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USGS Fire Science Activities

Hazards Management in Grand County, Colorado—Fire Fuels Characterization

U.S. Geological Survey Rocky Mountain Geographic Science Center

The USGS Fire Science Initiative is designed to identify potential wildfire risks and related hazards and to mitigate their effects on people, property, and natural resources. The USGS Rocky Mountain Geographic Science Center (RMGSC) plays an integral role in the fire science demonstration project targeting Grand County, Colo., which uses remote sensing imagery, other geospatial data, and advanced classification techniques to produce inventories and assessments of the current state of the ecosystem. The data gathered—extent of tree mortality and insect infestation, changes in fire fuels, susceptibility to post-fire effects, distribution of wildland-urban interface areas, etc.—will give much needed information to decisionmakers on the Federal, State, and local levels.

Introduction

The threat of wildfires continues to put pressure on planning and mitigation efforts at Federal, State, and local levels—especially in the wildland-urban interface (WUI) areas. A key part of combating these hazards is the ability to inventory and assess fire fuels and associated risks, yet much of this information is either unknown or unavailable at scales adequate for decisionmaking. The U.S. Geological Survey (USGS) Fire Science Initiative is designed to identify potential wildfire risks and related hazards and to mitigate their effects on people, property, and natural resources.

As a part of this initiative, the USGS Rocky Mountain Geographic Science Center (RMGSC) plays an integral role in the fire science demonstration project targeting Grand County, Colo. (fig. 1). The extensive lodgepole pine forests in Grand County are suffering widespread mortality from an unprecedented outbreak of Mountain Pine Beetle (*Dendroctonus ponderosae*), which is altering fire hazard and risk significantly. The county is an ideal choice for an integrated scientific approach to hazard assessment because it has a reservoir system that provides water to millions of users throughout the state; an expanding WUI; a variety of Federal, State, and privately owned land; and such at-risk values as the presence of threatened and endangered species. Potential post-wildfire effects include a risk of flooding and debris flows, damage to community and critical infrastructure, and the impairment of water quality and availability for human and animal use.

The USGS RMGSC is using remote sensing imagery, other geospatial information, and advanced classification techniques to support fire science activities in Grand County. Specifically, these data and methods are being used to produce inventories and assessments of the current state of the ecosystem, including tree mortality as a result of insect infestation, susceptibility to erosion and other post-fire effects, the distribution of WUI areas, and other at-risk values. Products derived from this information will then be used to help address scientific questions pertaining to fire behavior, fire effects, and fuels management within forests from the individual stand to landscape scale.

