

# Land Cover Classification and Analysis using Radar and Landsat data in North Central Ethiopia

Haile K. Tadesse and Allan Falconer

George Mason University, Fairfax, VA, 22030

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# Introduction

- ▶ For many years, Landsat data has been used to monitor land cover and deforestation in different part of the world
- ▶ Optical remote sensing was widely used instrument to classify land-cover
- ▶ In the tropics image classification using optical remote sensing is difficult
- ▶ This is due to lack of good quality Landsat or other optical data

# Introduction Cont.

- ▶ Active sensors are not affected by cloud cover and can be a reliable source of remote sensing data for tropical areas
- ▶ Radar data can be collected from space using RADARSAT, Shuttle Imaging Radar (SIR), the European Space Agency, and ALOS
- ▶ One problem with radar data is the presence of speckle noise
- ▶ Therefore, some de-speckling techniques were used in this study

# Introduction Cont.

- ▶ Different algorithms can be used for land cover classification
- ▶ Maximum Likelihood Classifier (MLC) is one of the commonly used statistical algorithms
- ▶ Expert system and decision tree classifiers are also used to classify land cover
- ▶ There are many decision tree classifiers and among these C4.5 has been used for land use classification
- ▶ C4.5 algorithm is a hierarchical decision tree builder and can handle continuous and discrete attributes

# Objective

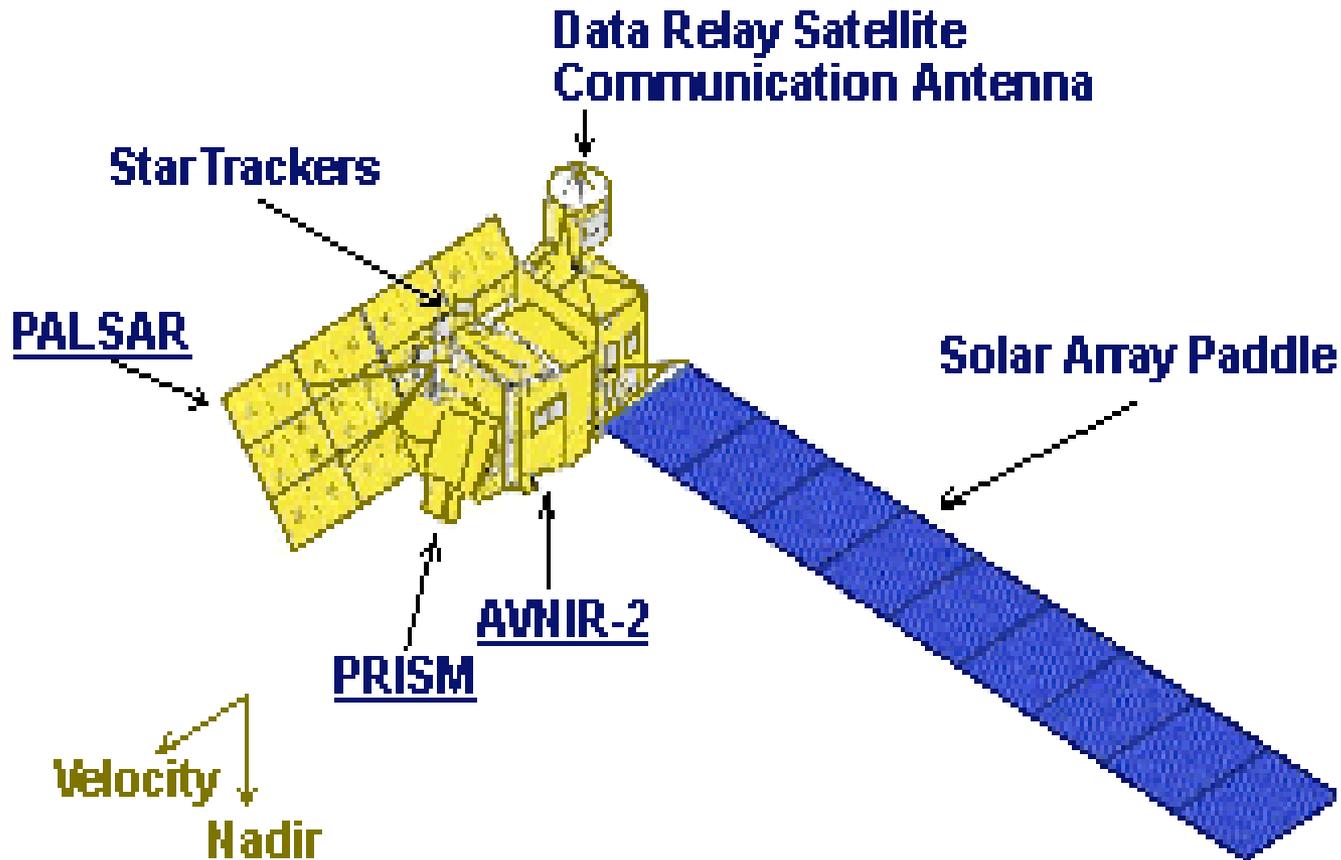
- ▶ To analyze land cover classification using radar and Landsat data
- ▶ To compare the impact of image enhancement techniques on land cover classification
- ▶ To compare the Maximum Likelihood Classifier (MLC) and C4.5 classification Algorithms on land cover classification accuracy assessments

