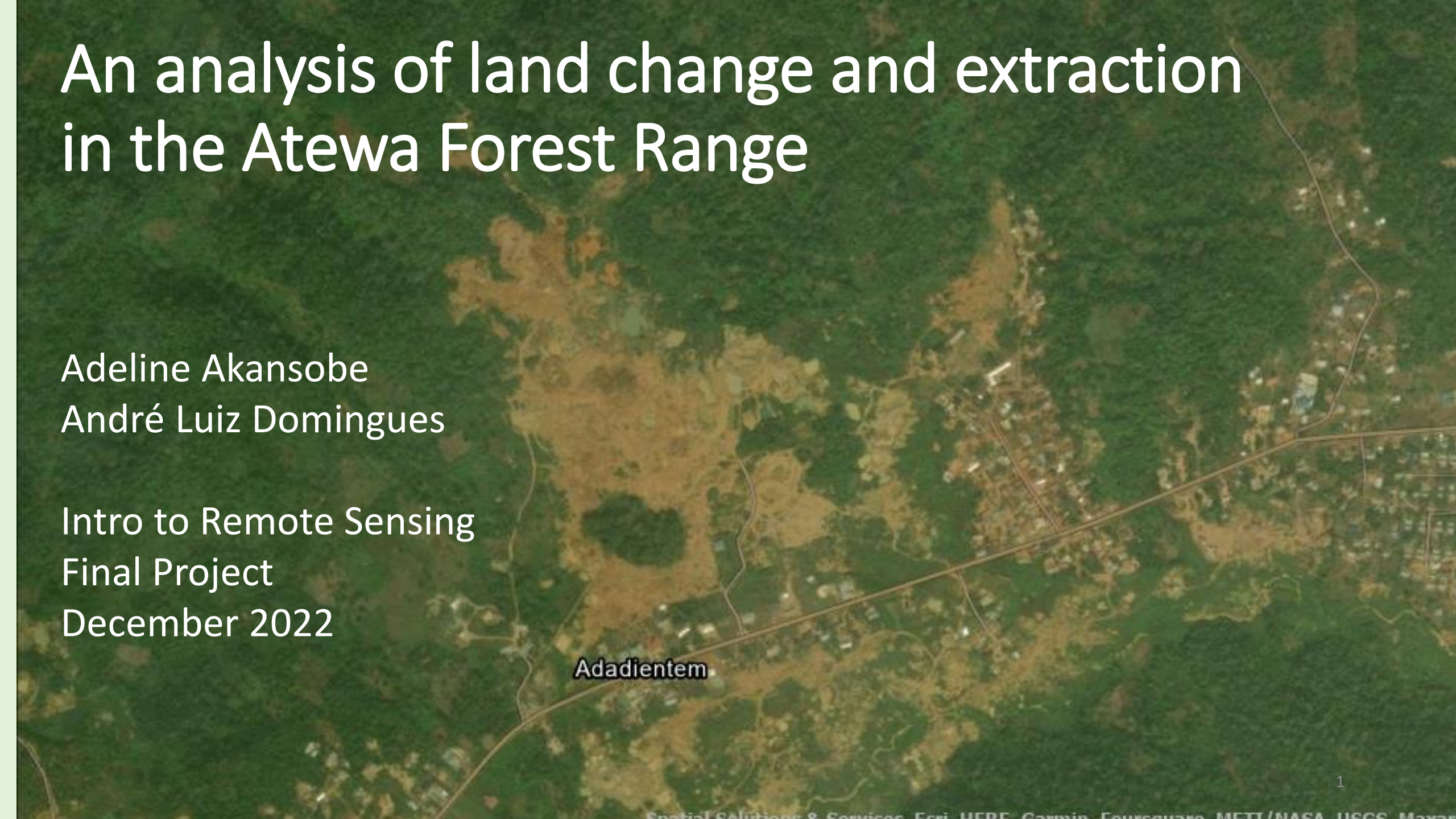
An analysis of land change and extraction in the Atewa Forest Range

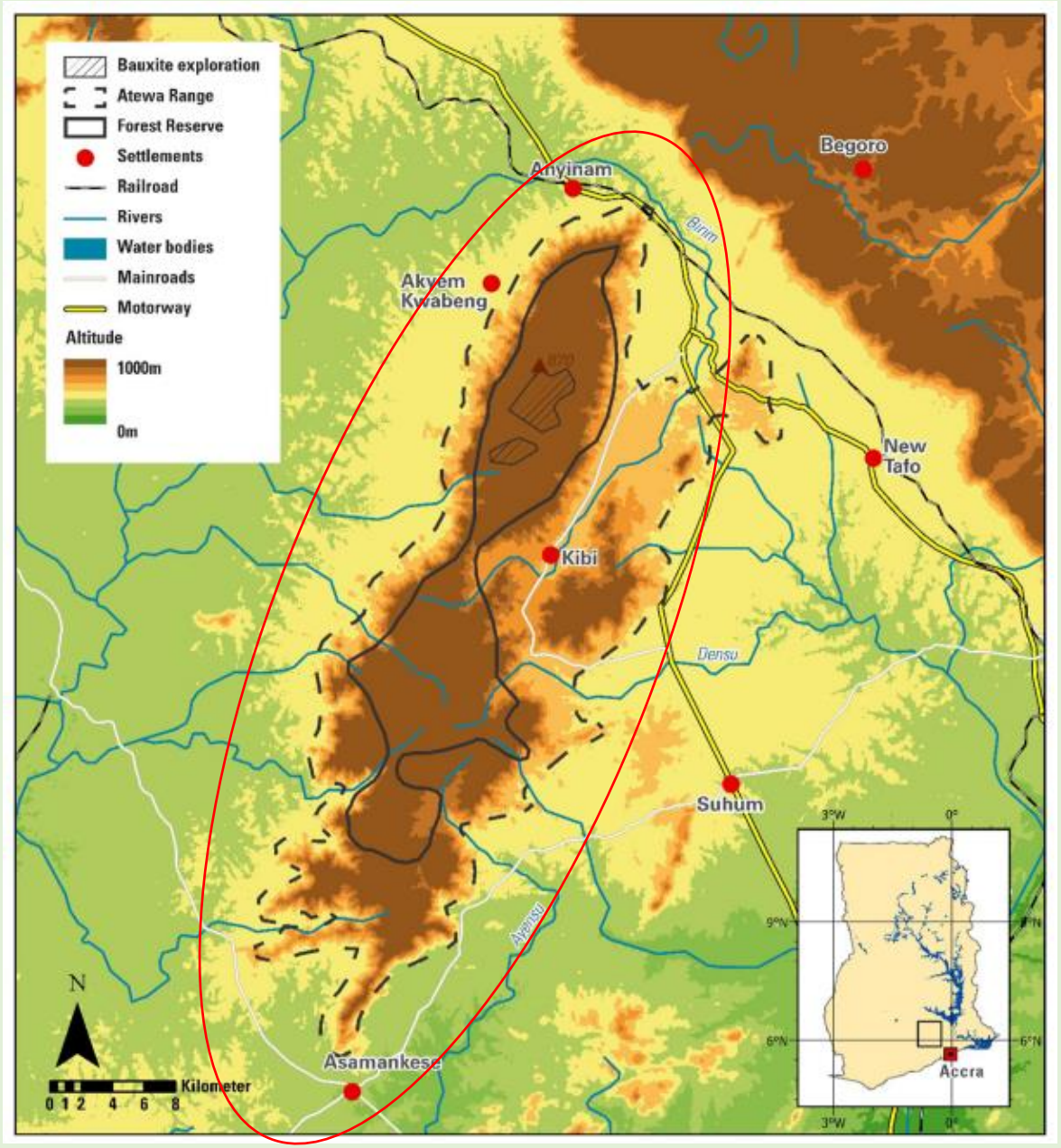
Adeline Akansobe
André Luiz Domingues

Intro to Remote Sensing
Final Project
December 2022



Study Area

- The Atewa Forest Reserve is located in the Eastern region of Ghana.
- Our study area encompasses the Atewa Range. It includes the reserve and a buffer of 5 to 10km of the surrounding area.
- Our study area includes the communities of Asamankese, Kibi, Anyinam, and Akyem Kwabeng



Atewa Range. Study area in red.

(Purwins 2020)

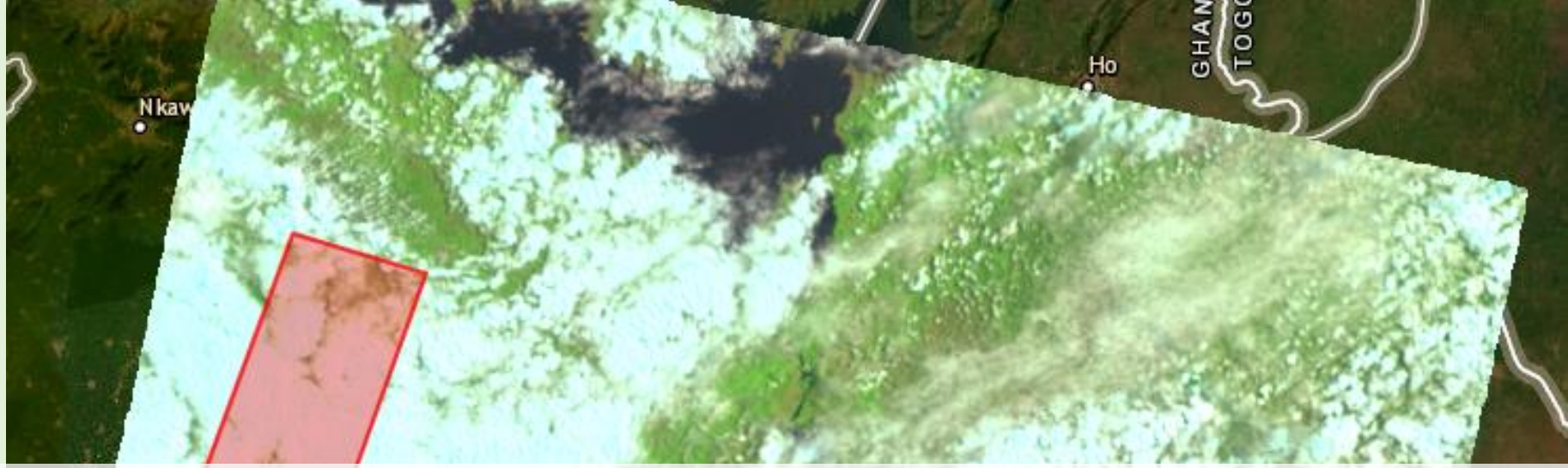
Research Question

- **How has land cover in the Atewa Range changed in the past 19 years?**
  - 2003 to 2017 to 2022
- What land cover types have been gaining, losing and at what intensity?

- What can the patterns of land change tell us about the drivers of deforestation?
  - *bauxite mining, gold mining (galamsey)*
  - *infrastructure*
  - *logging*
  - *agriculture*

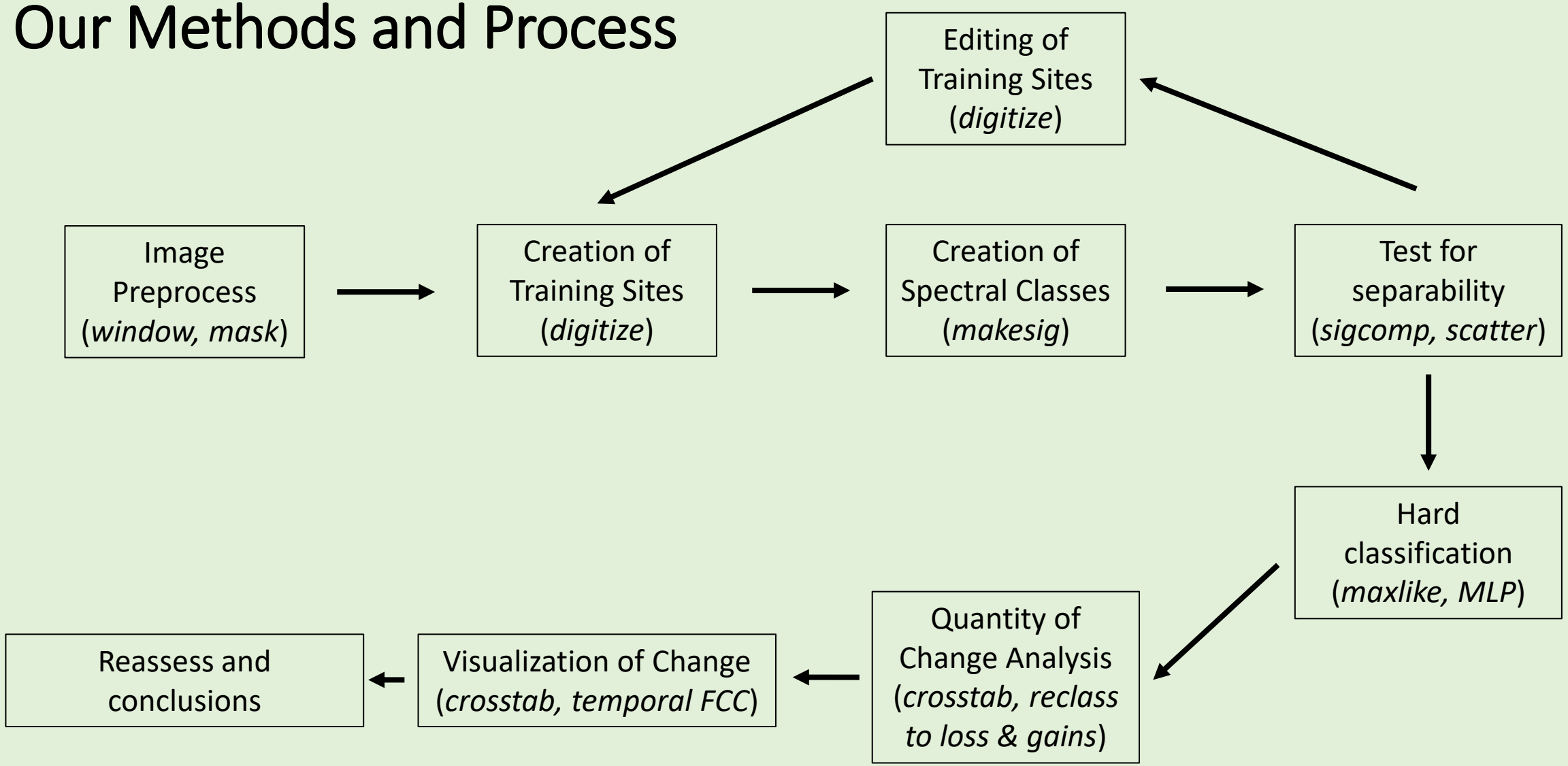
Gold mining in the Atewa Range (Afanyi-Dadzie 2019)

