Monitoring of Carbon Stocks

The role of TerraSAR-X to assess forest degradation
Examples from Ghana & Kalimantan

October 2012
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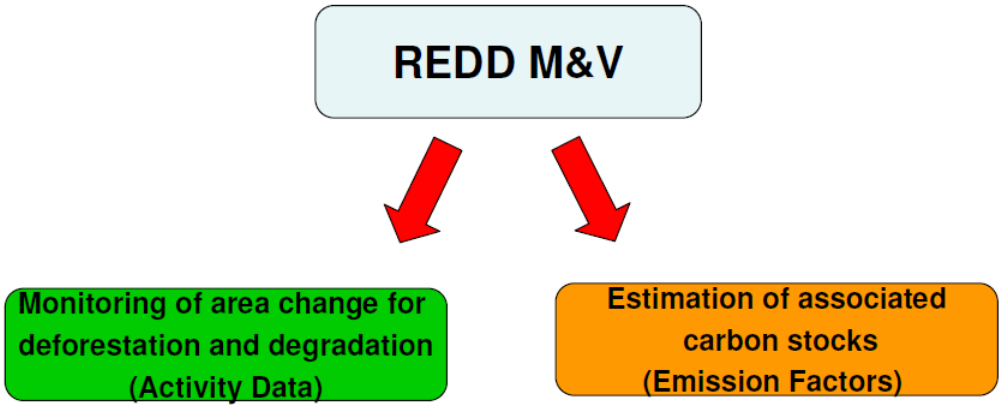
Contents

- Monitoring of Carbon Stocks – Measurement concept
- Main Assets of TerraSAR-X to support REDD+ MRV
- Amplitude Change Detection
- Examples of ACD Ghana
- Use of TerraSAR in DeforestAction (cooperation with GMES award winner 2011 GEODAN)
- Outlook – TanDEM a potential source for reference mapping ?

Monitoring of Emissions from deforestation & degradation

- IPCC methodologies can be used to convert past or future land use change into associated emissions



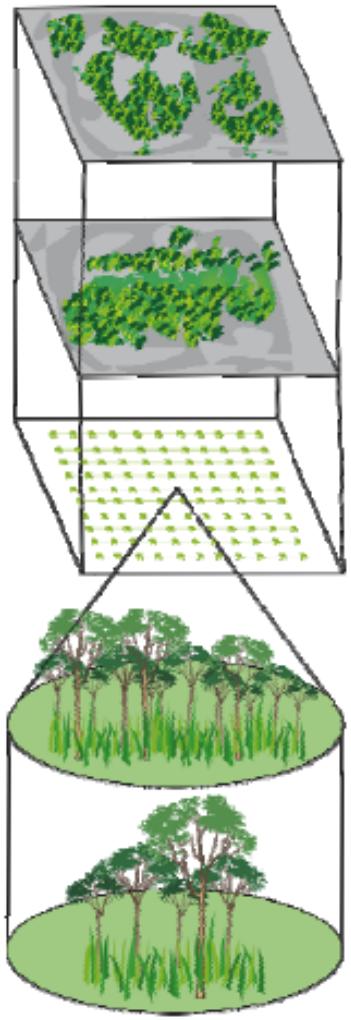
AD = Activity data
EF = Emission Factors

AD X EF = Emissions

Detailed mapping of status quo T0
Assess changes T0→T1→T2→Tn

Multi-phase Forest Inventory combining RS & in-situ assessments

Carbon Stock Assessment by Multi-phase Forest Inventories



Remote Sensing Phase1
(Forest/Non-Forest Stratification)

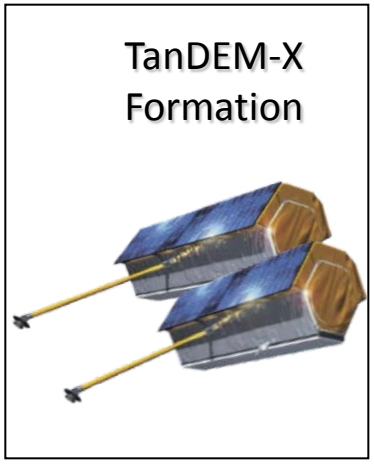
Remote Sensing Phase 2
(Stratification of Forest Formations)

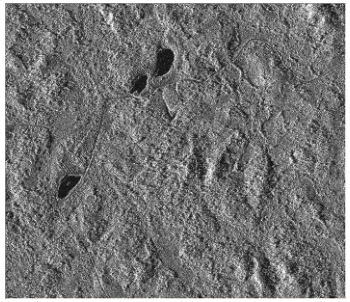
Field Survey
(Biomass assessment on sample plots)

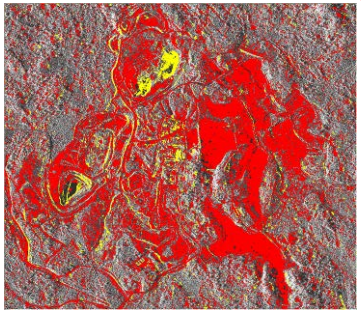
Tree measurements
(Dendrometric parameters)