# Methods and Data Sources

- ▶ MLC, C4.5 algorithms for land cover classification
- ▶ De-speckling and Texture measures to enhance radar data
- ▶ Median, Lee-Sigma and Gamma-MAP de-speckling methods were used to suppress speckle
- ▶ Variance texture measure was the only texture techniques applied in this study
- ▶ TM Landsat data from USGS and PALSAR Radar data from Advanced Land Observing Satellite (ALOS) were used

# PALSAR radar data—dual polarisation (HH+HV)

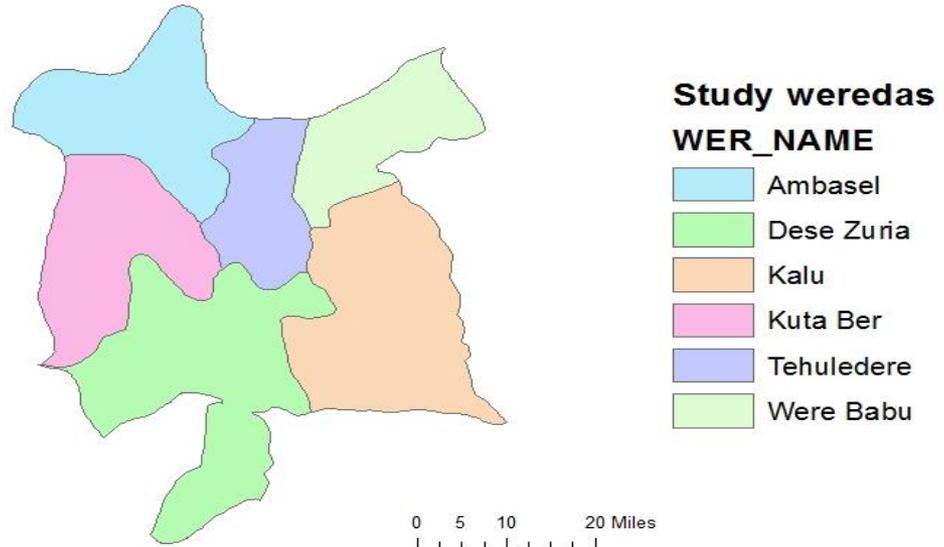
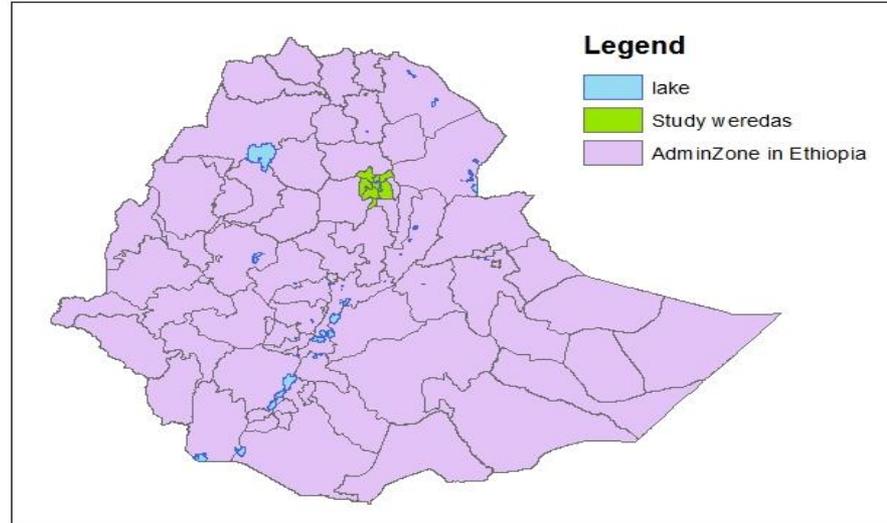
[http://www.eorc.jaxa.jp/ALOS/en/about/about\\_index.htm](http://www.eorc.jaxa.jp/ALOS/en/about/about_index.htm)