Data



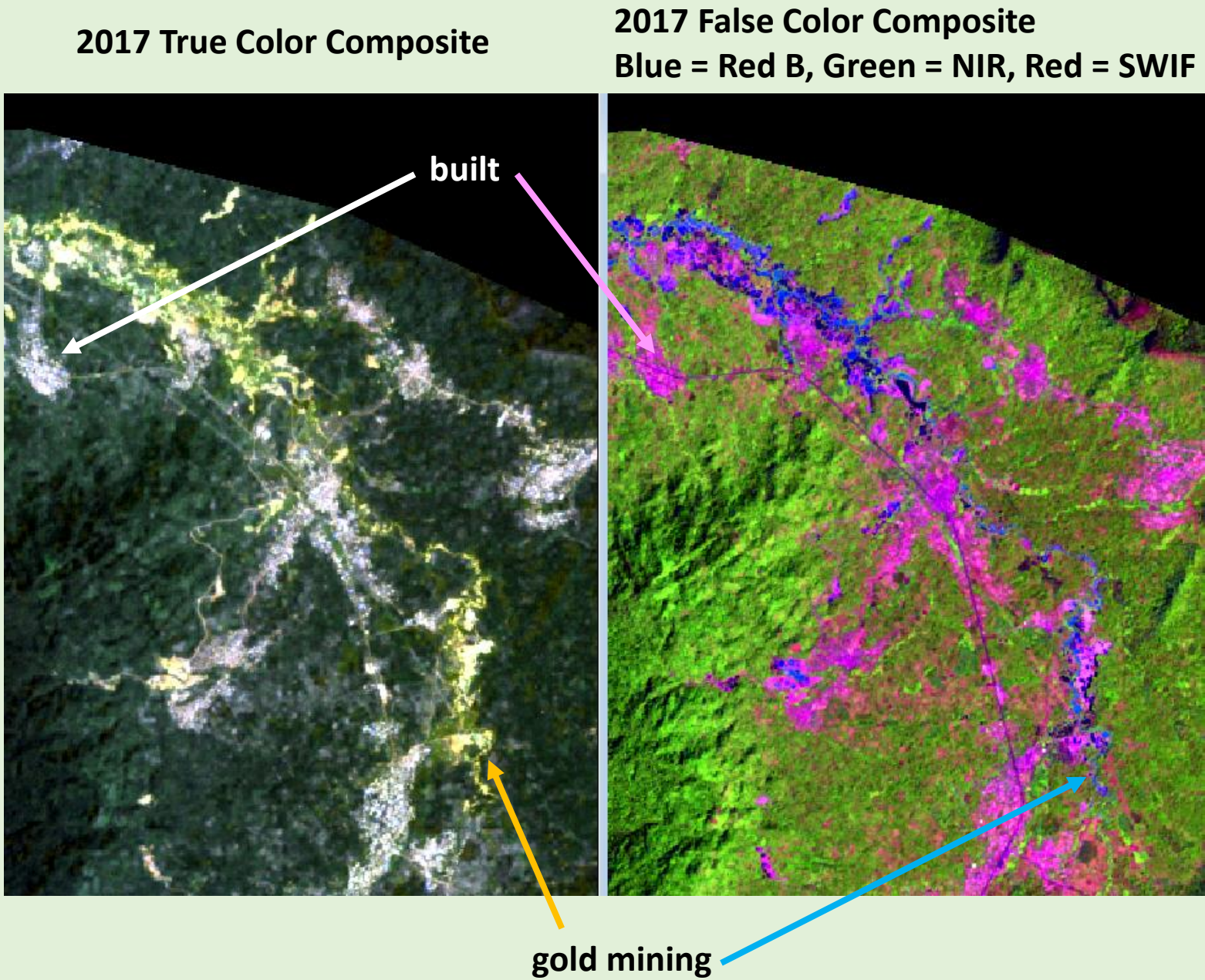
- Data obtained through USGS earth explorer.
- Used Landsat 7 image from February 12, 2003.
- Used Landsat 8 images from January 25, 2017, and December 22, 2021.
- Difficulty finding cloud free images. Unable to get images from equal time intervals. We were able to get images from around the dry season (December to February).
- All images were Landsat Collection 2 and Level 2. They were already corrected to surface reflectance.
- Landsat image spatial resolution of 30m.
- Planet 2017 image.
- Vector file of Atewa reserve boundaries from Ghana government site.
- All data processing done on TerrSet.

Our Methods and Process



Identifying training sites

- Mainly used TCC since gold mining stood out as yellow and built as white, blue, and light brown.
- Tried different False Color Composites:
    1. Gold mining corresponded with areas of high red reflectance and showed up as blue in a 4,5,6 FCC (Landsat 8). Built areas displayed as pink.

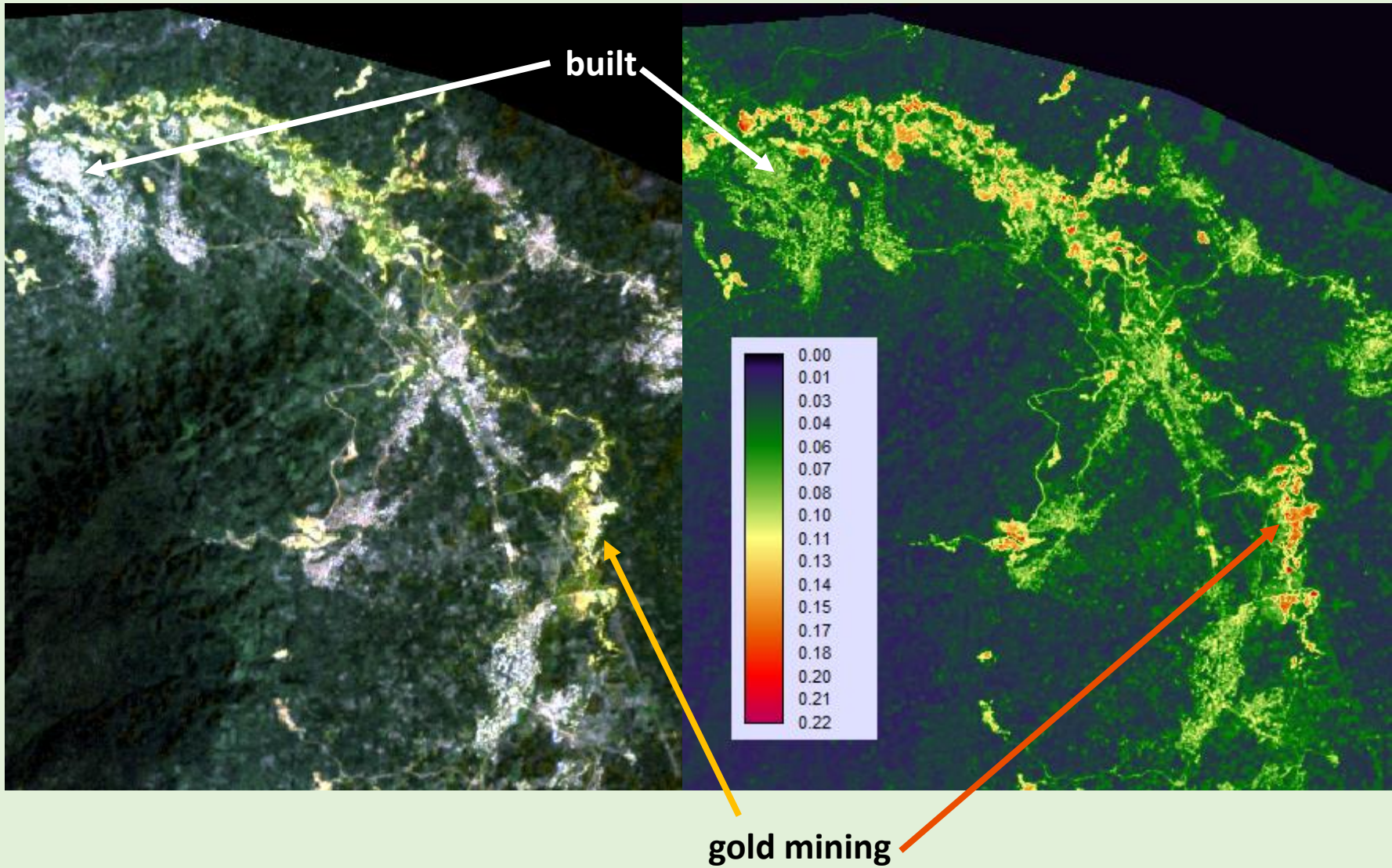


Identifying training sites

- Tried different False Color Composite and ratios:
  2. We tried a couple of ratios and found that a normalized difference ratio of 4by2 was the best for identifying mining from built.
  3. Areas of high values (mining) have a higher reflectance of red than blue.
  4. **We concluded that gold mining has a higher red reflectance than the other classes.**

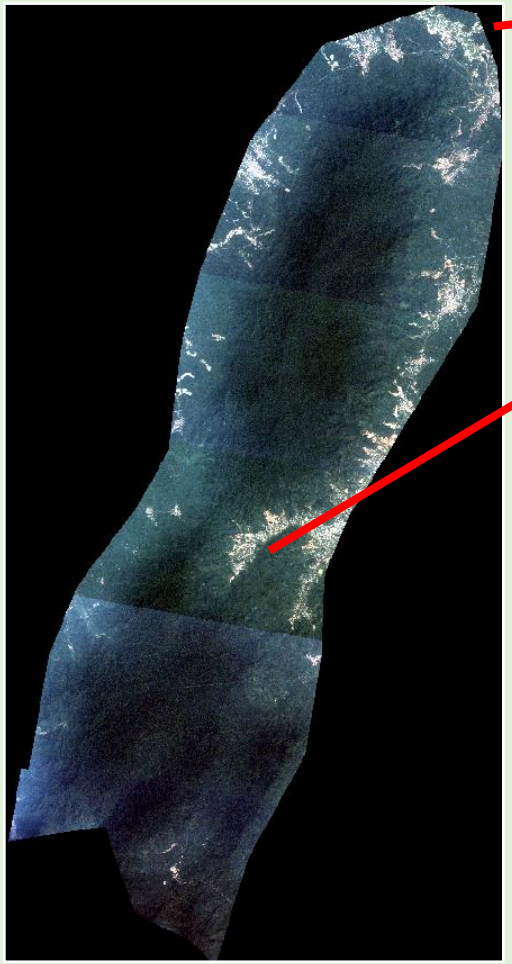
2017 True Color Composite

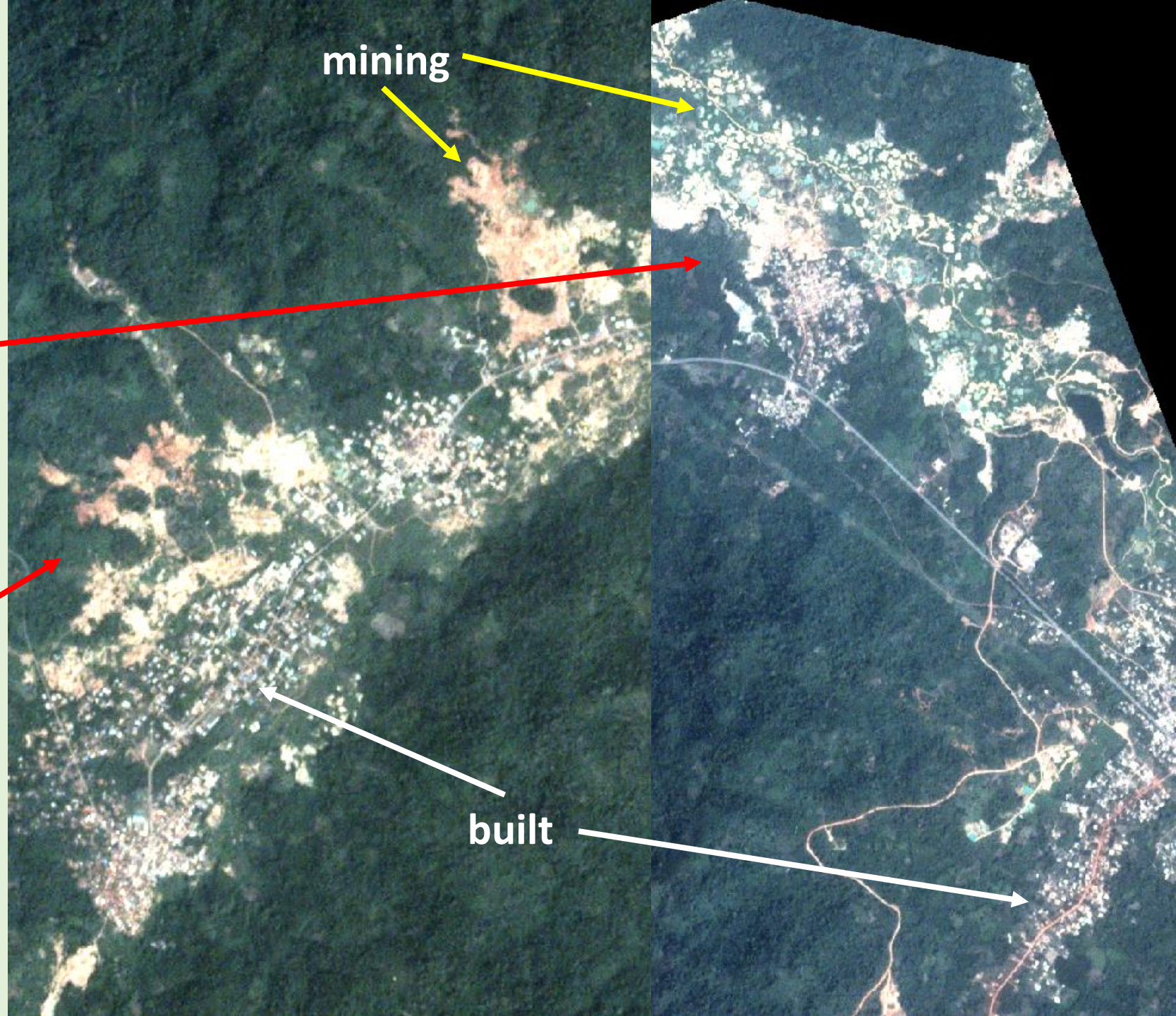
2017: 4by2 ratio
(red – blue) / (red + blue)



