CALFIRE Northern Region Fire Response Plan- Executive Summary

Background

The California Department of Forestry & Fire Protection (CALFIRE) is charged with emergency services response in the State. Their jurisdiction includes over 31 million acres of land and they also provide services to local government agencies in 35 counties.

Operating with a budget of $1.05 billion, they deal with an average of 5,600 Wildland Fires annually and another 350,000 Non-Woodland Fire Emergencies. They have 5,000 permanent personnel and another 20,000 volunteer and seasonal responders that activate during fire season. In addition, there are numerous firehouses, firefighting equipment and air assets that they operate to deal with fires.

Problem

Calfire has an expansive area of responsibility and a limited number of resources to deal with fires that arise within its area of responsibility(AOR). What is the optimal way to utilize the resources that Calfire has, minimizing the operating costs and providing the service they are charged with delivering?

Focusing on Northern California, there are 12 units that respond to fires. These units are comprised of ground commodities that include fire engines, bulldozers, and fire crews and air commodities that include OV-10 Broncos, S-2T Tankers, and UH-1H Helicopters.

There are three seasonal 'hot' spots that are high threat due to their frequency, potential for high acreage burns and loss to life and property.

Formulation

The model is a multi-commodity flow network, where the desired outcome is the minimization of costs of the commodity flow and commodity utilization for a one-day fire scenario.

$$\min_Y \sum_k \sum_{i,j} (c_{i,j}^k * Y_{i,j}^k) + \sum_j \sum_k (ac^k * AA_j^k)$$

[$c_{i,j}^k$ = $/dist] Cost to move commodity(k) along arc(i,j).

[$Y_{i,j}^k$ =Number of commodity(k) moved along arc(i,j)

[ac^k = $] Activation cost of commodity(k)

[AA_j^k] = Number of commodity(k) assigned to fire(j)

Commodity Cost and Capabilities

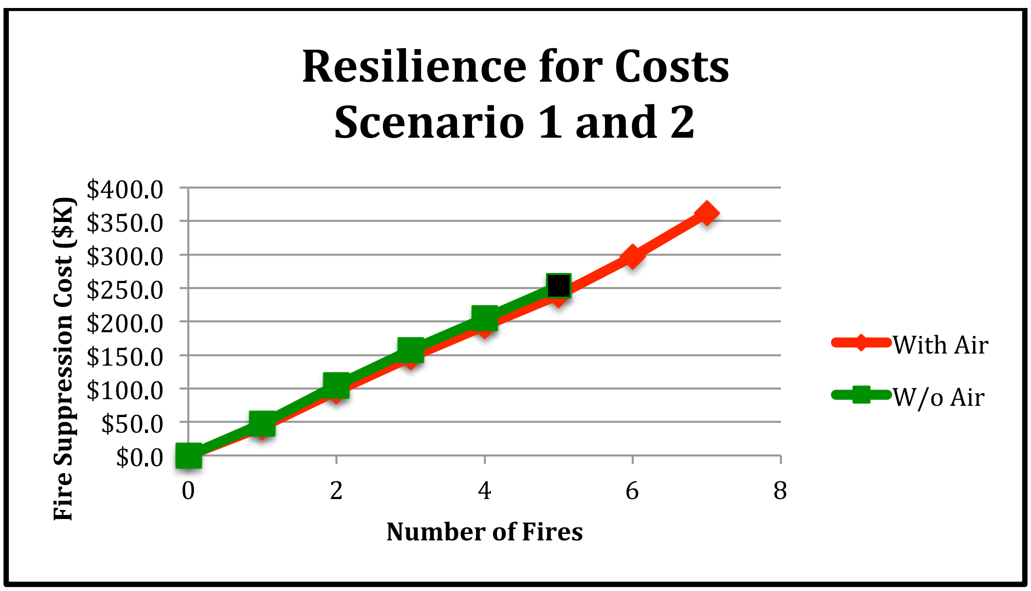
Each asset has a different firefighting capability that is proportional to the fire suppression ability they bring to the fire. The operating costs and commodity capabilites are displayed in the chart below. The initialization cost is 12 hours of air commodities and 24 hours of ground commodities operating costs. The demand at each fire node is a uniform random variable from 2000 to 3000 units of fire fighting capability.