Single Tree Biomass Assessment
(Randomised Branch Sampling)

Assessment of carbon stock changes - Efficiency of combined inventories







t0 t1 t2 t3

Why use TerraSAR for Change Detection

- Weather independant site access to any point on Earth
  - Compared to Optical acquisitions → more consistent coverages wrt. to input data quality and time consistency, actuality
- Excellent radiometric stability
  - Comparable backscatter → Fully automatic processing chain
- Geometric accuracy unrivalled by any other commercial space-borne sensor today
  - Very high orbit precision of TS-X allows sub-pixel coregistration of T1, T2…Tn
  - Particularly relevant when field measurements of small extent are combined with remote sensing data
- Flexible resolution (1m, / 3m / 18m) & footprint
  - Enable choice of most approriate resolution and coverage

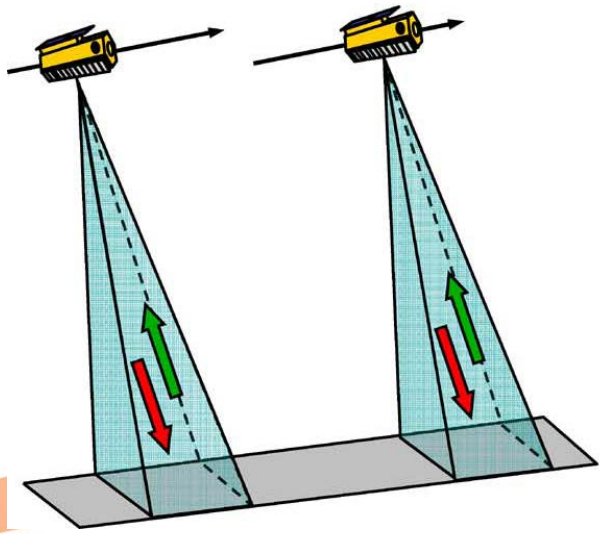
Approaches for change analysis

- Map to map comparison
  - Fuller et al. 2003 conclude: „*measurement of small to medium scale changes over large areas requires level of precision which are near impossible to achieve with satellite image classification alone*.“

  →for 10 class maps the accuracy at both times needs to be 99% to detect a smaller than 20% change with 90% reliability.

- Image to Image change detection
  - Utilization of two images
  - Same acquisition geometry
  - Nx11 days

→Both amplitude & phase show a very high sensitivity to detect surface changes over time



*

Amplitude Change Detection

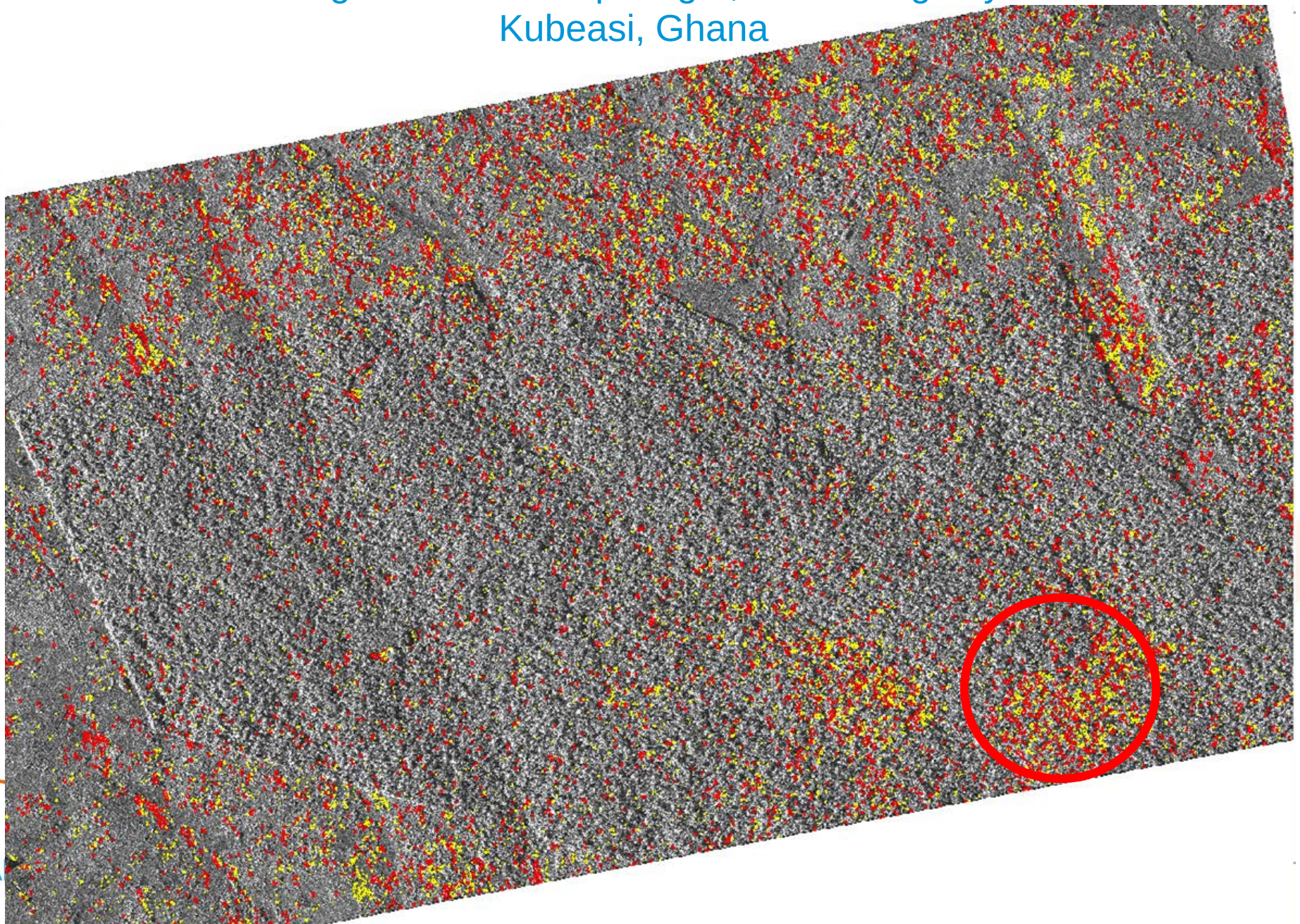
- Amplitude Change Detection
  - Compared to optical imagery the change Indicator shows differences in the canopy structure
  - Cut trees in canopy layer lead to new shadow and layover regions ->Change of backscatter
    - shadow areas -> decrease in backscatter
    - often in conjunction with increase (layover) depending on canopy structure/ density of top crown layer
    - change of texture
  - Comparably robust measure: backscatter changes are induced by differences in object geometry