Identifying training sites

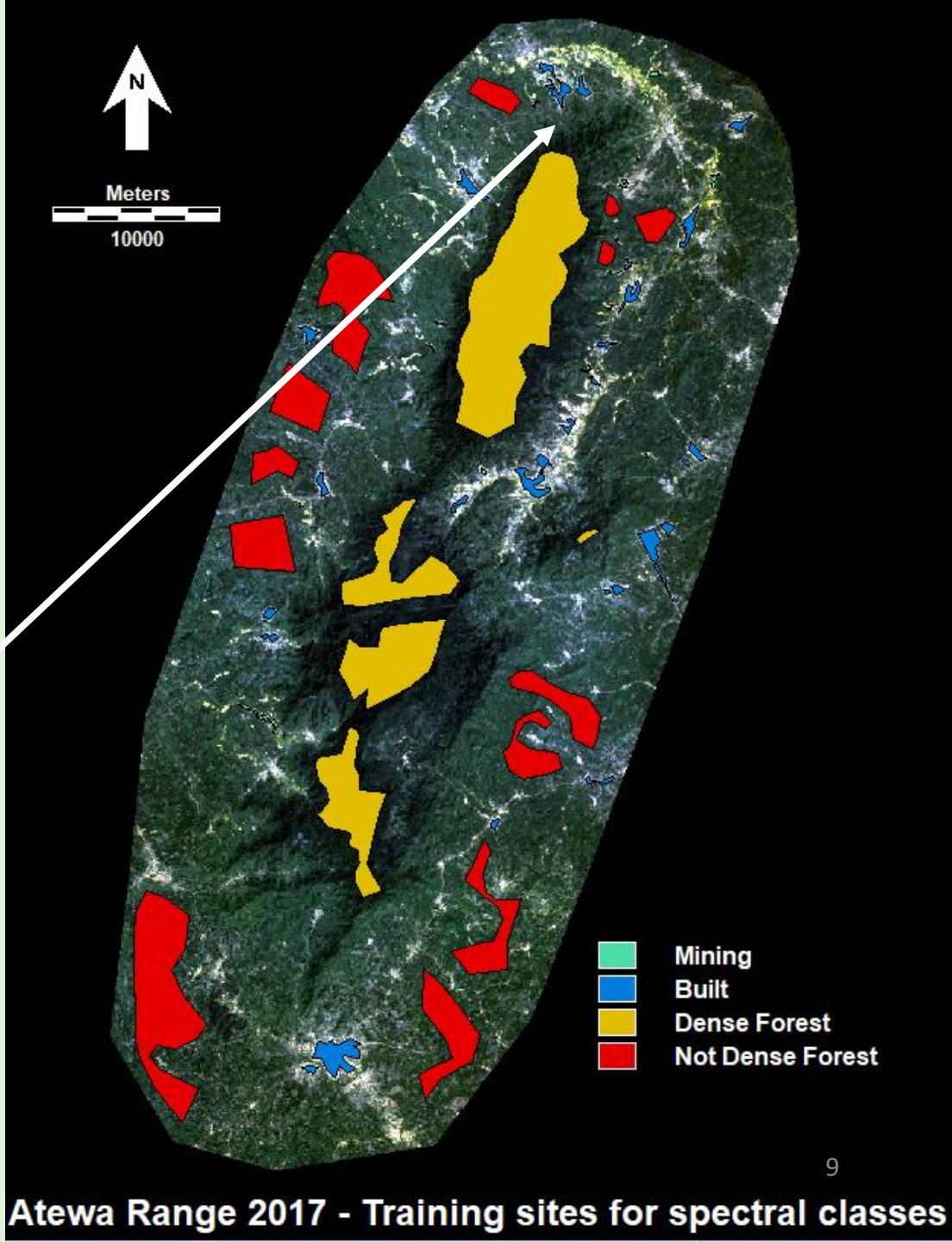
- We also used planet data from 2017 to help identify features





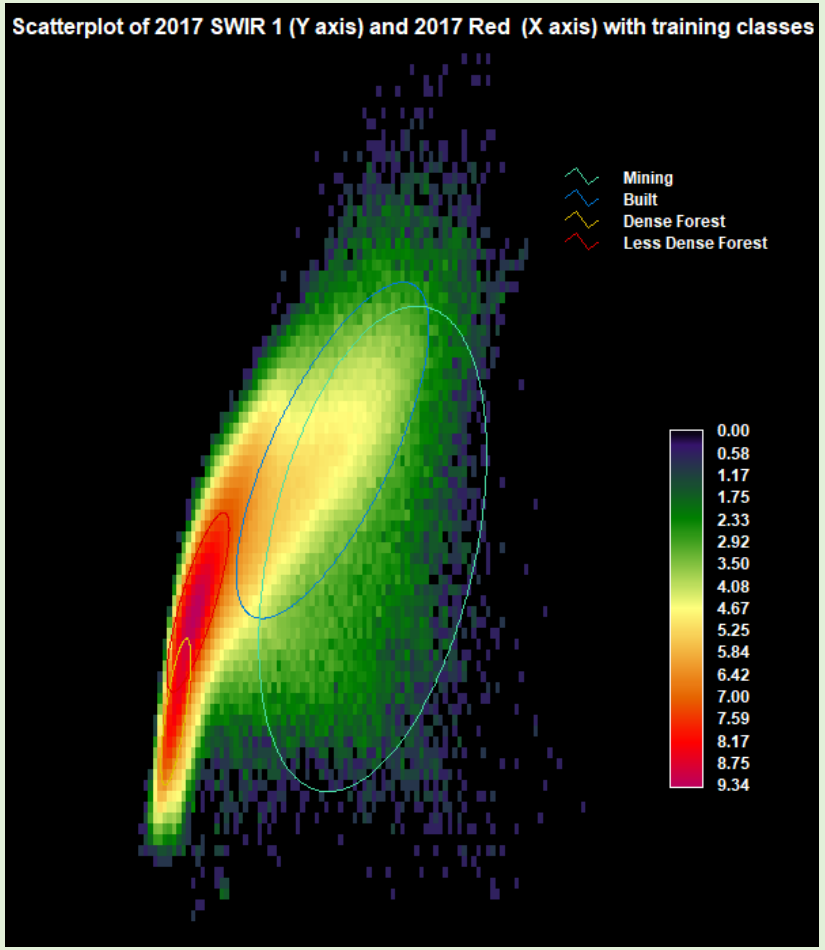
Vector training sites for supervised hard classification

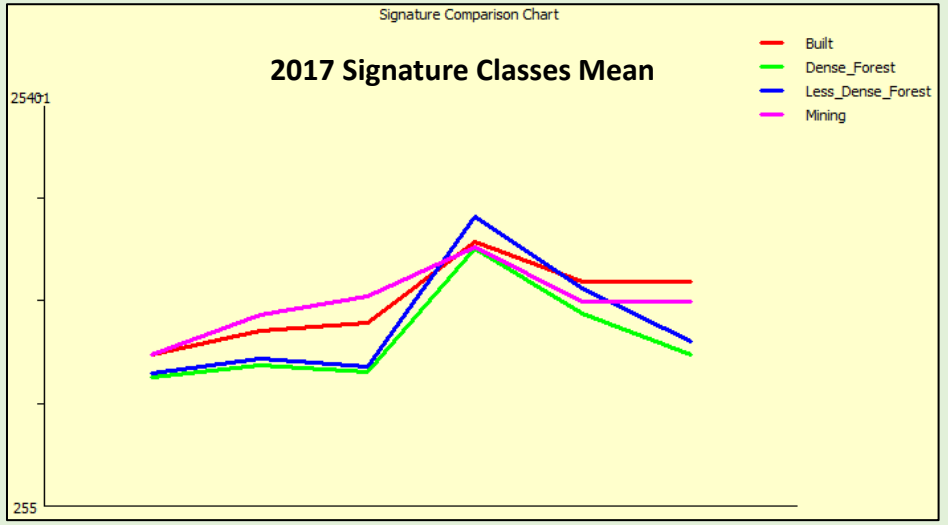
- Vegetation was divided into two classes:
  - Dense Forest mostly limited to the Atewa range.
  - Less Dense Forest was the vegetation at lower elevations and in-between settlements. Less dense forest included areas of fragmented deforestation.

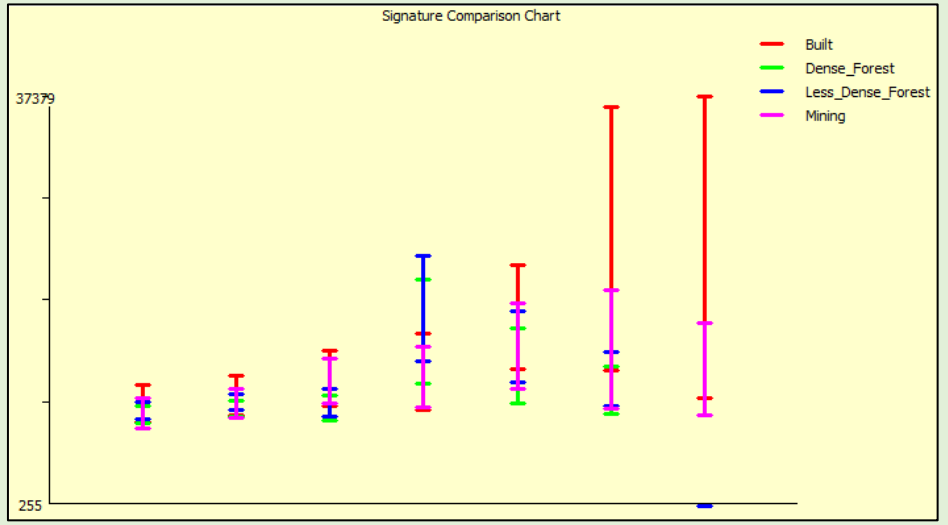


Testing training sites for separability

- We had difficulty achieving separability between mining and built since both classes have exposed soil. Mining has higher red reflectance and built has higher SWIR reflectance.
- The vegetation classes are also similar but have some separability in the NIR and SWIR1 bands.

