Operational Monitoring of Alteration in Regional Forest Cover Using Multitemporal Remote Sensing Data (2000-2003)

Janet Franklin
Doug Stow
John Rogan

Lisa Levien

Chris Fischer

Consultants: Curtis Woodcock and Xueqiao Huang

Objectives of the Study

Overview

* **This research will apply remote sensing techniques to map changes in forest cover in California**

* **The scope of this research will be the testing and improvement of an operational FS-CDF forest change monitoring program**

Objectives of the Study

Research Objective 1

Establish an operational forest cover change monitoring program based on the following project efficiency indicators:

Change-map accuracy assessment
Flexibility of implementation
Interpretability of methods and results
Consistency across phenologically diverse areas

Objectives of the Study

Research Objective 1: Related research questions

1. Which change detection techniques produce the most accurate, interpretable maps of forest cover change?

2. How do the existing FS-CDF program methods compare to those generated by state-of-the-art techniques?

3. How do results differ between southwest and northeast California study sites?

Objectives of the Study

Research Objective 2

Implement the forest monitoring program established in Objective 1 to analyze the extant data sets (1996-2000 and 1990-2000)
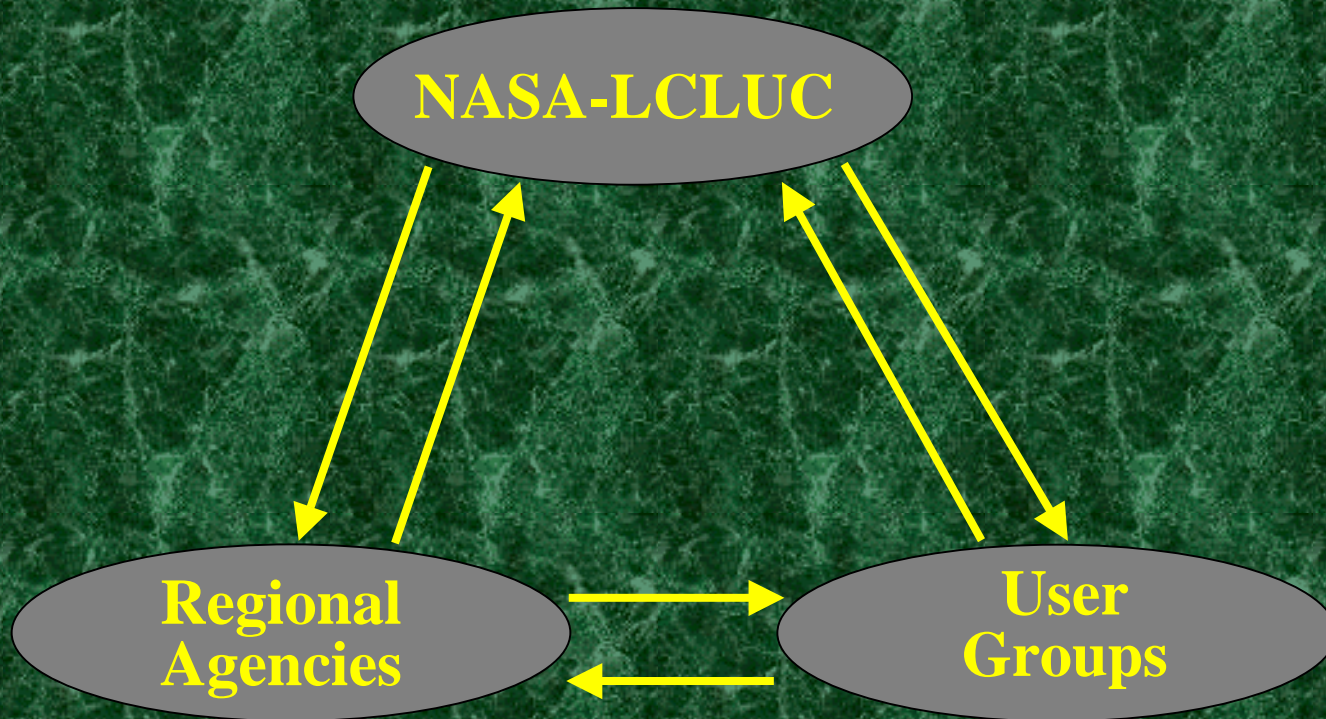
Objectives of the Study

Research Objective 2: Related research questions for the following time periods- 1990-1996, 1996-2000, 1990-2000

1. How is forest cover change manifested in terms of a) geographical extent, b) cause, c) rate?

2. How does forest cover change affect landscape spatial patterns (e.g., habitat fragmentation)?

3. How are changes in forest cover associated with mapped lifeform and species categories in the region?

Scientific Implications

Disturbance Monitoring

Logging
* Selective
* Clearcut

Fire
* Wildfire
* Prescribed

Pest Infestation

Regrowth
* Natural
* Replanting

Urban Growth

8-27-96   I6 615030 596-167   USDA-F

8-27-96   I6 615030 696-27   USDA-F

Symbols for Image Overlays

Change Detection Classes

Large Decrease in Vegetation
Moderate Decrease in Vegetation
Small Decrease in Vegetation
Small Increase in Vegetation
Moderate Increase in Vegetation
Large Increase in Vegetation
Non-vegetation Change

THP Boundary
Boundary of Silvicultural Method
CC   Clearcut
CT   Commercial Thinning
AP   Alternative Prescription
P   Plantation (from previous THP)