# Study area



Study area in North Central Ethiopia





**Forest** (Photo by H. Tadesse (10/2012))



## ▶ Agricultural field (Sorghum)

Photo by H. Tadesse (10/2012)



► **Urban** Photo by H. Tadesse (10/2012)

# MLC Classification results

- ▶ Maximum Likelihood classifier was used to classify the original radar data, de-speckled, variance texture, Landsat data and fused data
- ▶ The total number of validation pixels for all the analysis were 12229
- ▶ The four land cover units included in this study are water, urban, forest and agriculture
- ▶ For each land cover two validation sites were selected

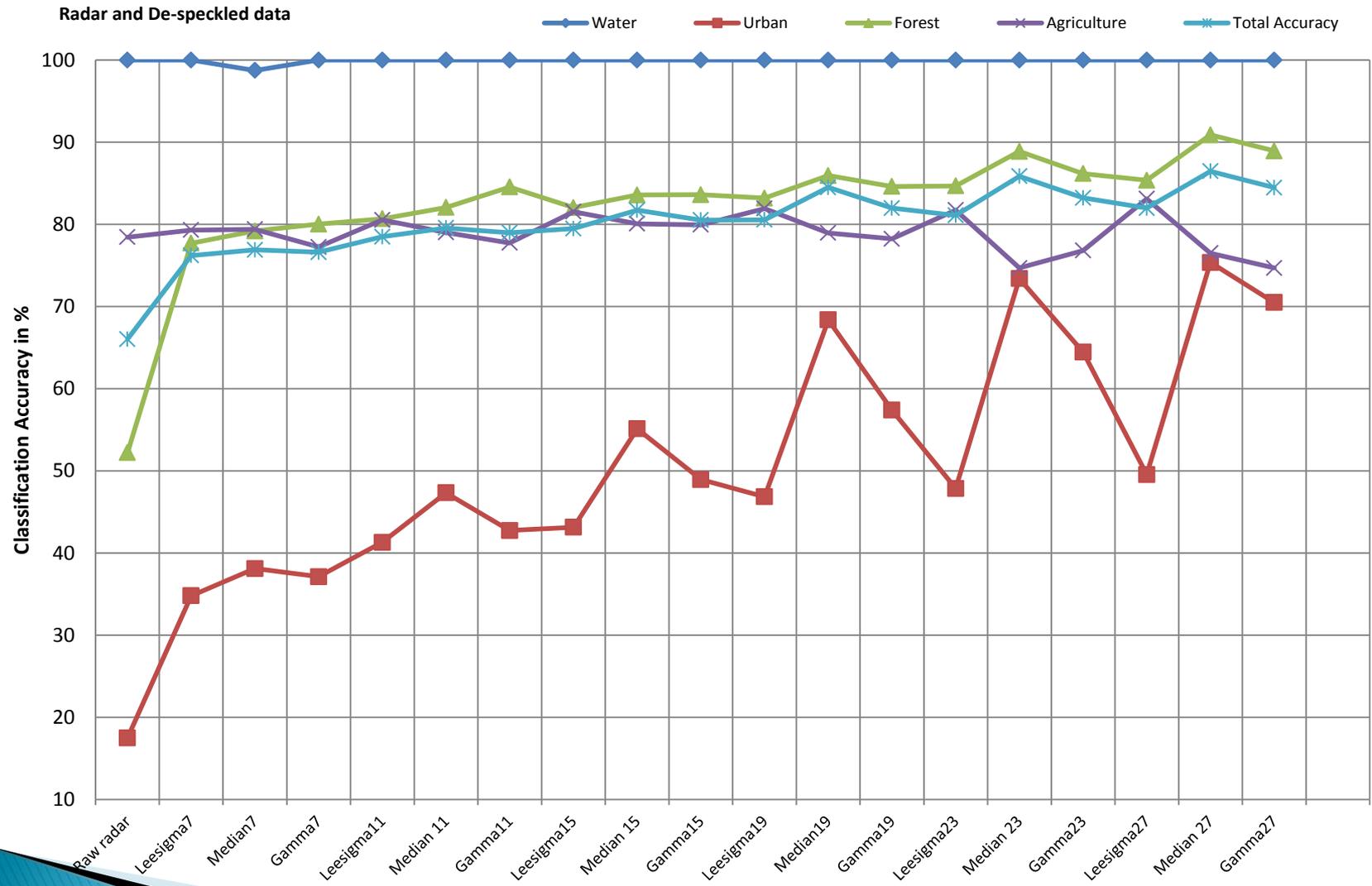
# Original Radar data MLC accuracy

Raw radar MLC accuracy matrix							
		Reference data					User Accuracy in %
		Water	Urban	Forest	Agriculture	Total	
Classified Data	Water	3316	19	3	222	3560	93.15
	Urban	0	401	63	3	467	85.87
	Forest	0	1165	1662	516	3343	49.72
	Agriculture	0	708	1455	2696	4859	55.48
Total		3316	2293	3183	3437	12229	
Producer Accuracy in %		100.00	17.49	52.21	78.44		
Overall Classification Accuracy							66.03%
Overall Kappa Statistics							0.54

# De-speckled radar data MLC accuracy

Kombolcha Median Speckle 27 MLC accuracy matrix						
	Reference data					User Accuracy in %
	Water	Urban	Forest	Agriculture	Total	
Water	3316	0	0	0	3316	100.00
Urban	0	1728	0	0	1728	100.00
Forest	0	565	2893	808	4266	67.82
Agriculture	0	0	290	2629	2919	90.07
Total	3316	2293	3183	3437	12229	
Producer Accuracy in %	100.00	75.36	90.89	76.49		
Overall Classification Accuracy						86.40%
Overall Kappa Statistics						0.82

# All de-speckled radar data accuracy assessment



# Variance Texture 51\*51 MLC accuracy

Kombolcha Texture 51 MLC accuracy matrix						
	Reference data					
	Water	Urban	Forest	Agriculture	Total	User Accuracy in %
Water	3316	0	0	0	3316	100.00
Urban	0	1622	0	0	1622	100.00
Forest	0	671	2503	22	3196	78.32
Agriculture	0	0	680	3415	4095	83.39
Total	3316	2293	3183	3437	12229	
Producers Accuracy in %	100.00	70.74	78.64	99.36		
Overall Classification Accuracy						88.8%
Overall Kappa Statistics						0.85