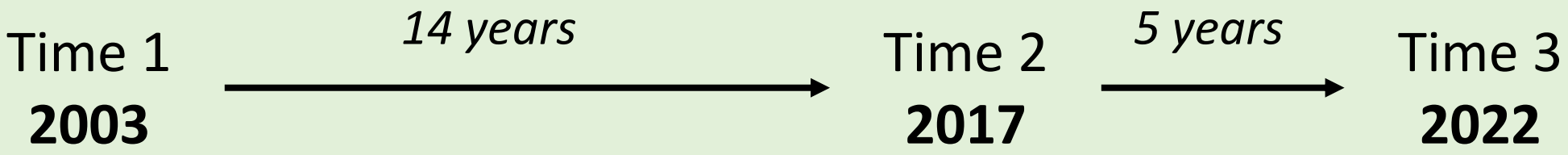




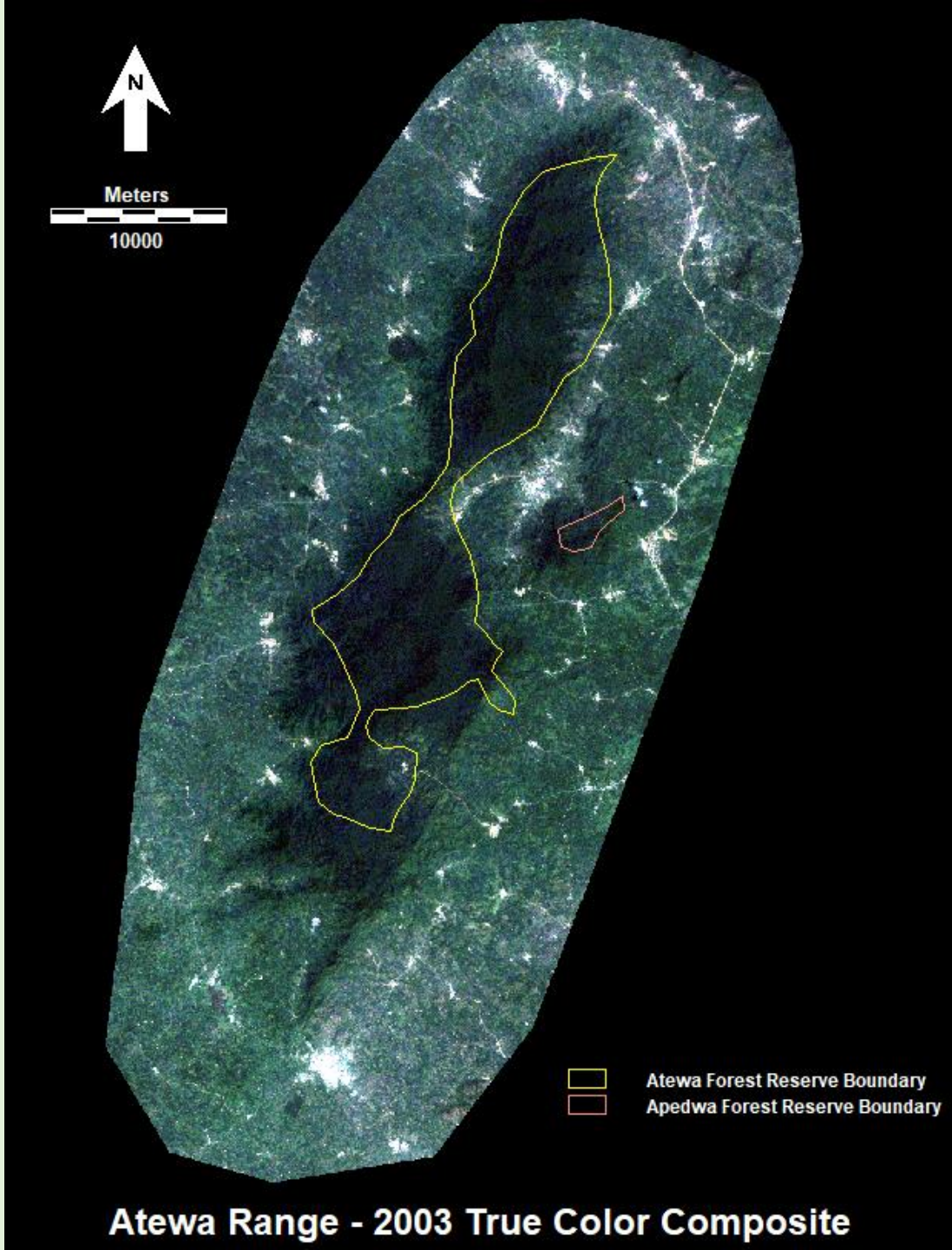


2017 Signature Classes Min - Max

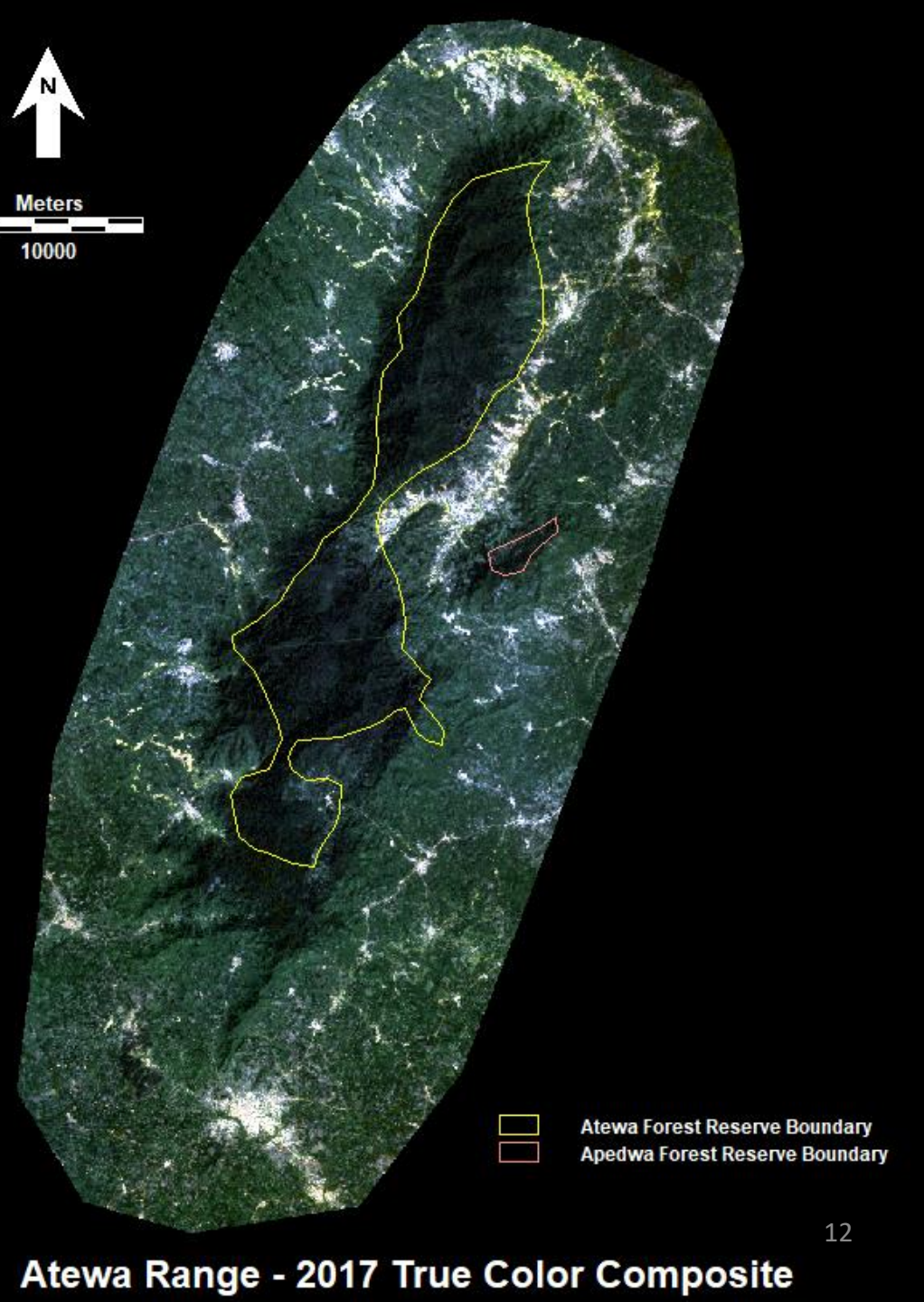
Results of classification



14-year interval



Atewa Range - 2003 True Color Composite



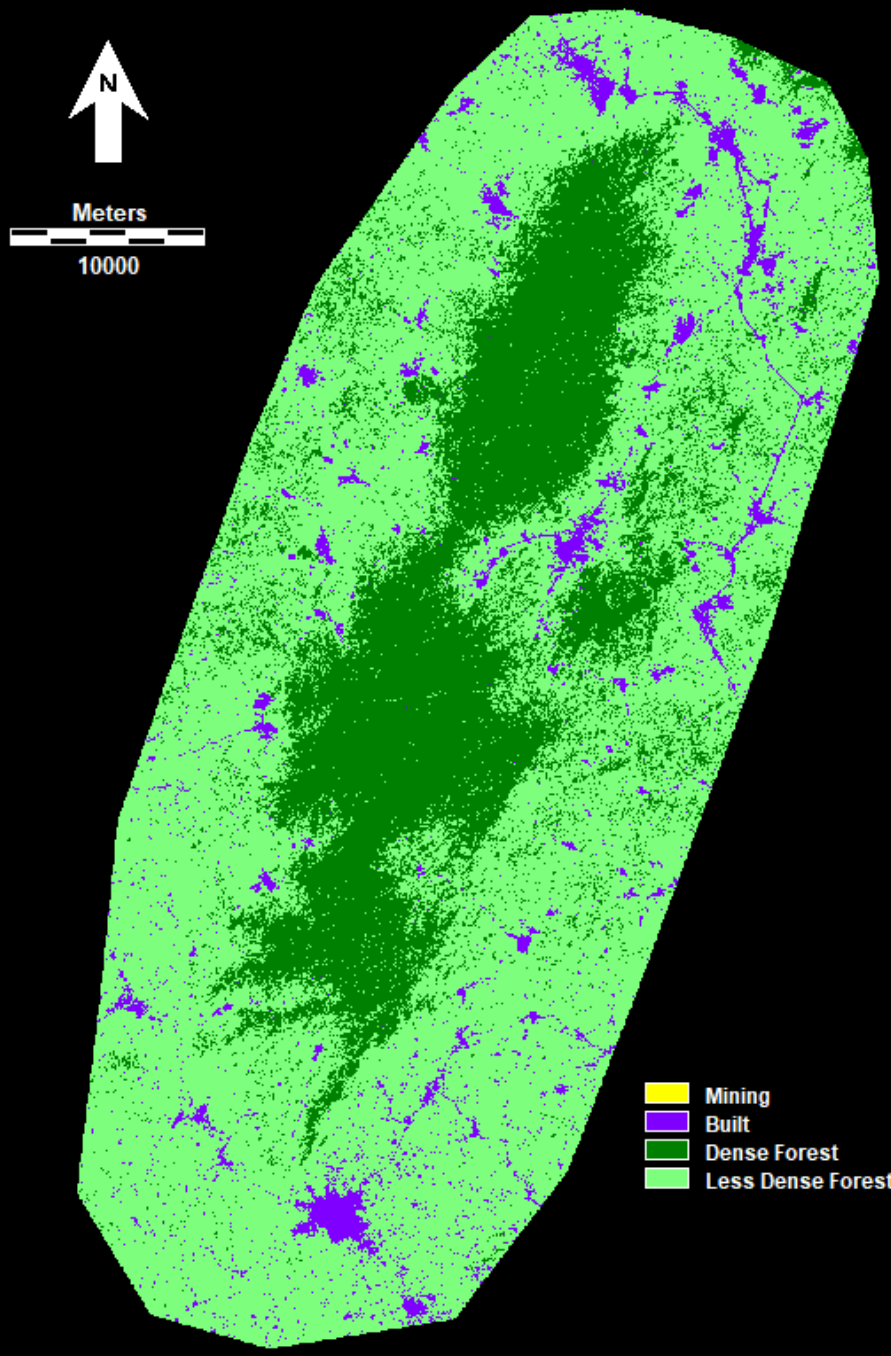
Atewa Range - 2017 True Color Composite

1. Minimal mining in 2003

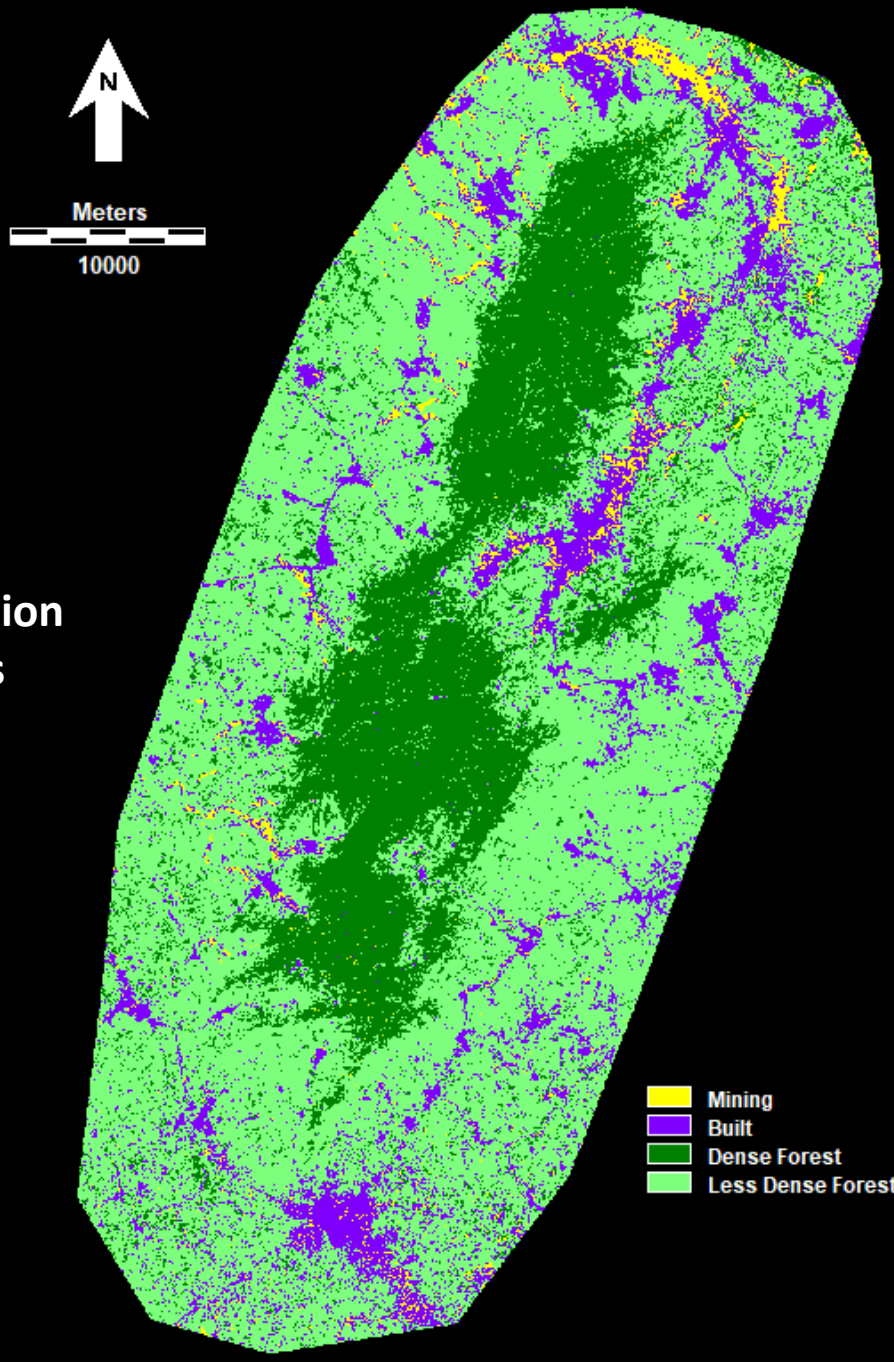
2. **79.2%** of mining gained on less dense forest