Scientific Implications
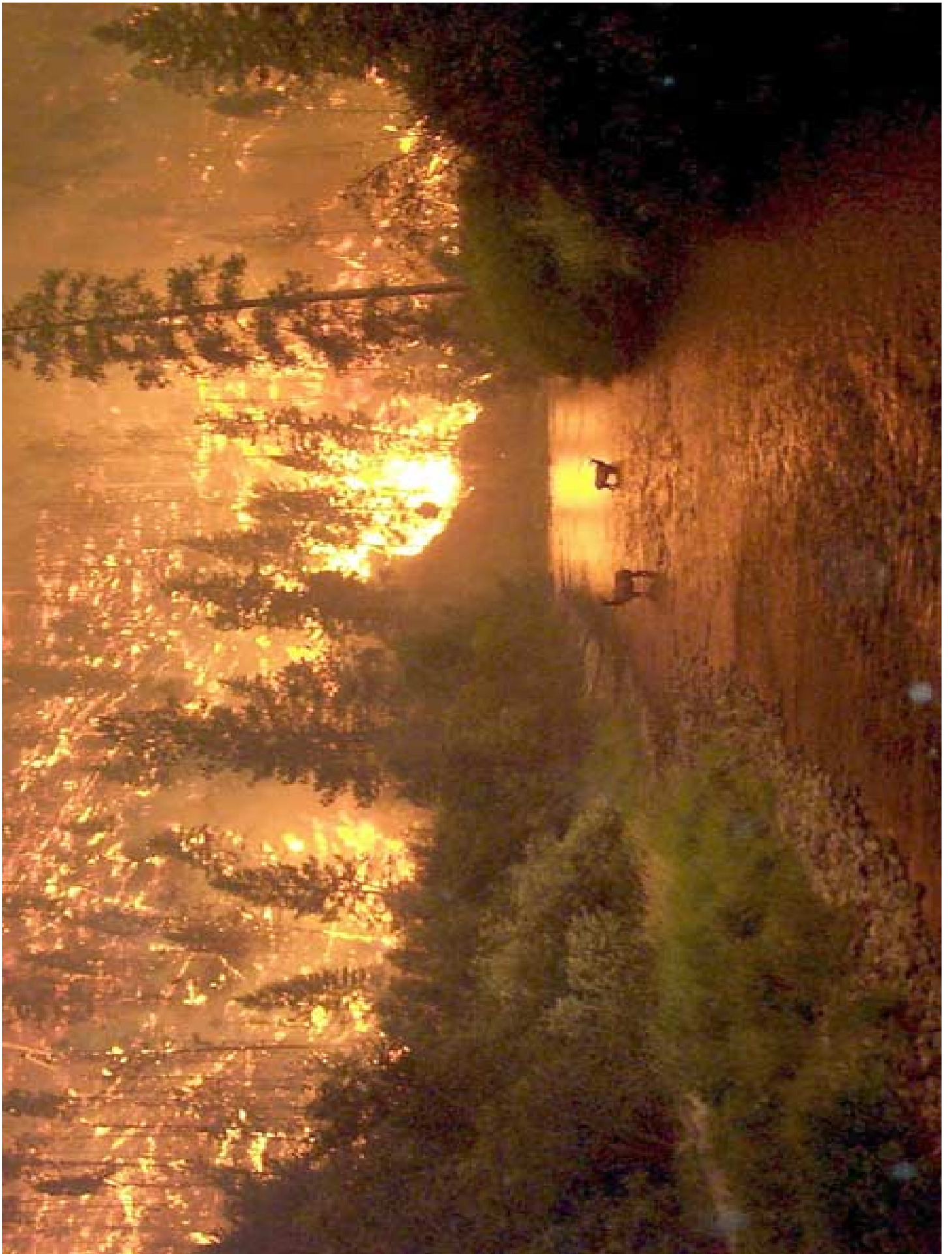
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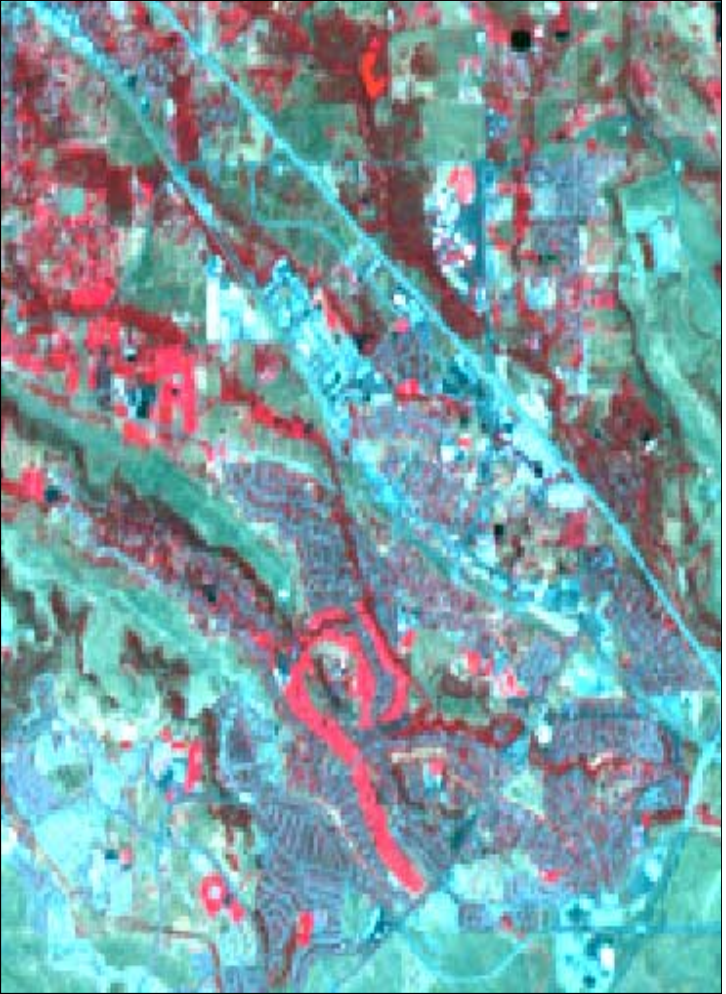
Heritage of the Research