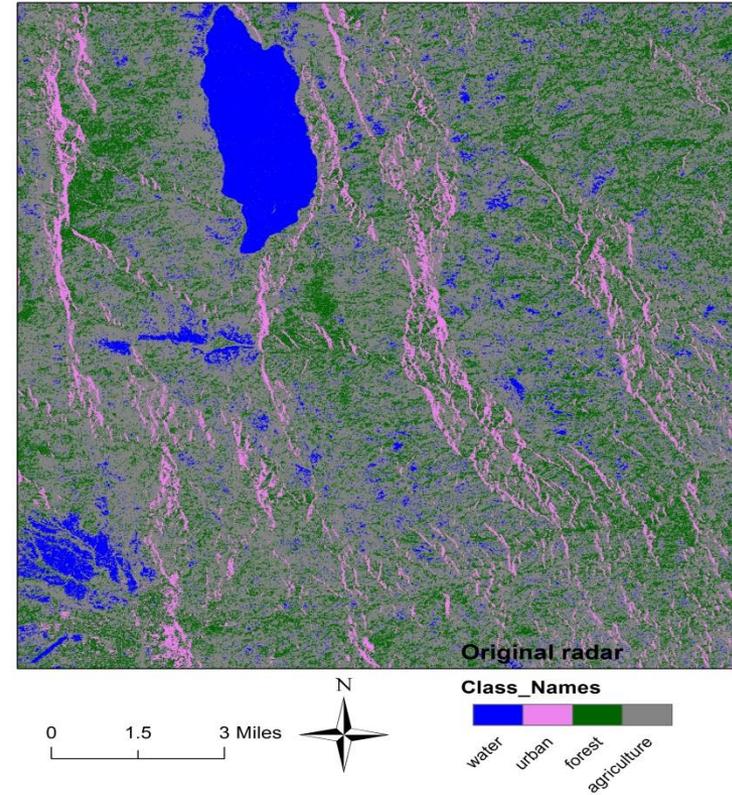
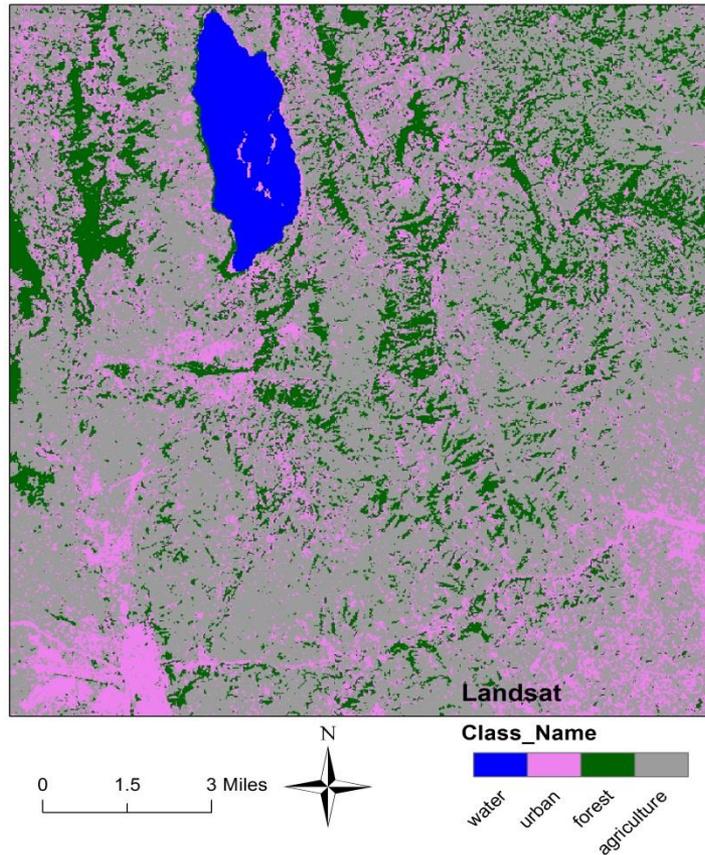
# Landsat data MLC accuracy

Landsat data MLC accuracy matrix						
	Reference data					
	Water	Urban	Forest	Agriculture	Total	User Accuracy in %
Water	3316	0	0	0	3316	100.00
Urban	0	2264	92	483	2839	79.75
Forest	0	0	2980	52	3032	98.28
Agriculture	0	29	111	2902	3042	95.40
Total	3316	2293	3183	3437	12229	
Producers Accuracy in %	100.00	98.74	93.62	84.43		
Overall Classification Accuracy						93.70%
Overall Kappa Statistics						0.92

