Remote Sensing of Equine Bermudagrass Pastures from a Helikite™

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Spatial Properties of Grasslands

Grasslands are inherently variable because of complex surface relief and spatial variability of parent materials and soils. As a result the grassland landscape may be dissected by patches of distinct or not so distinct plant associations of herbaceous, shrub, and tree species. Grasslands serve as an energy reservoir for herbivores ranging from bacteria to large mammals.

Grazing horses contribute to spatial complexity of the grassland landscape because of the spatial nature of grazing of the herd and individuals, diet-selection and diet-learning.

Spatial properties of grasslands also vary with time from transient effects, such as ambient temperature and rain showers to seasonal and long-term trends, such as global warming.

Humans impact spatial properties of grasslands by imposing management regimens such as the establishment and fertilization Of pasture, fencing and watering of paddocks, selection of horses, fixing the stocking rate, and imposing grazing systems.

It is difficult to describe, measure, and understand grassland ecology while earth-bound. Remote sensing of grasslands from aerial platform will surely increase our understanding of grasslands.

Objectives

To assess the condition of equine pastures from digital images taken from digital cameras carried aloft in a tethered balloon-kite.

Grazing system

Eleven adult Thoroughbred and Quarterhorses mares were used to graze 5 acres of cold-hardy Wrangler bermudagrass that was seeded in 2003.

The bermudagrass pasture was subdivided into 6 paddocks of 0.8 acres with electrified tapes with portable water service.

Grazing started on 29 May and ceased on 13 September 2006.

Horses grazed each paddock in rotation for one week,

Stocking rate: 2.2 mares per acre for 113 days.

Stocking density: 14 mares per acre for 7 days.

After horses were moved to the next paddock grazed paddock was mowed to 4 inches and worked with a spring tine harrow to disperse dung.

Ammonium nitrate was broadcast at 50 lb N /acre to all paddocks at the same time five times at monthly intervals.

Remote Sensing Instrumentation

A helium-filled balloon-kite Helikite™ was used to carry two Sony DSC-U30 digital cameras about 400 feet directly above the equine bermudagrass pastures.

One camera recorded normal RGB images and the other was modified to record near infra red (NIR) images The cameras recorded "JPEG" images (300 kb) images at 12 images per minute on an internal storage card.

(Sama and Stombaugh, 2005. Adaptation and modification of digital imaging systems for remote sensing. ASAE Paper 051016).

Data Processing

The six paddocks were set up with the aid of a Trimble AGS132™ GPS unit and 39 perimeter fence posts were geo-referenced. The raster calculator tool of ArcMap 9.0 was used to overlay RGB and NIR images and geo-referenced for each paddock. The tool was used to determine the red reflectance (RED) from the RGB data and NIR reflectance on each ≈ 5x5 inch area.

Normalized Difference Vegetative Indices (NDVI) were estimated from this relationship: NDVI= (NIR-RED)/(NIR +RED)

Fig. 1. Ground level RGB digital image shows hummocks and shadows that emphasize hummocks in Paddock 6, 28 days after last grazed and mowed.

This project is supported in part by a USDA CREES Special Grant "Animal Health and Grazing Systems" and is a contribution to The University of Kentucky Equine Initiative.

Fig. 2. Michael Sama and Luciano Baion of BAE launch the helium-filled Helikite.

Fig. 3. Two Sony DSC-U30 digital camera payload of the Helikite.

Fig. 4. Helikite moored 400' above bermudagrass paddocks on 10 August 2006. The eastern edge of which is outlined in red.

Fig. 5. RGB image of Paddock 1 at 09.30 on 10 August 2006, 22 days after second grazing ended on 19 July. Electric fence tape in east and south outlines Paddock 1. Dark band at top is a plank fence. Tree shadow is on right. Exposed soil in west was site of waterer. Power pole shadow is top center. Hummocks are accentuated by shade on their western side. Hummocks are smaller and more numerous (422 hummocks: 466 per acre) than in Paddock 6 (Fig. 8). Animal urination days: 154.

Fig. 6. NIR image of Paddock 1 on 09.30 on 10 August 2006. Paddock 1 had been grazed twice for 7 days starting 31 May and 12 July. Larger hummocks are accentuated by warmer canopy on the eastern edges and cooler (darker) herbage on western edges.