* **San Diego State-Boston University-USDA Forest Service forest cover mapping project**

California National Forests
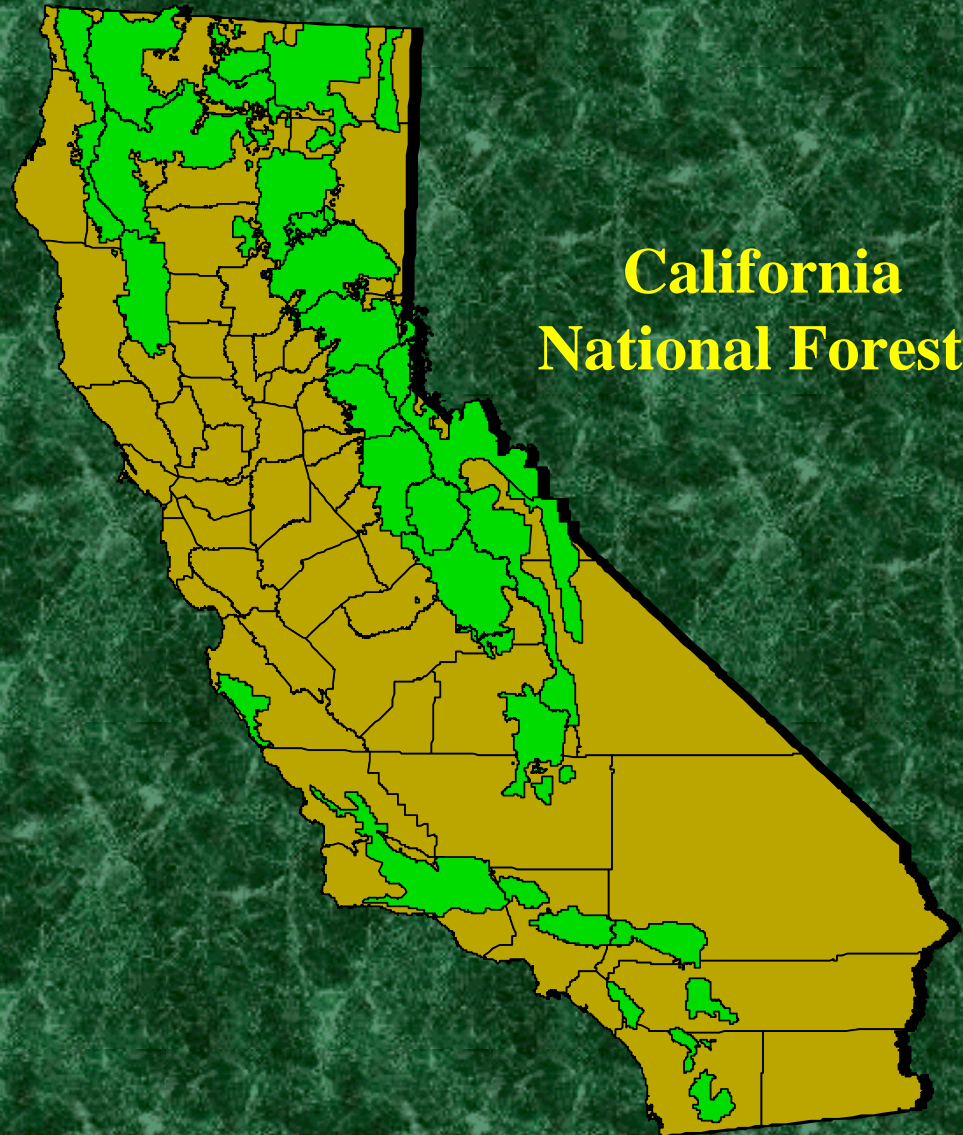
Heritage of the Research

*USDA Forest Service -
California Department
of Forestry and Fire
Protection Change
Monitoring
Program

