
Area of WUI (0.50)*

Fire hazard +
Fire behavior +
Ignition risk

Area of WUI

(* Normalized weights of primary criteria derived via the SMART technique)

Contributions of primary decision criteria to treatment priority in selected subwatersheds (inset prior slide) of MZ 16

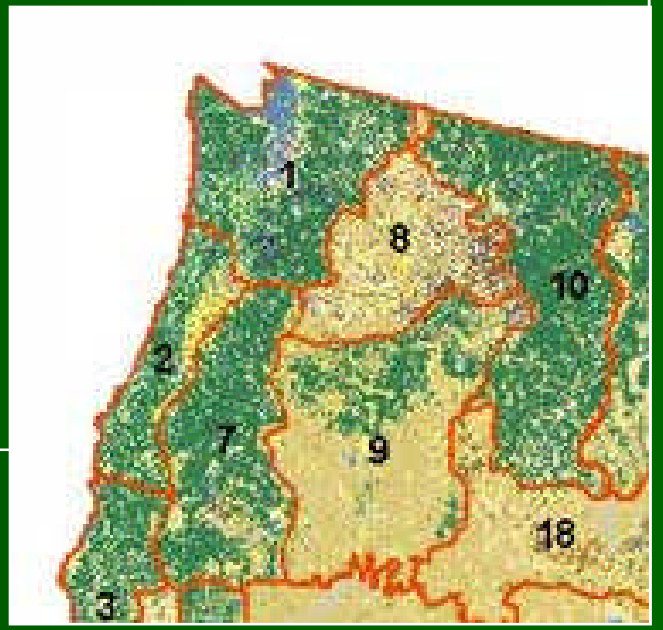


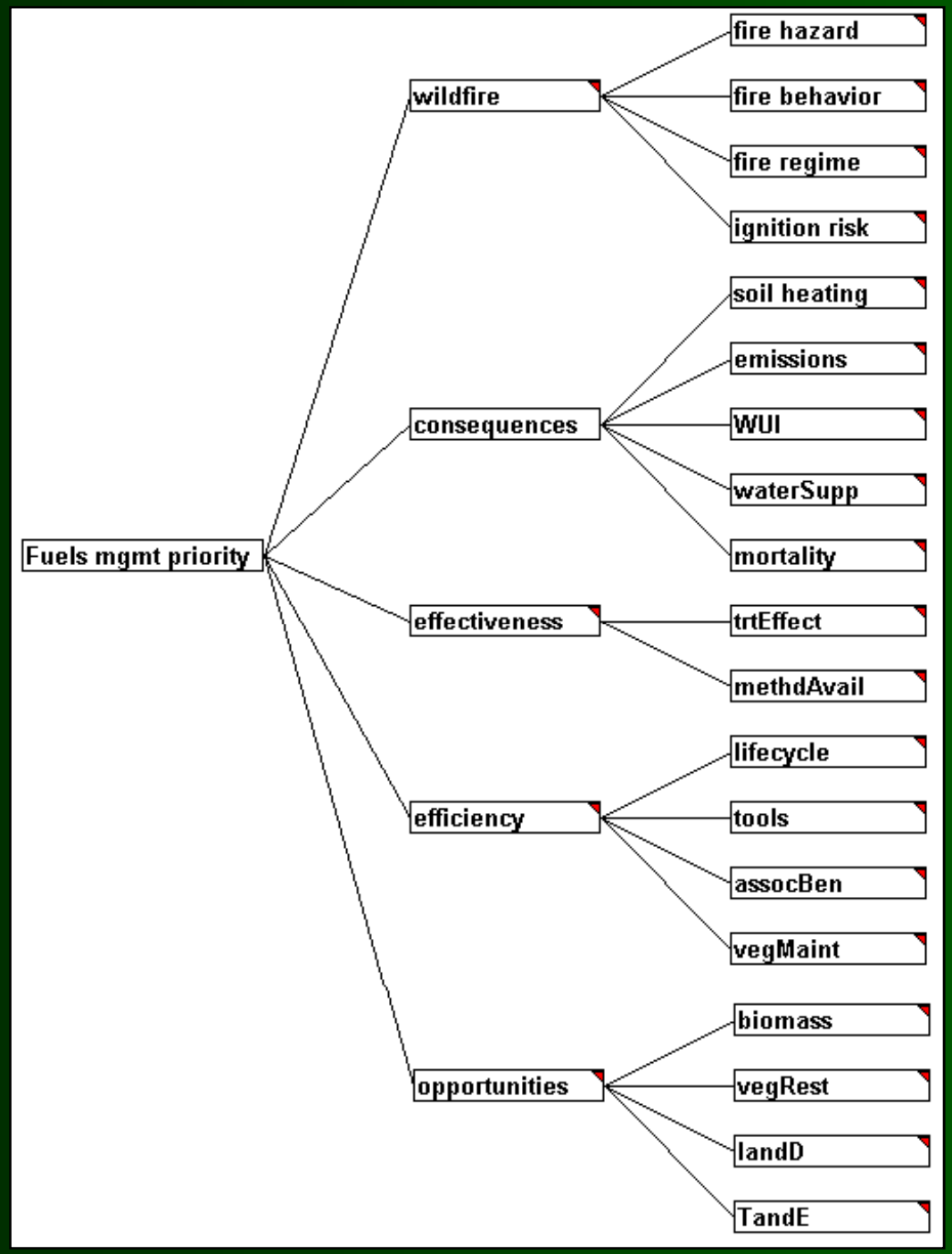
Lower priority

Higher priority

Summary

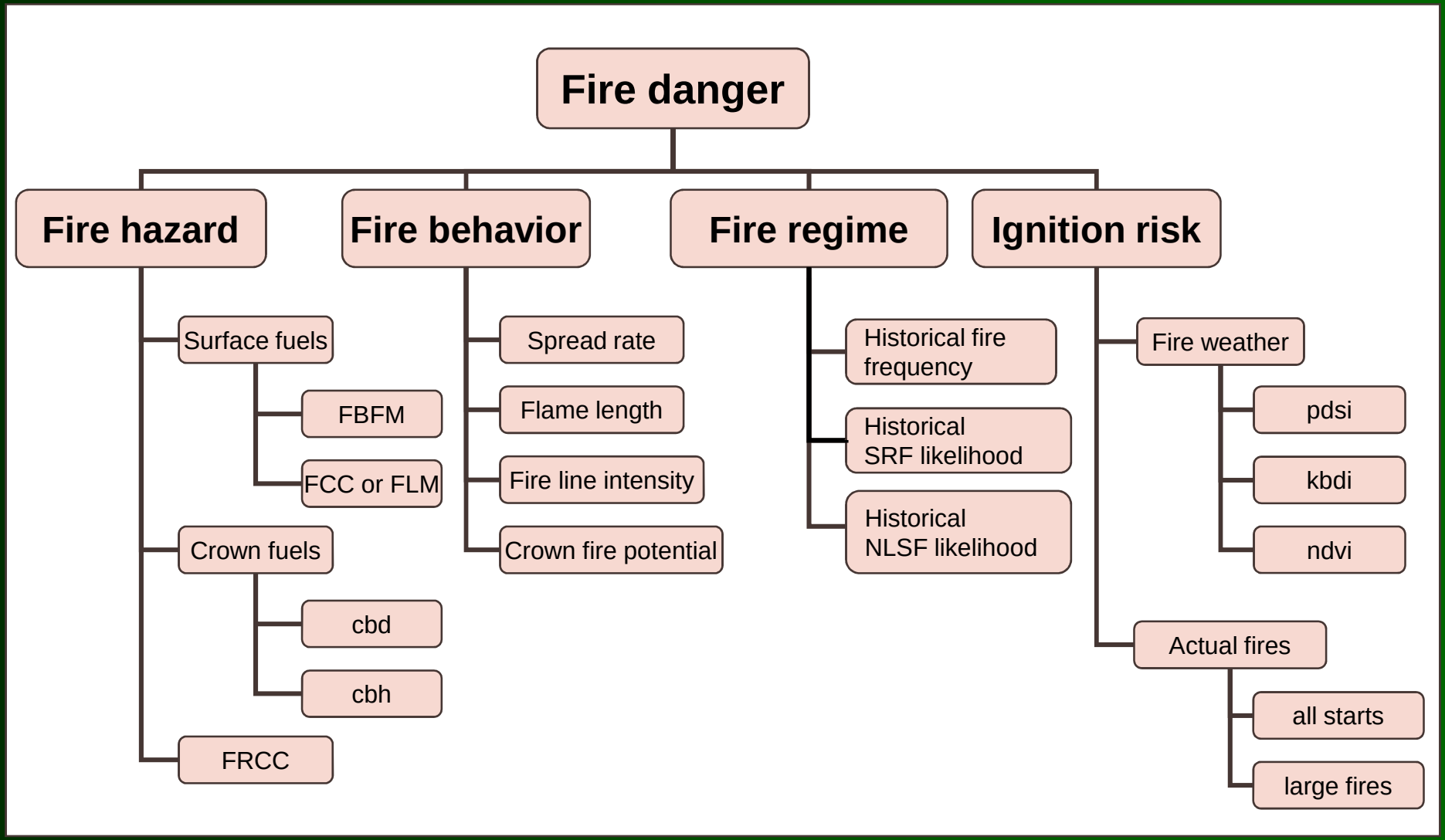
1. Decision-making is more robust and transparent when we consider the ecological state of systems alongside of important social and economic decision criteria.
2. Logic and analysis paths leading to any decision score are easily traced.
3. Weighting of ecological attributes and decision criteria can be adjusted through sensitivity analysis.
4. This model addresses 1 map zone. It is readily expanded to the CONUS enabling multi-scale analysis.
5. In a next step, we are expanding the model to evaluate 7 map zones covering the PNW Region.





6. In addition to WUI, we are adding other criteria to the regional decision model.

PNW *FireDanger* -- logic model outline



7. To the logic model, we are adding a 4th topic, *Fire regime*.
8. We are expanding the ignition risk topic.

Acknowledgements

Financial and in-kind support:

- PNW Research Station
- RMRS Station
- National Fire Plan
- LANDFIRE project