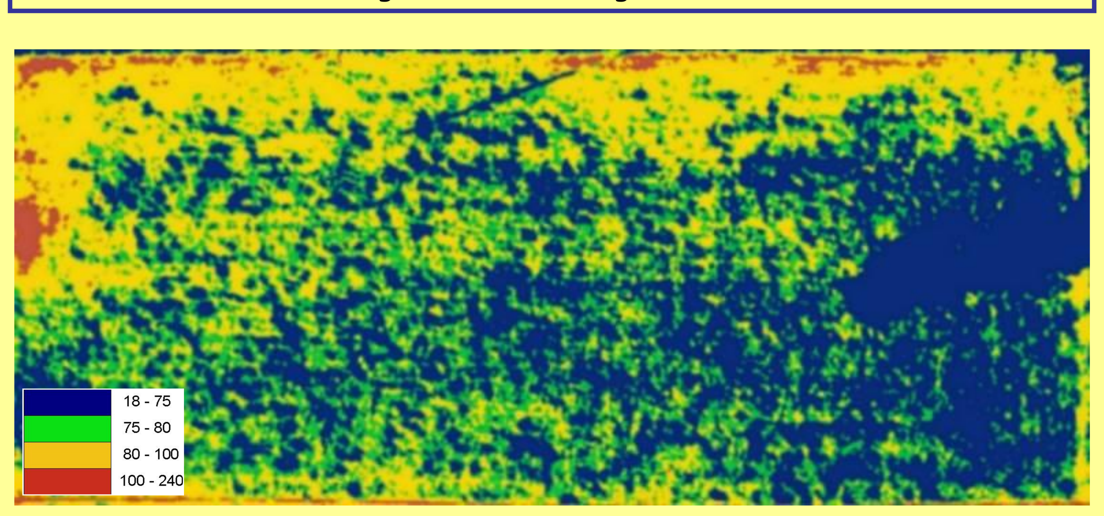


Fig. 7. Red reflectance image of Paddock 1 on 10 August 2006 filtered from RGB image (Fig. 5). Color ramp (inset) indicates least red reflectance (blue) to most red reflectance (red).

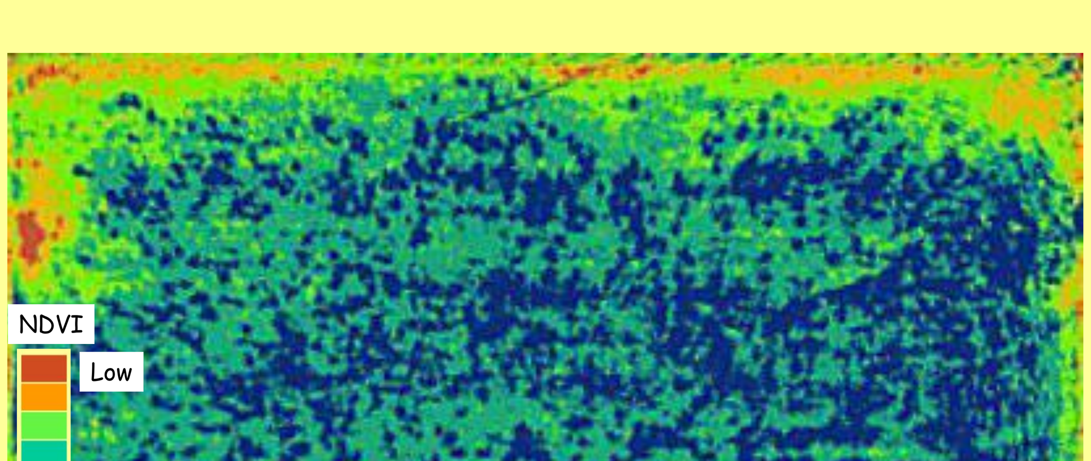


Fig. 8. NDVI image of Paddock 1 on 09.30 10 Aug. 2006 estimated from NIR (Fig, 6) and red reflectance (Fig. 7), 22 days after grazing for 7 days ending on 19 July.

Fig. 9. RGB image of Paddock 6 at 09.30 on 10 August 2006, 28 days after first grazing ended on 12 July. Hummocks were less numerous than in Paddock 5 (Fig. 5.) (246 hummocks: 321 per acre) perhaps because of fewer animal urination days (77 cf 154) and 7 more days of growth.

Fig. 10. NIR image of Paddock 6 on 10 August 2006 which was only grazed once for one week ending on 12 July 2006.

