NEWS ON "IRRIGATING THE SOIL TO MAXIMIZE THE CROP – AN APPROACH FOR WHEAT TO EFFICIENT AND ENVIRONMENTALLY SUSTAINABLE IRRIGATION WATER MANAGEMENT IN KENTUCKY"

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BACKGROUND

Crop irrigation has become a serious consideration of many farmers in Kentucky to avoid the consequences of dry weather during the growing season such as in the year 2012. For economical and for environmental reasons, functional soil properties and their spatial variability in farmers' fields need to be known as good as possible for better managing the timing and the amount of irrigation. The objectives of this project are to identify a way to derive field-scale soil hydraulic properties and their variability in combination of remote sensing and soil measurements, to implement this information in a computer-based management system, and to scale-up the information from the point and field scale to the watershed and regional scale. The expected results are a better site-specific knowledge of soil hydraulic properties to irrigate according to the local soil conditions and plant needs, and a computer-based system that supports soil and crop water management.

THE PURPOSE of this project is to develop a strategy for deriving a map of functional soil water characteristics based on easily obtainable land surface observations. **THE OBJECTIVES** are

- to derive a field-scale characterization of soil hydraulic properties for better irrigation management,
- to implement this information and sporadic soil and crop measurements into a computer model for describing the annual water status in different zones across the field while taking into account crop growth, and
- to evaluate different sources of land surface remotely sensed information as a basis for upscaling detailed information and knowledge to improve irrigation management at a regional scale.

Summary of Results obtained in Year 2:

- Reducing the sampling density from 1 sample per acre to 1 sample per 5 acres did not substantially reduced the information and precision of the clay content map as long as VERIS EC measurements were included in the mapping.
- A wireless accessible network of soil moisture sensors was installed across the field at 46 nodes with sensors at three soil depths at each node. Soil water potential data can be downloaded and are available on an hourly basis.
- Spatial differences in soil hydraulic properties cause different infiltrability for natural rainfall and irrigation water. In clayey zones, the soil permeability is not large enough and irrigating with 7/10 of an inch rate causes surface runoff.
- Currently, our recommendation is to irrigate clayey zones at a lower rate and more frequently to achieve water infiltrating into and wet the soil profile.

The experiments in this project are conducted at Hillview Farms in Princeton, KY with the farmer Trevor Gilkey. Investigations are conducted in the Hargis Field, which is classified as different types of silt loam soils by NRCS. Despite this classification, we also identified a substantial area to fall under silty clay loam. In fall 2015, wheat was planted in this field, which is now followed by double-crop soybeans. The field is under pivot irrigation which covers an area of approximately 80 acres.

In this project, one graduate student, Javier Reyes, works on soil mapping, soil moisture, remote sensing and crop state variables. A second graduate student, Xi Zhang joined the team and he is working on soil hydraulic processes and computer simulation of soil water transport.

The intensive grid sampling (96 locations, 5 depths each with 8" layer thickness), complemented by Veris 3100 EC measurements resulted in the clay content map shown in Figure 1. For the upper map, each sampling point represents an area of approximately 0.5 acre. Such an intensive sampling is justified for research purposes but is not affordable for a routine survey of many fields in the same or different farms. In a scenario calculation, we reduced the density of soil sampling points to 1 point per 5 acres. The resulting map in the bottom part of Figure 1 which is supported by the existing set of Veris EC measurements does not reveal any information loss. This results is very promising as the density of 1 point per 5 acres is realistic under practical farm conditions.

Notice the two red dots in the North-Western and the South-Eastern parts of the field, the first point representing a location with high clay contents (silty clay loam) and with the second representing the more typical silty part of the field.

In Figure 2, satellite (source: Landsat) maps of NDVI during different growing stages of the winter wheat are shown. The rectangle area in the bottom of the map represents a zone in which the wheat did not receive any nitrogen fertilizer and was sprayed later before tobacco was planted in this area. NDVI well captures this development over time. Also, a lower vigor of what is visible in the western part of the field from April on where the soil is clayey, and the growing conditions and the wheat stand are by far not as good and dense as for example in the eastern parts of the field where the soil is silty, deeper, and has a higher level of plant available water capacity.

