Estimation of pasture biomass to support food security in Niger

Anne Schucknecht[1], Michele Meroni[1], François Kayitakire[1], Amadou Boureima[2]

[1]European Commission Joint Research Centre (EC JRC), Ispra, Italy; [2]Ministry of Livestock, Niamey, Niger

Background

- Livestock (Fig. 1) has an important economic role in Niger
- High vulnerability of pastoral production systems due to high inter-annual variability of rain and hence pasture production
- Ministry of Livestock produces:
  - Monthly pastoral bulletins during rainy season → avoidance of overexploitation, efficient resource use and early drought warning
  - Phytomass map at the end of the season → forage balance based on estimated biomass and livestock number to identify areas potentially exposed to fire risk or forage deficits

Fig. 1: Livestock in Niger (photo credit: ILRI/Stevie Mann; www.flickr.com/photos/ilri/6999430969/)

Objective

Improve remote sensing based biomass estimation and hence food security management in Niger

Current approach:

- Semi-empirical relationship between Normalized Difference Vegetation Index (NDVI) from SPOT-VEGETATION (SPOT-VGT) and biomass at the end of the current season → relationship significantly driven by spatial heterogeneity in biomass production

Proposed approach:

- Utilise observed biomass variability in space AND time to build a predictive model (no field measurements for the current year needed)
- Use phenology-tuned proxy of biomass production based on Fraction of Absorbed Photosynthetically Active Radiation (FAPAR) and simplified light use efficiency approach

Data & Methods

- 10-day FAPAR image composites from SPOT-VGT (1 km spatial resolution) for 1998–2012
- Dataset of measured biomass (B_m) at the end of the rainy season (103 sites; 1988–2013; total number of measurements = 1062) from Ministry of Livestock
- Calculation of seasonal cumulative FAPAR (CFAPAR) value [1]: baseline subtracted, time interval dynamically adjusted for every site and every year based on start and end of season (estimated using a model fit approach applied to the FAPAR time series)
- Biomass data cleaning and selection (only pastoral sites with >3 data pairs and not presenting anomalous records) → 63 sites used
- Linear regression model creation and testing at two pooling levels: global and department level
- Cross-validation (cv) by leaving one full year out

Results & Discussion

- Coefficient of determination (R^2) for regression between B_m and CFAPAR varies strongly among single sites (Fig. 2) → might be caused by quality issues and other processes (such as grazing) affecting measured biomass and not accounted for in the model

