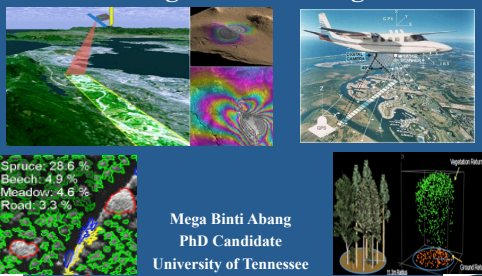


### Feasibility of measuring individual trees using remote sensing



Spruce: 28.6 %  
Beech: 4.9 %  
Meadow: 4.6 %  
Road: 3.3 %

Mega Binti Abang  
PhD Candidate  
University of Tennessee  
Department of Forestry, Wildlife and Fisheries

Room 160 Plant Biotech Building  
Wednesday April 24 2013 12:20 pm

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### Outline

- Introduction
  - definition
  - usage
  - limitation
- Current knowledge
  - recent studies
  - application
  - difficulties
- Future direction
- References
- Picture source

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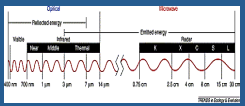
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### Introduction

- Remote sensing – technique to get information about objects through analysis of data collection (Northern Arizona University)
- Detection of electromagnetic energy from aircraft or satellites.
- Electromagnetic spectrum – 2 i.e. optical and microwave wavelength regions.
- Optical remote sensing : wavelengths 0.4-14 mm.
- Microwave remote sensing : wavelengths 1mm-1m.



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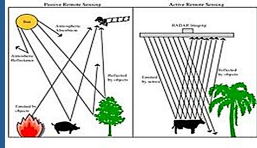
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### Introduction

- Type of sensor :
  - Active sensors - emit a pulse and later measure the energy returned or bounced back to a detector – Radarsat (land cover and land use monitoring)
  - Passive sensors - measure radiation that reaches a detector – aerial photography or Landsat Thematic Mapper (vegetation structure and ground surface)



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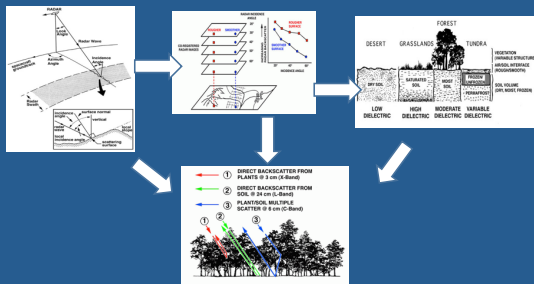
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### Basic of remote sensing:



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### Limitations of microwave sensor image

- Thermal imaging system very expensive to acquire and process
- Detector materials must be kept extremely cold



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### Limitations of microwave sensor image

- Thermal infrared imaging systems difficult to calibrate
- Data collected is computationally expensive
- Thermal images can be difficult to interpret
- Thermal images of water measures only the very top layer of the water surface

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### Limitation of conventional sensors:

- Accuracy of individual-tree classification remains low (Li et al., 2013)
- Sensitivity and accuracy decrease
- Ability to represent spatial pattern

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### Current knowledge

- LIDaR –Light Detection and Ranging /Laser Imaging Detection and Ranging
- Airborne LIDaR-Directly measure the 3-dimensional distribution of plant canopy
- Accurately estimate LAI and aboveground biomass even in those high-biomass ecosystems where passive and active radar sensors fail

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## Predicting nitrogen using spectral response

Table 2. Results of SMLR and ANN for N concentration measurements.

Species	Treatments	SMLR			ANN	
		r <sup>2</sup>	p	# wavebands	r <sup>2</sup> (Test)	r <sup>2</sup> (Validation)
<i>Avicennia germinans</i>	C	0.355	<0.001	1	0.861	0.113
	log(1/C)	0.331	<0.001	1	0.715	0.483
	BNC	0.750	<0.001	10	0.907	0.416
	log(1/BNC)	0.757	<0.001	10	0.830	0.455
<i>Rhizophora mangle</i>	C	0.453	<0.001	4	0.443	0.414
	log(1/C)	0.322	<0.001	4	0.822	0.453
	BNC	0.733	<0.001	7	0.870	0.444
	log(1/BNC)	0.709	<0.001	6	0.773	0.628

r<sup>2</sup>—measure how well future outcomes will be predicted by a model  
 BNC—band depth at the center of the absorption feature, r<sup>2</sup> = 0.91

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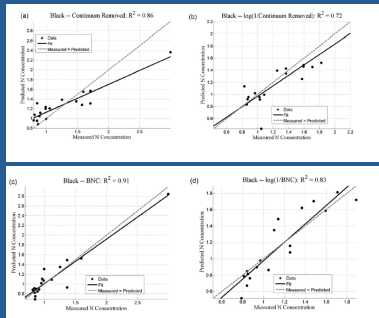
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## Artificial neural network testing results for black mangrove




