# Mapping Desert Grassland Community Type with EOS MISR Multi-angle Data and SVM algorithms

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**Goal**: To improve estimates of above- and belowground C pools in desert grasslands by providing more accurate maps of plant community type, canopy structural parameters, and soil/shrub/grass cover. The ability to model biogeochemical processes depends on knowledge of cover and community type, as well as other parameters. Moderate resolution Earth Observation is the only technology which provides a means to regularly map changes in community type and structure over large areas. Here we evaluate applicability of Multi-angle Imaging Spectro-Radiometer (MISR) data and surface anisotropy patterns derived from kernel-driven and MRPV BRDF models in classification and review the accuracy improvement with SVM algorithms.

**Study Area and Date**: In the Chihuahuan semi-desert province, the intensive study sites are the Jornada Experimental Range in southern New Mexico near Las Cruces and Sevilleta National Wildlife Refuge in central New Mexico south of Albuquerque, NM. Date from May 24 to June 3, 2002. This period is the end of the dry season. All shrubs are leafed out but grasses and some other small plants are dormant.

**Data**: The 3 MISR products were used in the experiments. They are (1) the MISR level 1B2 MI1B2T terrain-corrected product, (2) the MISR Level 1B2 MI1B2GEOP Geometric parameters product, and (3) the MISR Level 2 MIL2ASAE aerosol product.

**Method**: Maximum likelihood classification (MLC) and support vector machine (SVM) classification algorithms were used to perform several classification experiments. The area covered by the Jornada and Sevilleta vegetation maps is around 1492.4 square kilometers (23,978 pixels at 250 meter spatial resolution). We used 15 classes for these classification experiments, where there are 5 classes from the Jornada and 11 classes from the Sevilleta.

**Results**: The results of the experiments are shown in the following tables and figures. When only spectral data were used the overall accuracies were 45% and 64% for the MLC and SVM methods, respectively; much lower.

**Table 1 Error matrix of the maximum likelihood classification**

| Classes | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Sum | User |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 126 | 15 | 1 | 81 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 224 | 56.2 |
| 2 | 7 | 213 | 15 | 397 | 26 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 659 | 32.3 |
| 3 | 3 | 22 | 533 | 224 | 206 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 988 | 53.9 |
| 4 | 1 | 30 | 6 | 4863 | 388 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5288 | 92.0 |
| 5 | 4 | 15 | 32 | 217 | 1703 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 1976 | 86.2 |
| 6 | 0 | 0 | 0 | 0 | 0 | 541 | 196 | 27 | 199 | 10 | 0 | 36 | 28 | 0 | 1 | 1038 | 52.1 |
| 7 | 0 | 0 | 0 | 0 | 0 | 116 | 2369 | 88 | 412 | 50 | 2 | 158 | 34 | 0 | 2 | 3231 | 73.3 |
| 8 | 0 | 0 | 0 | 0 | 0 | 17 | 58 | 1653 | 429 | 199 | 26 | 3 | 3 | 0 | 0 | 2388 | 69.2 |
| 9 | 0 | 0 | 0 | 0 | 1 | 74 | 243 | 161 | 1791 | 116 | 26 | 30 | 304 | 0 | 3 | 2749 | 65.2 |
| 10 | 0 | 0 | 0 | 0 | 0 | 2 | 21 | 164 | 138 | 872 | 77 | 5 | 74 | 0 | 0 | 1353 | 64.4 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 55 | 93 | 309 | 1 | 205 | 0 | 0 | 670 | 46.1 |
| 12 | 1 | 0 | 1 | 1 | 7 | 63 | 387 | 16 | 67 | 10 | 1 | 732 | 54 | 0 | 8 | 1348 | 54.3 |
| 13 | 0 | 0 | 0 | 26 | 4 | 2 | 16 | 1 | 27 | 16 | 10 | 7 | 887 | 60 | 2 | 1958 | 83.8 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 3 | 0 | 143 | 436 | 0 | 583 | 74.8 |
| 15 | 0 | 0 | 0 | 0 | 2 | 4 | 28 | 1 | 18 | 5 | 1 | 25 | 10 | 0 | 128 | 222 | 57.7 |
| Sum | 142 | 295 | 588 | 5809 | 2338 | 819 | 3321 | 2117 | 3137 | 1371 | 455 | 997 | 1746 | 496 | 144 | | |
| Producer | 88.7 | 72.2 | 90.6 | 83.7 | 72.8 | 66.1 | 71.3 | 78.1 | 57.1 | 63.6 | 67.9 | 73.4 | 50.8 | 87.9 | 88.9 | | 72.2 |