- Pre-requisite
  - VHR SAR imagery (TerraSAR High resolution SpotLight -> StripMap
  - Repeat pass acquisitions
  - Comparable season at t1 and t2

→The change indicator layer provide the result of the automated change detection.
  - provide information that a change has occurred
  - do not give an indication about the type of the change.

TerraSAR-X acquistions Ghana

TerraSAR-X High Resolution SpotLight, Area of high dynamic near Kubeasi, Ghana



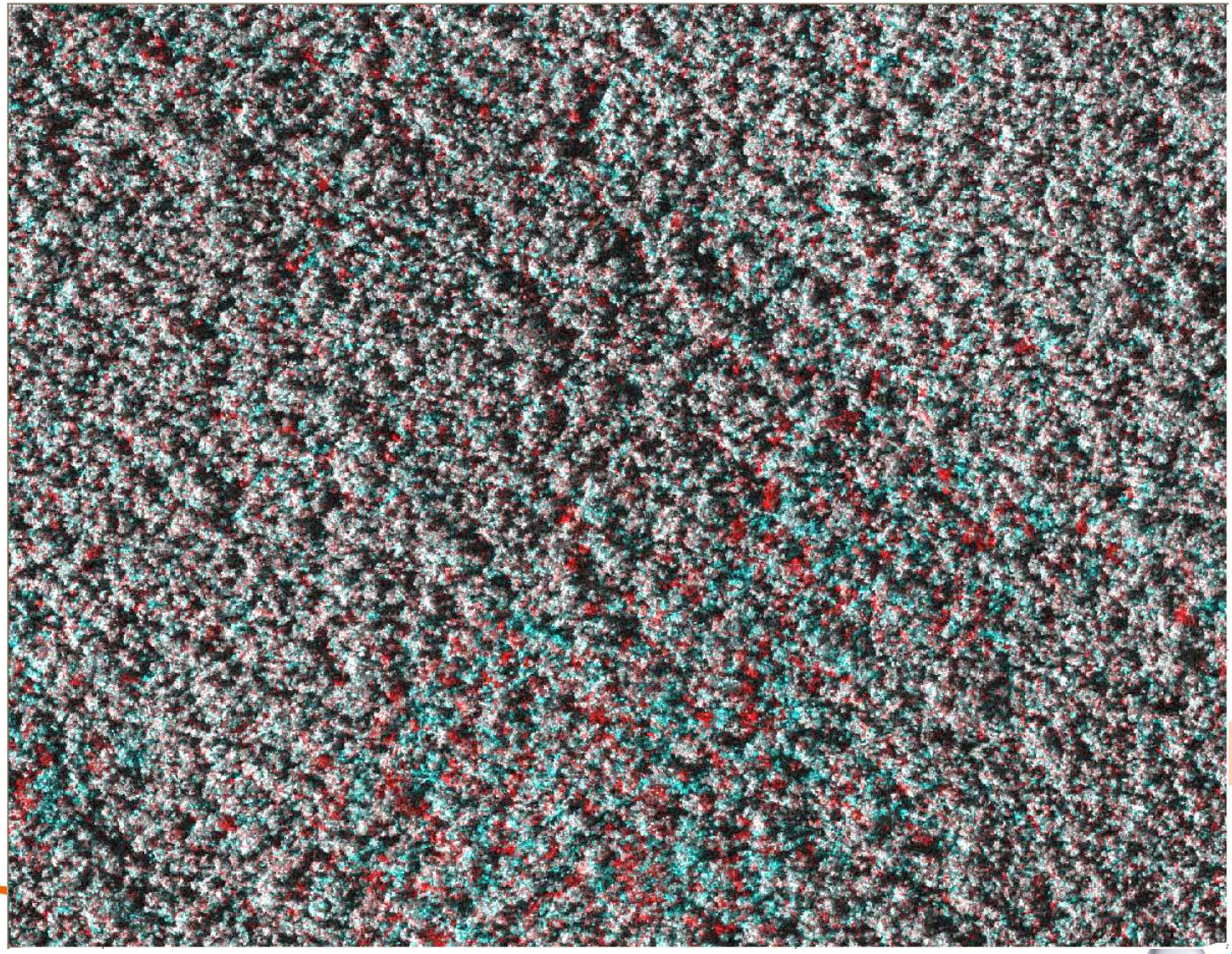
TerraSAR-X High Resolution SpotLight, Area of high dynamic near Kubeasi, Ghana

