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Analysis of Thirty Years of Land Change in Georgia: Patterns, Carbon Dynamics and Drivers

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Collabs:	Paata Torchinava Zviad Tiginashvili

Project carried out in collaboration with Volker Radeloff's LCLUC project in the Caucasus

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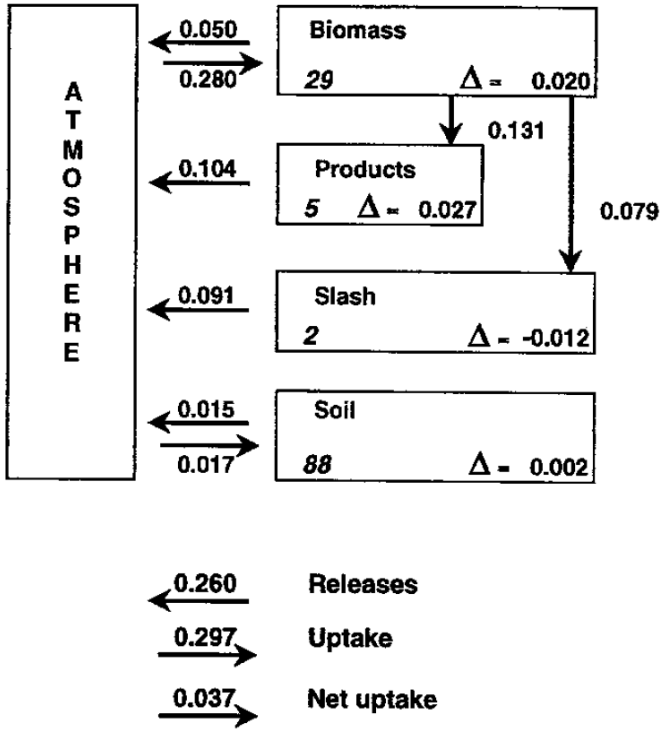
Background

- NASA Carbon Cycle Science 2004; former Soviet Union countries
- Proposal: quantify deforestation, harvest, forest expansion, carbon bookkeeping of associated emissions, Black Sea Region[1]
- Approach: categorical change map by comparing image pairs, accuracy measures to communicate map quality