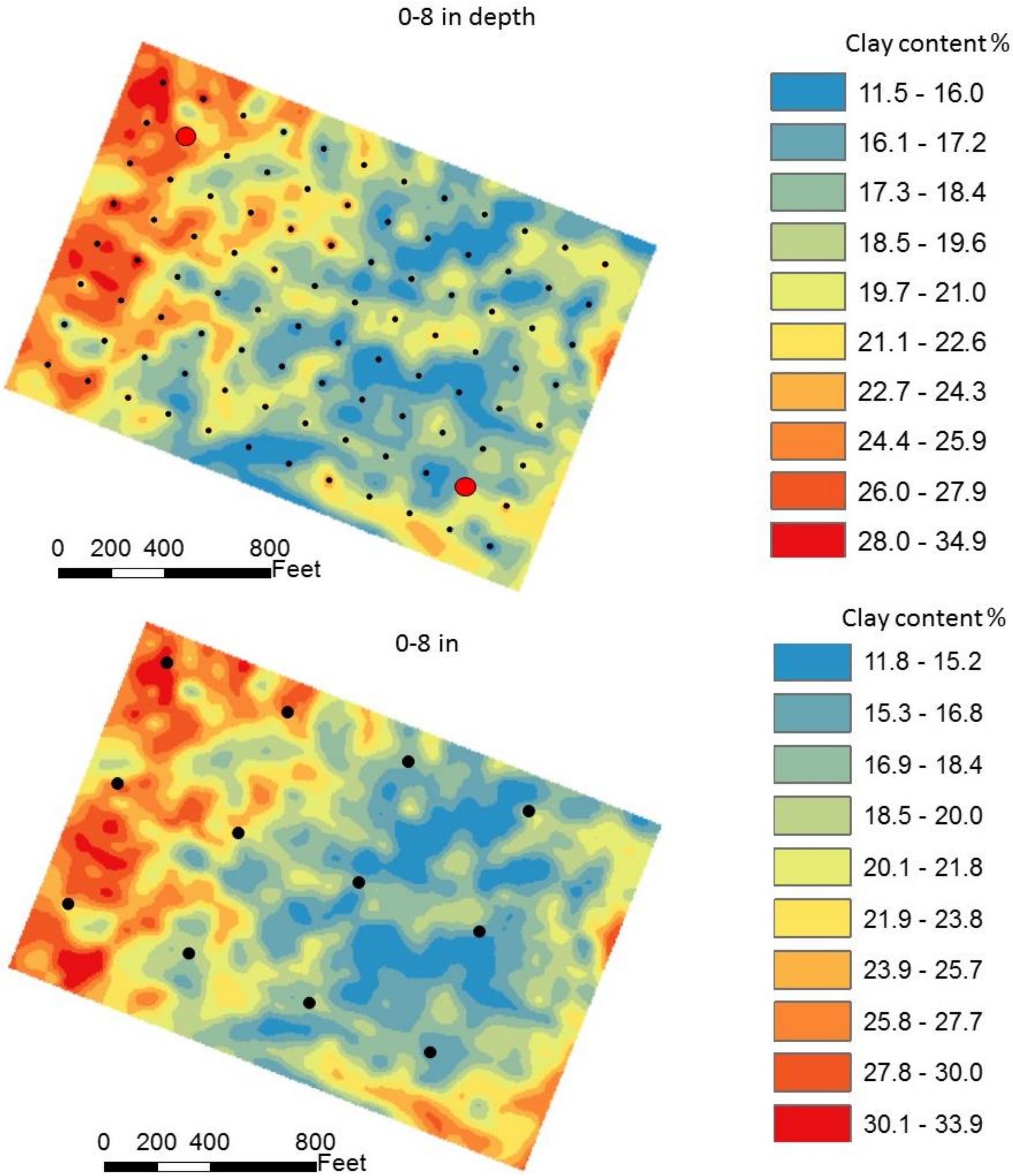

Fig. 1. Soil clay content maps for the Hargis field, computed based on clay content and VERIS EC measurements. Top: Clay content point density is 2 points per acre. Bottom: Clay content point density is 1 point per 5 acres.