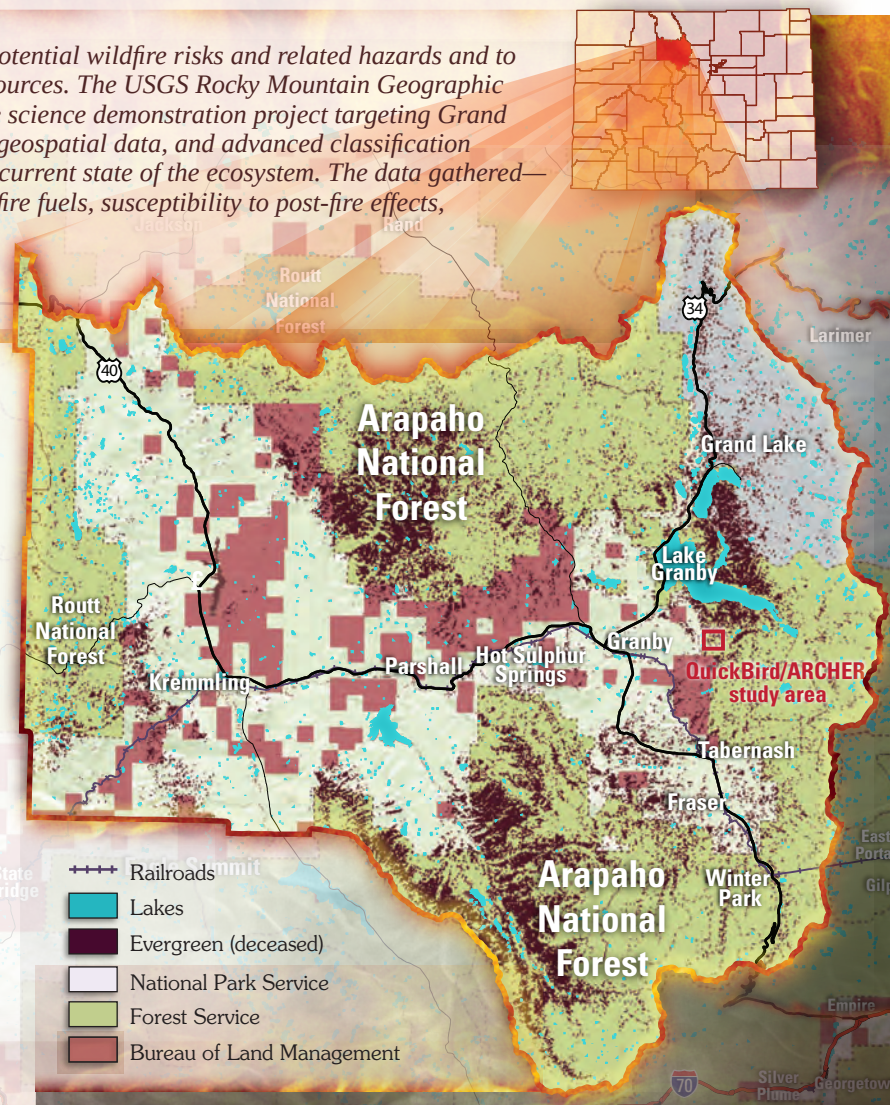

Figure 1. Map for Grand County, Colo., showing locations of Federal lands and deceased conifer populations. Red box shows location of study area for figures 3, 4, 6, and 7.

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Previous Accomplishments: Fiscal Years 2006–2007

In FY06, the USGS contributed to a pilot effort focused on high-risk wildland-urban interface (WUI) zones in Grand County. This effort conducted an initial pre-fire hazards inventory of the potential effects on life and property from post-fire flooding, landslides, and erosion within the Three Lakes watershed area in Grand County. The inventory included the geospatial analysis and classification from high-resolution 2005 NAIP (National Agricultural Imagery Program) natural color photography, medium-resolution Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) multispectral imagery, and elevation information. Potential hazard-event variables such as structures, topography, and deceased coniferous vegetation were identified and their spatial relationship quantified.

In FY07, a countywide 30-meter landcover inventory was produced using multi-year Landsat imagery, derived vegetation indices, National Land Cover Data (NLCD), and other ancillary geodata, employing a fusion of pixel-based and object-oriented classification techniques (fig. 2). This product (current to Fall 2006) illuminates the significant human and environmental changes that have occurred in Grand County during the past decade—not fully accounted for in other existing national landcover datasets—and includes a Deceased Conifer class, which illustrates the increasing scope of Mountain Pine Beetle infestation and concomitant vegetation mortality in the region.

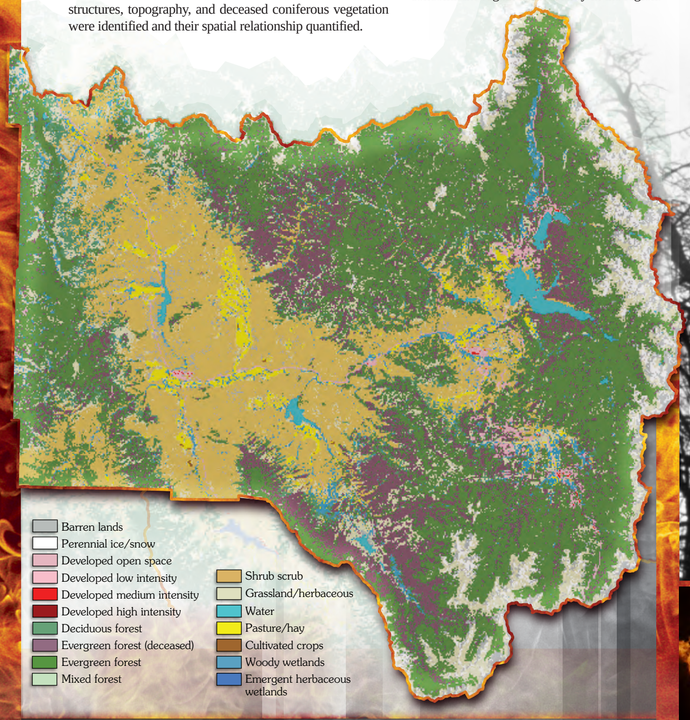

Figure 2. Updated Grand County, Colo., landcover dataset, derived from 1995–2006 Landsat imagery, NLCD, and other geodata. This product captures recent landcover change due to urbanization and identifies deceased coniferous vegetation (largely attributed to Mountain Pine Beetle infestation).