Northeastern CA

Northern Sierra

North Coast

Southern Sierra

Southern CA
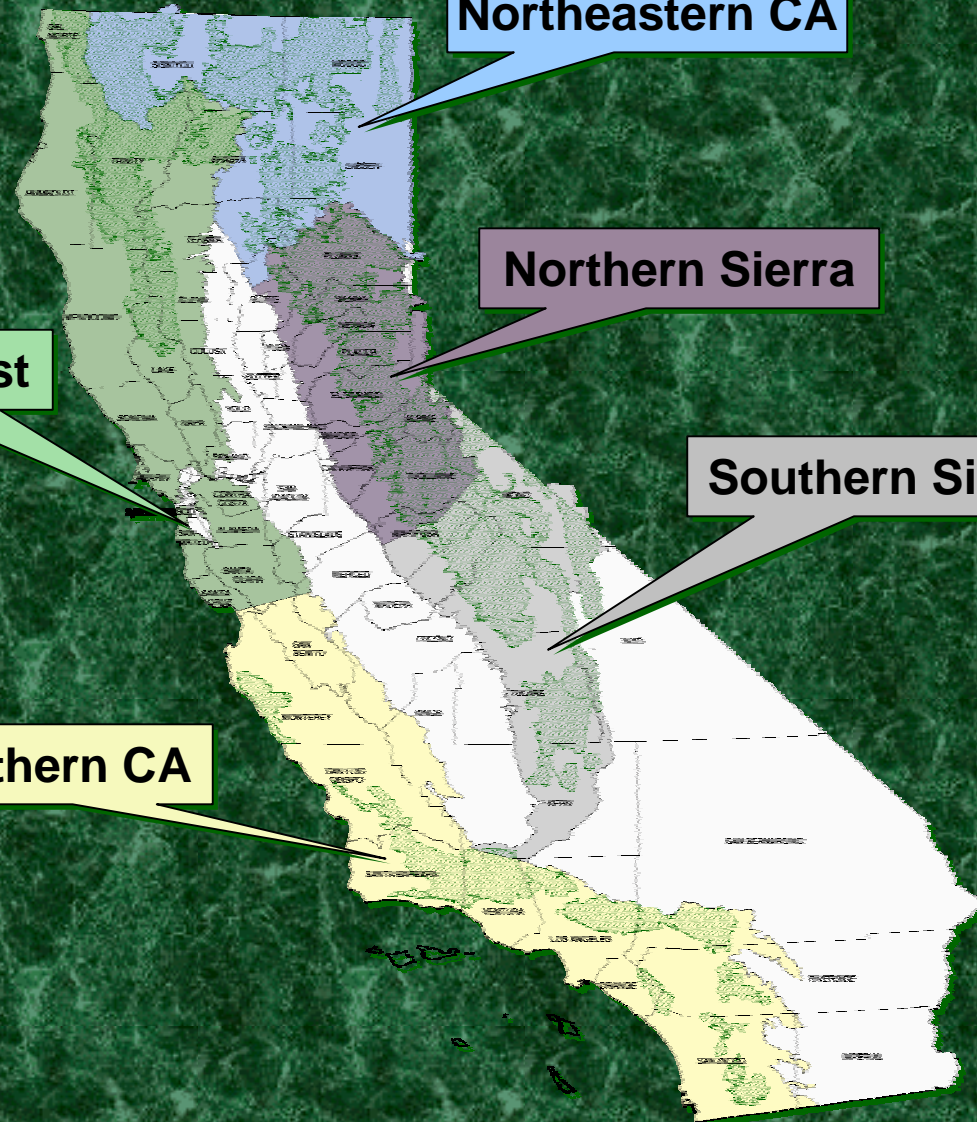
Methods

The research proposed presents a comprehensive, multitemporal, multistage forest cover change monitoring strategy

1. Data sets

Landsat 5 and 7, Aerial Photos, ADAR, IKONOS

Fire Perimeters, Pest Records, Logging Records

Methods
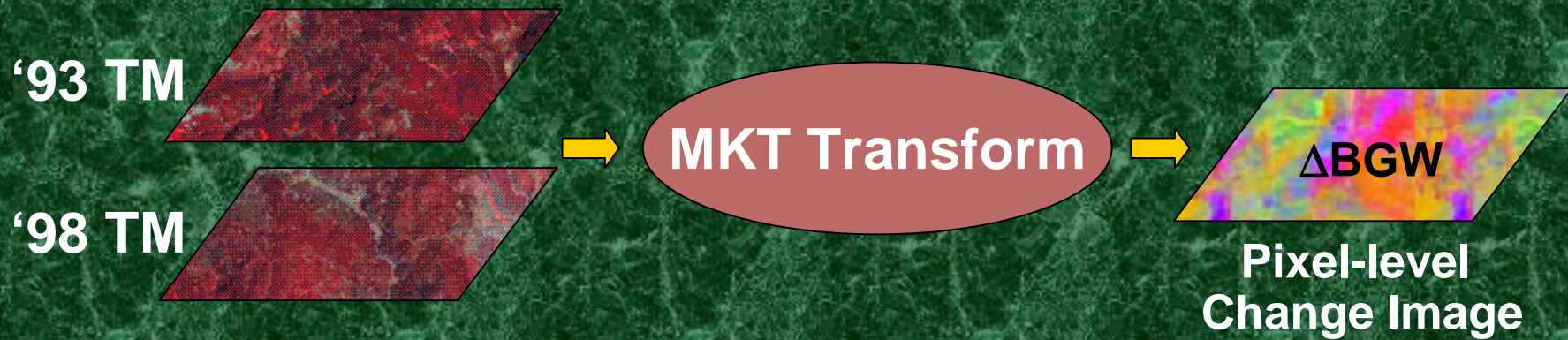
Program Methods - Phase I
Classify and Label Change

Segment-level Change Image

Classify Change

- **Aerial Photos**
- **GIS Layers**
- **Other Imagery**

Phase I Change Map

Methods

Program Methods - Phase II
Aerial Photography

Methods

Program Methods - Phase II
Machine Learning Classifier

- **measured Δ canopy**
- **BGW signatures**
- **covertype**
- **"seasonality"**
- **climate (Δ precip)**
- **cause**
- **aspect**
- **slope**
- **land use zoning**

Classifier → Assess Classification → **Correct** → Final Change Map with Canopy Classes