Houghton et al. (1999), *Science* vol. 285

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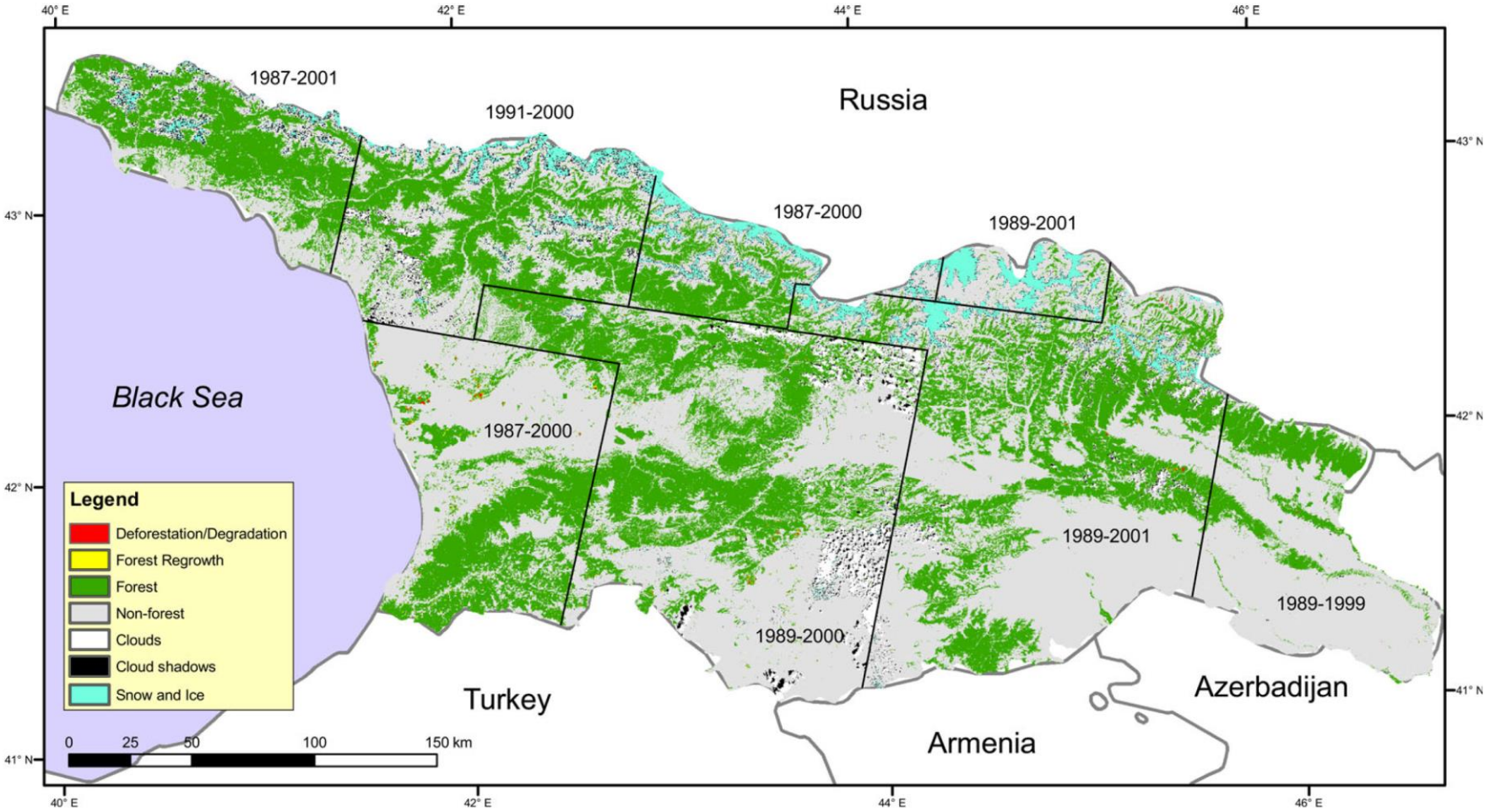
[1] NASA Carbon Cycle Science, 2005-2008, PI: Woodcock (*Quantifying the Effects of…*)



Olofsson et al. (2010), *Carbon Balance & Management* vol. 5

Georgia, results, earlier study[1]

- Hard to map deforestation – area estimate 1990-2000, almost 100% margin of error (as opposed to Romania[2])
- Forest expansion not stat. sign. different from zero
- Forest degradation/recovery – categorical mapping failed to characterize landscape dynamics
- Land use legacy impact current carbon dynamics