3. **9.7%** of mining gained on dense forest

Hard Classification Results

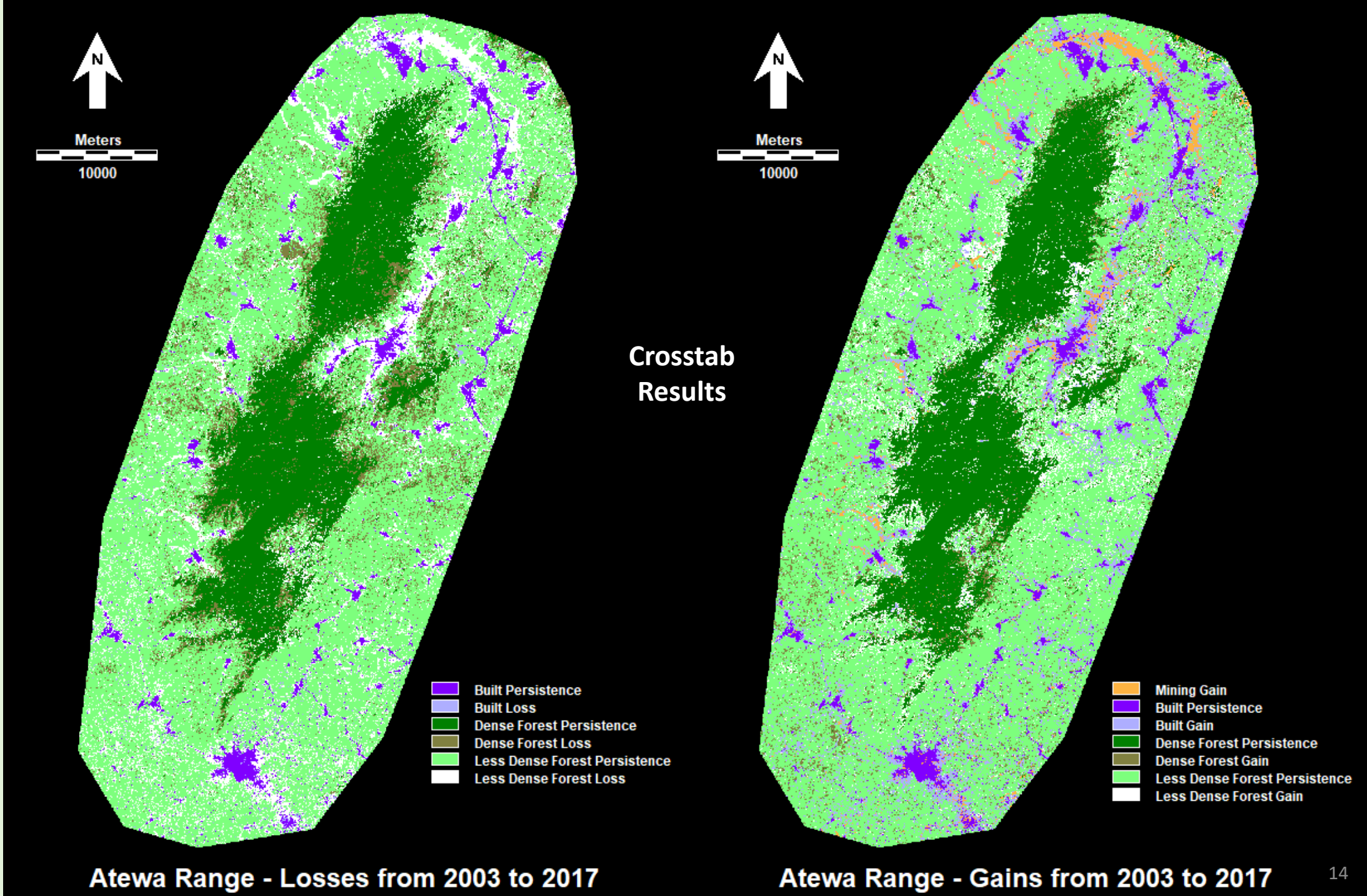


Atewa Range - 2003 Maximum Likelihood Classification

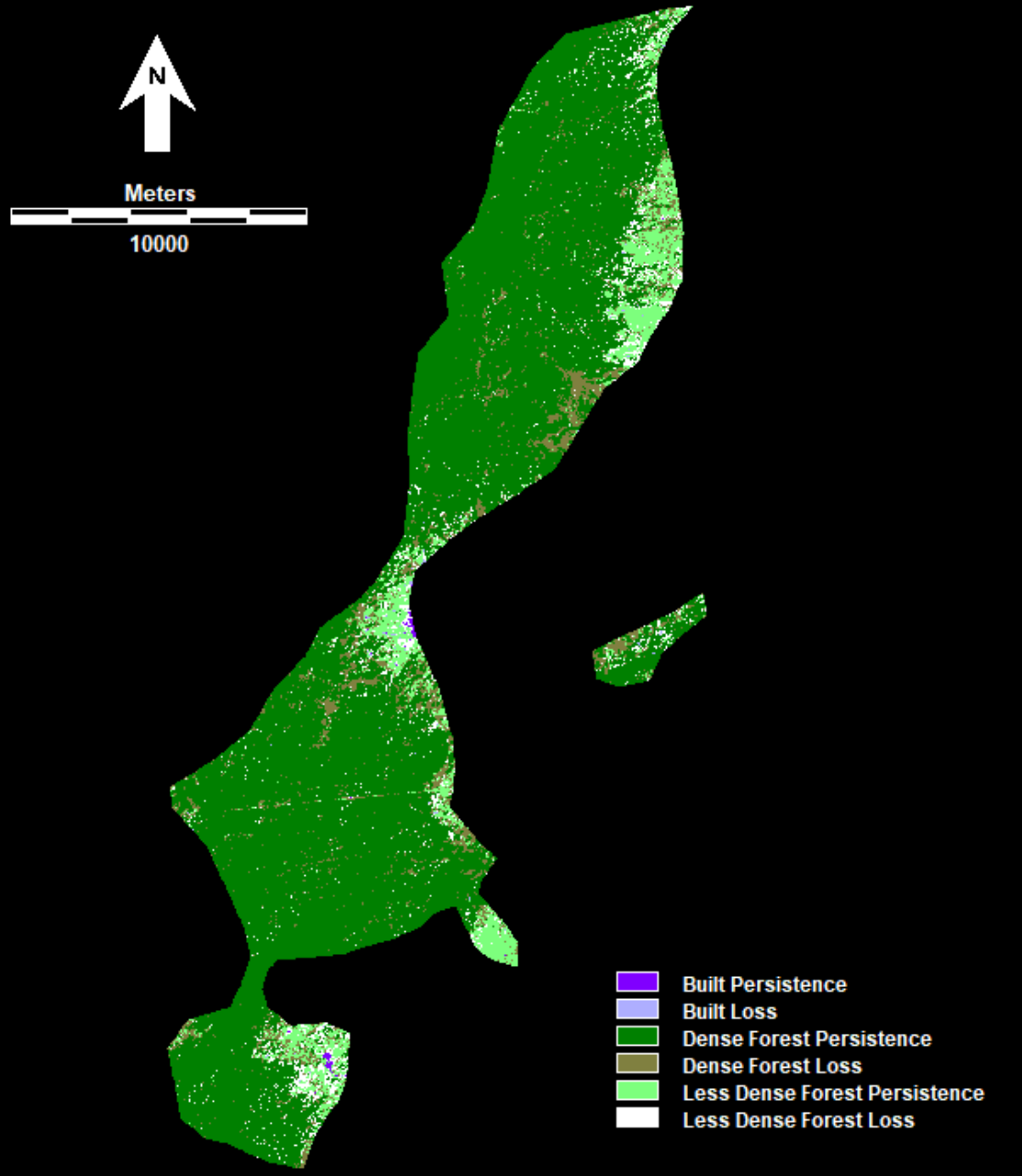


Atewa Range - 2017 Maximum Likelihood Classification

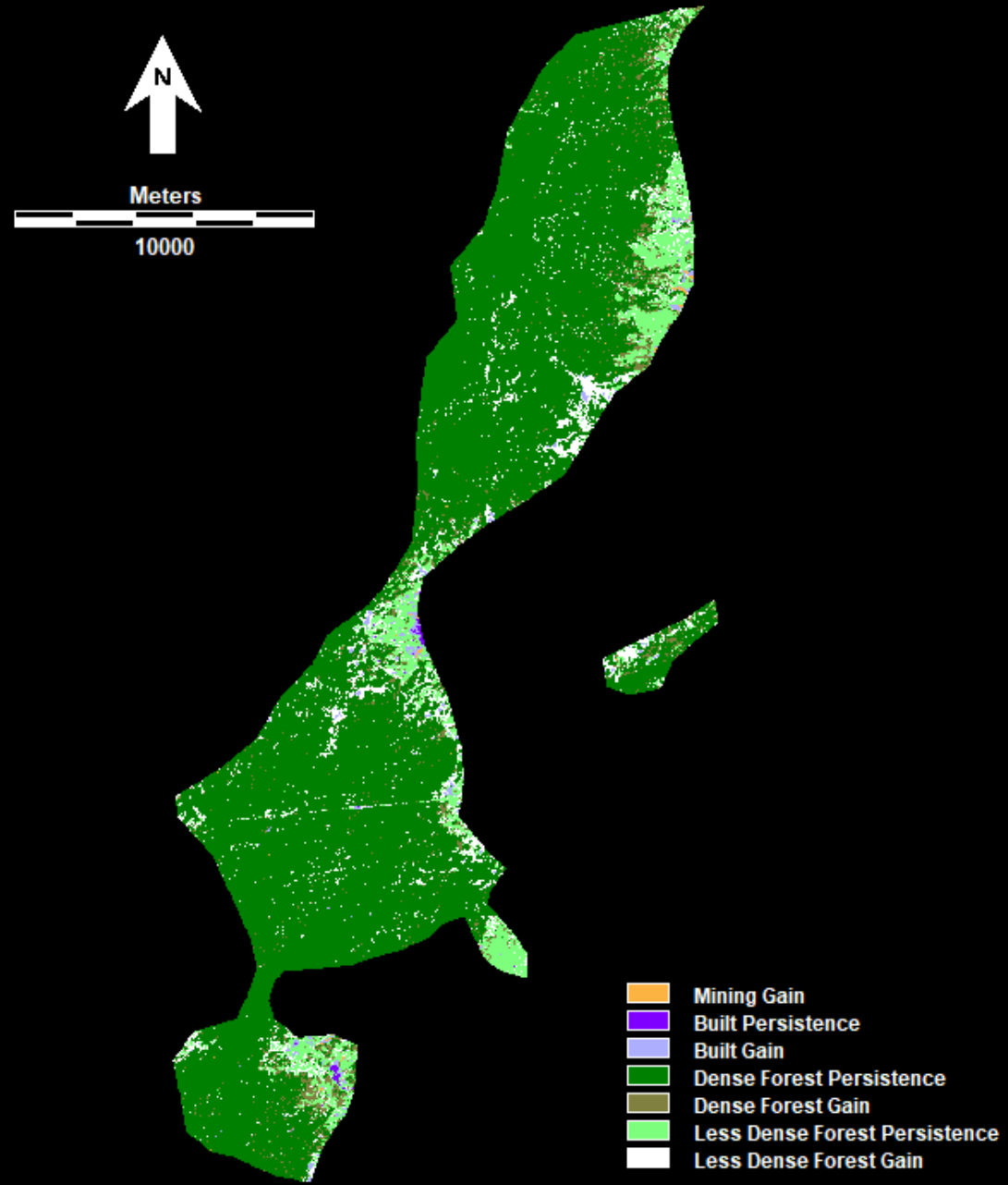
1. **0.2%** of dense forest loss to mining
2. **12.8%** of 2003 dense forest lost
3. Less dense forest decreased by **9.4%**
4. Built gained by **152%**



1. **1.5%** of reserve had gain of mining
2. **4.1%** of 2003 dense forest inside reserve lost
3. Built area increased by **275%**, covering **1%** of the reserve