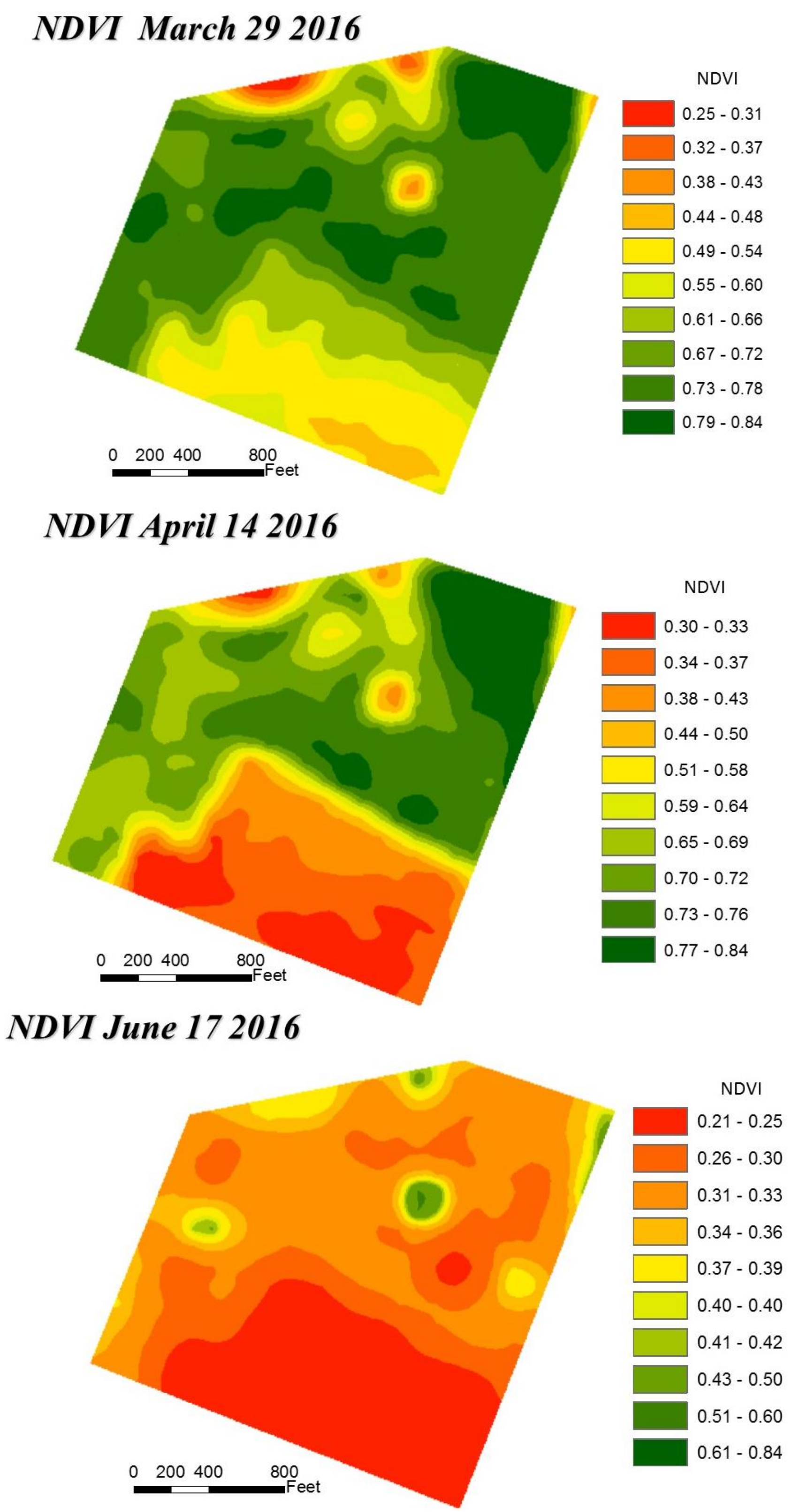

Figure 2. Landsat images of NDVI, downloaded for a resolution of 90 by 90 ft. NDVI. The rectangle in the bottom is an area where wheat was killed and tobacco planted. Satellite NDVI captures the zones of crop vigor.