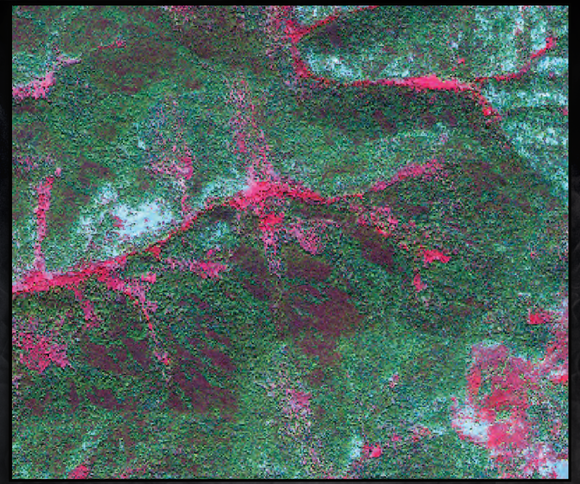

Figure 3. DigitalGlobe QuickBird II multispectral natural color image, 2.4-meter resolution.

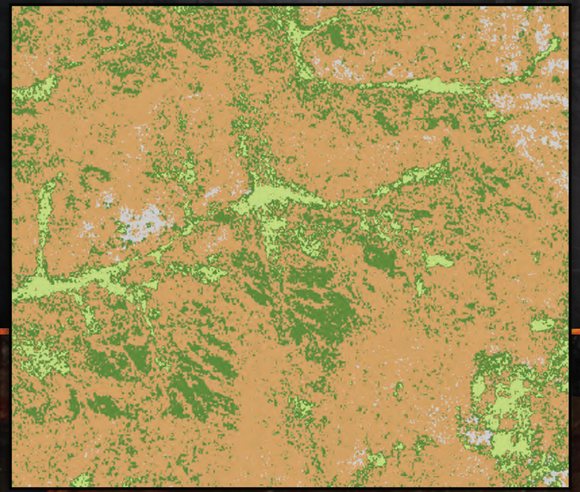

Figure 4. Preliminary generalized classification delineating conifer morality; from DigitalGlobe QuickBird II imagery.

Present and Planned Future Activities

Field visits conducted within Grand County during the summer of 2007 generally verified the accuracy of the updated 30-meter landcover product. However, they also underscored the need for high-resolution spatial, spectral, and temporal imagery as a means to characterize and monitor the rapidly changing landscape. To meet this need, the USGS RMGSC is currently using available high-resolution DigitalGlobe QuickBird II imagery (collected in August 2007) to develop classification systems that combine both pixel-based and object-oriented methodologies and that will be able to produce a fine-scale landcover inventory covering eastern Grand County (figs. 3, 4). Other sources of remote sensing imagery (such as ASTER and Landsat), derived landcover products, and geospatial data will also be used in this project. This product will support a host of fire science activities, including fire behavior studies and risk modeling, and is being used to produce updated 1:24,000-scale USGS topographic maps of eastern and central Grand County (fig. 5).

Figure 5. Topographic map of the Three Lakes area showing expanded WUI/community and dead coniferous vegetation at 5-m resolution, based on a recent topographic map (1:24,000) updated from a previous 1950s version

The USGS RMGSC is also currently evaluating the utility of the Civil Air Patrol's Airborne Real-time Cueing Hyperspectral Enhanced Reconnaissance sensor (CAP ARCHER) for forest assessment and environmental monitoring applications within Grand County. The CAP ARCHER imagery was acquired for an area of interest within the Three Lakes WUI in August 2007. The ARCHER system boasts 1-meter spatial resolution across 52 spectral bands spanning the visible green to near infrared spectrum. Preliminary classification results indicate that ARCHER may facilitate fine-scale delineation of deceased pine at multiple stages of beetle attack and foliar senescence (that is, red and gray stages); it may also enable the detection of insect-stressed vegetation (figs. 6, 7). The ARCHER sensor may prove to be a new tool for tree-level landcover mapping and fire fuels analysis and may contribute to the scientific understanding of forest structure and health.