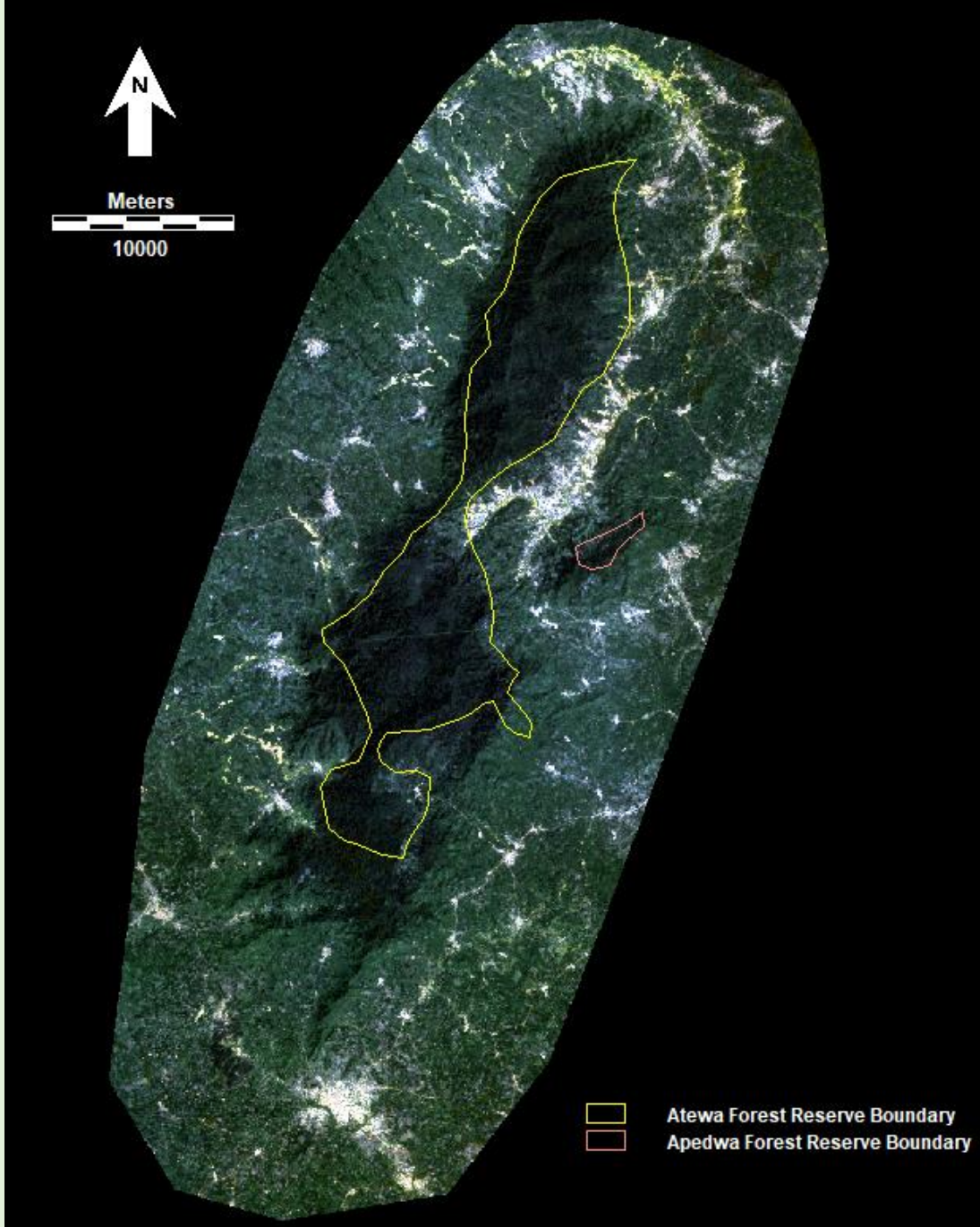


Losses Inside Forest Reserve Boundaries from 2003 to 2017

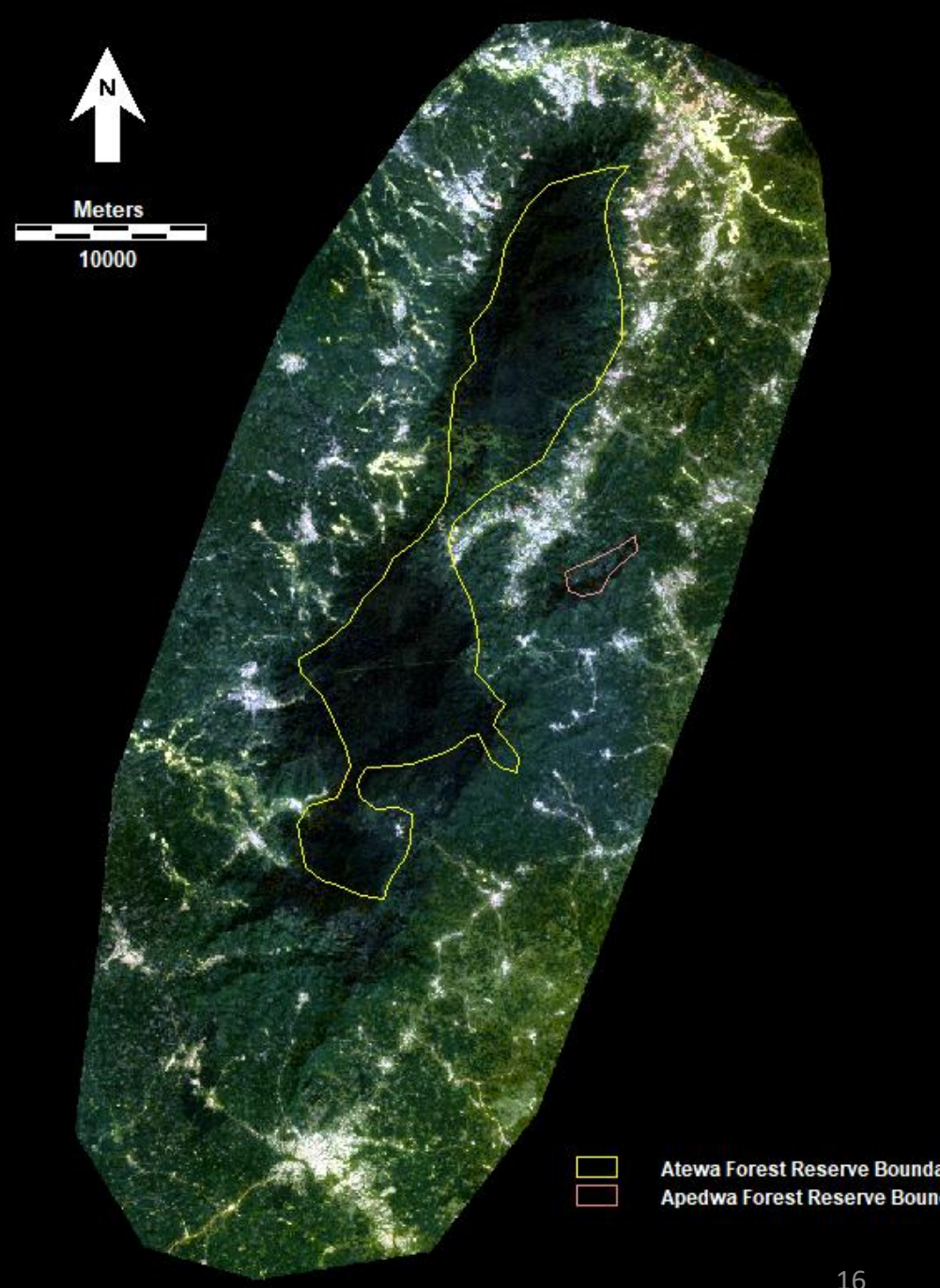


Gains Inside Forest Reserve Boundaries from 2003 to 2017

5-year interval

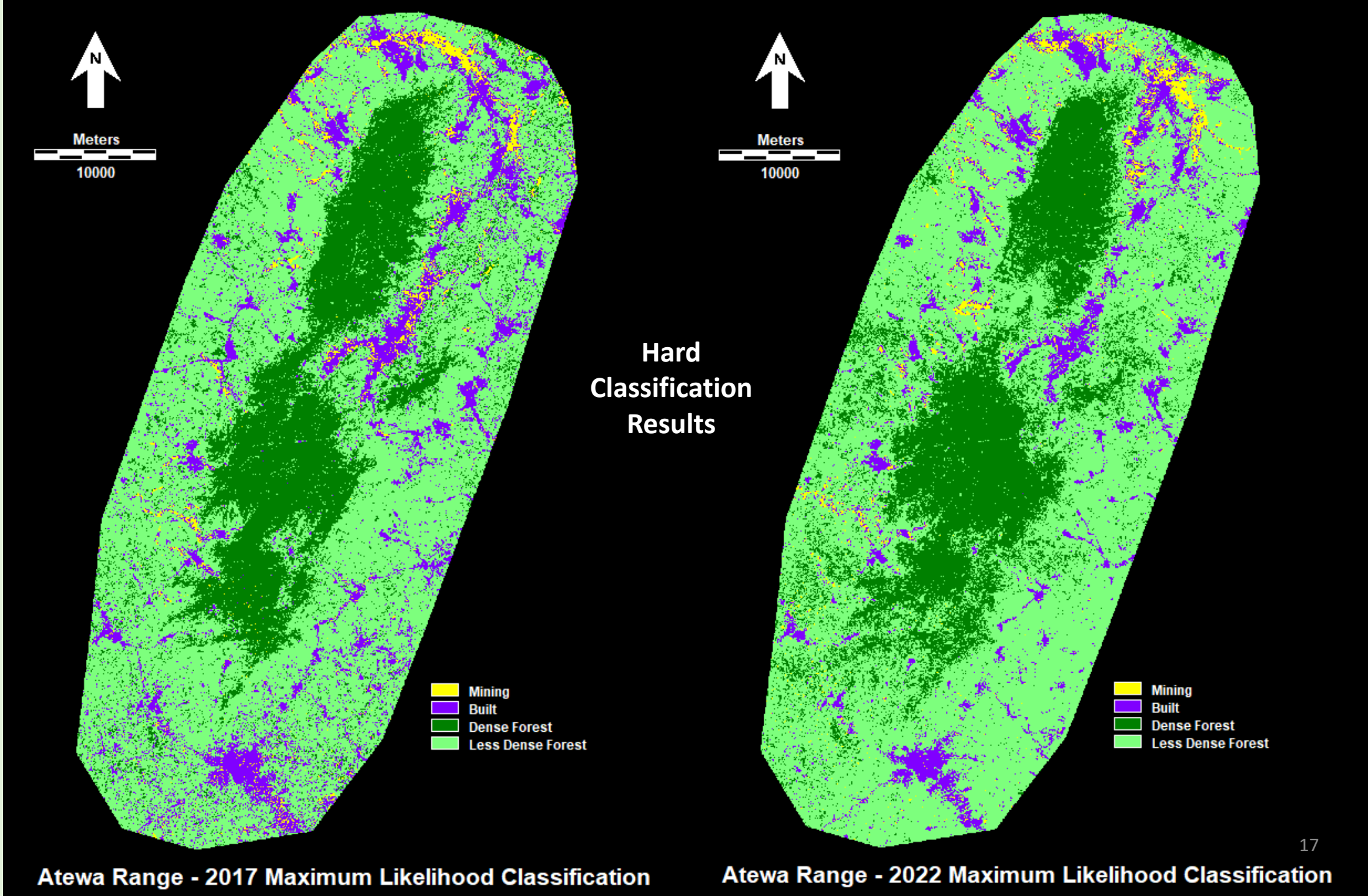


Atewa Range - 2017 True Color Composite

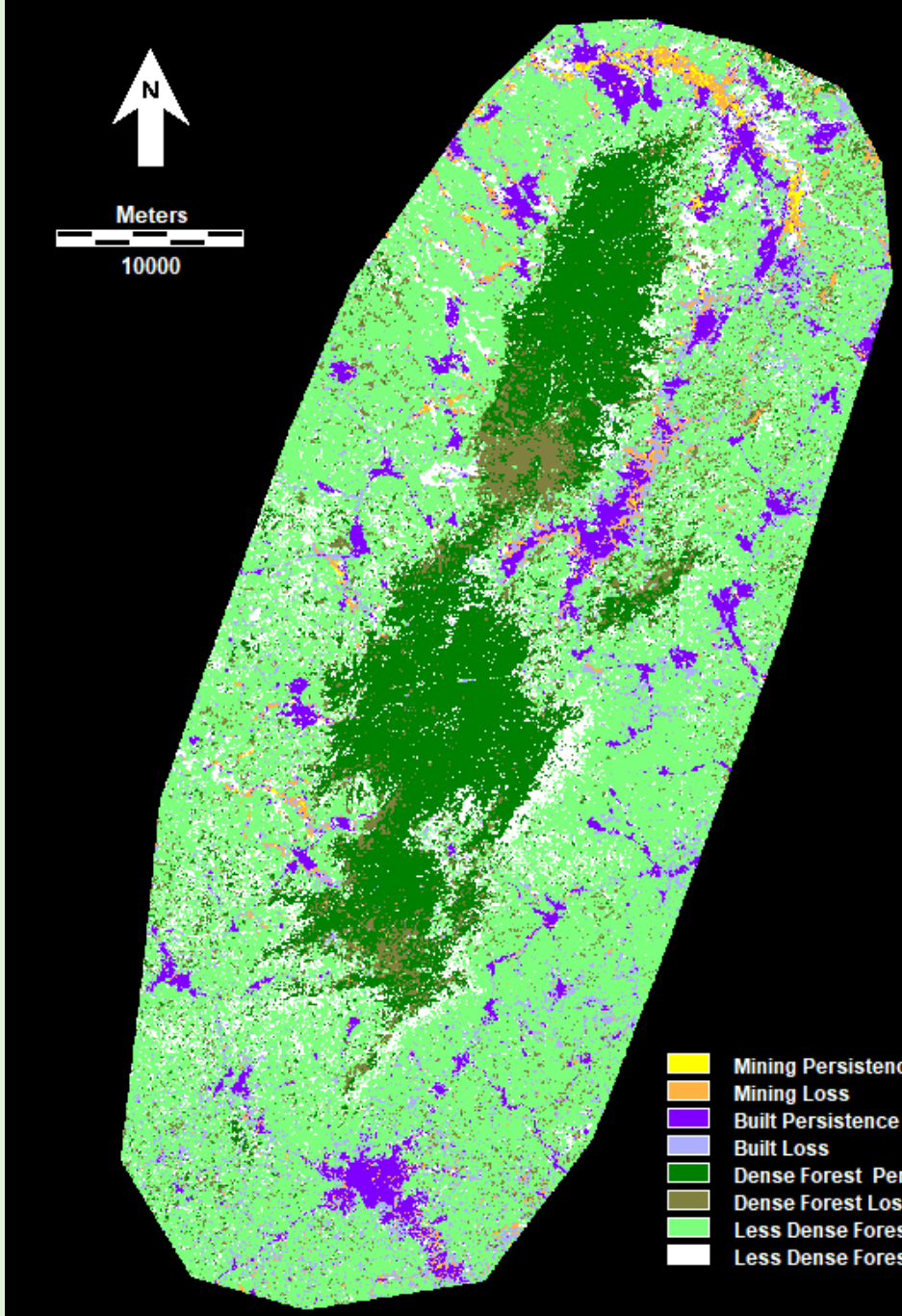


Atewa Range - 2022 True Color Composite

1. Government intervention in 2020
2. Decrease in mining

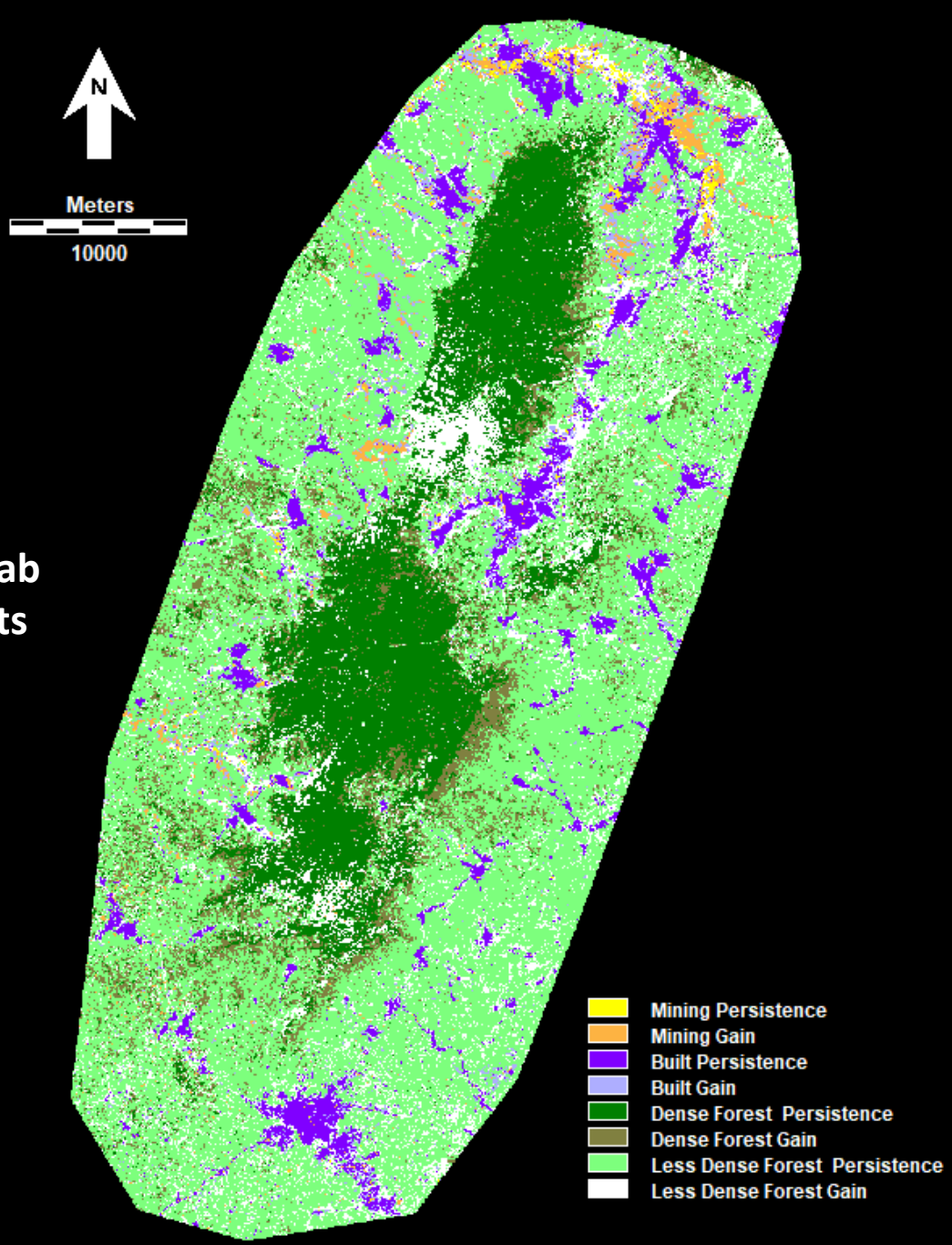


1. Mining decreased by **5.7%** in the area
2. Built decreased by **33%**
