

A Comparison of Snow Detection Methods for Determining Glacier Area on Mt. Hood, OR

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Objective

- Compare two methods
 - IR Simple Ratio
 - Normalized Difference Snow Index (NDSI)
- Determine which method better identifies snow-covered areas in RS images

Study Area

- Mt. Hood, Oregon



RS Images

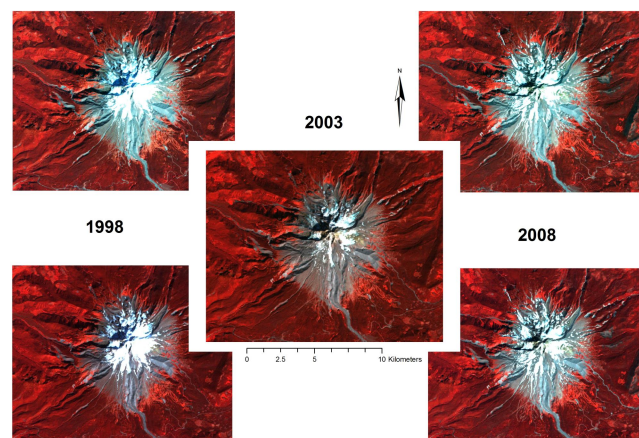
- Landsat 5 TM
 - 30m Resolution
- 3 years Over 10-year Period
 - September 28, 1998
 - September 26, 2003
 - September 07, 2008


Methods

- Preprocessing
 - Histogram Matching
 - Topographic Normalization
- Snow Detection
 - IR Simple Ratio
 - NDSI
 - Unsupervised Classifications
- Accuracy Assessments

Histogram Matching

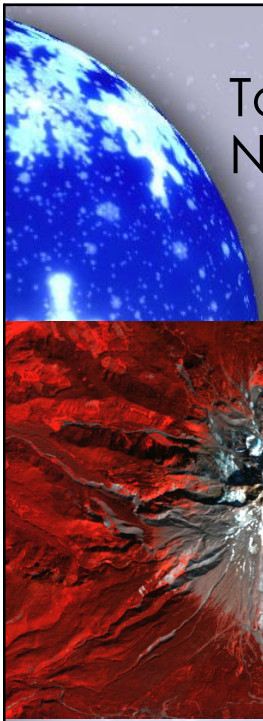
- Matched 1998 and 2008 Images to 2003



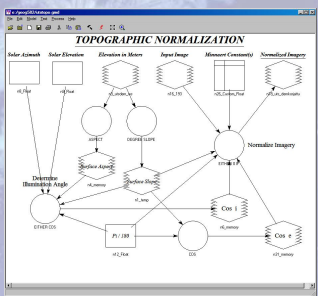
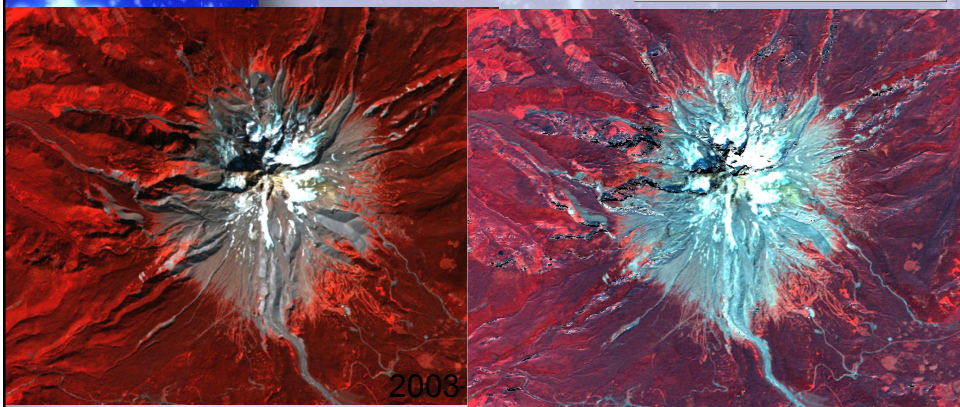


Topographic Normalization

- Non-Lambertian Model from Erdas
 - Based on User Input Constants (k)
 - Constants Difficult to Calculate
- Didn't work well
 - Some Smoothing Occurred
 - Increased Error in Shadows
 - Decreased Ability to Visually Differentiate Between Snow and Bare Earth



