The Ecosystem Disturbance and Recovery Tracker (eDaRT)

system prototype or high-fidelity near-real time ecosystem monitoring

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1. Introduction

Across the globe, the demand for timely and accurate ecosystem dynamics information at the Landsat spatial scale and various temporal scales is growing, and as of today, still exceeds the product availability. The diversity of disturbance metrics, sensitivity vs. reliability trade-offs, as well as requirements from timeliness of product generation and needed customizations, suggest that a single "centralized" comprehensive system is not likely to fill such diverse and dynamic demand in the near future.

To address daily ecosystem management needs, we have developed an initial version of the *Ecosystem Disturbance and Recovery Tracker* (*eDaRT*) system prototype for rapid assessment and product generation beyond annual comparisons to take advantage of all available Landsat images.

2. eDaRT Objectives

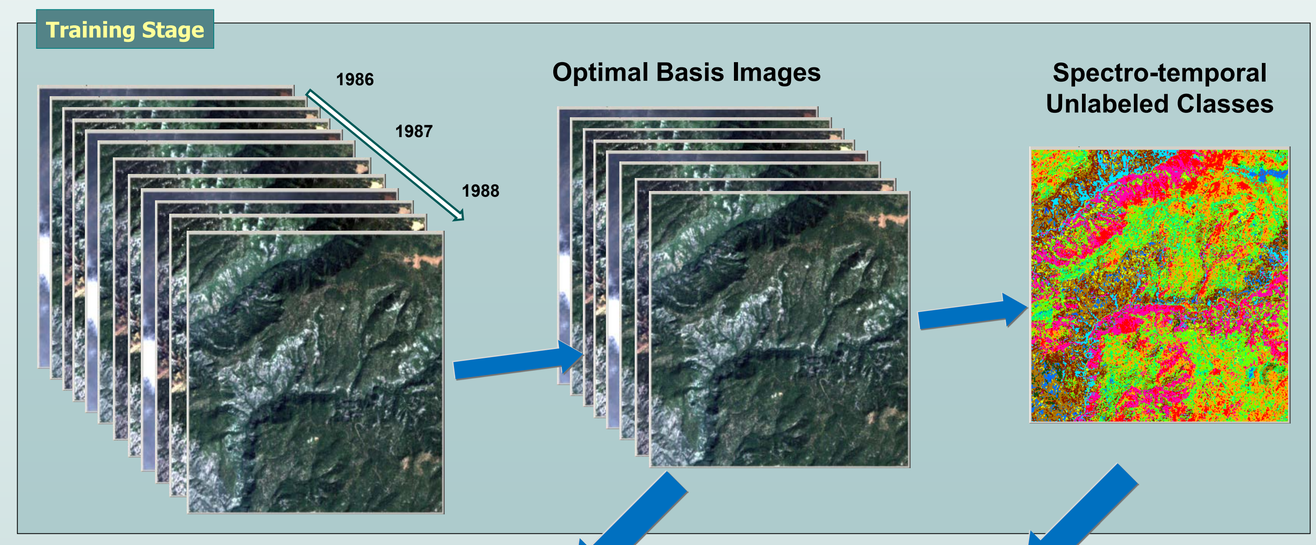
- Address multiple questions & inform land management:
  - **Early detection (accurate timing)** of disturbances for rapid assessments and tactical decision making;
  - **Sensitivity** to low-magnitude & small scale effects;
  - **Reliability & Robustness** against phenological and other irrelevant variability (not simply changes, but anomalies!)
  - **Grasslands and Shrublands, too** (not only forests!)
  - **Customized** Product Development and **Rapid** generation

3. Features & Current Functionality

- **Can process all available images.**
  - currently, Landsat 5/7 with <90% scene cloud/snow area
- **Fixed, user-defined baseline period.** No need to wait until there are enough cloud-free recent observations available: it is "ready to go" with the first available image.
- **Combines spectral, temporal, and spatial information**
- **Currently available products** (MATLAB & ENVI formats)
  - Cumulative Effect Classification Maps (for each date):
    - Disturbed (11 confidence classes), (see sect. 5.5)
    - Regenerating (11 confidence classes)
  - Timing of the First Disturbance Event (sect. 5.6)
  - Temporally filtered maps: retain only repeat detections

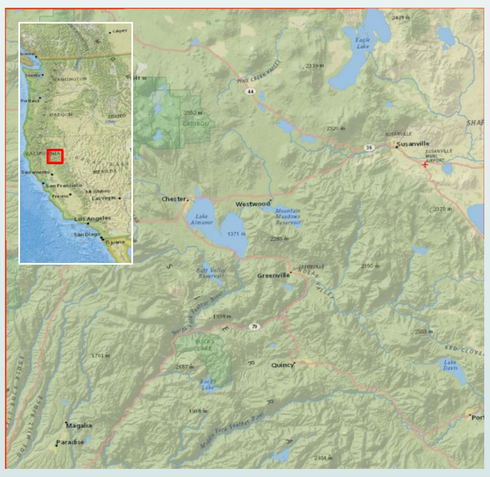
4. Algorithm Overview

Anomaly Detection Method: Segmented Dynamic Detection Model (sDDM)



