Carbon Management in the Fremont-Winema National Forest, Oregon

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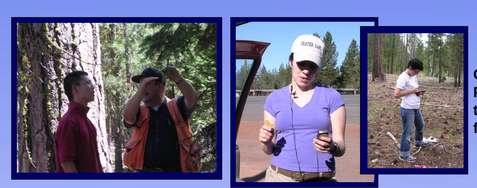
DEVELOP is a student-run, student-led internship program that extends NASA Earth Science research to local, county, state, and tribal governments and communities. In this project, students at NASA Ames Research Center in California provided managers of the Fremont-Winema National Forest with data and analysis for carbon management. The goal of this project was to demonstrate how different harvesting scenarios impact forest carbon budgets and to provide fire modeling outputs to assist managers in the mitigation of disturbances that could potentially impact the forest's carbon budget. The figures below display major components of this project, including: 1) a project flowchart, 2) model outputs from a NASA developed carbon simulation model, CASA, and 3) fire behavior characteristic model outputs from FlamMap. DEVELOP is funded by the Applied Science Program at NASA Headquarters.

Study Area

- **The Fremont-Winema National Forest is comprised of over two million acres.**
- **Oregon is a significant area of study as it is the leading provider of lumber in the United States.**
- **Within Fremont-Winema Forest, resource managers harvest 12 million ft³ of timber annually.**

Field Work

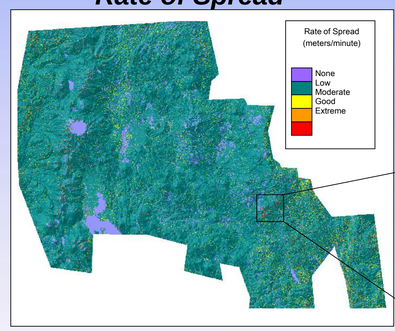
In July 2004, the team spent a week collecting data and making observations in the forest and surrounding area. A forest service ecologist (left photo) and a geomorphologist (right photo) assisted in vegetation species and land cover identification.