Time 1
2009-05-16

TerraSAR-X High Resolution SpotLight, Area of high dynamic near Kubeasi, Ghana

Time 2
2012-07-14

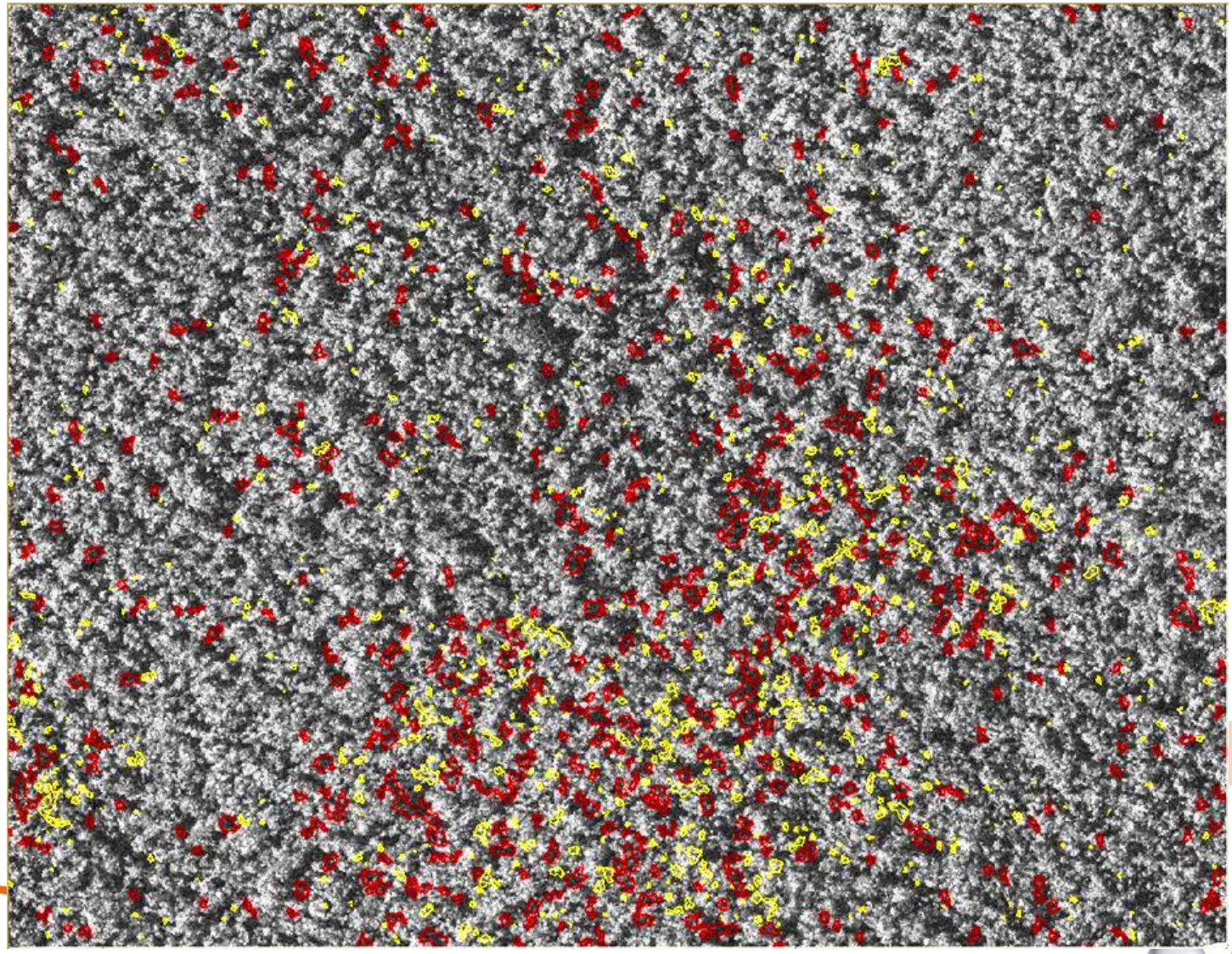
TerraSAR-X High Resolution SpotLight, Area of high dynamic near Kubeasi, Ghana



