Relationship Between Soil Spectral Properties and Sand, Silt and Clay Content of the Soils on the University of Arizona Maricopa Agricultural Center

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INTRODUCTION

The spectral reflectance properties of 552 Ap surface horizon soil samples collected from the MAC farm were measured using a Barnes Modular-Multiband Radiometer. All samples were passed through a 2mm sieve, mixed, and uniformly placed in 50 x 50 cm black trays. The data were collected on cloudless days, the sun Zenith angle was between 29 and 43 degrees, and ten readings per sample were taken and averaged. Reflectances were made with both dry and wet soil conditions.

RESULTS

Table 1 presents the % reflectance mean and standard deviation for all samples in each band, and correlates it to the sand, silt, and clay percentages. The correlation coefficients were negatively correlated to silt and clay and positively correlated to sand, with the highest correlations being between the .63 -.69 (red) and .76-.90 (near infrared) bands.

Step-wise multiple linear regression equations were computed (95% C.I.) relating the three soil separates to % reflectance in each band, and they are presented in Table 2. Three of the seven bands were significant for dry conditions (.76-.90, .45-.52, and 1.15-1.30) and two bands for wet conditions; however, the two significant bands were different for the sand, silt, and clay separates. The following were significant: sand .63-.69 and .52-.60; silt -.45-.52 and .76-
.90, and clay -.52-.60 and .63-.69. A correlation matrix to show the co-variance among the seven bands is presented in Table 3.

**SUMMARY**

The sand, silt, and clay content of MAC Farm soils are related to soil reflectance; however, reflectance may also be related to other soil characteristics. Other researchers have shown organic matter, iron, calcium carbonate content, and soil color to be correlated to reflectance. Additional research is being completed to investigate these relationships, and results of these studies will be presented in future papers.
Table 1. Percent reflectance mean and standard deviation and its linear relationship to sand, silt, and clay.

<table>
<thead>
<tr>
<th>Band (um)</th>
<th>% Reflectance</th>
<th>Linear Correlation (r)</th>
<th>Sand</th>
<th>Silt</th>
<th>Clay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry</td>
<td>Wet</td>
<td>Dry</td>
<td>Wet</td>
<td>Dry</td>
</tr>
<tr>
<td>.45 - .52 (blue)</td>
<td>12.7(1.8)</td>
<td>5.0(1.2)</td>
<td>.16</td>
<td>.63</td>
<td>.11</td>
</tr>
<tr>
<td>.52 - .60 (green)</td>
<td>18.0(2.5)</td>
<td>8.2(2.2)</td>
<td>.31</td>
<td>.67</td>
<td>.25</td>
</tr>
<tr>
<td>.63 - .69 (red)</td>
<td>25.3(3.4)</td>
<td>12.9(3.5)</td>
<td>.45</td>
<td>.69</td>
<td>.38</td>
</tr>
<tr>
<td>.76 - .90 (NIR)</td>
<td>31.0(3.9)</td>
<td>17.4(4.4)</td>
<td>.46</td>
<td>.69</td>
<td>.40</td>
</tr>
<tr>
<td>1.15 - 1.30 (NIR)</td>
<td>38.5(4.1)</td>
<td>22.9(5.0)</td>
<td>.41</td>
<td>.66</td>
<td>.36</td>
</tr>
<tr>
<td>1.55 - 1.75 (MIR)</td>
<td>39.8(4.3)</td>
<td>21.7(4.6)</td>
<td>.43</td>
<td>.62</td>
<td>.37</td>
</tr>
<tr>
<td>2.08 - 2.35 (MIR)</td>
<td>36.2(4.1)</td>
<td>15.1(3.4)</td>
<td>.43</td>
<td>.58</td>
<td>.37</td>
</tr>
</tbody>
</table>
Table 2. Multiple linear regression equations relating sand, silt, and clay to % reflectance in the various band wavelengths.

**Dry Conditions:**

\[
\begin{align*}
\% \text{ Sand} &= 12.98 + 675.31 \cdot (\% \text{ Refl} .76-.90) - 731.92 \cdot (\% \text{ Refl} .45-.52) \\
& \quad - 206.91 \cdot (\% \text{ Refl} 1.15-1.30) \\
R^2 &= .46 \quad F = 155
\end{align*}
\]

\[
\begin{align*}
\% \text{ Silt} &= 40.73 - 295.79 \cdot (\% \text{ Refl} .76-.90) + 368.16 \cdot (\% \text{ Refl} .45-.52) \\
& \quad + 74.48 \cdot (\% \text{ Refl} 1.15-1.30) \\
R^2 &= .40 \quad F = 124
\end{align*}
\]

\[
\begin{align*}
\% \text{ Clay} &= 46.29 - 379.52 \cdot (\% \text{ Refl} .76-.90) + 363.76 \cdot (\% \text{ Refl} .45-.52) \\
& \quad + 132.44 \cdot (\% \text{ Refl} 1.15-1.30) \\
R^2 &= .45 \quad F = 147
\end{align*}
\]

**Wet Conditions:**

\[
\begin{align*}
\% \text{ Sand} &= 8.33 + 1081.29 \cdot (\% \text{ Refl} .63-.69) - 1209.40 \cdot (\% \text{ Refl} .52-.60) \\
R^2 &= .50 \quad F = 270
\end{align*}
\]

\[
\begin{align*}
\% \text{ Silt} &= 48.30 + 421.53 \cdot (\% \text{ Refl} .45-.52) - 256.38 \cdot (\% \text{ Refl} .76-.90) \\
R^2 &= .44 \quad F = 215
\end{align*}
\]

\[
\begin{align*}
\% \text{ Clay} &= 48.46 + 574.22 \cdot (\% \text{ Refl} .52-.60) - 536.12 \cdot (\% \text{ Refl} .63-.69) \\
R^2 &= .47 \quad F = 242
\end{align*}
\]
Table 3. Correlation matrix to show the relationship among the seven spectral bands of MAC Farm soils.

<table>
<thead>
<tr>
<th></th>
<th>0.45-0.52</th>
<th>0.52-0.60</th>
<th>0.63-0.69</th>
<th>0.76-0.90</th>
<th>1.15-1.30</th>
<th>1.55-1.75</th>
<th>2.08-2.35</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRY</td>
<td>1.00</td>
<td>0.97</td>
<td>0.89</td>
<td>0.87</td>
<td>0.87</td>
<td>0.85</td>
<td>0.83</td>
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<tr>
<td>WET</td>
<td>1.00</td>
<td>0.99</td>
<td>0.97</td>
<td>0.96</td>
<td>0.95</td>
<td>0.93</td>
<td>0.92</td>
</tr>
<tr>
<td>DRY</td>
<td>1.00</td>
<td>1.00</td>
<td>0.99</td>
<td>0.99</td>
<td>0.97</td>
<td>0.96</td>
<td>0.95</td>
</tr>
<tr>
<td>WET</td>
<td>1.00</td>
<td>1.00</td>
<td>0.98</td>
<td>0.96</td>
<td>0.97</td>
<td>0.88</td>
<td>0.97</td>
</tr>
<tr>
<td>DRY</td>
<td>1.00</td>
<td>1.00</td>
<td>0.98</td>
<td>0.96</td>
<td>0.97</td>
<td>0.88</td>
<td>0.97</td>
</tr>
<tr>
<td>WET</td>
<td>1.00</td>
<td>1.00</td>
<td>0.99</td>
<td>0.97</td>
<td>0.99</td>
<td>0.97</td>
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