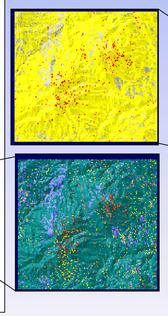


GPS & PDA used to record field data

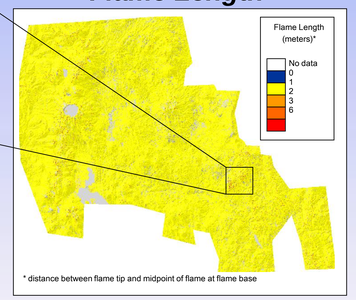
Fire Behavior Characteristic Mapping

Rate of Spread



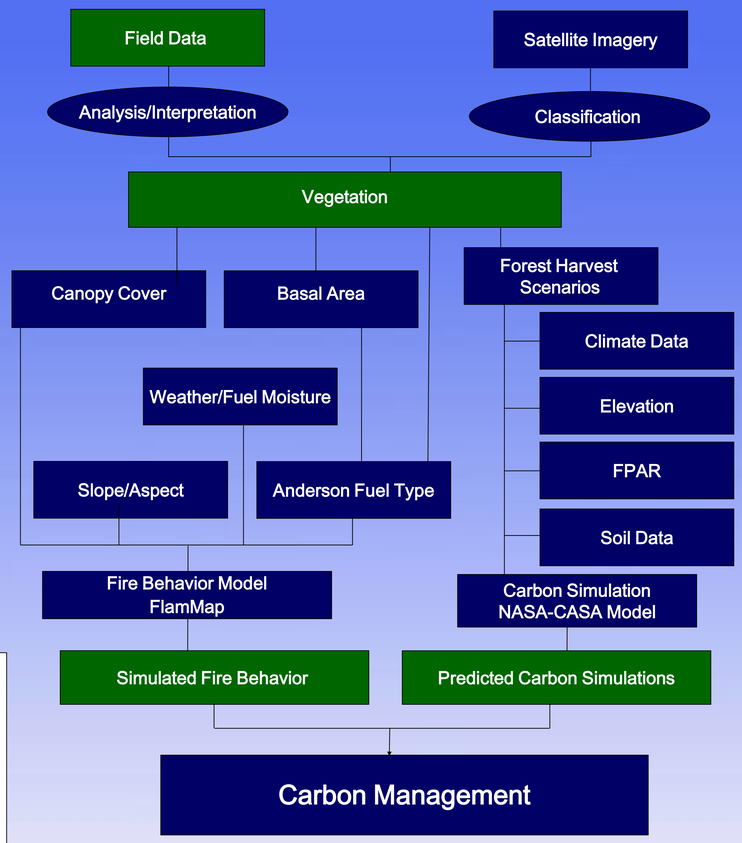


Flame Length



The map on the left is Rate-of-Spread in meters per minute, showing how fast a fire moves across a landscape. However, ROS by itself does not predict fire risk, since both a fast-spreading fire and a slow spreading fire can be hard to contain. We therefore created the flame length map on the right which is useful as it represents fire intensity. When rate of spread (or speed) and flame length (or intensity) are combined it provides an estimate of fire risk. As these maps were created to identify target areas for fuel-load reduction treatments, forest management may be interested in the south-east region enlarged between the maps, which under the conditions input to the FlamMap model would have an extremely fast moving fire with flame length extending approximately six-meters high. Fuel load reduction treatments, such as clearing slash and fallen trees to prevent large fires, could act as a management tool in preserving the forest's carbon budget.

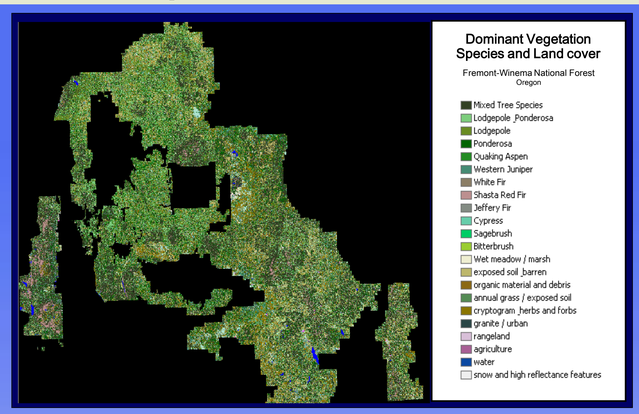
Project Flow Chart



DEVELOP Customers

- Fremont-Winema National Forest
- Bureau of Land Management
- Klamath Tribe
- Crater Lake National Park

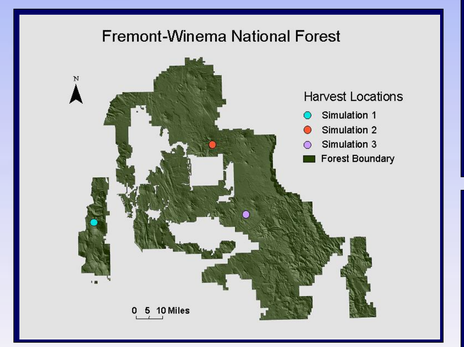
Vegetation Map

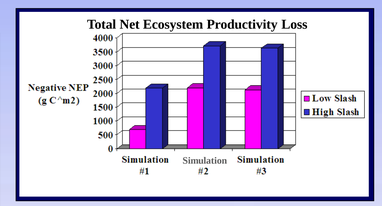


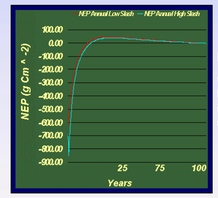
The map was created using 4 2003 Landsat 5 images, which were mosaicked and georeferenced in preprocessing. 281 training sets, created from various sources, were input to a supervised classification and reduced to the 22 class map you see here. Largest error was between selective cut, agriculture, and rangeland classes. To mitigate this error, bands 3_4 and 4_5 feature space, and the spectral signatures of pure pixels were used refine and separate classes.

Forest Harvest Carbon Simulations

The team worked with NASA scientist Dr. Christopher Potter, the P.I. for the NASA-CASA model. The model estimates Net Ecosystem Productivity (NEP) in grams of carbon based on climate, FPAR, soil texture, and elevation. Two different carbon level scenarios - consisting of high and low slash values - were chosen for three variable climate regions throughout the forest. Simulations were conducted at three different 1m² plot locations, which were chosen based on climate variability (high to low precipitation). Re-growth estimates were conducted using NASA-CASA to demonstrate the change in NEP after harvest.







Harvest location simulation 1

On the graph, the curve represents NEP after harvesting a 1 m² plot of timber, and subsequently 100 years of simulated re-growth.

Harvest location simulation 1 (high precipitation) would take approximately 15 years for annual NEP to return to net-zero NEP. Harvest location simulation 2 (low precipitation) would take more than 21 years of growth for annual Net Primary Productivity (NPP) carbon to level with carbon losses from slash decomposition. Harvest location simulation 3 (low precipitation), had the same results as harvest location simulation 2 in that it would take more than 21 years of growth for NPP to level with carbon losses from slash decomposition. For both harvest locations 2 and 3, there is a net loss of 2100-3700g C, because NPP slows down after 50 years of re-growth. All 3 harvest location simulations support the finding that NEP carbon will never return to the level it was before harvesting.