Commodity	Fire Fighting Capability	Operating Cost/Hr [$]	Initialization Cost [$]	Supply
Fire Engine	150	80	1900	190
Bulldozer	40	100	2500	32
Fire Crew	10	85	1000	85
Air Attack	100	1100	13200	6
Air Tanker	1500	2100	25200	10
Helicopter	500	1750	21000	6

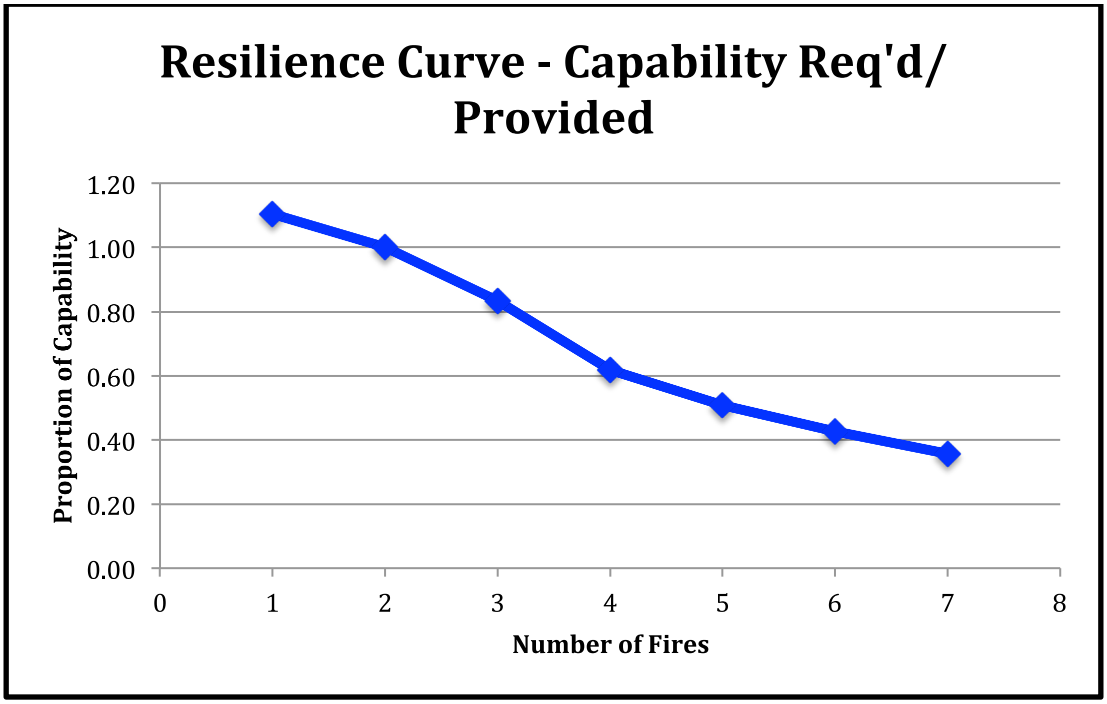
Network Attacks

There are three network attack scenarios. The first scenario is increasing the number of fires to produce the optimal mix of commodities to utilize while minimizing cost. The second scenario is the same as the first scenario, with a caveat that weather prohibits air operations. The final scenario exhausts the current network commodities by increasing fire demand 5-fold. This allows the model to generate fictitious commodities at the current bases when the fire demand exceeds the fire capabilities supplied. The results of this scenario recommend the procurement of commodities by type and quantity.

For the first two attacks, the Operator Resilience curve below details the results.



As depicted, the cost for the number of fires from one to seven increase from $42K to $361K. When no air assets are available, the CALFIRE North Network can only fully support 5 fires and the cost increase is between 6% and 11%.



The result of the final scenario is shown above. After two fires the procurement of additional commodities is required to meet each fire demand at 100%.

<u>Conclusions</u>

This model can provide the CALFIRE Operations Center a guideline ‘best’ fire response package from a financial perspective. Additional things that should be taken into consideration are the utility different assets provide, and a possible weighting factor. This issue was observed acutely because the model was resistant to deploying helicopter assets due to their high activation and operation cost compared to their ability to fight fires. The lack of the mobility they bring, and the mobility and situational awareness would probably offset the costs in an improved model.

In addition, the last scenario can be used to ‘stress-test’ the system if CALFIRE is looking for new basing locations or want to see what new asset acquisitions would be of higher value. With the basing, the proposed location can be added and the test run to see if that base produces ‘fake’ assets, and of what type. These results could provide policy makers with quantitative metrics for better decision making.