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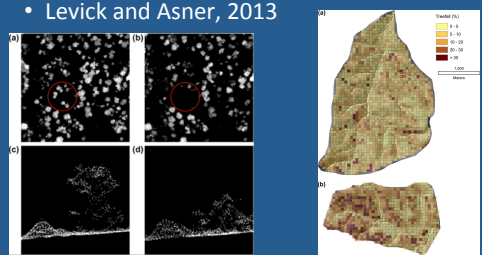
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## Current studies

- Levick and Asner, 2013



Landscape distribution of the proportion of treefall in the (a) Combretum and (b) Acacia catchments

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### Conclusion

- Time series LiDAR - a valuable tool for :
  - measuring rates and patterns of vegetation change at the landscape level,
  - delivering valuable spatial information for understanding vegetation structural dynamics

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### Errors and difficulties in classification

- Some crown were over-segmented into multiple subcrowns
- Two or three neighbouring tree crowns were detected as one large crown
- Require gap distribution
- Presence of understory trees causing abnormal feature value
- Effects of thinning and wind felling to tree features (Holmgren and Persson, 2004)
- Structural similarity of different species (Thompson et al., 2007)

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### Future directions

- Aid in monitoring and measuring the distribution and status of biodiversity for larger area
- As a early indicator/signal in areas with dying trees threatened with pest or disease
- As tool to early selection of areas where trees are timely to be harvested based on height and stem calculated from LIDAR data
- Detection of invasive species at early stage
- Recommend species to be planted in certain areas based on integration of data for example, soil type, soil moisture, environment and characteristics of plants.

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### References :

- Holmgren, J., Persson, Å., Söderman, U., 2008. Species identification of individual tree by combing high resolution LiDAR data with multi-spectral images. *Int. J. Remote Sens.* 29, 1537–1552.
- Holmgren, J., Persson, Å., 2004. Identifying species of individual trees using airborne laser scanner. *Remote Sens. Environ.* 90, 415–423.
- Lefsky, M. A. Cohen, W. B. Parker, G. G. Harding, D. J. 2002. Lidar remote sensing for ecosystem studies. *Bioscience*, 52:1, 19.
- Levis, S. R., Asner, G. P. 2013. The rate and spatial pattern of treefall in a savanna landscape. *Biological Conservation*, 157, 121–127
- Thompson, I.D., Maher, S.C., Rouillard, D.P., Fryxell, J.M., Baker, J.A., 2007. Accuracy of forest inventory mapping: some implications for boreal forest management. *For. Ecol. Manage.* 252, 208–221.
- Turner, W., Spector, S., Gardiner, N., Fladeland, M., Sterling, E., & Steininger, M. 2003. Remote sensing for biodiversity science and conservation. *Trends in ecology & evolution*, 18:6, 306-314.
- Reithberger, J., Krzystek, P., Stilla, U., 2008. Analysis of full waveform LIDAR data for the classification of deciduous and coniferous trees. *Int. J. Remote Sens.* 29, 1407–1431.
- Zhang C, Kovacs JM, Wachowiak MP, Flores-Verdugo F. 2013. Relationship between Hyperspectral Measurements and Mangrove Leaf Nitrogen Concentrations. *Remote Sensing*. 5(2):891-908.

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### Picture sources :

- <http://www.neonnotes.org/2012/06/reflections-on-remote-sensing-ecology-and-the-neon-aop/>
- <http://www.mtec.com/halcon/applications/application.pl?name=remote>
- <http://ee.stanford.edu/~zebkcr/>
- <http://www.angkasa.gov.my/?q=node/302>
- [http://satftp.soest.hawaii.edu/space/hawaii/vfts/kilauea/radar\\_ex/page1.html](http://satftp.soest.hawaii.edu/space/hawaii/vfts/kilauea/radar_ex/page1.html)
- [http://satftp.soest.hawaii.edu/space/hawaii/vfts/kilauea/radar\\_ex/page3.html](http://satftp.soest.hawaii.edu/space/hawaii/vfts/kilauea/radar_ex/page3.html)
- [http://satftp.soest.hawaii.edu/space/hawaii/vfts/kilauea/radar\\_ex/page4.html](http://satftp.soest.hawaii.edu/space/hawaii/vfts/kilauea/radar_ex/page4.html)
- [http://satftp.soest.hawaii.edu/space/hawaii/vfts/kilauea/radar\\_ex/page5.html](http://satftp.soest.hawaii.edu/space/hawaii/vfts/kilauea/radar_ex/page5.html)
- [http://satftp.soest.hawaii.edu/space/hawaii/vfts/kilauea/radar\\_ex/page6.html](http://satftp.soest.hawaii.edu/space/hawaii/vfts/kilauea/radar_ex/page6.html)
- <http://www.co.mcleod.mn.us/mcleodco.cfm?pageID=598&sub=yes3>

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Thank you

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