Red: 2009-05-16, Green+ Blue: 2012-07-14

Removed trees appear in red, re-/growth in cyan

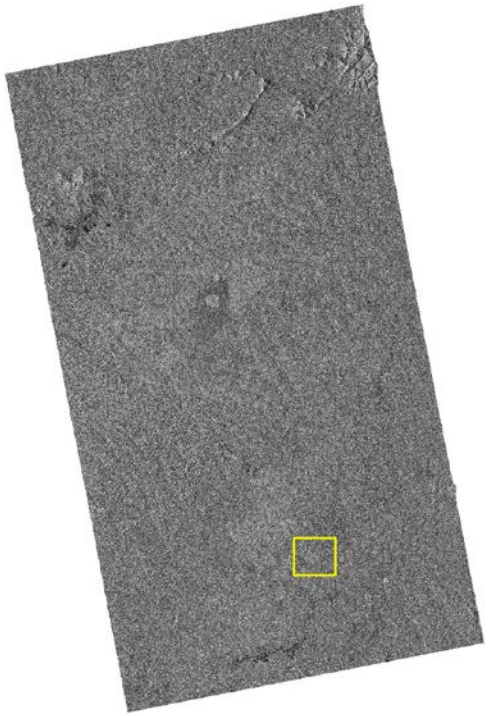
TerraSAR-X High Resolution SpotLight, Area of high dynamic near Kubeasi, Ghana

