Objective 7: Human Activity on Suspended Dust and PM$_{10}$ Emissions

Title: Use of Landsat data to distinguish soil covers on erodible dryland soils

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Objectives
1. Create data sets that are coincident with the L1 soils (Aridisols) and Path 44, Row 27 of Landsat such that sequences of at least three years are available.
2. Determine the cropping cycle at specific sample locations using Landsat data.
3. Determine the quality of soil cover during the summer fallow part of the cropping cycle.

Recent Accomplishments
In previous work we were able to show that bare soil + summer fallow decreased from 40 % to 27 % and small grains increased from 28 % to 43 % between 1988 and 2002 (Table 1). However, Figure 1 shows that the study also included L2 soils, which are primarily Mollisols. They are still in an Aridic moisture regime, but have greater rooting depth, and over the centuries, have supported more plant cover. This proposal is to separate the L1 soils for independent study and to add more dates to determine if alternating summer fallow was being used, and if so, were the soils covered or bare.

Table 1. Classification summary.

<table>
<thead>
<tr>
<th>Land Cover</th>
<th>1988 (ac)</th>
<th>1988 (%)</th>
<th>2002 (ac)</th>
<th>2002 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grassland</td>
<td>287,171</td>
<td>23</td>
<td>331,926</td>
<td>25</td>
</tr>
<tr>
<td>Bare soil/Summer Fallow</td>
<td>488,016</td>
<td>40</td>
<td>355,068</td>
<td>27</td>
</tr>
<tr>
<td>Small grain</td>
<td>349,144</td>
<td>28</td>
<td>571,189</td>
<td>43</td>
</tr>
<tr>
<td>Green crop</td>
<td>108,656</td>
<td>9</td>
<td>69,309</td>
<td>5</td>
</tr>
</tbody>
</table>

Also from our previous work, Figure 2 is to show that we think Landsat has enough spectral separation capability to delineate the categories of cover to answer the proposed questions. We were able to separate green crops, small grains, Club wheat, permanent grassland, bare soil, and summer fallow that was not completely bare. This proposal will address the question of tracking, over a period of years, the cycling of crops with summer fallow on the L1 soils.
Figure 1. Study area showing coverage by Landsat Path 44, Row 27 that is coincident with L1 and L2 soils.
Figure 2. Scatterplot of pixels based on six wavelength bands of reflectance values available from the ETM+ sensor onboard Landsat 7.

**Planned Research**

Wind erosion of agricultural soils is an important contributing factor to the decline of air quality in the Inland Northwest and many other parts of the world. The problem is especially acute in semiarid cropping areas where soil must be fallowed for a season to accumulate enough moisture to grow the next crop. Currently, crop management practices are being researched that strive to provide profitability and keep cover on the soil for longer periods of time, thus decreasing the amount of soil available to be entrained in the wind. Success of these studies will mean adoption of new farming methods and will be measured in decreased particulate in the air during wind storms, profitable farming operations, and increases in the amount of cover left on soil. Remote sensing can contribute to our knowledge about how the amount of soil cover is changing over time.
Our particular interest now is to determine how soil cover has changed over the last 15 years on the highly erodible L1 soils and can that be quantified. The L1 soils are described by Boling et al. (1998) as dry, coarse-silty loessial soils formed under shrub-steppe vegetation and having lime at a depth of 24-40 inches. They are in an Aridic moisture regime and are primarily classed as Aridisols. All crop production on these soils depends upon moisture stored during the winter season. The Aridic moisture regime has no period of as many as 90 days when water is otherwise available for plant growth. There is no effective precipitation during the warm part of the growing season. The classical farming technique on these soils has been to plant a crop of winter wheat every other year, so that the alternate year could be used to collect more moisture. The soil during the interim year was protected from evapotranspiration by creating a dust mulch maintained in a weed-free condition by cultivation. However, the soil during the interim year was left unprotected from the wind unless residue from the previous crop was sufficient to keep the soil covered or the surface roughened. There are practices available to accomplish this, the question is to what extent are they being used on the L1 soils.

The last 15 years includes data collection by two satellites that have potential application to this problem. They are Landsat 5 with the TM sensor and Landsat 7 with the ETM+ sensor. Both have nominal 30 m resolution on the ground. The issue here is to recognize spectra of bare soil, dead plant residue, soil that is roughened by dead plant residue, and green plants. Fields that are in traditional summer fallow at the time of imaging will present bare soil spectra. Fields in current crop will be green to bright yellow depending on phenology and fields with trashy fallow will present a combination of the bare soil spectra and dead plant spectra, and shadows. CRP fields will have combinations of green and brown plant material and bare soil in some areas.

The soils of concern are the L1 units from the State General Soil Map (Boling et al., 1998) as shown in Figure 1. The three blocks that are partly within Adams County will be examined over as many sequential years as possible to determine how cropping cycles have been conducted. Landsat images will be purchased as available during the summer growing season. Ideally, mid-July images will be used. Suitable images are available or are already in our data base for 1987, 1988, and 1989. Also available is the sequence from 1999 to 2003, and possibly 2004. Apparently separable categories will be determined in the image data as was done for Figure 2. Ground verification data is available from previous studies and will be collected from a 2004 image if one becomes available. All images will be georegistered and corrected for atmosphere contamination. Results will be reported in tabular form as well as classified image maps.

References