Not Correct → **Refine Training Data**
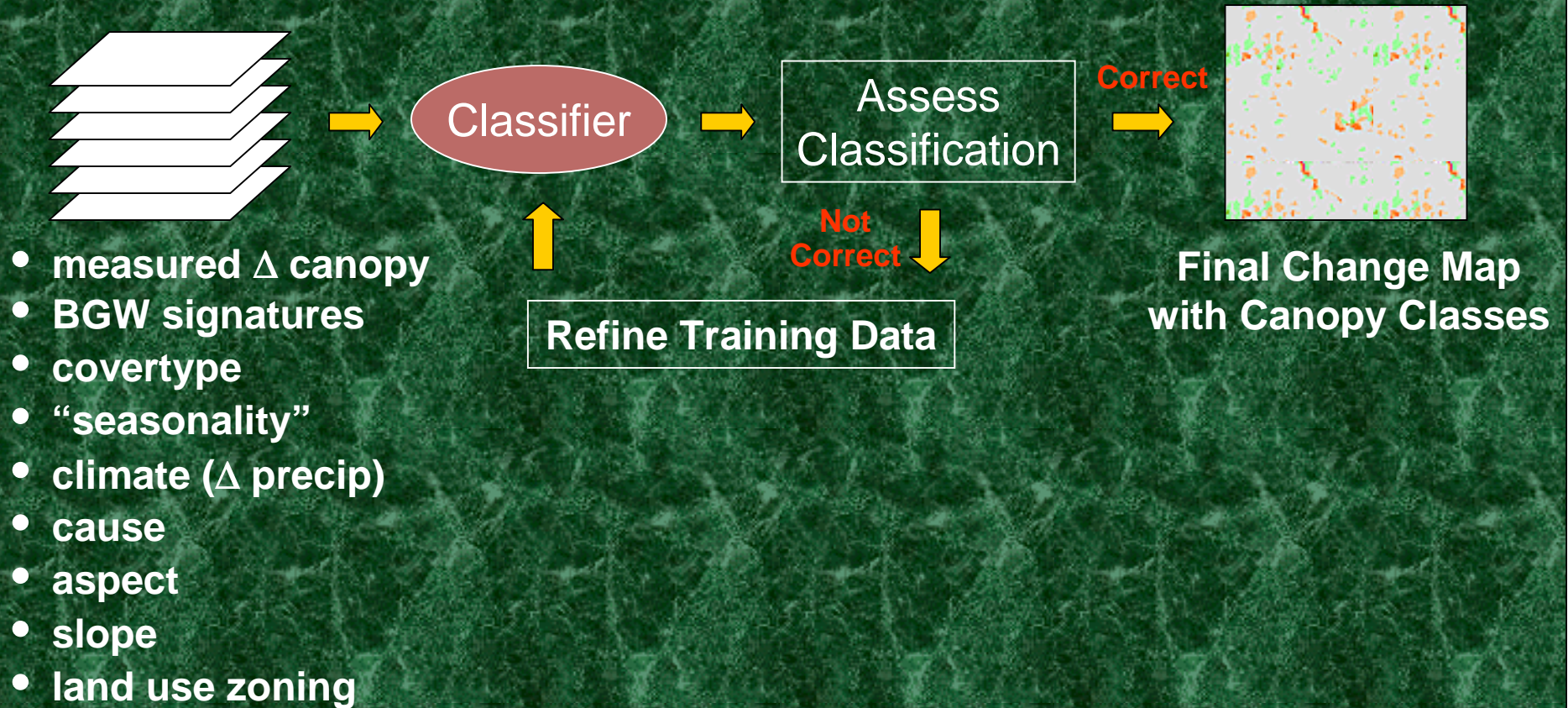
Methods

Change Data
with accuracy assessment

- - 70 to - 100% CC
- - 41 to - 70% CC
- - 16 to - 40% CC
- + 15 to - 15% CC
- + 16 to + 40% CC
- + 41 to + 100% CC
- Shrub/Grass Decrease > 15%
- Shrub/Grass Increase > 15%
- Change w/in Existing Urban Area
- Terrain Shadow
- Cloud or Cloud Shadow

Cause Database

- Mortality
- Wildfire
- Harvest
- Regeneration
- Fuel Break
- Thinning
- Development
- Conversion
- Other
- Unknown
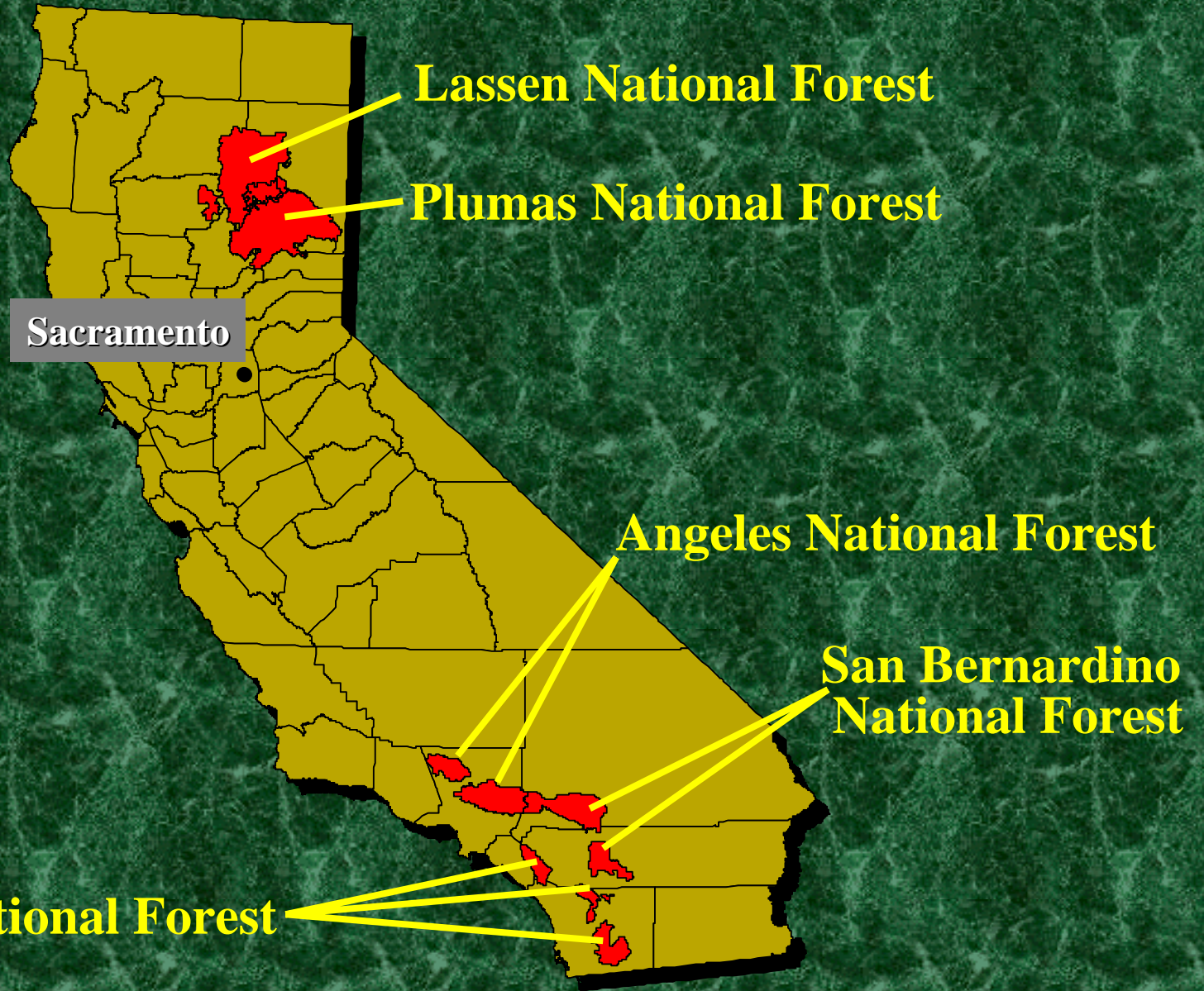
Methods