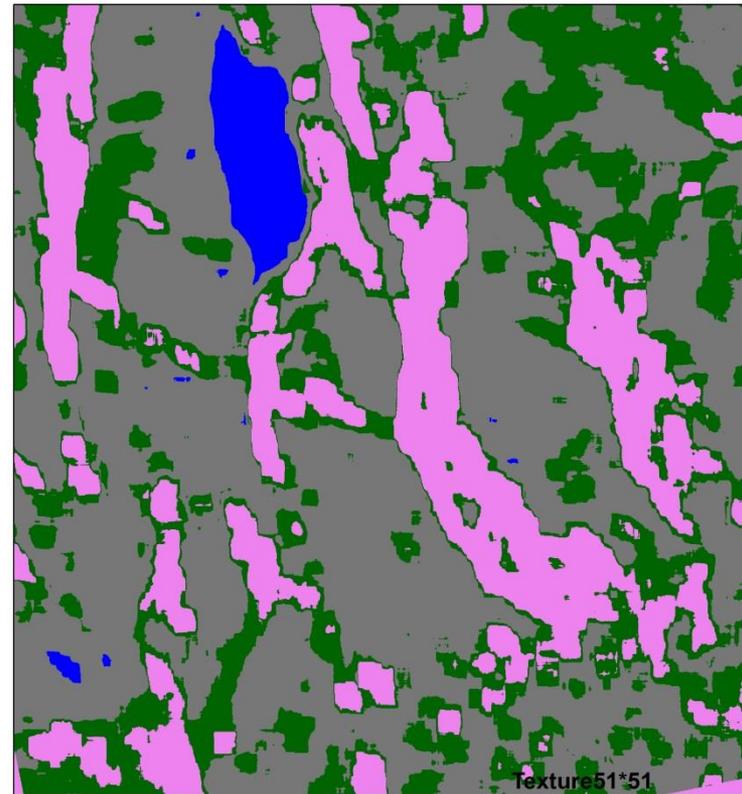
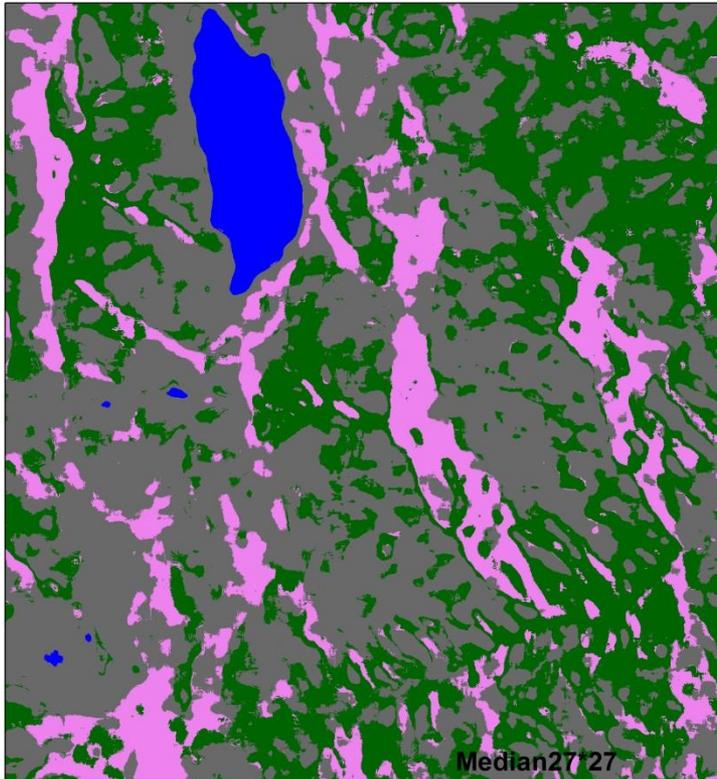
# Landsat and Texture 35\*35 fused data

Landsat and texture 35 MLC accuracy matrix						
	Reference data					User Accuracy in %
	Water	Urban	Forest	Agriculture	Total	
Water	3316	0	0	0	3316	100.00
Urban	0	2269	0	2	2271	99.91
Forest	0	2	3025	18	3045	99.34
Agriculture	0	22	158	3417	3597	95.00
Total	3316	2293	3183	3437	12229	
Producers Accuracy in %	100.00	98.95	95.04	99.42		
Overall Classification Accuracy						98.4%
Overall Kappa Statistics						0.98