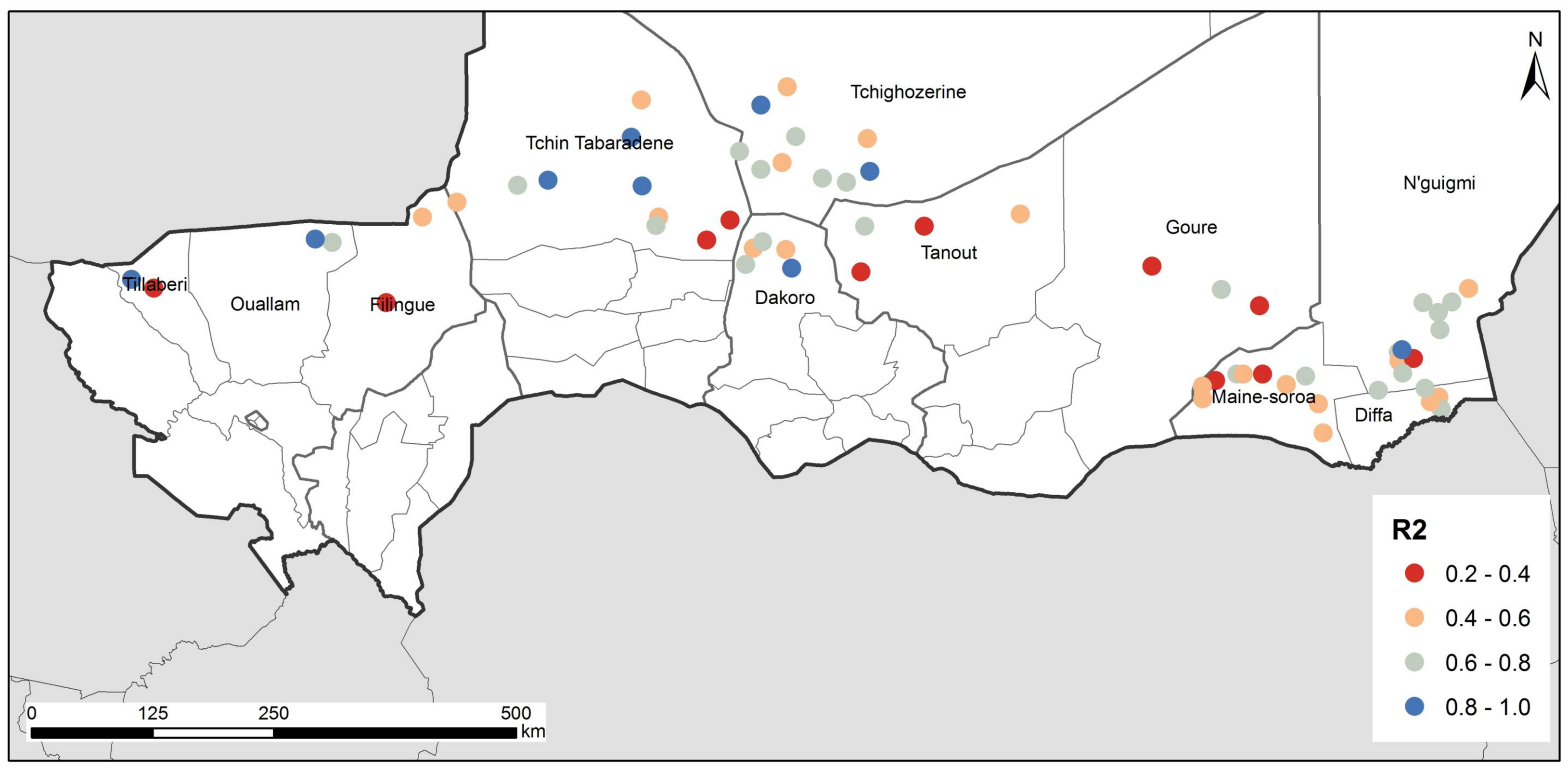

Fig. 2: Location of selected sites and R^2 for site specific regression between B_m and CFAPAR

- Model with department specific gains and offsets performs notably better than model with single gain and offset (Table 1, Fig. 3) → additional and spatially heterogeneous agro-ecological parameters (such as grazing pressure, species composition and soil spectral properties) may influence relationship between standing biomass at the end of the season and CFAPAR

Table 1: R^2 and cross-validated R^2 of the two pooling levels and number of coefficients to be tuned

Model	R^2	R^2_{cv}	# coefficients
Global level	0.33	0.31	2
Department level	0.54	0.49	2 * # dep = 18

Conclusion & Outlook

- Increased specificity of the model (department level tuning) increased estimation performances
- Definition of specific units (now departments) can be improved to represent agro-ecological clusters using remote sensing information
- Panel regression model can be tested to take into account spatial heterogeneity reducing possible over-parameterization

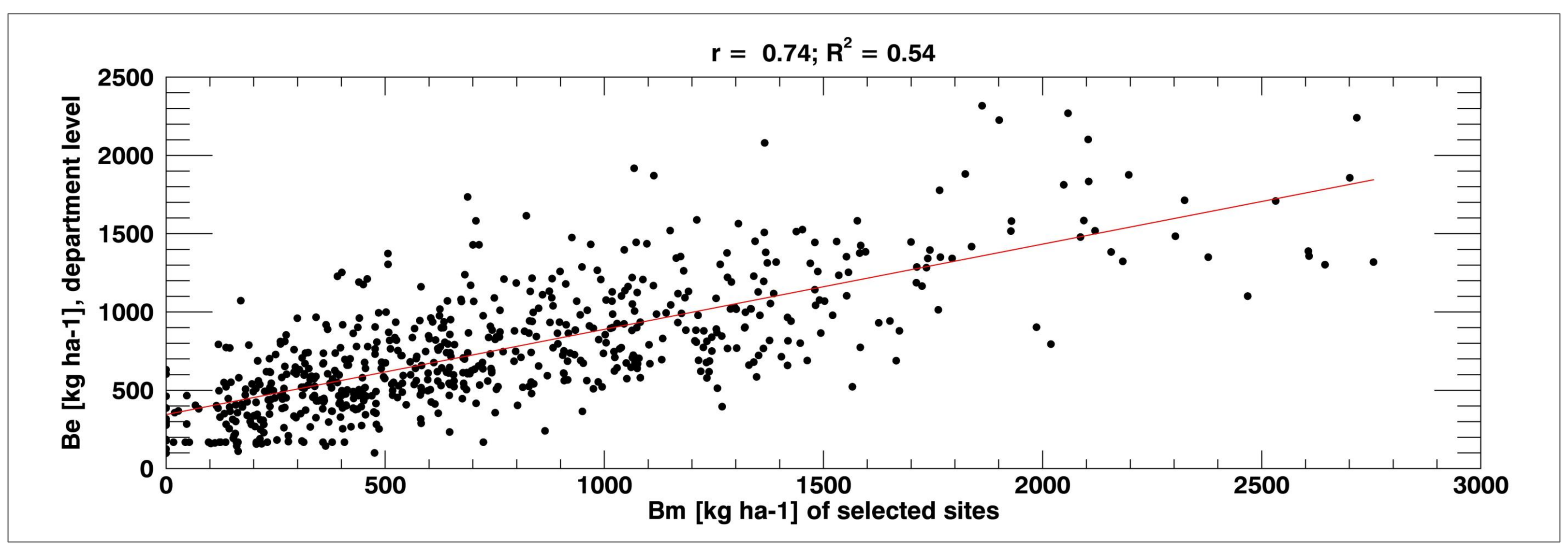

Fig. 3: Scatterplot of B_m and estimated biomass for model tuned at the department level

Contact
Anne Schucknecht
EC JRC • Institute for Environment and Sustainability
Monitoring Agricultural Resources Unit • Food security team
Email: anne.schucknecht@jrc.ec.europa.eu

www.jrc.ec.europa.eu

References

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