2. Field Data Collection

3. Radiometric Normalization

4. Geometric Processing

5. Image Enhancement Techniques

      Change Vector Analysis

      Spectral Mixture Analysis

      Spatial Indices (Texture-Context)

6. Classification

      Decision Tree

      ANN-Fuzzy ArtMap

7. Evaluation

Data Plan

DATA TYPE	NOMINAL SPATIAL RESOLUTION	SPATIAL EXTENT	TEMPORAL COVERAGE	ACQUISITION STATUS
Landsat TM 5	30 m	NE California SW California	June 1990 June 1996	Acquired
Landsat 7 ETM	30m	NE California SW California	June 2000	Acquired
IKONOS	1m 4m	NE California SW California	Sept 2000	To be acquired
Digital Orthophographs	Scale: 1:2400	NE California SW California	1989, 1996, 2000 1989, 1996, 2000	Acquired
VCL	25m Horizontal 1m Vertical	NE California SW California	2000? 2001?	To be acquired
MODIS MVI (MOD 13)	250m	California State	June 2000	To be acquired
MODIS Aerosol Product (MOD 08)	10 km	California State	June 2000	To be acquired

Work Schedule

| TASKS AND DELIVERABLES	PROJECT YEAR 1- 2000/ 2001				PROJECT YEAR 2- 2001/ 2002				PROJECT YEAR 3-2002/ 2003			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
These general task categories apply to Phases I and II	Program Prototyping and Testing ------------> For 1996-2000 and 1990-1996 Data						Program Implementation ------------------> For all Data					
1. Acquire Image Data	——	——	——	——								
2. Acquire Collateral Data	——	——	——	——	——	——	–					
3. Image Preprocessing			——	——	——							
4. Field Data Collection	——				——				——			
5. Enhancement and Classification				——	——	——	——	——				
6. Meetings	——		——		——		——		——	——	——	——
7. Presentations		*		*			*			*	*	*

Current Findings

* Forest cover change mapping

* Research Question:

Can Multitemporal Spectral Mixture Analysis techniques be effectively used to accurately map forest cover changes in southern California?

* Specifically:

     - What categories of forest cover change can be mapped using MSMA techniques?
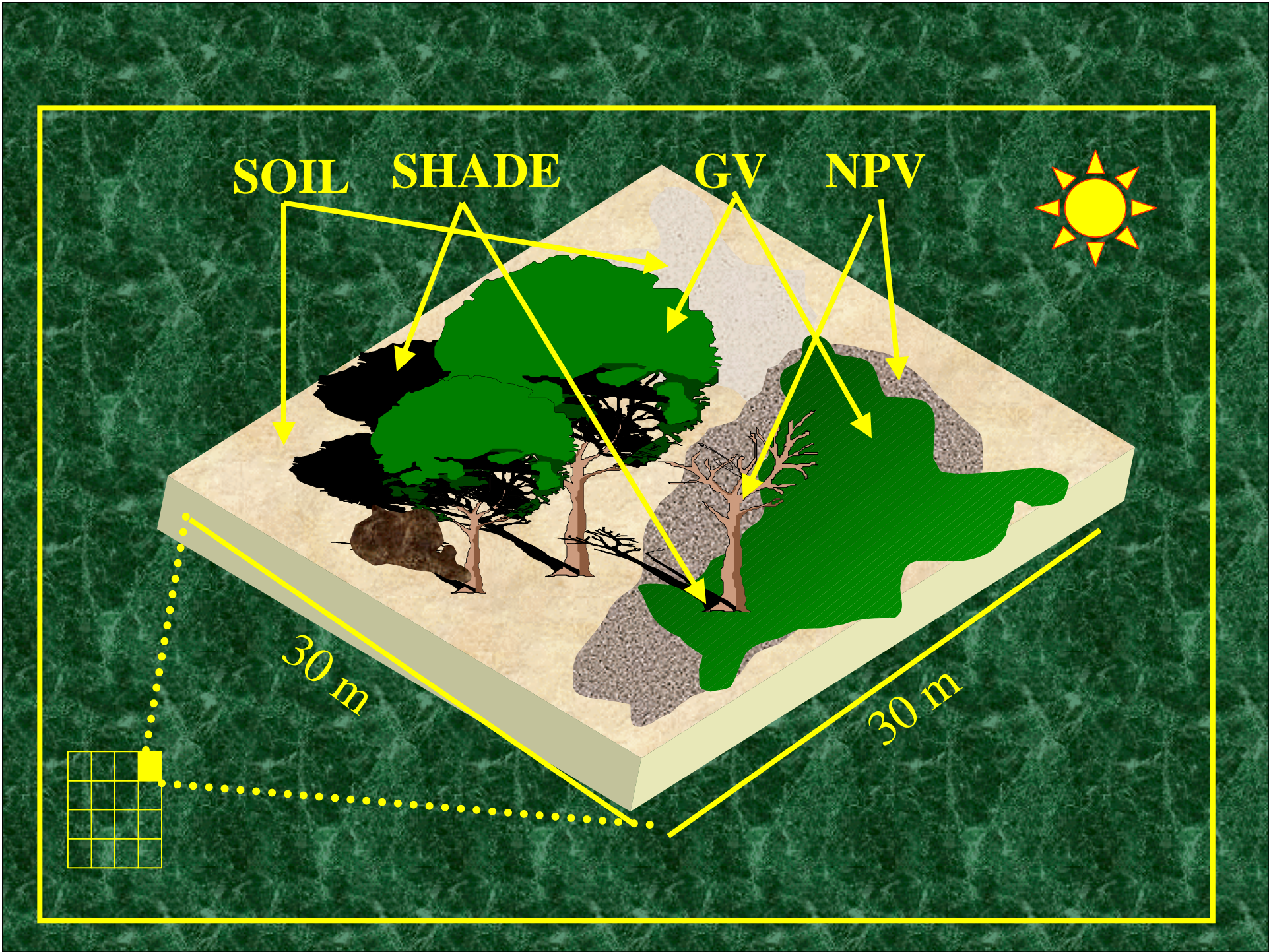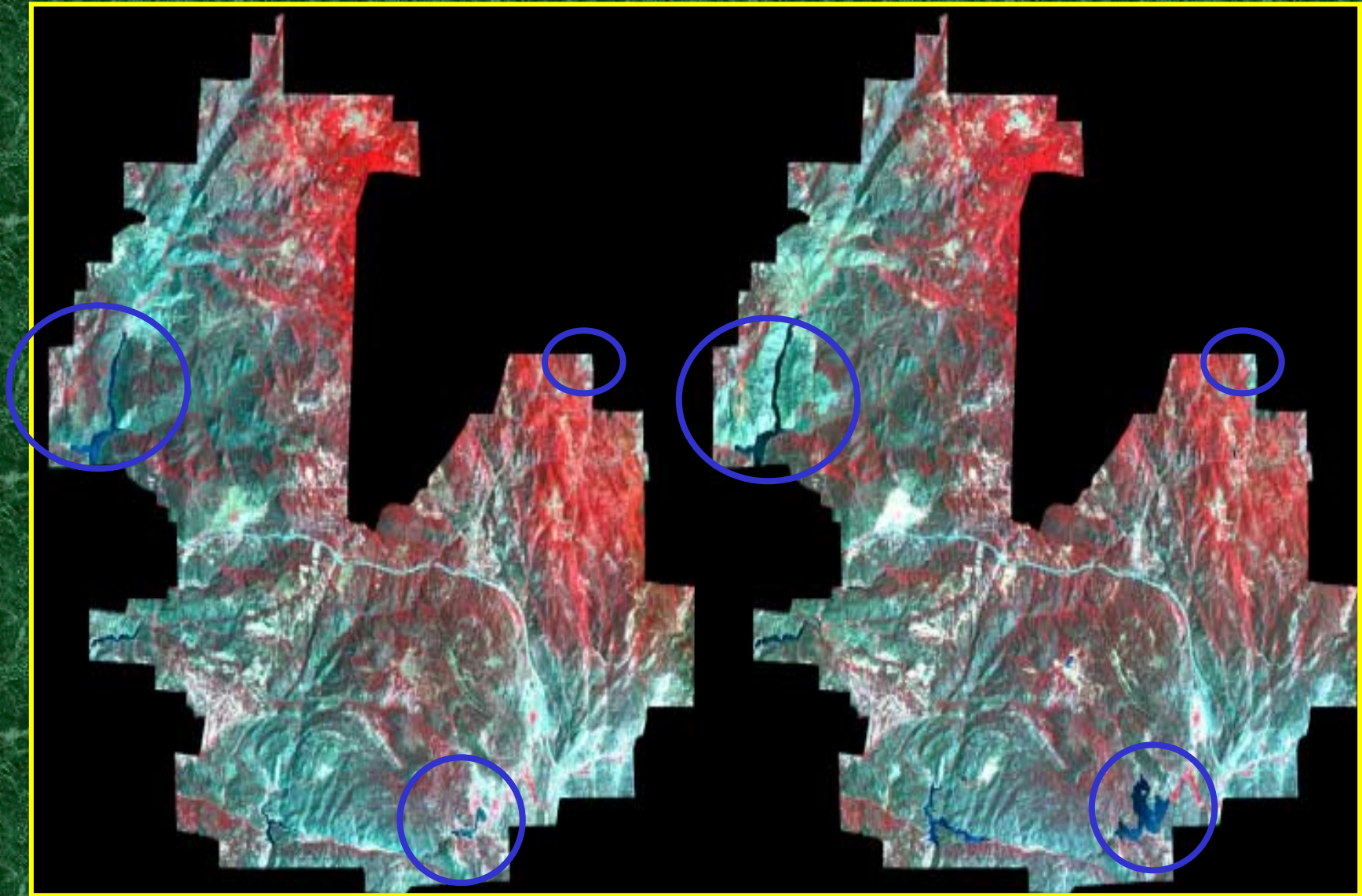
SOIL SHADE GV NPV