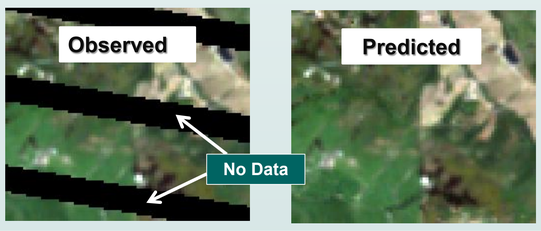
- **The Segmented DDM** extends the DDM approach by Koltunov et al. (2009).
- **The sDDM concept:** resolve the "no-anomaly" value at a pixel of a current image using:
  - past values at that pixel, and
  - the relationship between past and current values at other pixels belonging to a similar land cover type
- **eDaRT fuses the sDDM with spatial context analysis,** thus boosting detection sensitivity.

5. eDaRT Performance and Sample Outputs



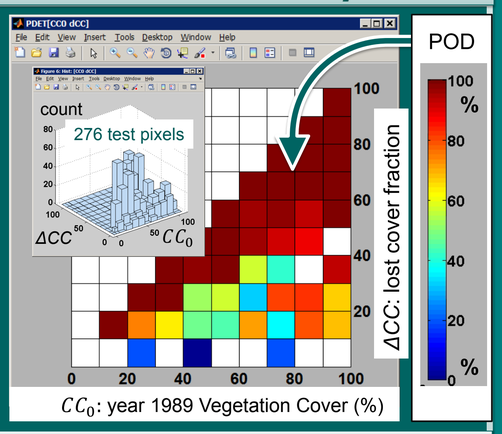
Scene	Northern California, 3763 x 3860 30-m Landsat 5 pixels
Baseline image period	year 1989 (7 basis images used)
Monitoring Period	11/1989 – 11/2011: April –November (219 dates total)

5.1 Seamless Background Prediction



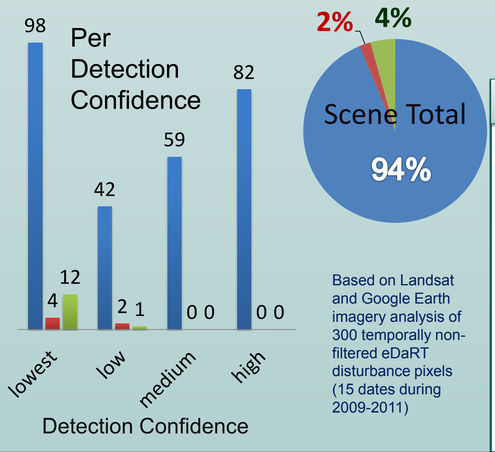
5.2 Probability of Detection (POD) vs. Disturbance Intensity

Sample:	276 pixels from various disturbance intensity levels
Disturbance intensity	ΔCC (estimated change in Vegetation Canopy Cover)
Sampling scheme	random, stratified by intensity level
Assessment Method	visual interpretation of multitemporal high-resolution imagery (Google Earth, NAIP)



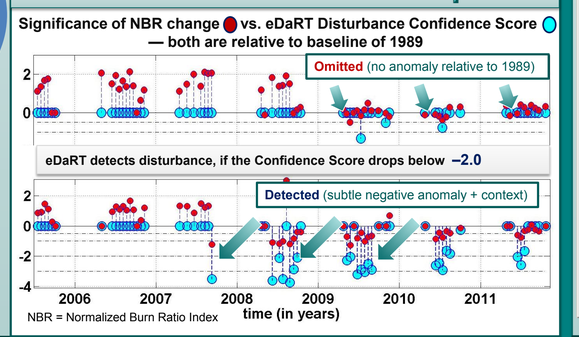
5.3 User accuracy: 94-98%

How many of the eDaRT detections are True Disturbances?