Topographic Normalization



IR Simple Ratio

- Masked Vegetation
- IRSR = Band 4/ Band 5
- Layer Stack with Multi-spectral Image
- Perform Unsupervised Classification
 - 10, **20**, 50 Classes
- Recode for Snow & Not Snow



NDSI

- NDSI = $\frac{\text{Band 2} - \text{Band 5}}{\text{Band 2} + \text{Band 5}}$
- Two Methods
 - NDSI Threshold
 - NDSI > 0.4
(Hall, 1995 and Shimamura, 2006)
 - Unsupervised Classification
 - Create Thematic Data for Accuracy
 - NDSI Classified
 - Layer Stack with Multi-spectral Image
 - Unsupervised Classification: 20 Classes
 - Recode




Results - IRSR

- Can Not Identify Snow in Shadows

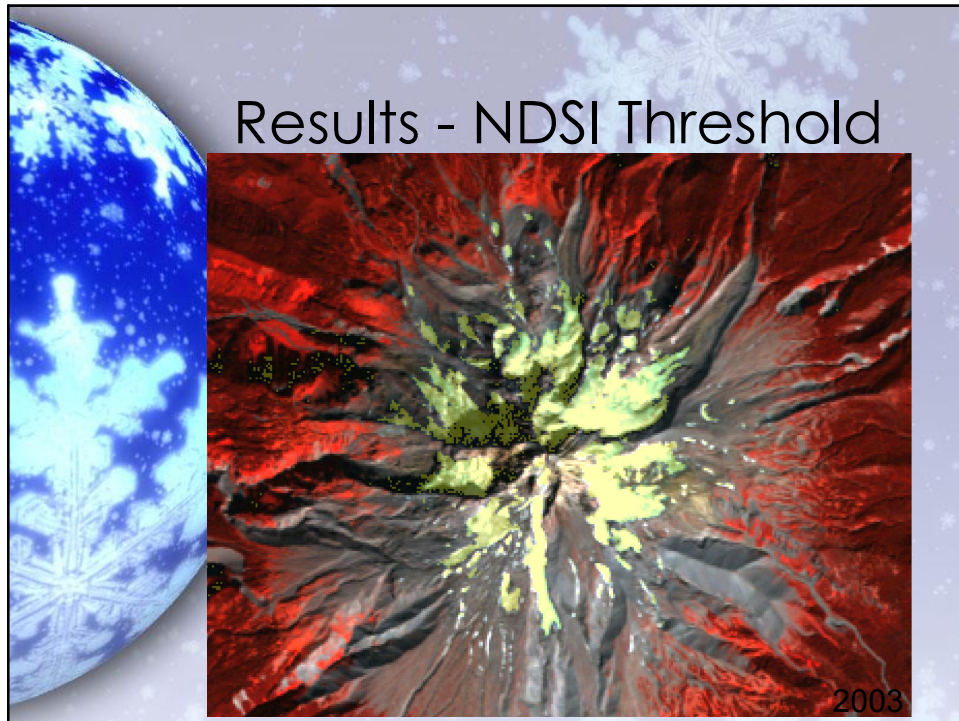


2003



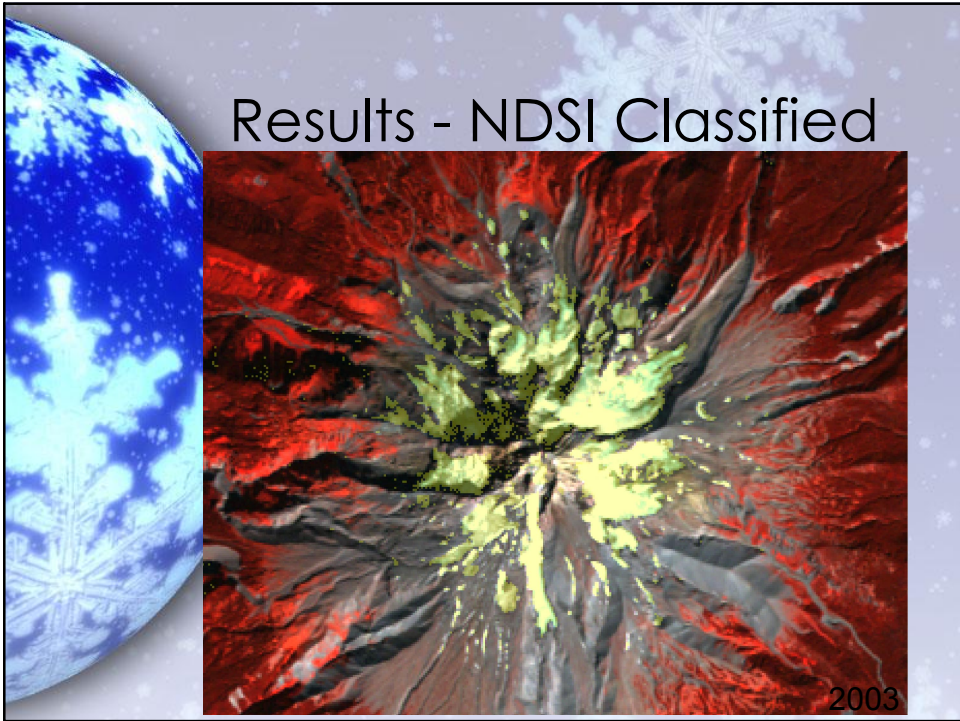
Results - NDSI Threshold

- NDSI Identifies Snow in Shadows
- Areas Below Mountain with NDSI > 0.4 Identified as Snow



Results - NDSI Classified

- NDSI Identifies Snow in Shadows
- Issues Differentiating Between Snow and Bare Earth



Accuracy Assessment

- 100 Equalized Random
 - Verified Against Original Image
- Classification Accuracy (%)

	IRSR	NDSI Th	NDSI CI
1998	99	96	94
2003	100	98	89