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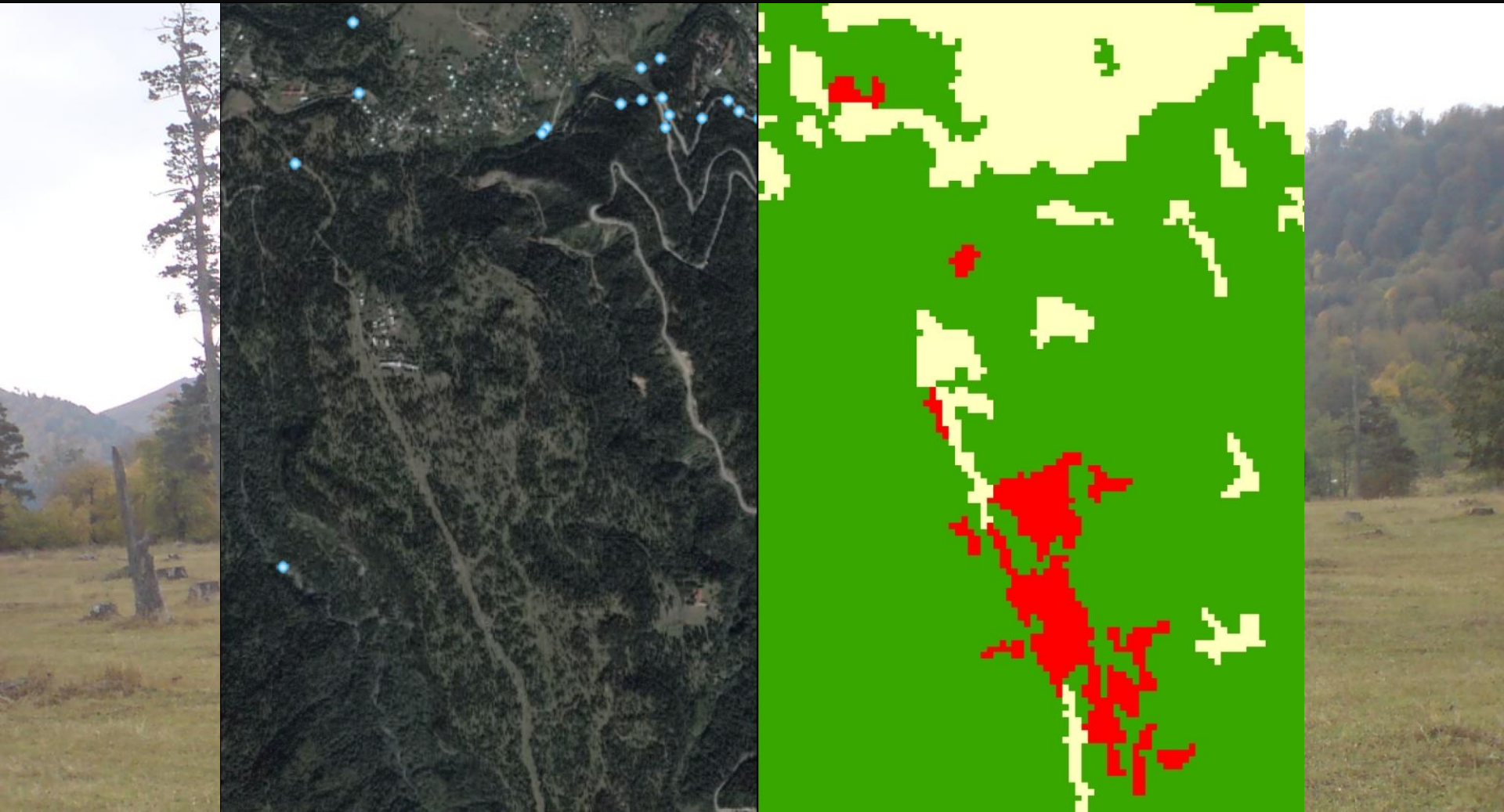
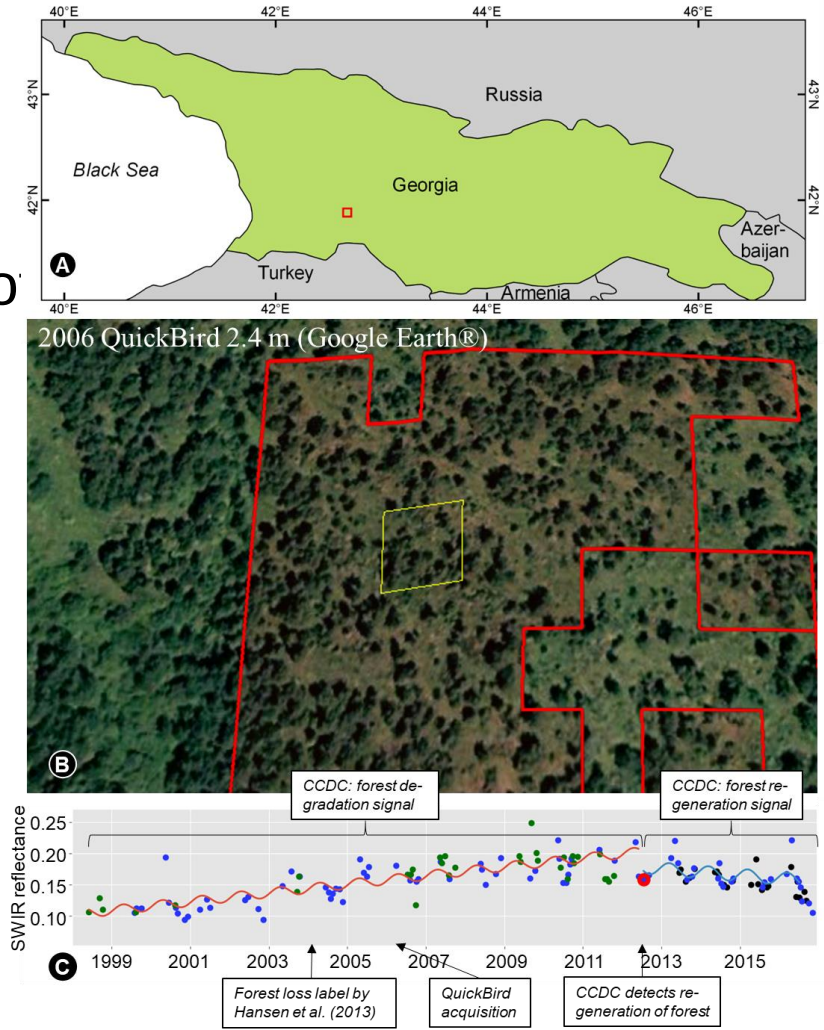
[1] Olofsson et al. (2010), *Carbon Balance & Management* vol. 5
[2] Olofsson et al. (2011), *Environmental Research Letters* vol. 6