**Table 2 Error matrix of the support vector machine classification**

| Classes | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | Sum | User |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 88 | 5 | 1 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 112 | 78.6 |
| 2 | 6 | 121 | 11 | 32 | 8 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 179 | 67.6 |
| 3 | 5 | 22 | 388 | 70 | 79 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 564 | 68.8 |
| 4 | 40 | 124 | 87 | 5567 | 255 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 6074 | 91.7 |
| 5 | 3 | 20 | 100 | 118 | 1981 | 0 | 2 | 0 | 1 | 0 | 1 | 2 | 2 | 0 | 0 | 2230 | 88.8 |
| 6 | 0 | 0 | 0 | 0 | 0 | 446 | 60 | 8 | 82 | 3 | 0 | 20 | 5 | 0 | 0 | 624 | 71.5 |
| 7 | 0 | 1 | 0 | 0 | 6 | 185 | 2764 | 80 | 474 | 53 | 1 | 271 | 29 | 0 | 6 | 3870 | 71.4 |
| 8 | 0 | 1 | 0 | 0 | 2 | 16 | 21 | 1629 | 224 | 153 | 4 | 7 | 4 | 0 | 1 | 2062 | 79.0 |
| 9 | 0 | 0 | 0 | 0 | 3 | 111 | 246 | 237 | 2163 | 107 | 31 | 40 | 113 | 0 | 8 | 3059 | 70.7 |
| 10 | 0 | 1 | 0 | 3 | 0 | 3 | 25 | 150 | 47 | 935 | 86 | 8 | 20 | 0 | 5 | 1283 | 72.9 |
| 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 69 | 266 | 0 | 30 | 0 | 0 | 371 | 71.7 |
| 12 | 0 | 0 | 0 | 0 | 2 | 45 | 171 | 6 | 34 | 5 | 0 | 628 | 15 | 0 | 22 | 928 | 67.7 |
| 13 | 0 | 0 | 1 | 1 | 1 | 10 | 23 | 5 | 105 | 44 | 66 | 11 | 1455 | 81 | 13 | 1816 | 80.1 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 71 | 415 | 1 | 487 | 85.2 |
| 15 | 0 | 0 | 0 | 0 | 1 | 3 | 9 | 1 | 1 | 2 | 0 | 9 | 2 | 0 | 88 | 116 | 75.9 |
| Sum | 142 | 295 | 588 | 5809 | 2338 | 819 | 3321 | 2117 | 3137 | 1371 | 455 | 997 | 1746 | 496 | 144 | | |
| Producer | 62.0 | 41.0 | 66.0 | 95.8 | 84.7 | 54.5 | 83.2 | 76.9 | 69.0 | 68.2 | 58.5 | 63.0 | 83.3 | 83.7 | 61.1 | | 79.6 |