# Landsat and Radar classified data



# Median 27\*27 and Texture 51\*51



# C4.5 classifier results

- ▶ C4.5 algorithm was applied to both radar and Landsat data to compare land cover classification accuracy
- ▶ For this classifier, an open source software WEKA data mining was used and in this software C4.5 is called J48
- ▶ Both training and test samples were converted to WEKA data format for the land cover classification

# Original radar data C4.5 accuracy

Kombolcha Raw radar C4.5 accuracy matrix						
	Classified data				Total	Producer Accuracy in %
	Water	Urban	Forest	Agriculture		
Water	3316	0	0	0	3316	100.0
Urban	26	891	940	436	2293	38.9
Forest	23	460	1893	807	3183	59.5
Agriculture	264	284	751	2138	3437	62.2
Total	3629	1635	3584	3381	12229	
User Accuracy in %	91.4	54.5	52.8	63.2		
Overall Accuracy					67.4%	
Kappa statistics					0.56	

# De-speckled radar data (Median 27\*27)

Kombolcha Median27 C4.5 matrix						
	Water	Urban	Forest	Agriculture	Total	Producer Accuracy in %
Water	3316	0	0	0	3316	100.0
Urban	0	1677	616	0	2293	73.1
Forest	0	322	2092	769	3183	65.7
Agriculture	0	52	279	3106	3437	90.4
Total	3316	2051	2987	3875	12229	
User Accuracy in %	100.0	81.8	70.0	80.2		
Overall accuracy					83.3%	
Kappa statistic					0.78	