In this year, for the first time, a wireless network of soil moisture sensors (water marks) was installed in the field at 46 locations. At each location, one water mark sensor is installed at 8, 16, and 24” depth. After installations and initial troubleshooting, hourly sensor data can now be downloaded from the internet. We want to show here two examples of our initial results obtained in this year’s winter wheat. The upper part of Figure 3 represents the silty clay loam in the western part of the field (Fig. 1). The clayey soil in this zone dries out much faster and to a larger extent than the silty soil in the bottom part of Figure 3. Other results have shown that water infiltrates much harder in the clayey soil than in the silt loam. This reduced infiltration goes along with surface runoff that is observed also by the farmer for both natural rainfall and irrigation above a certain intensity.

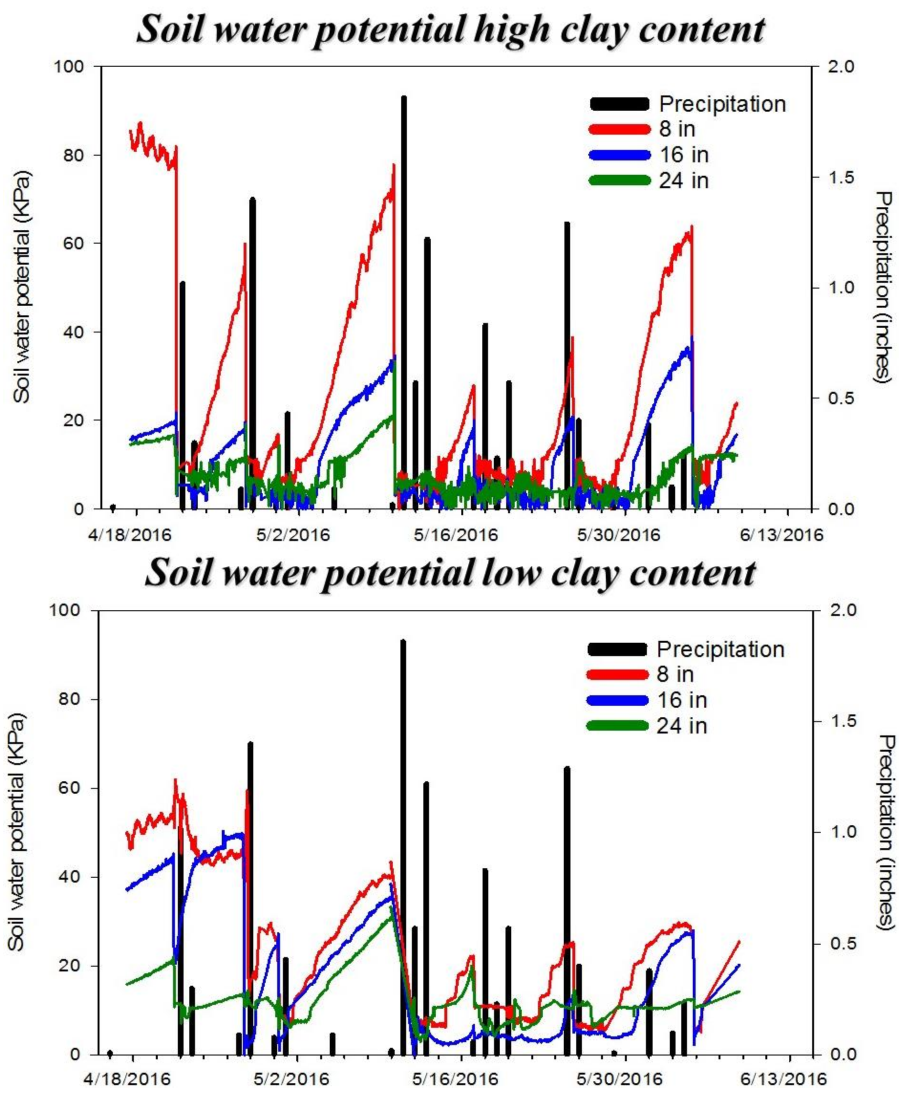

Figure 3. Time series of daily precipitation and soil water potential measured hourly at three different depths in the silty clay zone (upper part) and the silt loam zone (bottom part) of the field.

Finally, in Figure 4, we show two different snapshots of soil water potential distributions for a wet day (May 2, 2016) and a dry day (June 4, 2016). For better visualization of spatial differences, we use different scales for both maps. Notice, that the spatial differences are really very small for the May 2 map. All soil moisture potential values are above field capacity in this map. Under such circumstances, any spatial differences are compensated by subsurface lateral flow. We will continue to analyse situations like this with the topographic map. Under wet conditions, soil textural differences are not considerably reflected in the soil water potential map. On the other hand, the soil moisture conditions changed drastically during the following month with little rainfall and high crop water uptake. The bottom part of Figure 4 now well reflects the differences caused by higher and lower soil clay contents. Especially the western part of the field with high clay contents indicates severe drying. Please notice that such a map can be obtained for the field on an hourly basis.