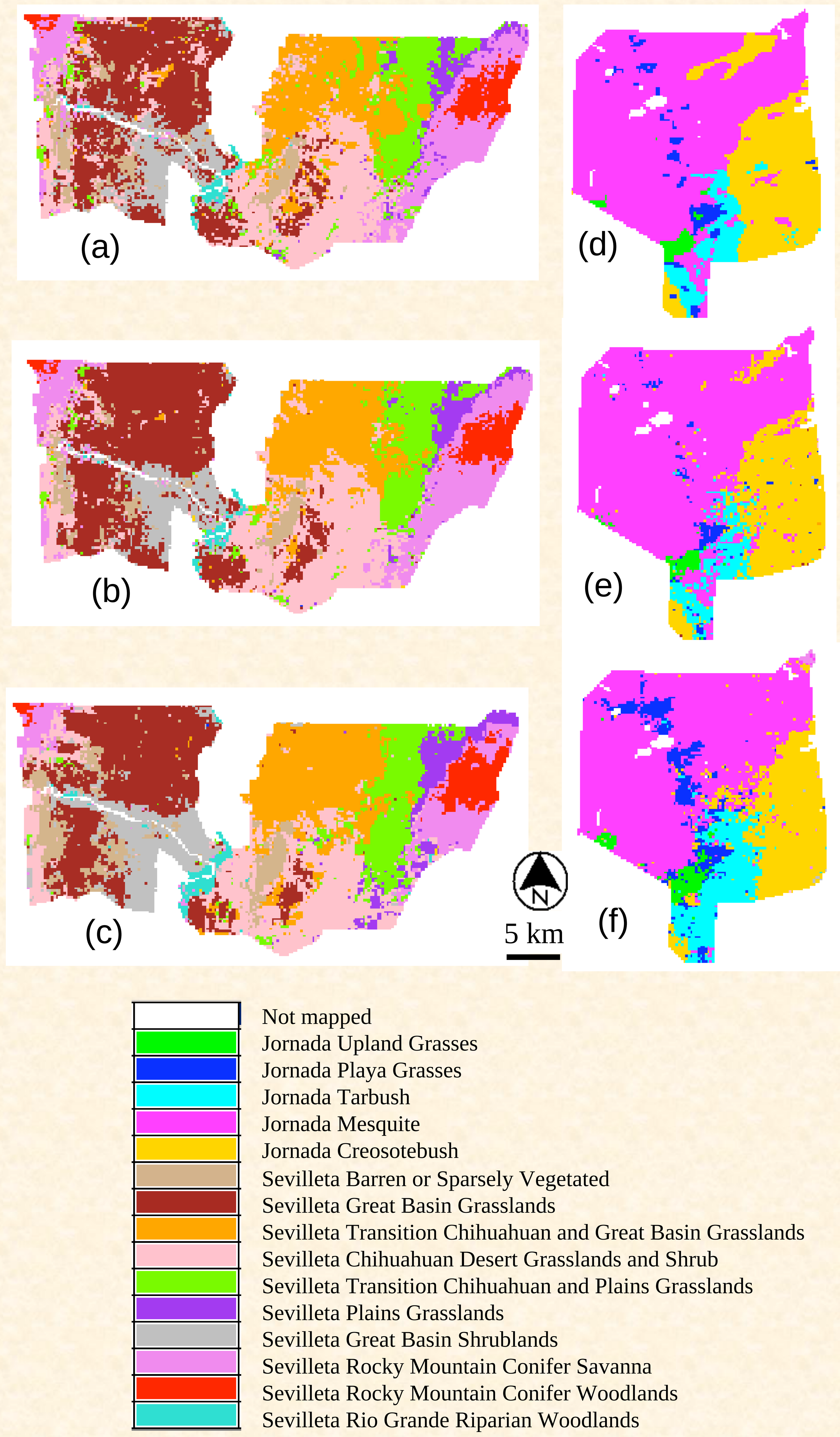


**Figure 1.** Community Type Maps for:

| the Sevilleta National Wildlife Refuge | the Jornada Experimental Range |
|---|---|
| (a) 1998 LTER Vegetation Map | (d) 1998 LTER Vegetation Map |
| (b) Support Vector Machine method | (e) Support Vector Machine method. |
| (c) Maximum likelihood method. | (f) Maximum likelihood method |

**Conclusions:** This research shows that **multi-angular observations, surface anisotropy patterns and SVM algorithms can provide much improved semi-arid vegetation type differentiation**:

1) Important additional information is provided by the *ρ0*, *k*, *b* parameters of the MRPV model and the *iso*, *vol* and *geo* parameters of the RossThin-LiSparseMODIS model in the red and NIR bands; and

2) SVM algorithms improve semi-arid vegetation type mapping substantially when used in conjunction with multi-angle data and derived products.

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