This proposal

- Time series-based monitoring o
  forest degradation and *post-disturbance landscapes*
- *Spatiotemporal* carbon bookkeeping[2]
- *Social science* component – socioeconomic and ecological determinants of land dynamics



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CODED

- Using a modified version of CODED[1] (Continuous Degradation Detection)
- Time series analysis of endmember fracions
- Fraction of shade endmember instead of NDFI (normalized degradation fraction index)

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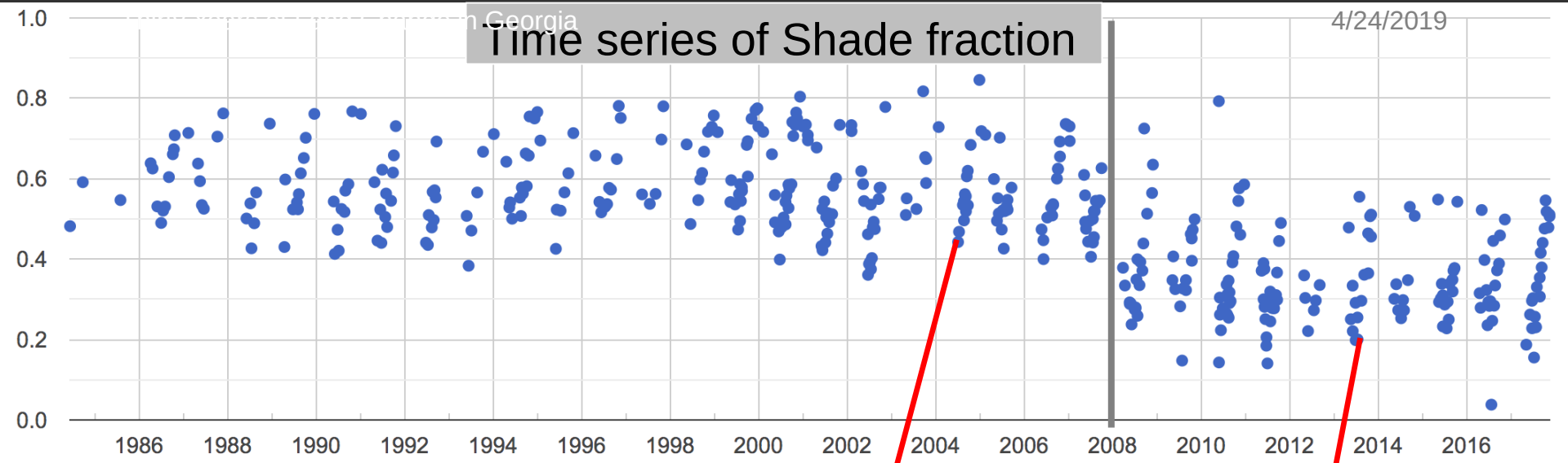
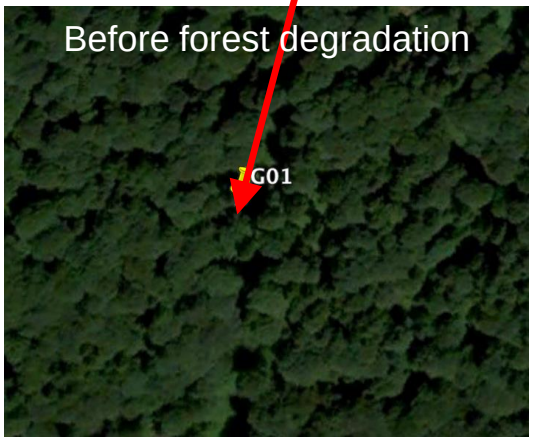
1 Bullock, E. L., Woodcock, C. E., & Olofsson, P. (2018). Monitoring tropical forest degradation using spectral unmixing and Landsat time series analysis. *Remote Sensing of Environment*.