2008	99	97	97

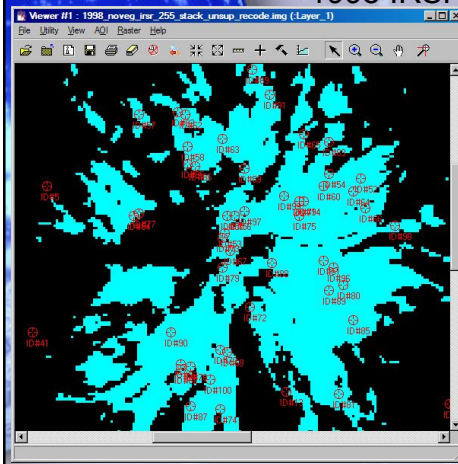
Accuracy Assessment Cont'd

- Kappa Statistics

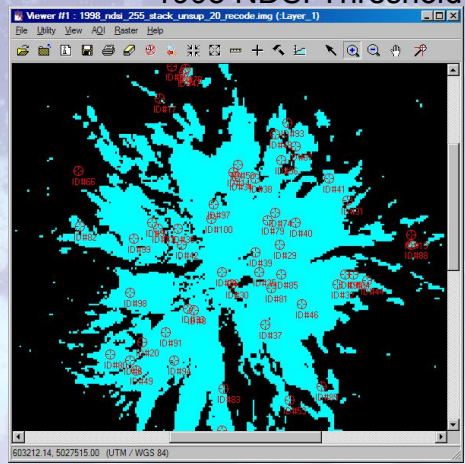
	IRSR	NDSI Th	NDSI CI
1998	0.98	0.92	0.88
2003	1.00	0.96	0.78
2008	0.98	0.94	0.94

Accuracy Assessment Cont'd

1998 IRSR



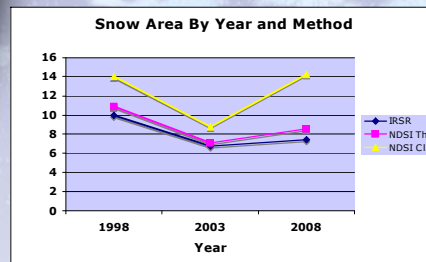
1998 NDSI Threshold



Results - Glacier Area

- Snow Area (km²)

	IRSR	NDSI Th	NDSI CI
1998	9.95	10.87	14.00
2003	6.74	7.07	8.78
2008	7.41	8.54	14.26




Conclusions & Limitations

- IRSR is Most Conservative for Area Est.
 - Doesn't ID Snow in Shadows
 - AA Not Reliable Due to Exclusion of Shadow Areas
- NDSI Threshold is Moderate
 - IDs Snow in Shadows
 - Doesn't Account for User's Information
 - Includes Areas Below Mountain that Are Not Likely to be Snow
- NDSI Classified is Most Liberal
 - IDs Snow in Shadows
 - Classes Aren't Well Defined
 - Human Error/Mixed Pixels



Next Time...

- Higher Resolution Images
- Mask Vegetation for NDSI
- Subset Consisting Mostly of Study Area
- Number of Classes
 - $50 > n > 20$
- Address Debris on Snow



References

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