3. Dense Forest increased by **6.7%**
4. Less dense Forest increased by **4.2%**



Atewa Range - Losses from 2017 to 2022

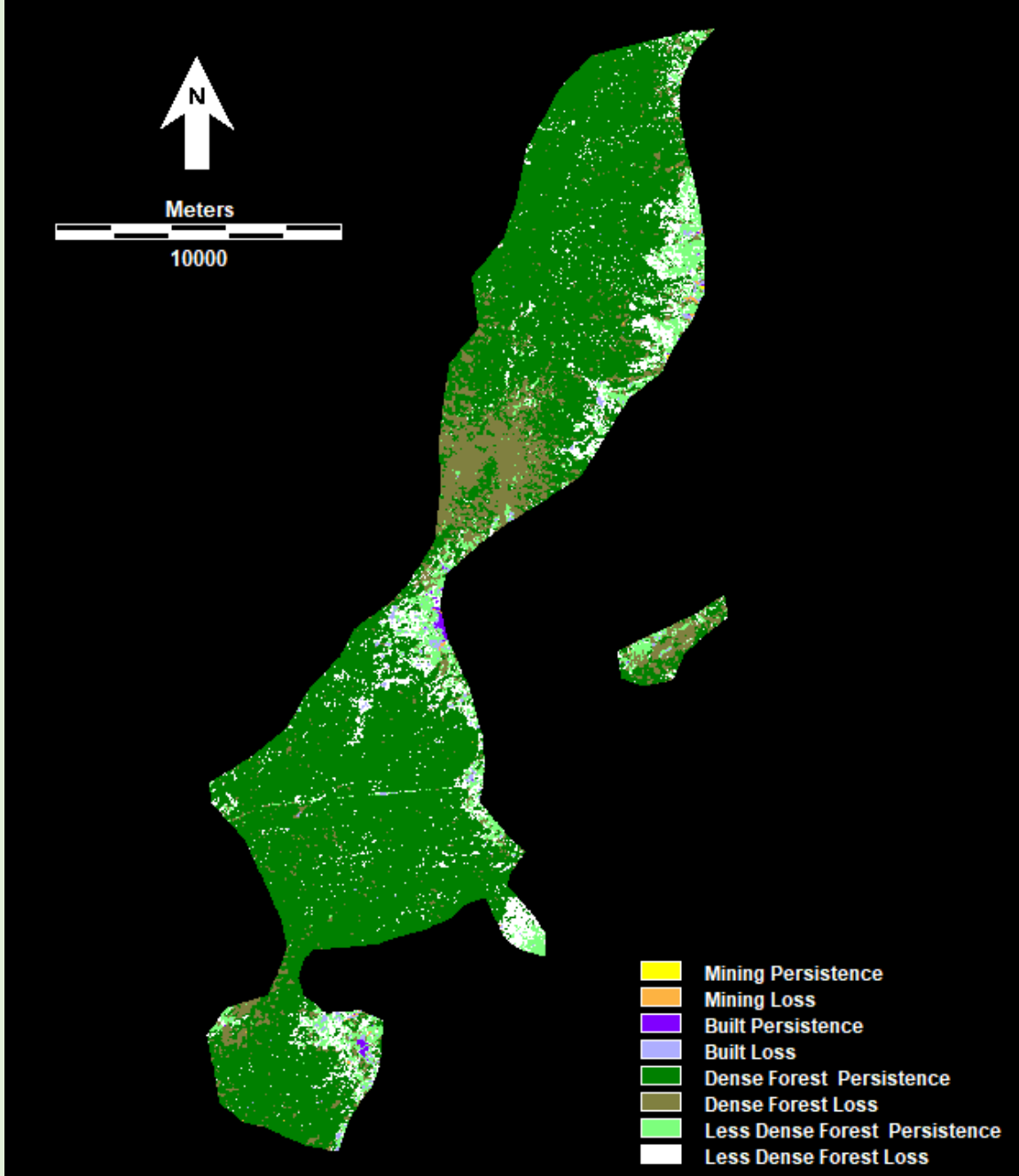
Crosstab Results



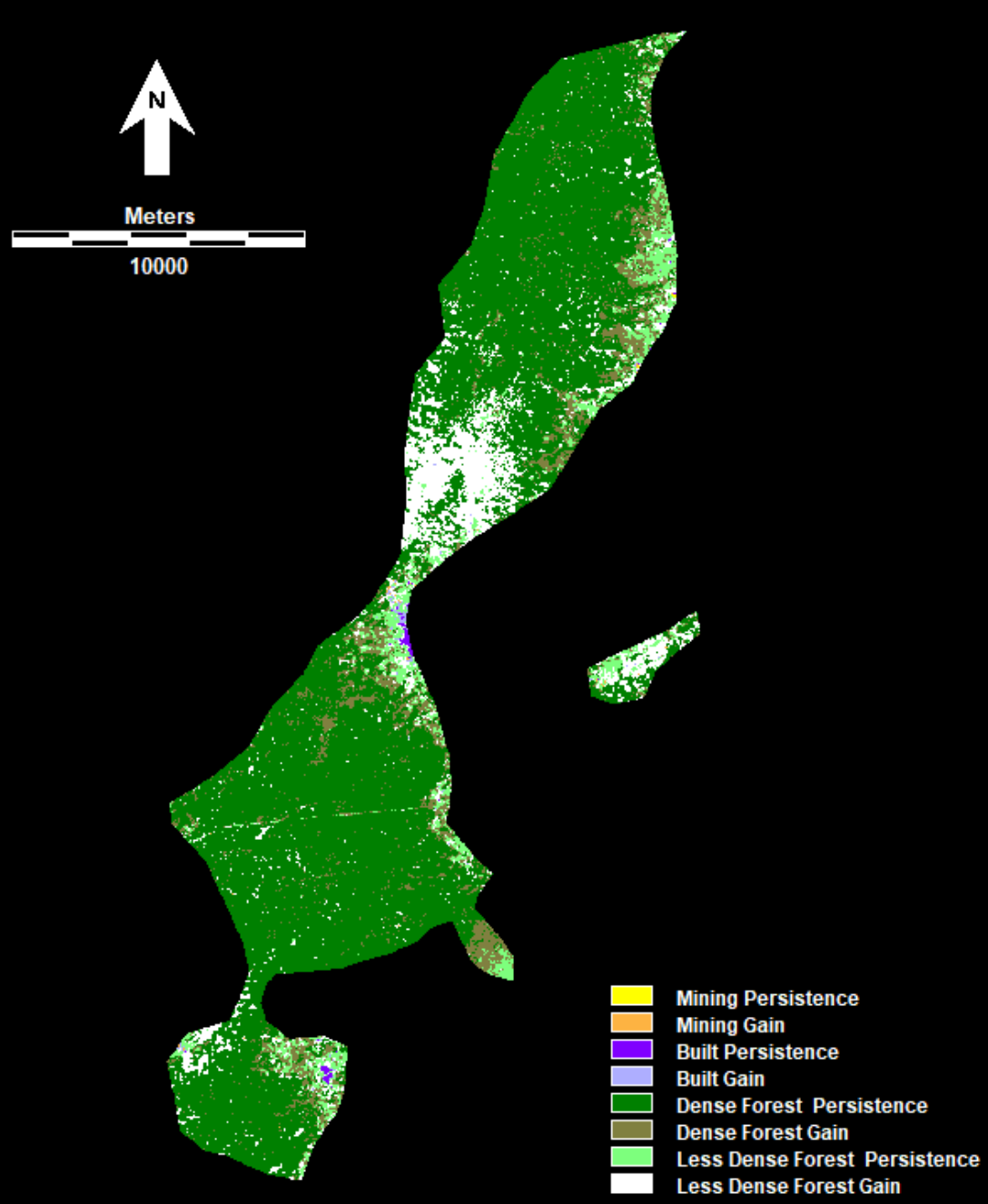
Atewa Range - Gains from 2017 to 2022

1. Mining decreased by **43%** inside the reserve

2. Built areas decreased by **32%** inside the reserve



Losses Inside Forest Reserve Boundaries from 2017 to 2022



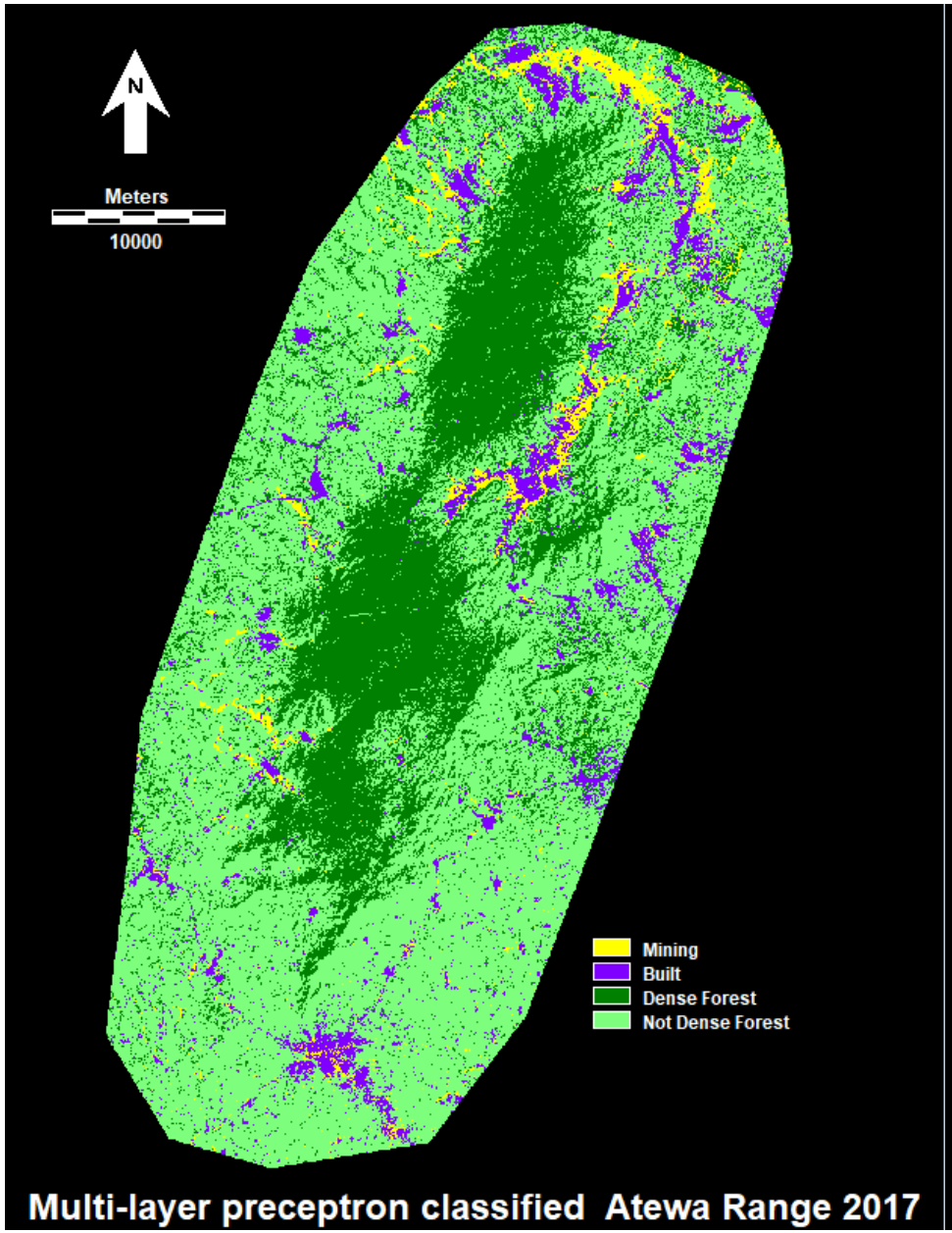
Gains Inside Forest Reserve Boundaries from 2017 to 2022