The USGS RMGSC is using remote sensing imagery and other geospatial information to develop products to support fire science efforts in Grand County, Colo. The best available information, including medium- and high-resolution imagery and geospatial data, is being used to evaluate landscape change and related potential wildfire effects on the Three Lakes WUI and associated watersheds. The spatial and temporal aspects of hazards and the potential for interaction among hazards are also being evaluated by USGS scientists in other disciplines, who will use RMGSC's results to evaluate the effects of tree mortality and potential wildfires on several critical processes and ecosystem services: water quality and quantity, aquatic habitat and native fish populations, erosion and debris flow potential, and social and economic values.

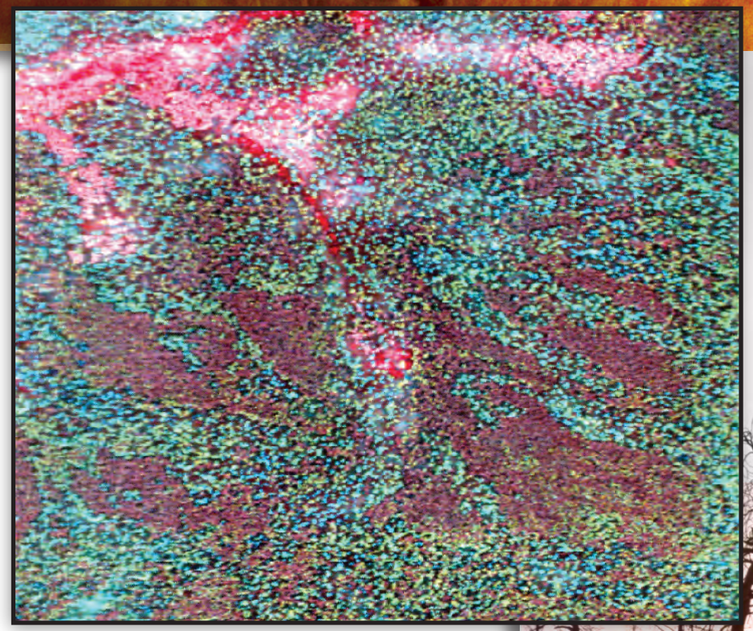

Figure 6. CAP ARCHER high-resolution hyperspectral image, 1-meter resolution.

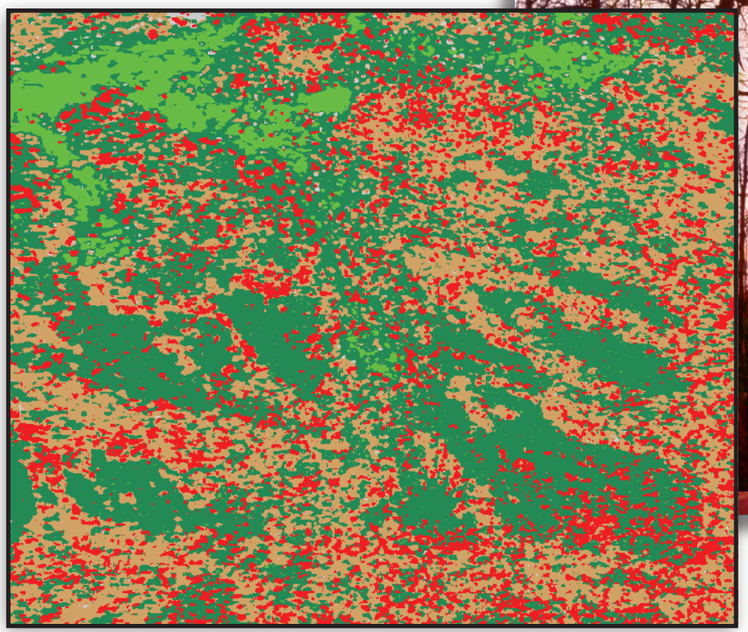

Figure 7. Preliminary generalized classification delineating multi-stage conifer mortality; from CAP ARCHER imagery.

Photograph by Craig Brunsden

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