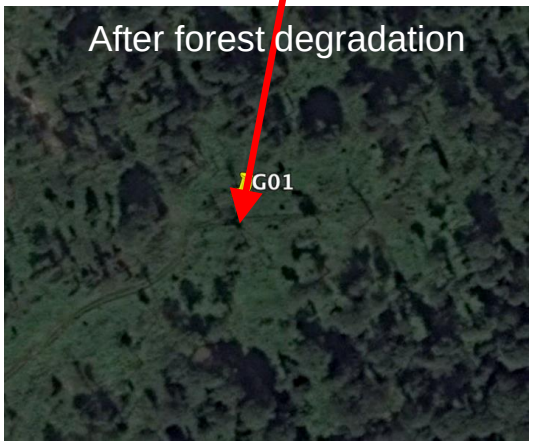
Time series of Shade fraction

4/24/2019





High-res 07/06/2004



High-res 08/13/2013

Thirty Years of Land Change in Georgia

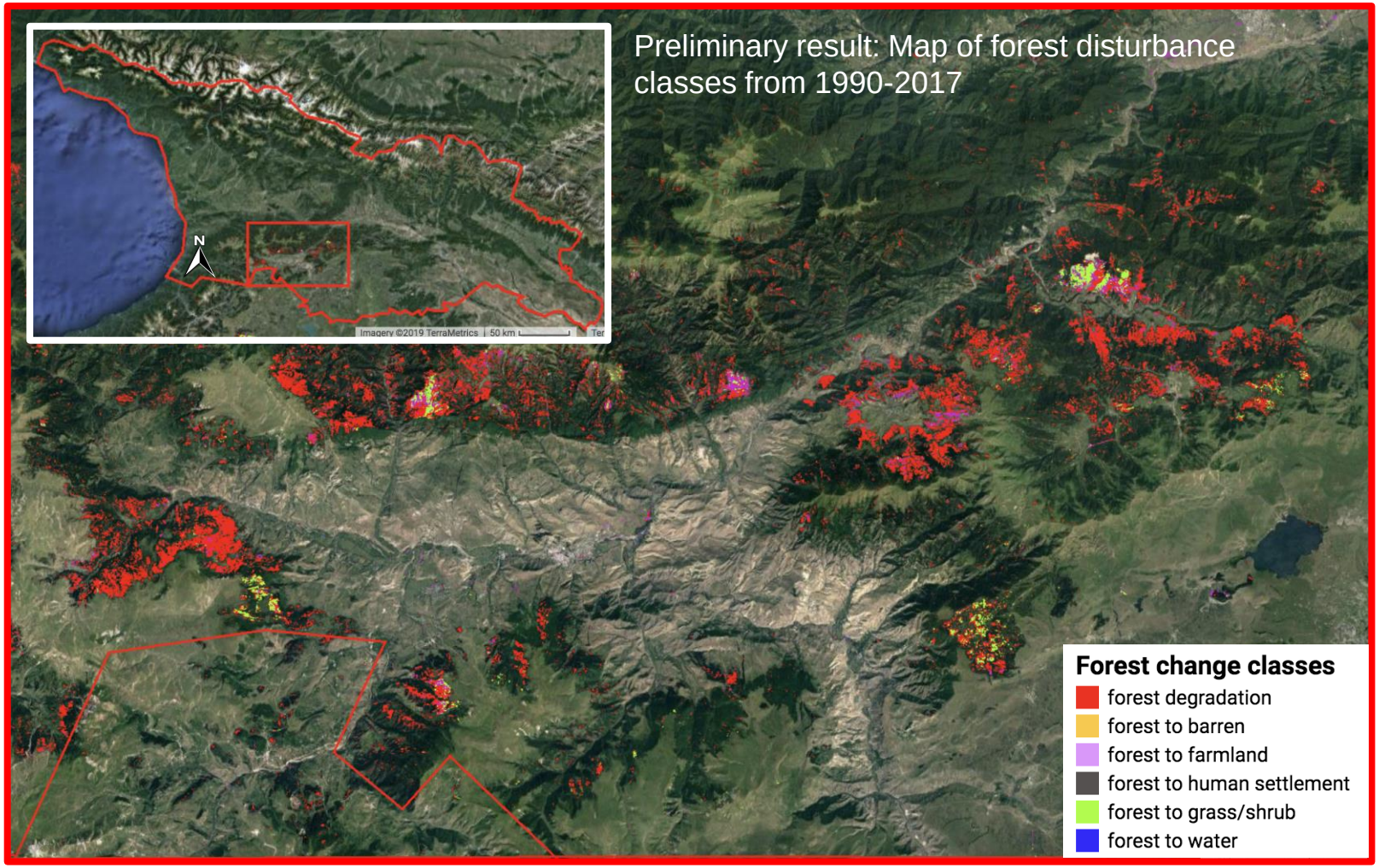
4/24/2019

Preliminary result: Year of forest disturbance map from 1990-2017

Change Year

