Non-Destructive Estimation of Dynamic Vegetation Parameters in Tallgrass Prairie

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Introduction

- Grassland vegetation parameters such as biomass, fuel moisture content (FMC), and vegetation water content (VWC) are important for studies on grassland management, wildfire decision making, and remote sensing of soil moisture.
- Field based methods to estimate dynamics vegetation parameters are time consuming and destructive.
- Ground based remote sensing devices measure the reflectance of vegetation which can be used as alternative to estimate vegetation parameters in nondestructive ways.
- The **objective** of our study is to develop nondestructive methods to measure vegetation biomass, FMC and VWC in grasslands near Stillwater, Oklahoma.

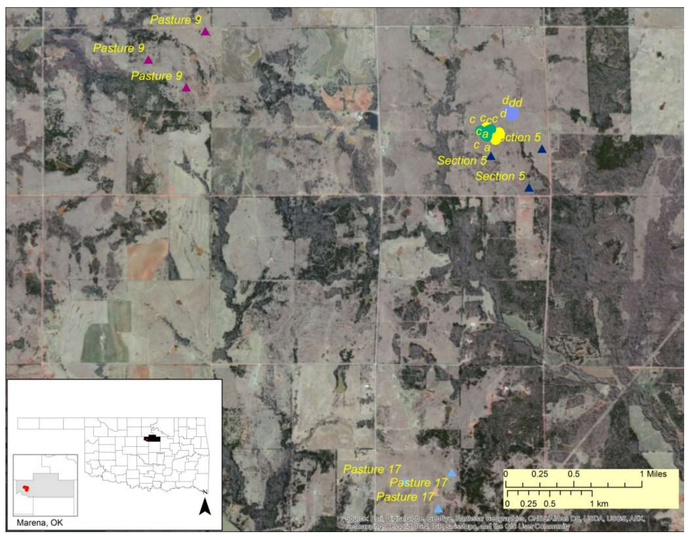

Fig 1. Location of nine sampling areas in grasslands of Stillwater, Oklahoma, US. Stillwater has humid and subtropical type climate. The soil type ranges from silty clay loam to very fine sandy loam. Dominant species are little bluestem, big bluestem, indiangrass, post oak and eastern red cedar.

Materials and Methods

- Biomass, FMC, VWC and spectral reflectance were measured in grassland during the 2012-2013 growing seasons.
- Vegetation samples (live and dead) data were obtained in 0.5 m^2 plots, and oven dried for five days (Fig 2).
- Reflectance data was measured using handheld multispectral radiometer (MSR5, Cropscan Inc., Rochester, MN) as in Fig 2. The MSR5 radiometer was chosen since it scans vegetation using five sensor bands that are similar to the wavelength bands featured in Landsat Thematic Mapper.
- Day of year (DOY), canopy height (CH), and Normalized Difference Vegetation Index (NDVI) were related to biomass, FMC and VWC to create multiple linear regression models.
- Artificial Neural Network models (ANN) for predicting biomass, FMC, and VWC were also developed using the same input variables.
- Coefficient of determination (R^2), root mean square error (RMSE) and bias were used to evaluate the predictive quality of models.

Fig 2: Overview of vegetation sampling (left) and MSR5 spectroradiometer (right)

Result and Discussion

- DOY, NDVI, and CH data allowed reasonable predictions of biomass and FMC(r^2>0.54) using either multiple regression or ANN models (Fig 3).
- NDVI and CH and the squares of these variables, were used in the multiple regression model for VWC.
- Bias error is near zero in multiple linear regression models for biomass, FMC, and VWC. Coefficients of determination were slightly increased and RMSE values were smaller in the ANN models compared to multiple linear regression model.
- The neural network model developed with data from two years in this study, when tested, yielded more accurate predictions of biomass, FMC, and VWC over multiple linear regression models.
- Olson & Cochran(1998) also reported that using ANN model predicted grassland biomass more accurately than multiple linear regression model.
- No assumption is required while using ANN to explore relationship between the variables
- NDVI and plant height showed high correlation with biomass production in cropland at three locations in Oklahoma (Freeman et al. 2007).

