

Fusing optical and radar data to estimate sagebrush, herbaceous, and bare ground cover in Yellowstone

(Accepted on 30 September 2009 by Remote Sensing of Environment)

SHENGLI HUANG*†, CHRISTOPHER POTTER*, ROBERT L. CRABTREE†‡,
STACEY HAGER‡, PEGGY GROSS §

*NASA Ames Research Center Mail Stop 242-4, Moffett Field, CA 94035 USA

†Yellowstone Ecological Research Center, 2048 Analysis Drive, Suite B, Bozeman, MT
59718, USA

‡ HyPerspectives Inc., 2048 Analysis Drive, Suite C, Bozeman, MT 59718, USA

§ California State University, Monterey Bay, 100 Campus Center, Seaside, CA 93955,
USA

*Corresponding author. Email: huang@yellowstoneresearch.org Tel: 001-406-5561414

Abstract

The arid and semi-arid sagebrush-grass ecosystem occupies a substantial portion of rangelands in the western United States. Using remote sensing techniques to map the percent of sagebrush, grass/forb, and bare ground components is necessary for forage production estimation and natural resource management over large areas. However optical data have significant deficiencies in these ecosystems because of exposed bright soil, spectrally-indeterminate vegetation, and a large dead vegetation component. Radar data also have deficiencies caused by factors such as antenna pattern calibration, local incidence angle (LIA), soil moisture, and surface roughness. With the complementary

vegetation information gained from optical data and radar data, these two datasets were fused to estimate 10-m sagebrush, grass, and bare ground percent cover in the non-forested areas of Yellowstone National Park, which is a representative native western rangeland ecosystem of the US. The datasets were processed to resolve the issues of antenna pattern calibration and LIA effect. Peak green Landsat, late fall Airborne Visible and Infrared Imaging Spectrometer (AVIRIS), and Airborne Synthetic Aperture Radar (AirSAR) data were fused in this analysis. AVIRIS, Landsat, AirSAR and elevation data were used to segment the study area into two main subcategories of “pure grass” and “mixed sagebrush and grass”. Landsat Tasseled Cap Greenness (LTCG) was used to retrieve bare land and grass percentages in pure grass areas. In the areas with mixed grass and sagebrush, standardized LTCG and radar C_{vv} were used to derive the vegetation cover percentage, and the ratio of standardized LTCG and radar L_{hv} was further used to calculate the relative abundance of sagebrush and grass. Comparison between the field and remote sensing estimations shows the correlation coefficients were 0.838, 0.746, and 0.830 for bare land, grass, and sagebrush, respectively. When grouped into three discrete categories of “low”, “medium”, and “high”, the overall accuracies were 79.4%, 75.9%, and 77.6%, respectively. Our study shows the potential for application of global spaceborne C- and L-band radar and optical data fusion for large-area rangeland monitoring.

Key words: sagebrush, percentage cover, remote sensing, SAR, data fusion, Yellowstone