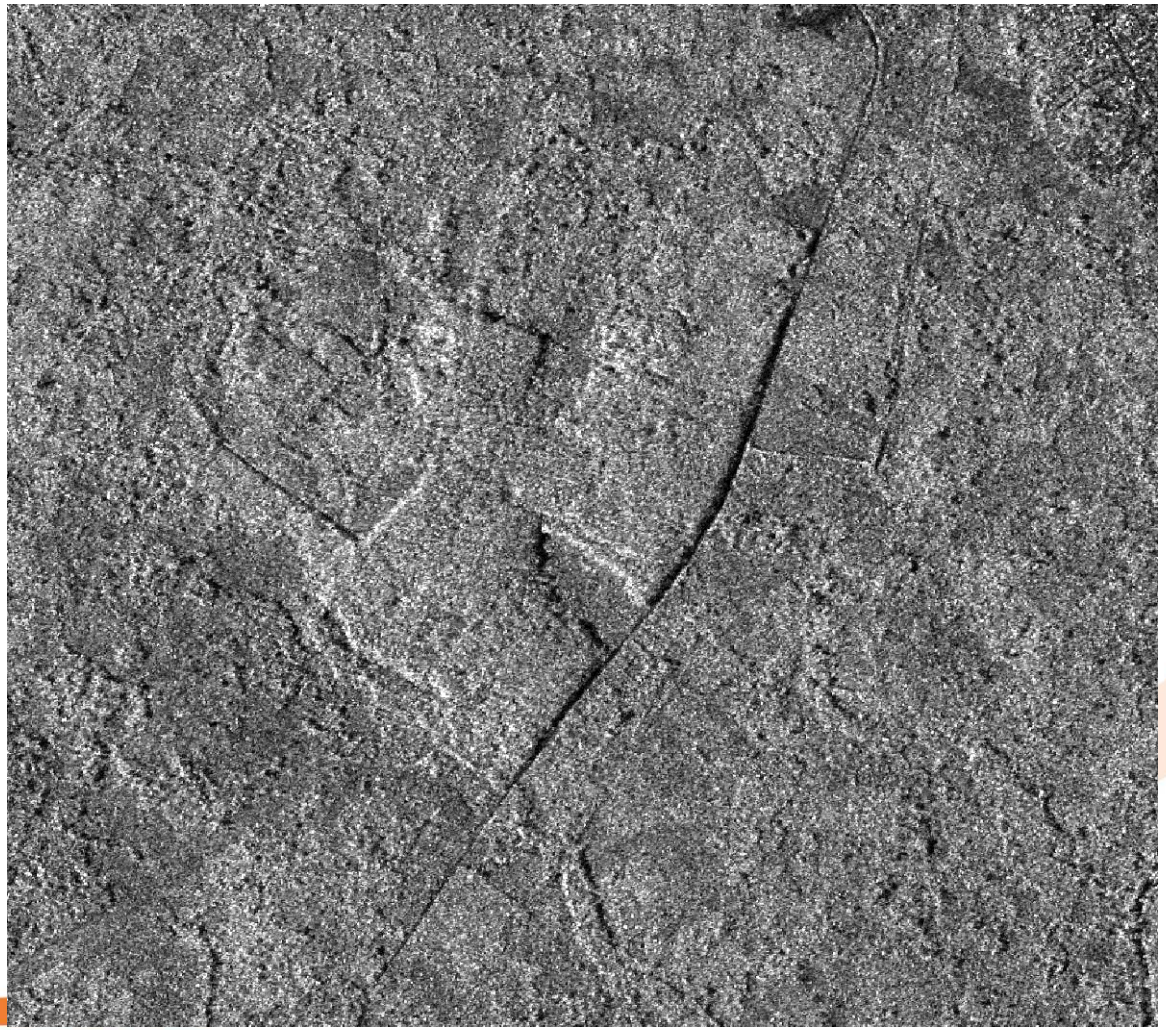


Time 2
2012-07-14
+
Change Indicators
Decrease in red
Increase in yellow

TerraSAR-X acquistions Ghana

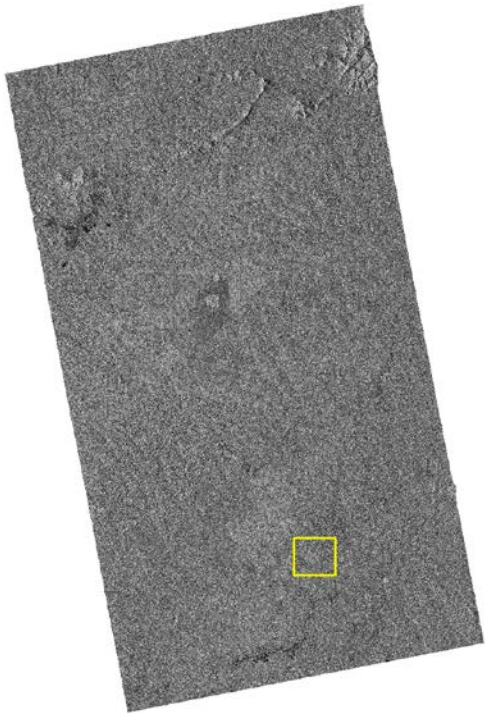
Change Detection, TerrraSAR-X StripMap, Kade Ghana