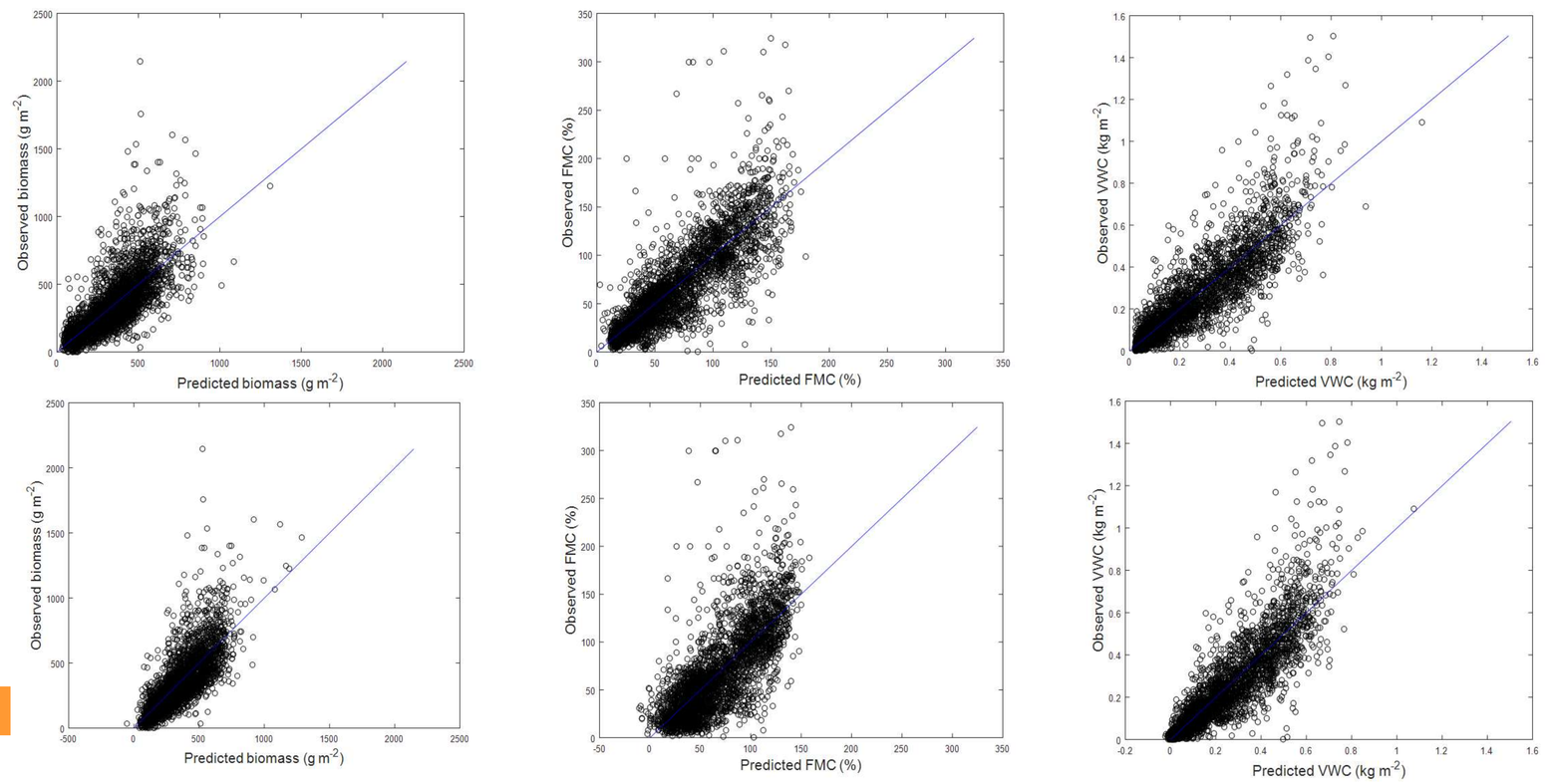

Fig 3. Plot of observed vs predicted different vegetation parameters from Multiple Regression models (upper three) Artificial Neural Network model (lower three)

Table 1. Statistical summary from the linear regression model and ANN model

Vegetation parameters	Linear regression model			ANN model		
	R^2	RMSE	Bias	R^2	RMSE	Bias
Biomass (g m^{-2})	0.54	151.36	-5.88e-13	0.59	143.81	-1.73
FMC (%)	0.57	31.04	-9.43e-14	0.69	26.34	0.026
VWC (kg m^{-2})	0.76	0.1040	-6.7e-04	0.79	0.1014	-3.4e-04

Conclusion

- Both multiple linear regression models and ANN models predicted biomass, FMC and VWC with acceptable accuracy, however ANN predicted more accurately.
- ANN model appear to be a better tool for predicting vegetation parameters than multiple linear regression model.
- Key challenges to more accurately predict vegetation dynamics include the role of the phenology and the spatial variability of soil properties.

Acknowledgement

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