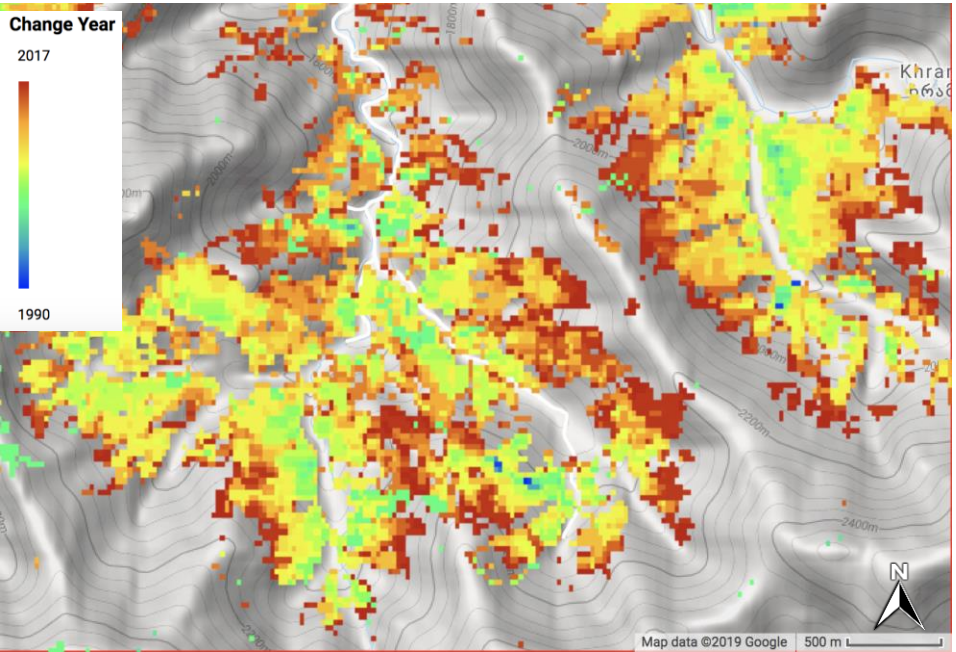
2017

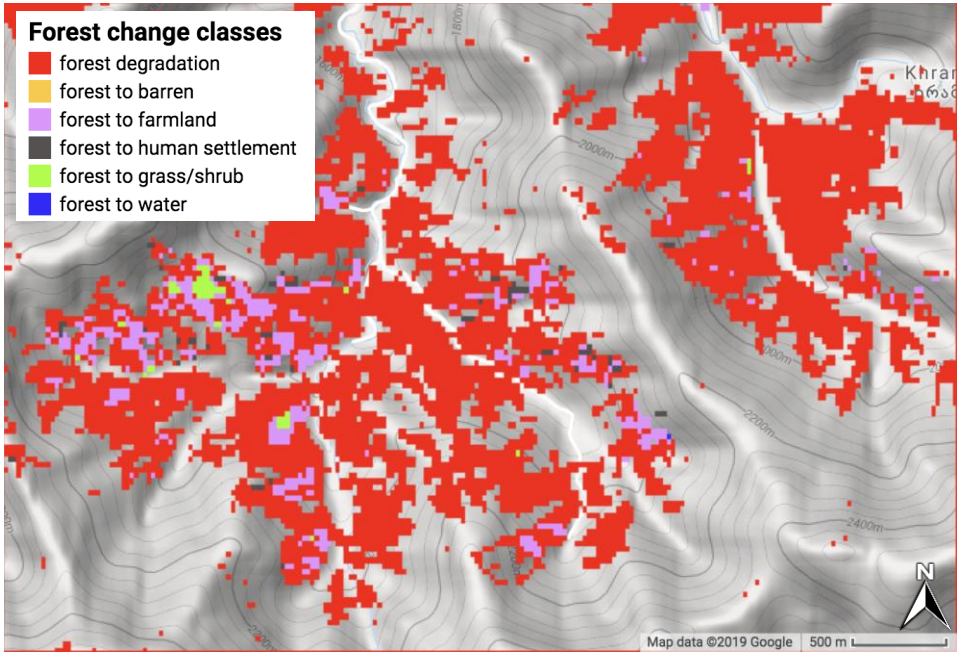
1990


Preliminary result: Map of forest disturbance classes from 1990-2017
N
Imagery ©2019 TerraMetrics | 50 km
Forest change classes
forest degradation
forest to barren
forest to farmland
forest to human settlement