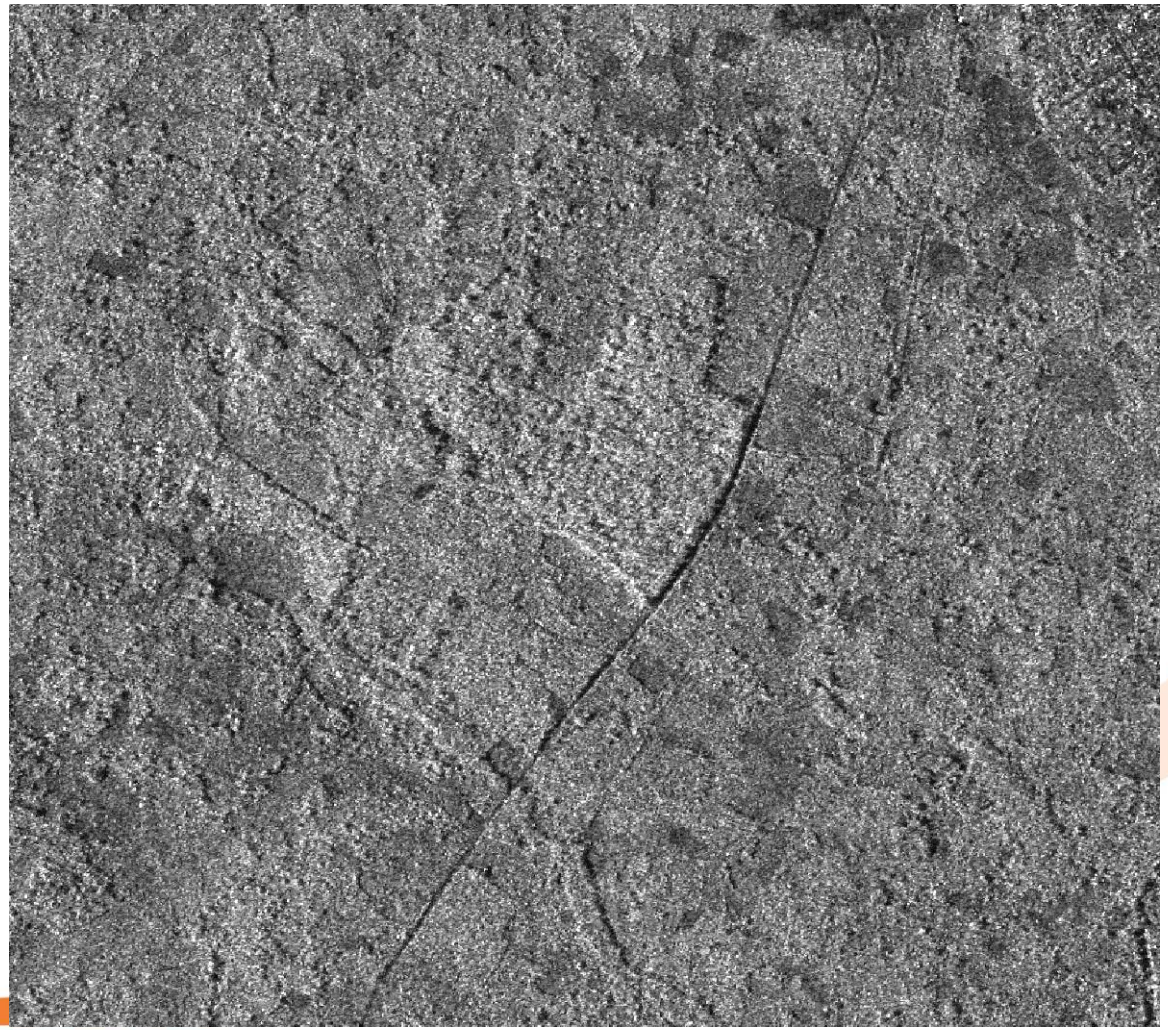




Intensity image from April 17th, 2010

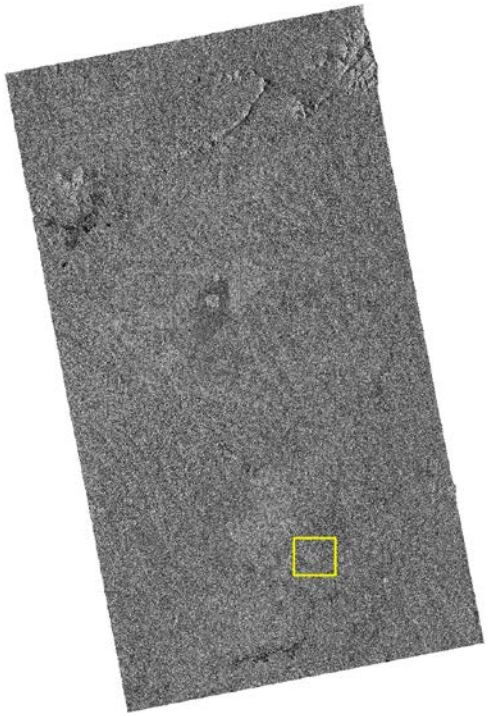
Change Detection, TerrraSAR-X StripMap, Kade Ghana