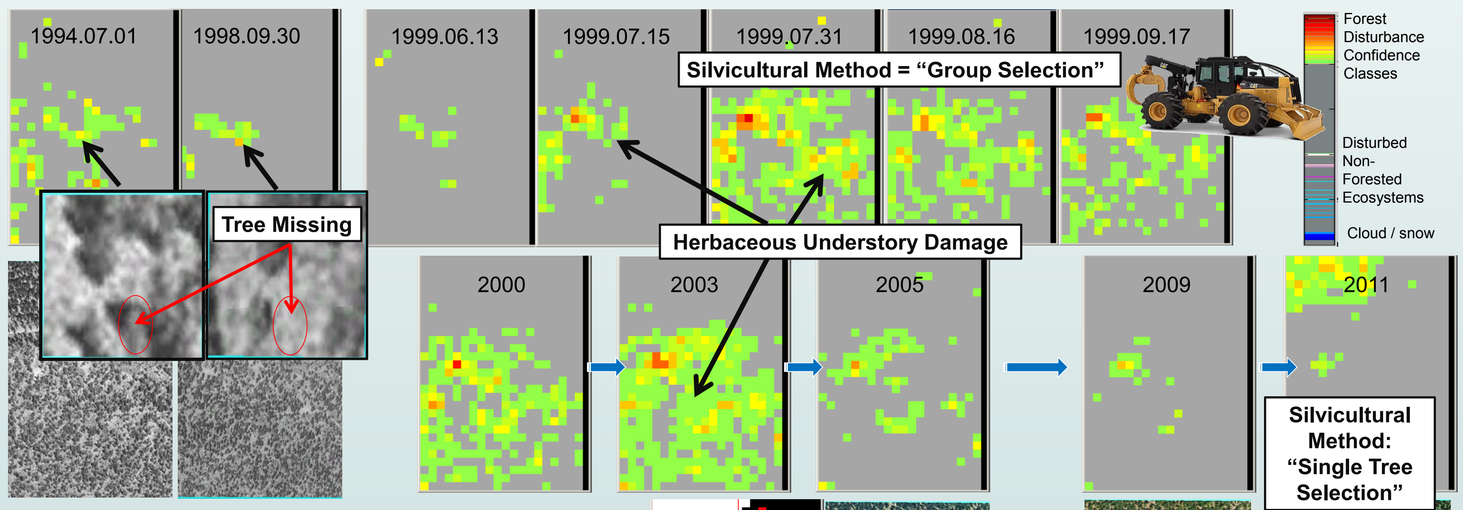


Based on Landsat and Google Earth imagery analysis of 300 temporally non-filtered eDaRT disturbance pixels (15 dates during 2009-2011)

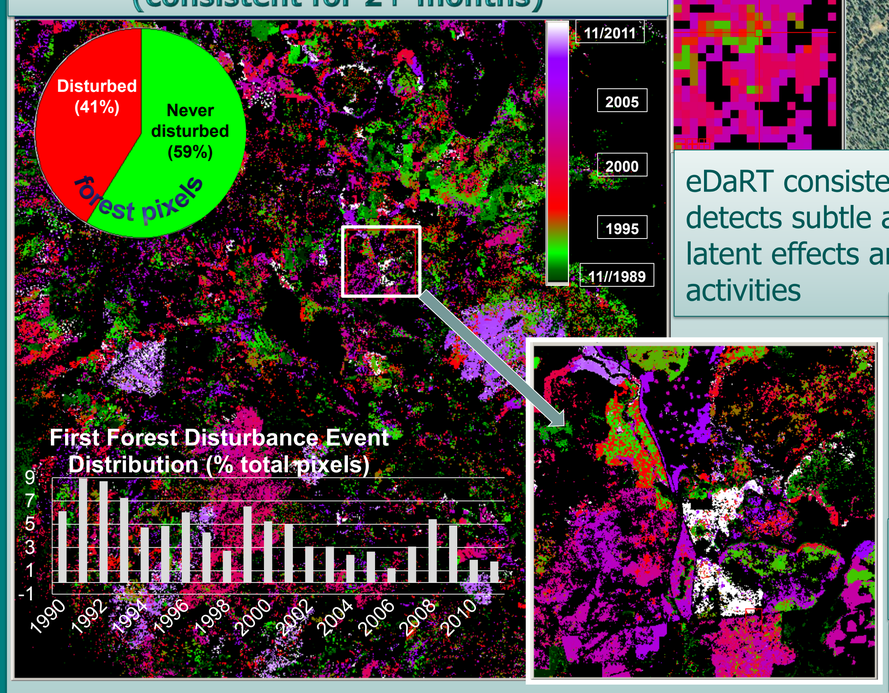
5.4 Detected and Missed Impacts



5.5 eDaRT reveals Multiyear Selective Logging and Understory Damage by Tractors/Skidders



5.6 Timing of First Forest Disturbance (consistent for 2+ months)



eDaRT consistently detects subtle and latent effects and activities

- ✓ selective logging, thinning,
- ✓ understory clearing, mastication
- ✓ … and higher level impacts (duh!)

6. Conclusions

The evolving monitoring capabilities of eDaRT will complement the suite of forest monitoring tools to provide a synoptic view of ecosystem dynamics and disturbance processes at high temporal scales.

Basic outputs of the eDaRT system are being used today to support daily management of California ecosystems

New products and functions are under active development, based on user demand

References

- Koltunov, A., Ben-Dor, E., Ustin S.L. (2009) "Image construction using multitemporal observations and Dynamic Detection Models". *International Journal of Remote Sensing*, v.30 (1) pp.57-83
- Koltunov, A. & S. Ustin (2007) Early fire detection using non-linear multitemporal prediction of thermal imagery. *Remote Sensing of Environment*, 110, 18-28

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