forest to grass/shrub
forest to water

Expansion of forest degradation

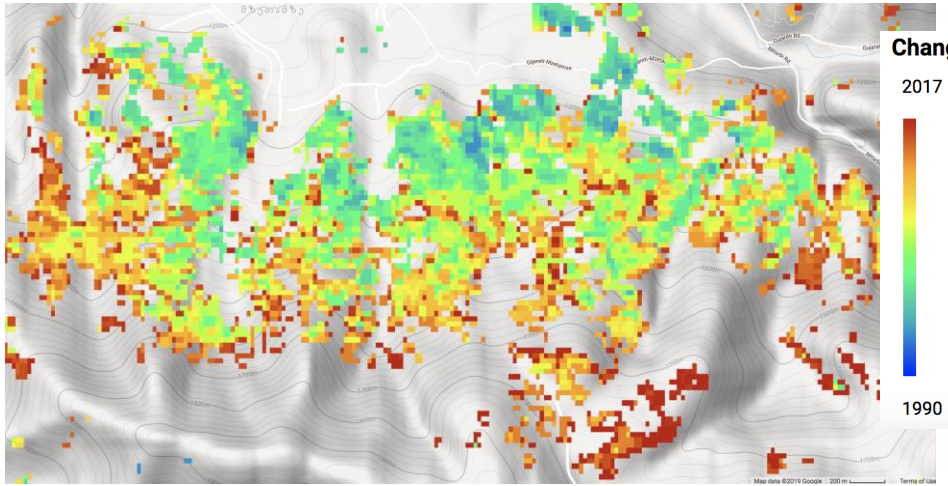
From accessible area to less accessible area

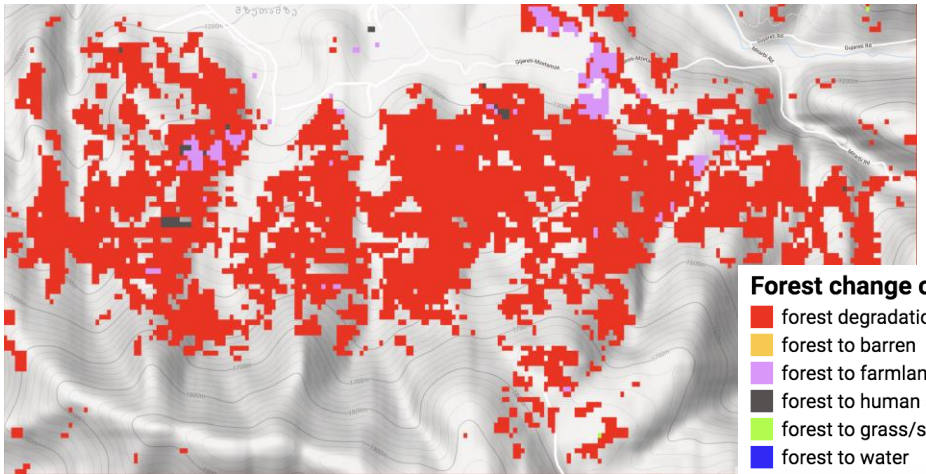




Expansion of forest degradation

From accessible area to less accessible area





What drives forest degradation?

