United States Department of Agriculture

Final Report

Title:	Advancing Remote Sensing Applications for Sustainable Forest Management in Indiana

Sponsoring Agency	NIFA	**Project Status**	COMPLETE
Funding Source	Mcintire Stennis	**Reporting Frequency**	Final
Accession No.	1003456	**Project No.**	IND011523MS
Project Start Date	10/20/2014	**Project End Date**	09/30/2019
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Submitted By	Julie Estrada	**Date Submitted to NIFA**	02/18/2020

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Performing Department

Forestry & Natural Resources

Non-Technical Summary

Hardwood forests are important timber sources and provide critical wildlife habitat, and their overall quality is closely related to management activities (Annand and Thompson 1997, Jenkins and Parker 1998, Morrissey et al. 2010). Forest management relies on spatially-explicit information on tree species composition and size structure. The conventional remote sensing data analysis is not effective enough to derive forest cover maps with sufficient information for forest management. The existing forest cover data in Indiana contain limited species information and no tree-size/age information. For example, the 1992 and 2001 National Land Cover Data classified all the hardwood forests into one forest type and are not useful for designing tree species/size-dependent sylviculture approaches. The land cover data developed by the Indiana Gap Analysis Project did not consider subclasses of hardwood forests either, and the overall accuracy of the map product was only 70.98%. When such low-accuracy forest-cover maps are used for forest management planning, actions may be unexpectedly misled due to error propagation (Shao et al. 2001&2003, Shao and Wu 2008). Therefore, it is important to obtain accurate forest cover maps with adequate forest-type and site-structure information. Such map products are broadly needed for intensive management of hardwood forest ecosystems, both publically and privately owned, in Indiana. Various remote sensing techniques have been extensively used in boreal and tropical forests but their applications in the central hardwood forest region are still limited. Our remote sensing experiment in Indiana will have broader implications to forest mapping in the central hardwood forest region.

Accomplishments

Major goals of the project

The overall objective is to improve the applications of remote sensing data in sustainable management of the central hardwood forest ecosystems through institution capacity that involves both the producers and users of remote sensing algorithms. Specific objectives are threefold:

1. To apply OBIA in characterizing forest landscapes

We will use state-of-the-art protocols and interfaces of OBIA techniques, which have been used and advanced in our previous land-use projects, to improve automated OBIA algorithms with multispectral remote sensing data acquired in Indiana. The goal is to map precise forest landscape characterizations that help forest sustainability in south-central Indiana.

2. To apply LiDAR data in mapping forest structure

We will develop algorithms to estimate 3-D structure of hardwood forests with LiDAR data that have been acquired by the State of Indiana. The goal is to develop structure-oriented forest data layers, including forest canopy surface/gaps and forest tree heights for hardwood forests in south-central Indiana.

3. Mapping forest structure and composition for sustainable forest management

We will incorporate LiDAR-derived forest structure information into forest classification with OBIA. The goal is to develop improved forest maps with integrated information of forest structure and spectral characteristics and make the forest maps available for intensive forest management activities in south-central Indiana as an example for entire central hardwood forest regions.

What was accomplished under these goals?

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Figured out a way to identify individual trees with low-density lidar data; summarized the inherent properties of the overall accuracy metric in remote sensing classification; developed an algorithm for digitally measuring tree diameters; acquired new imagery for natural forests and plantations with umanned aerial systems.

What opportunities for training and professional development has the project provided?

We demonstrated tree diameter algorithm at the annual meeting of The USDA Hardwood Tree Improvement and Regeneration Center.

How have the results been disseminated to communities of interest?

Yes. The USDA Hardwood Tree Improvement and Regeneration Center

What do you plan to do during the next reporting period to accomplish the goals?

We will work with the organization of forest inventory and analysis of USDA Forest Service to improve the tree diameter measurement algorithm. We will publish an OBIA method in tree canopy measurements with umanned aerial systems.

Participants

Actual FTE's for this Reporting Period

Role	Non-Students or faculty	Students with Staffing Roles			Computed Total by Role
		Undergraduate	Graduate	Post-Doctorate	
Scientist	0.3	0	0.5	0	0.8
Professional	0	1.6	0	0	1.6
Technical	0	0	0	0	0
Administrative	0	0	0	0	0
Other	0	0	0	0	0
Computed Total	0.3	1.6	0.5	0	2.4

Student Count by Classification of Instructional Programs (CIP) Code

Undergraduate	Graduate	Post-Doctorate	CIP Code
5	1	0	03.01 Natural Resources Conservation and Research.

Target Audience

Forestry professionals, forest surveyers, forest researchers

Products

Type	Status	Year Published	NIFA Support Acknowledged
Journal Articles	Published	2019	YES

Citation

Shao, G., G.F. Shao, and S.L. Fei. 2019. Delineation of individual deciduous trees in plantations 1 with low-density LiDAR data. International Journal of Remote Sensing 49(1): 346–363.

Type	Status	Year Published	NIFA Support Acknowledged
Journal Articles	Published	2019	NO

Citation

Liao, J.F., G.F. Shao, C.P. Wang, L.N. Tang, Q.L. Huang, and Q.Y. Qiu. 2019. Urban sprawl scenario simulations based on cellular automata and ordered weighted averaging ecological constraints. Ecological

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Journal Articles	Published	2019	YES

Citation

Shao, G.F., L.N. Tang, and J.F. Liao. 2019. Overselling overall map accuracy misinforms about research reliability. Landscape Ecology 34(11): 2487–2492.

Type	Status	Year Published	NIFA Support Acknowledged
Book Chapters	Published	2019	NO

Citation

Shao, G.F. 2019. Optical remote sensing. In: International Encyclopedia of Geography: People, the Earth, Environment, and Technology. D. Richardson (ed.). Wiley & Sons, Inc., P2390–2395.

Other Products

Product Type

Protocols

Description

A terrestrial stereoscopic photogrammetric algorithm for digitally measuring tree diameters

Changes/Problems

{Nothing to report}