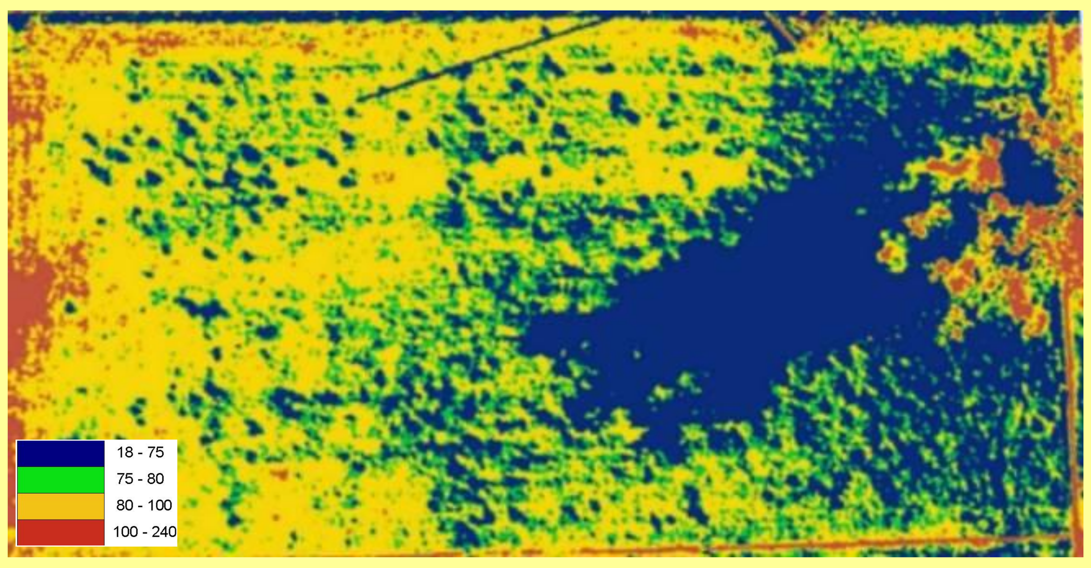


Fig. 11. Red reflectance image of Paddock 6 on 10 August. Hummocks absorb red light and appear blue. Data was filtered from RGB image (Fig.9).

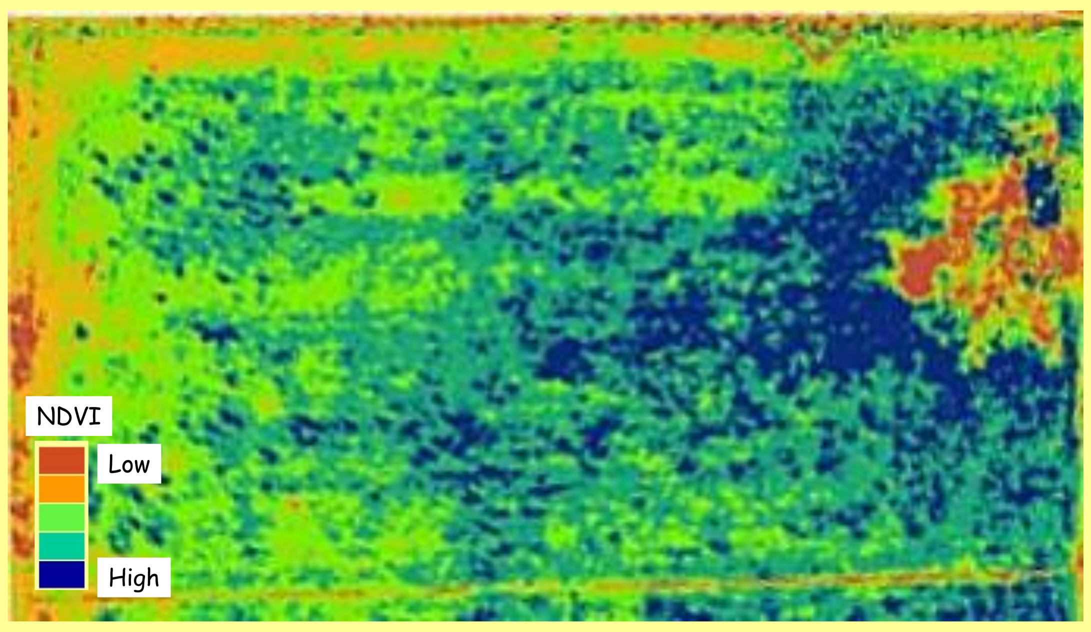


Fig. 11. NDVI image of Paddock 6 on 09.30 10 Aug. 2006, estimated from NIR reflectance (Fig. 10) and red reflectance (Fig. 11).