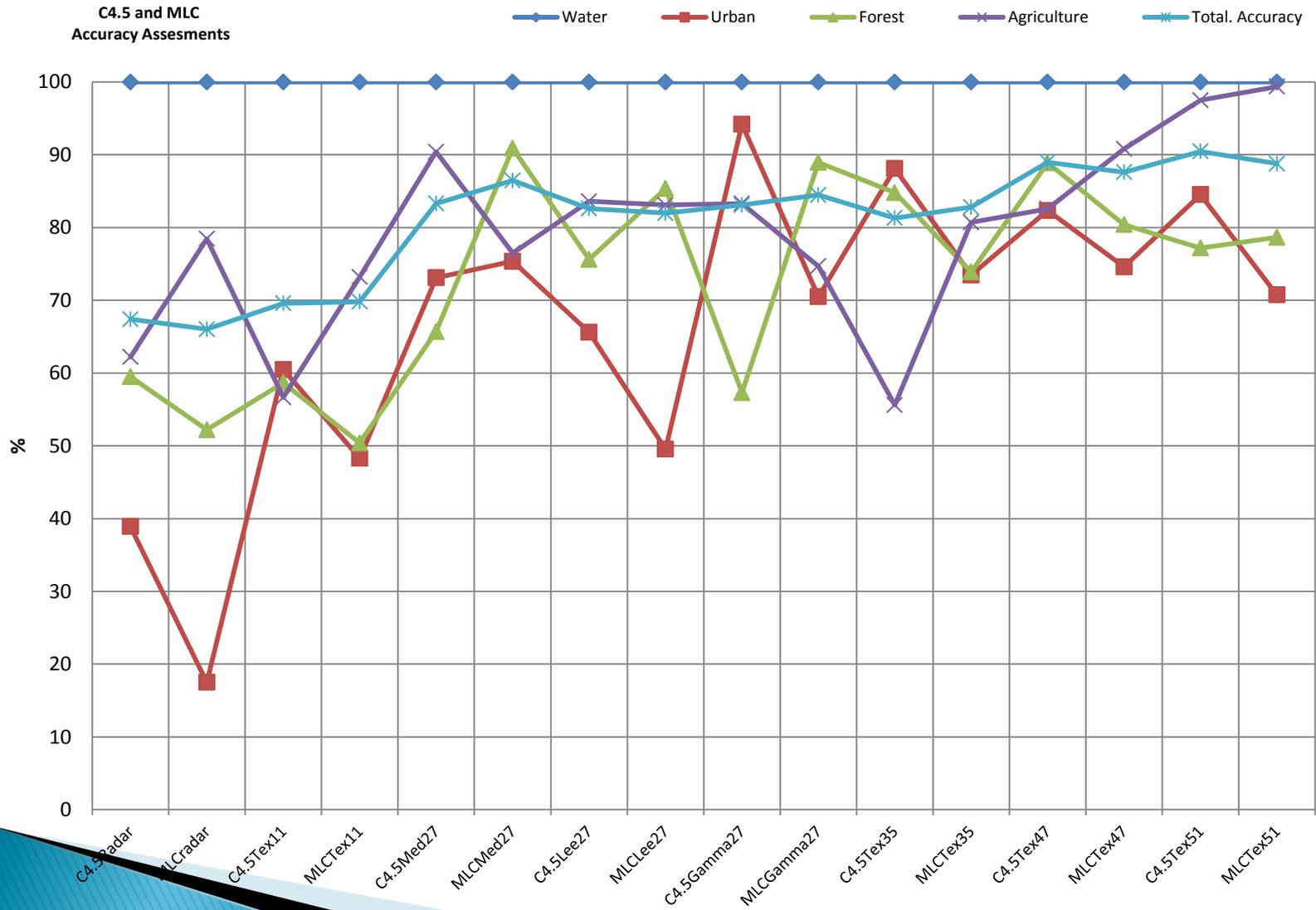
# Texture 51\*51 C4.5 accuracy

Kombolcha Texture 51*51 C4.5 accuracy matrix						
	Classified data				Total	Producers Accuracy in %
	Water	Urban	Forest	Agriculture		
Water	3316	0	0	0	3316	100.0
Urban	0	1938	355	0	2293	84.5
Forest	0	9	2457	717	3183	77.2
Agriculture	20	0	66	3351	3437	97.5
Total	3336	1947	2878	4068	12229	
User Accuracy in %	100.0	99.5	85.4	82.4		
Overall Accuracy					90.5%	
Kappa statistics					0.87	

# Landsat data C4.5 accuracy

Kombolcha C4.5 Landsat accuracy matrix						
	Water	Urban	Forest	Agriculture	Total	producers Accuracy in %
Water	3316	0	0	0	3316	100.0
Urban	0	2227	4	62	2293	97.1
Forest	25	13	3013	132	3183	94.7
Agriculture	0	1127	455	1855	3437	54.0
Total	3341	3367	3472	2049	12229	
User Accuracy in %	100.0	66.1	86.8	90.5		
Overall Accuracy					85.1%	
Kappa statistic					0.8	

# MLC and C4.5 classification comparison



# Conclusion

- ▶ The findings of this research study underscored that the importance of de-speckling and texture measures for land cover classification
- ▶ In most cases, MLC classifier achieved better overall classification accuracy compared to C4.5 when de-speckling was applied
- ▶ The best classification accuracy achieved using de-speckling techniques was when median was applied at window size 27\*27

# Conclusion

- ▶ All de-speckling methods used in this study produced more than 81% overall classification accuracy at this window size.
- ▶ Overall, increasing window size beyond 27 decreases the overall and individual land cover accuracy in de-speckling filtering
- ▶ Texture also produced very good land cover classification accuracy 88.8 and 90.5% when MLC and C4.5 classification algorithms were applied respectively

# Conclusion

- ▶ Texture measures produced good accuracy at larger window size compared to de-speckling
- ▶ C4.5 algorithm achieved the best urban producer accuracy in most cases compared to MLC classification
- ▶ This study shows that classification results were dependent on the type of classification algorithm and image enhancement methods used
- ▶ This research also indicated the importance of radar for land cover classification in tropics

# Acknowledgments

- ▶ USGS for Landsat data
- ▶ Alaska Satellite Facility and NASA for Radar data
- ▶ Ministry of Agriculture in Ethiopia for secondary data
- ▶ Image Ethiopia Tours for logistical support in my field trip to the study area.

# Comments

- ▶ Thank you very much