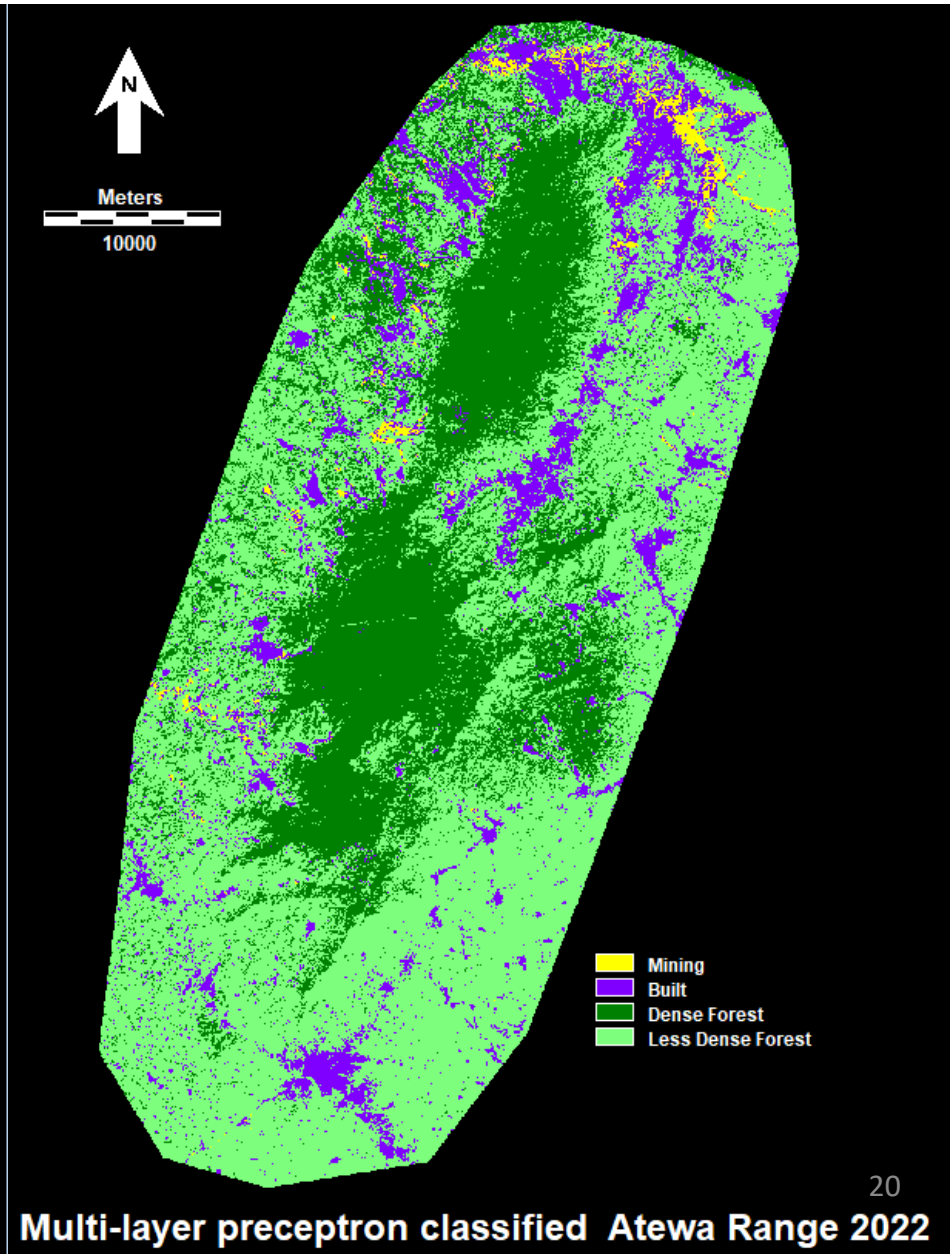
1. To confirm the decrease in mining we tried a new classification. MLP also identified a decrease in mining from 2017 to 2022, and an eastern shift of the mining area in the north.

2. The decrease could be due to government intervention in 2020 aimed at decreasing *illegal* mining.
(Mesti News, 2020)

3. In the MLP classification there was a decrease of mining by **67%** in the study area extent from 2017 to 2022.

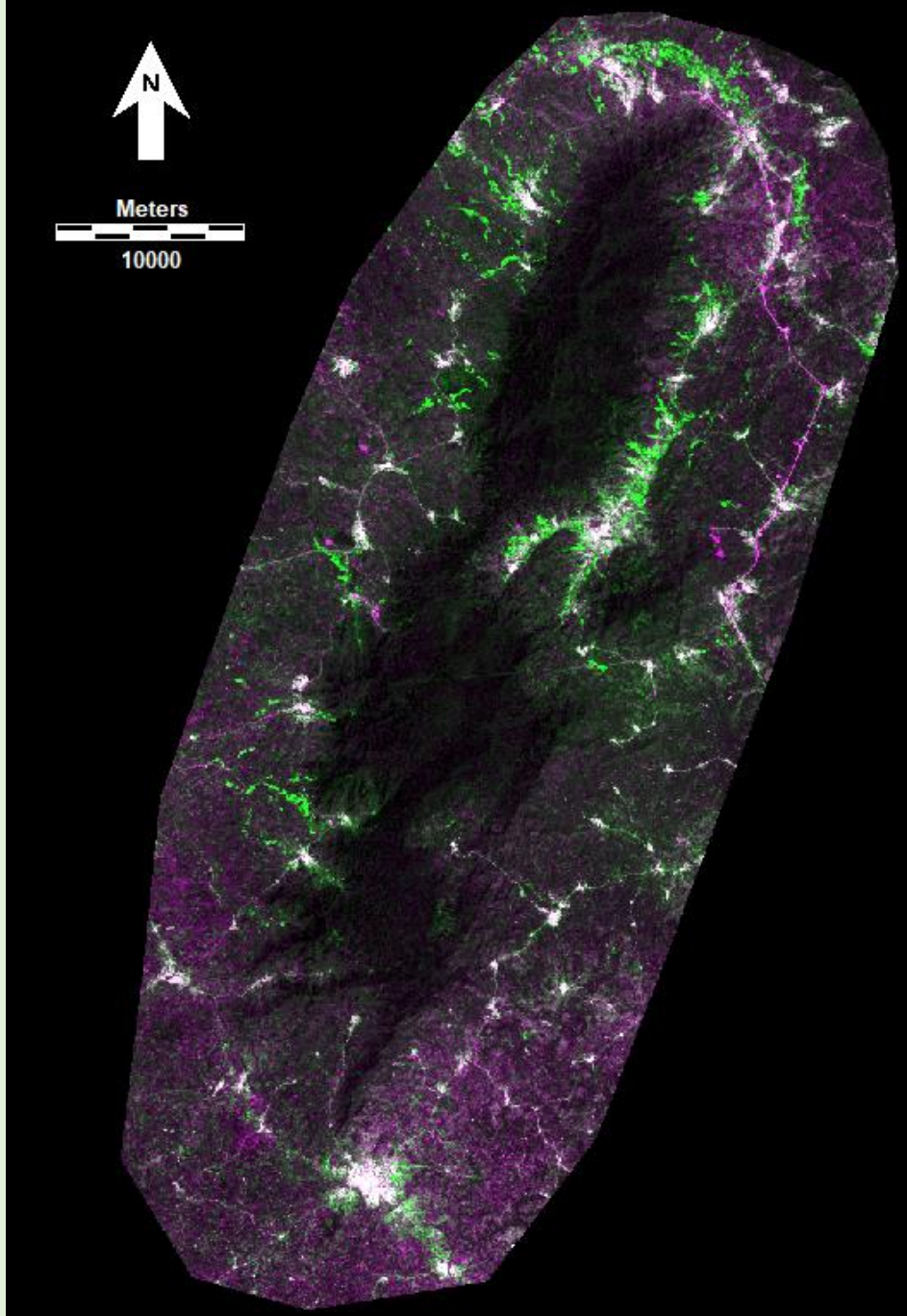
Testing classification with different training sites and method



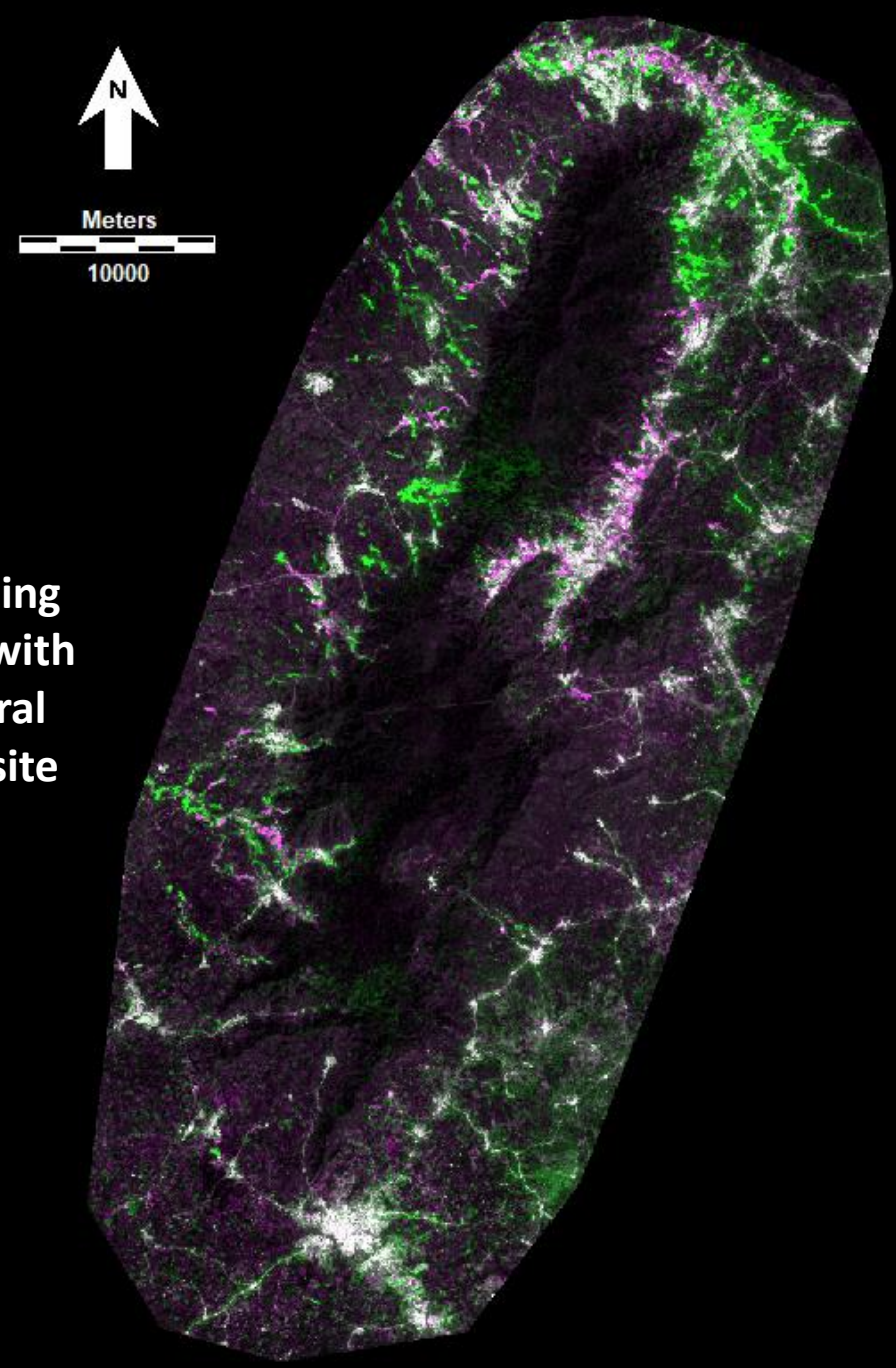


- **Magenta** represents areas with high red reflectance at time 1 and low at time 2. **Such as areas where vegetation was replaced by pavement or gained on soil. Or shift of dry soil to wet.**

- **Green** represent areas with low red reflectance at time 1, and high at time 2. **Such as exposed soil from mining. Or where wet soil became dry.**



Visualizing change with temporal composite



Atewa Range - Temporal FCC Red Band 2003-2017

Atewa Range - Temporal FCC Red Band 2017-2022

Conclusions

Drivers of landcover changes:

1. Gold mining
2. Built (settlement expansion and mining infrastructure)

Pre - Government Interventions:

- Mining and built increased while forest classes decreased.

Post - Government Interventions:

- Mining and potential decrease of built, while forest classes increased
- Reduction of Mining by 43% and Built by 32% within forest reserve boundary

Citations

Amponsah, A., Nasare, L. I., Tom-Dery, D., & Baatuuwie, B. N. (2022). Land cover changes of Atewa Forest Reserve, a biodiversity hotspot in Ghana. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4054505

Purwins, S. (2020). Bauxite mining at Atewa Forest Reserve, Ghana: A political ecology of a conservation-exploitation conflict. GeoJournal, 87(2), 1085–1097. https://doi.org/10.1007/s10708-020-10303-3

Images:

Afanyi-Dadzie, E. (2019, December 9). NGOs refute GIADEC's claims on safe bauxite mining in Atewa Forest. Citi Newsroom. Retrieved October 20, 2022, from https://citinewsroom.com/2019/12/ngos-refute-giadecs-claims-on-safe-bauxite-mining-in-atewa-forest/

Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community