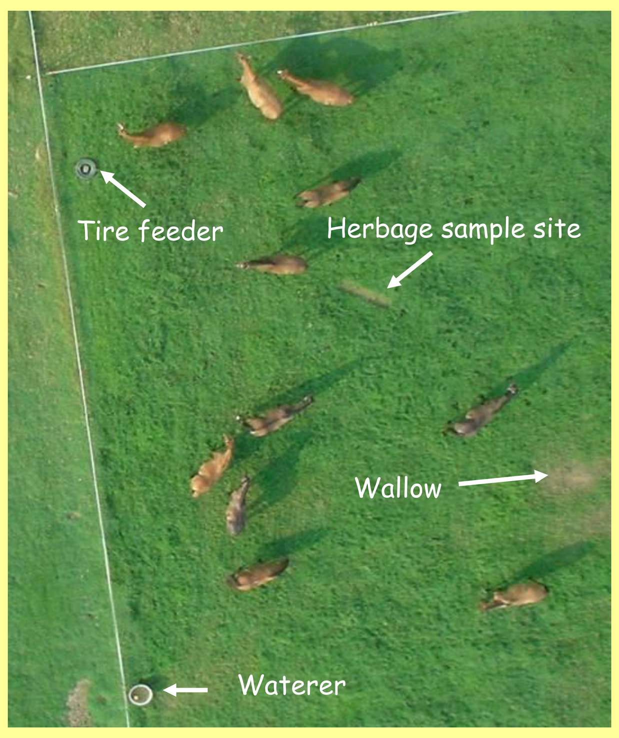
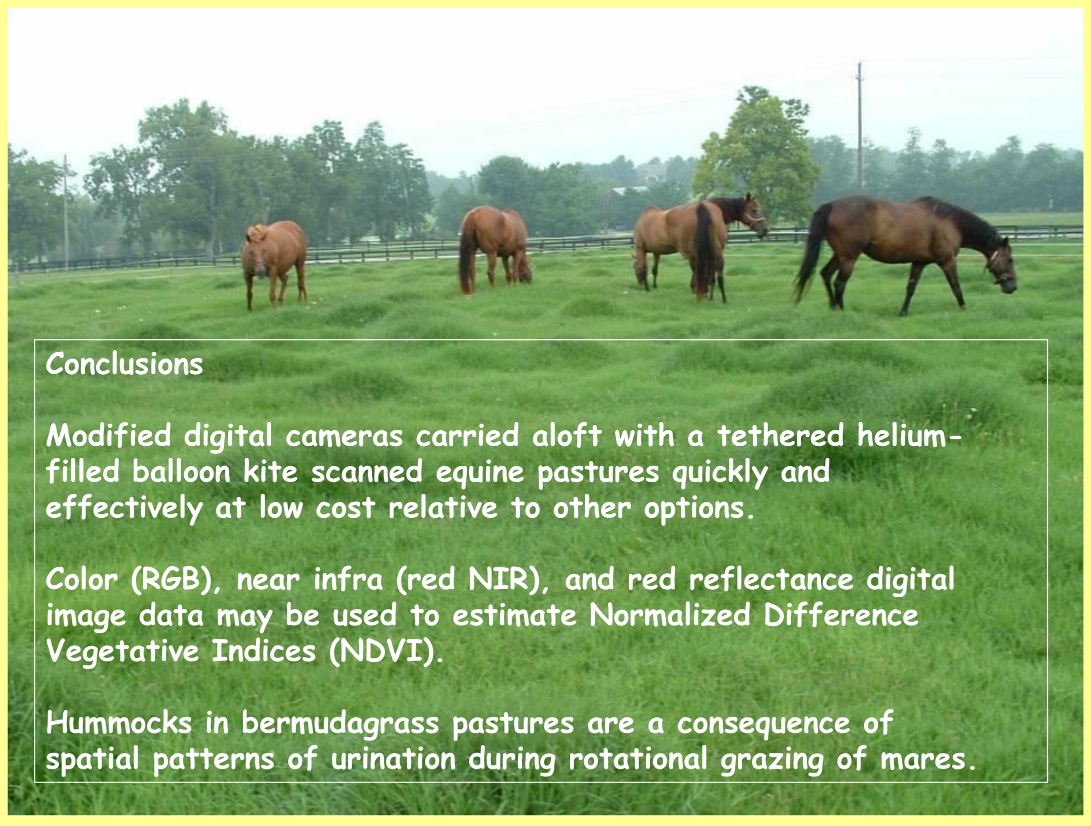


Fig. 12. Eleven mares check out Helikite from Paddock 5.



Conclusions

Modified digital cameras carried aloft with a tethered helium-filled balloon kite scanned equine pastures quickly and effectively at low cost relative to other options.

Color (RGB), near infra (red NIR), and red reflectance digital image data may be used to estimate Normalized Difference Vegetative Indices (NDVI).

Hummocks in bermudagrass pastures are a consequence of spatial patterns of urination during rotational grazing of mares.