- Forest degradation – most prevalent landscape process
- Scoping trip to Georgia Nov. 4-11, 2018, to meet with scientists and various government officials
- Also, field visits and interviews with farmers and foresters

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Drivers of forest degradation?

- Multiple stressors:
  - Logging for fuelwood
  - Climate change
  - Fires
  - Pests
- Fuelwood important:
  - Lack of employment
  - High poverty levels
  - Living standard disparities between urban and rural areas

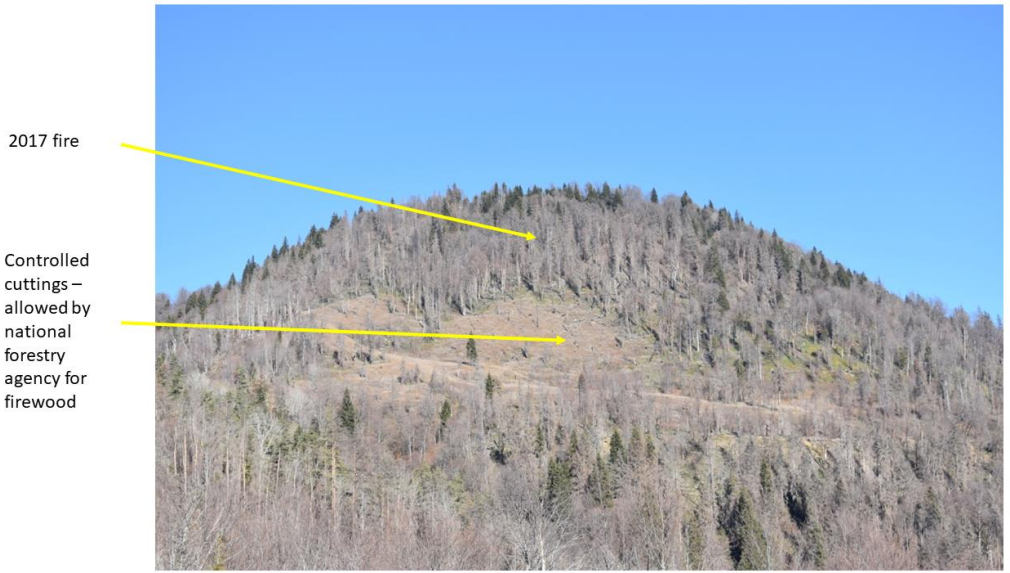

Photo: Dr. Rachael Garrett

Drivers of forest degradation?

- Hypothesized drivers of forest disturbance
  - Demand for fuelwood (climate + price of heating alternatives + income + labor/time available + culture)
  - Access to forests (roads + vehicles + forest law enforcement)
- Econometric model specification (with available data)
  - Panel analysis:
    - Forest degradation ~ demand for fuelwood + access to forest
    - Observations = pixels, years = census matched w/ remote sensing

Ph.D. student Owen Cortner (second from right) and collaborator Paata Torchinava (right) discuss forest change maps with scientists at the National Forestry Agency

Co-investigator Dr. Rachael Garrett (right) listens to a kiwi farmer (left) in Samagrelo-Zemo Svaneti discuss international markets for Georgian produce

Collaborator Paata Torchinava (middle) and Ph.D. student Owen Cortner (right) listen to the history of a farmer's (left) land and the surrounding area in Samegrelo-Zemo Svaneti

Next steps (1/2)

- Expand database of socioeconomic variables, and begin analysis of available agricultural census data
- Fieldwork July 2019; interviews with farmers, foresters, land managers, other stakeholders; collect reference obs. and biomass of degraded forest
- Article on land management institutions from perspective of shocks; assess new technologies and governance frameworks

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Next steps (2/2)

- Run CCDC algorithm (Continuous Change Detection and Classification) for mapping of land change
- Expand the study area to the Caucasus region, including Georgia, Armenia and Azerbaijan and northern Caucasus Mountains region
- Design sample for for estimation of area and map accuracy

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