30 m

30 m

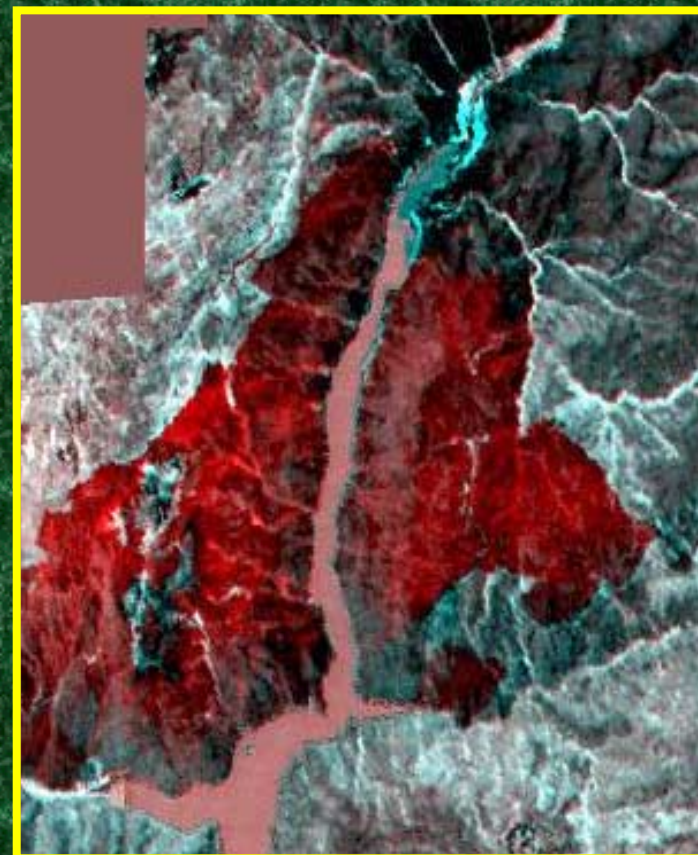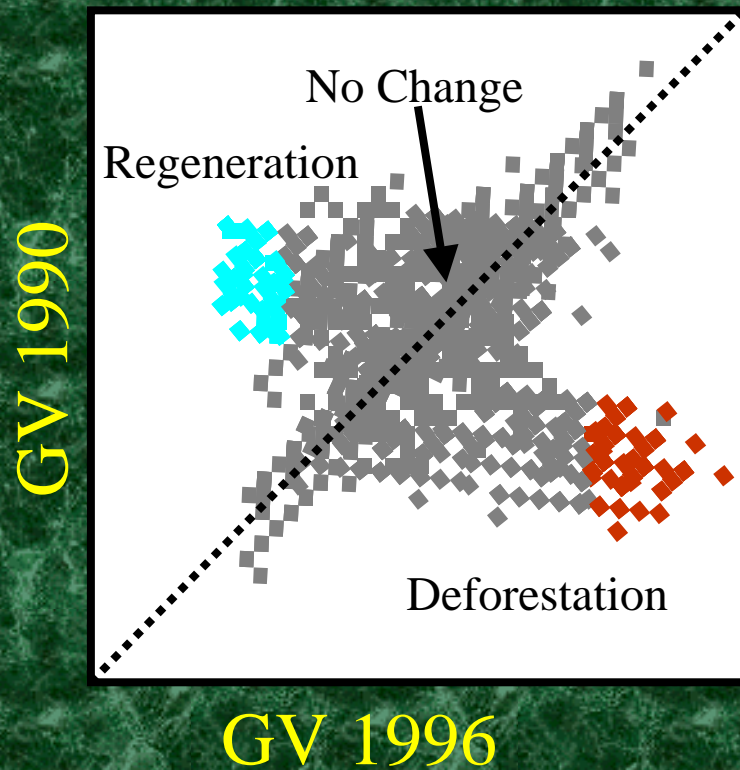Descanso: June 1990

Descanso: June 1996

Endmembers used to Model 90-96 Scenes

FRACTION ANALYSIS

Regrowth and Deforestation

No Change

Regeneration

GV 1990

GV 1996

Deforestation

Red = GV 1990
Blue, Green = GV 1996

Results

Contingency Matrix: Decision Tree Classification

	REF TOTALS	CLASS TOTALS	CORRECT	PRODUCER'S ACC.	USER'S ACC.	KAPPA
Water Recharge	33	30	26	78.79%	86.87%	0.82
No Change	44	30	23	52.27%	76.67%	0.66
Vegetation Increase	27	30	20	74%	66%	0.59
Vegetation Decrease	25	30	23	92%	76.67%	0.72
Change in Non-vegetated areas	21	30	16	76%	53%	0.45
Totals	**150**	**150**	**108**	**72%**		**0.65**