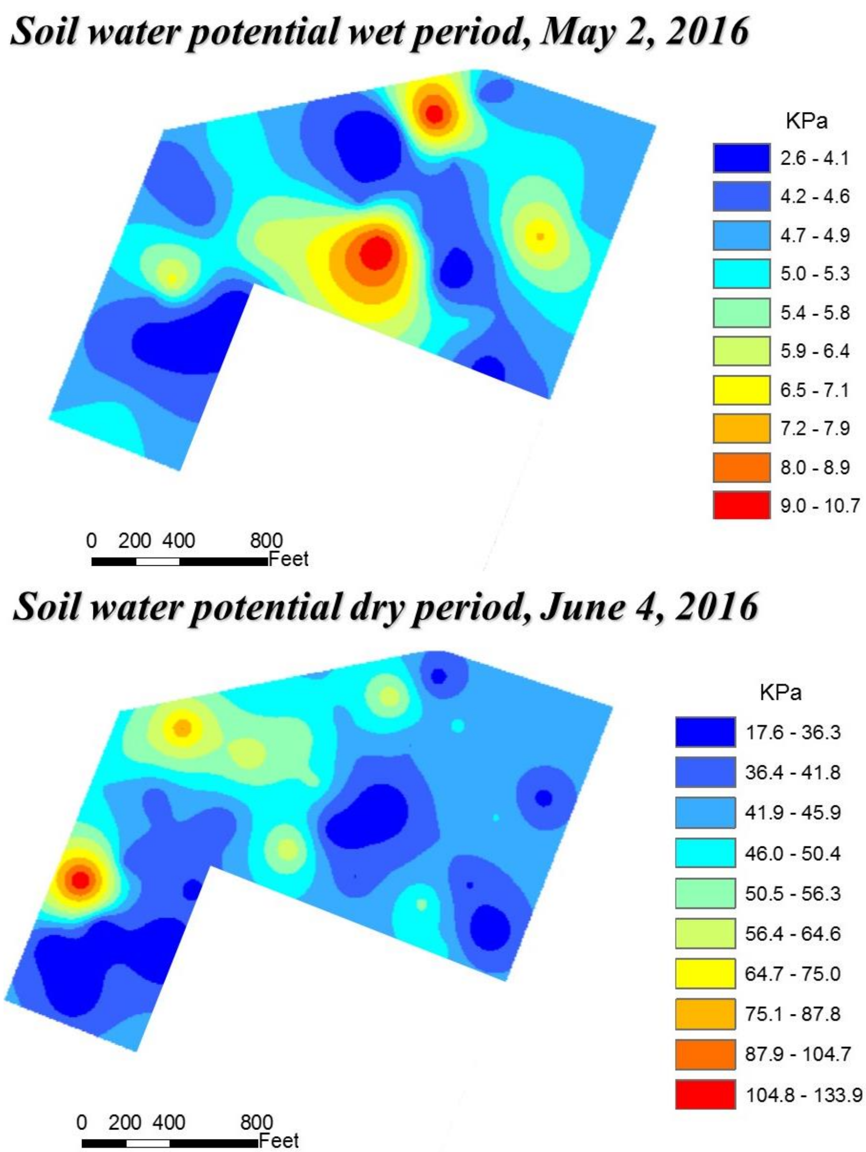

Figure 4. Soil water potential on May 2 (top part), and June 4, 2016 (bottom part). Notice the different scale of contour colors.

SUMMARY

In year 2 of the project, further progress was made towards continuous mapping of soil texture and moisture and understanding the hydrologic differences occurring in this field. Crop vigor is well reflected by satellite-based NDVI. Future analysis will include the topographic model. Computer simulations realistically reflect the occurrence of surface runoff in clayey zones in the field. For these zones, we recommend more frequent irrigation at substantially lower rates in order to get the water into the soil where it is needed and to avoid surface runoff.

ACKNOWLEDGEMENT

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