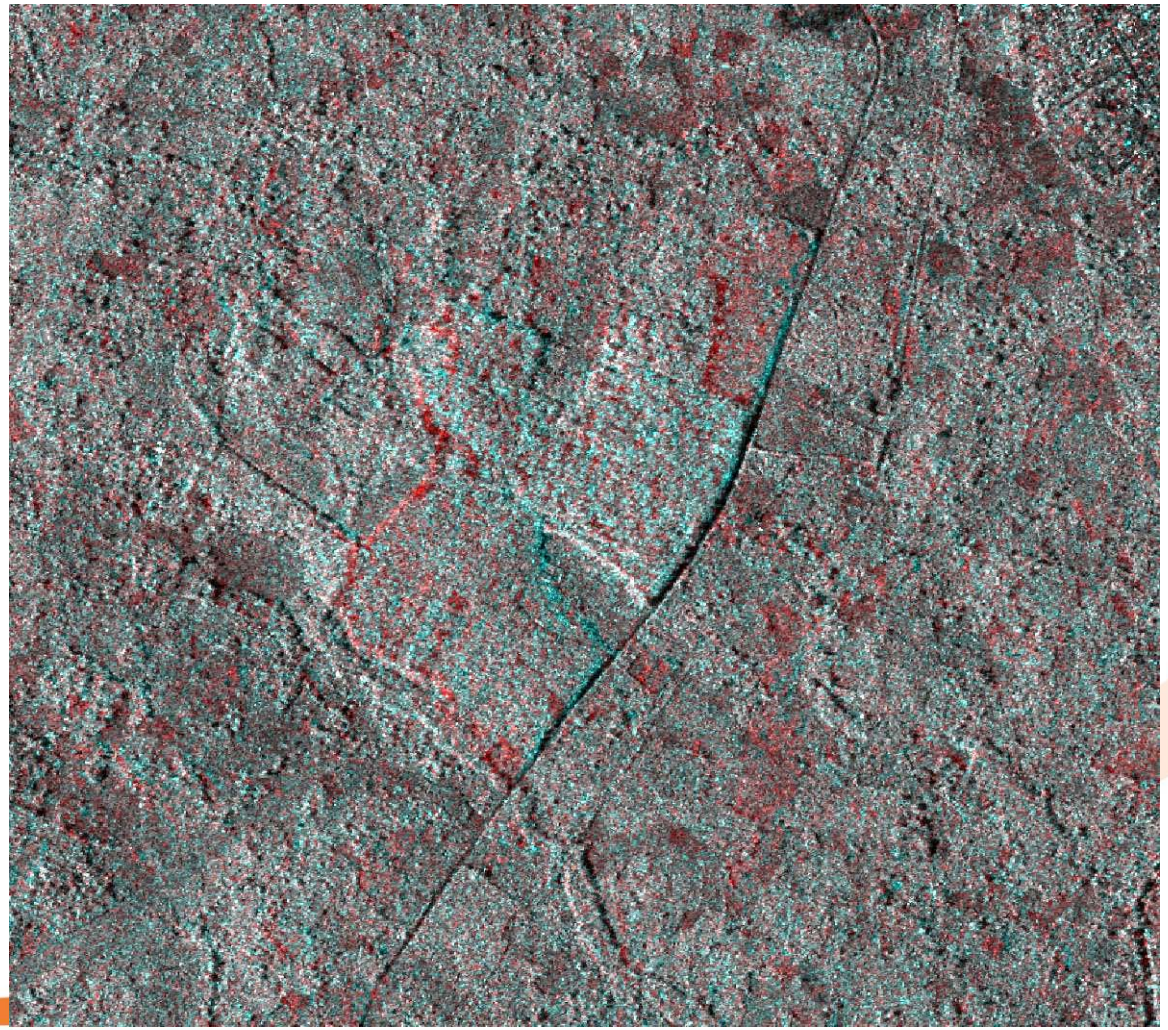




Intensity image from May 4th, 2012

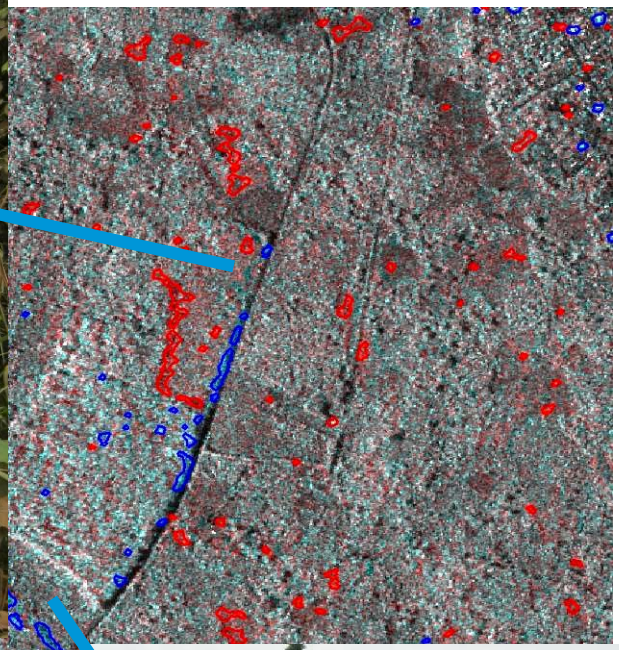
Change Detection, TerrraSAR-X StripMap, Kade Ghana

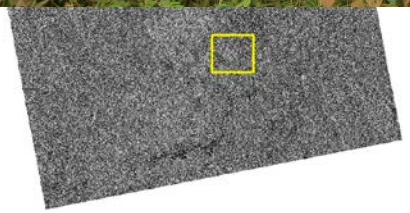


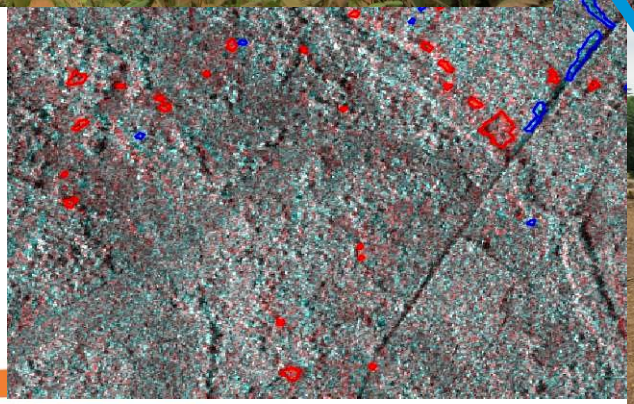


RGB color composite from April 17th 2010 (red) and May 4th, 2012 (cyan)

pMap, Kade Ghana







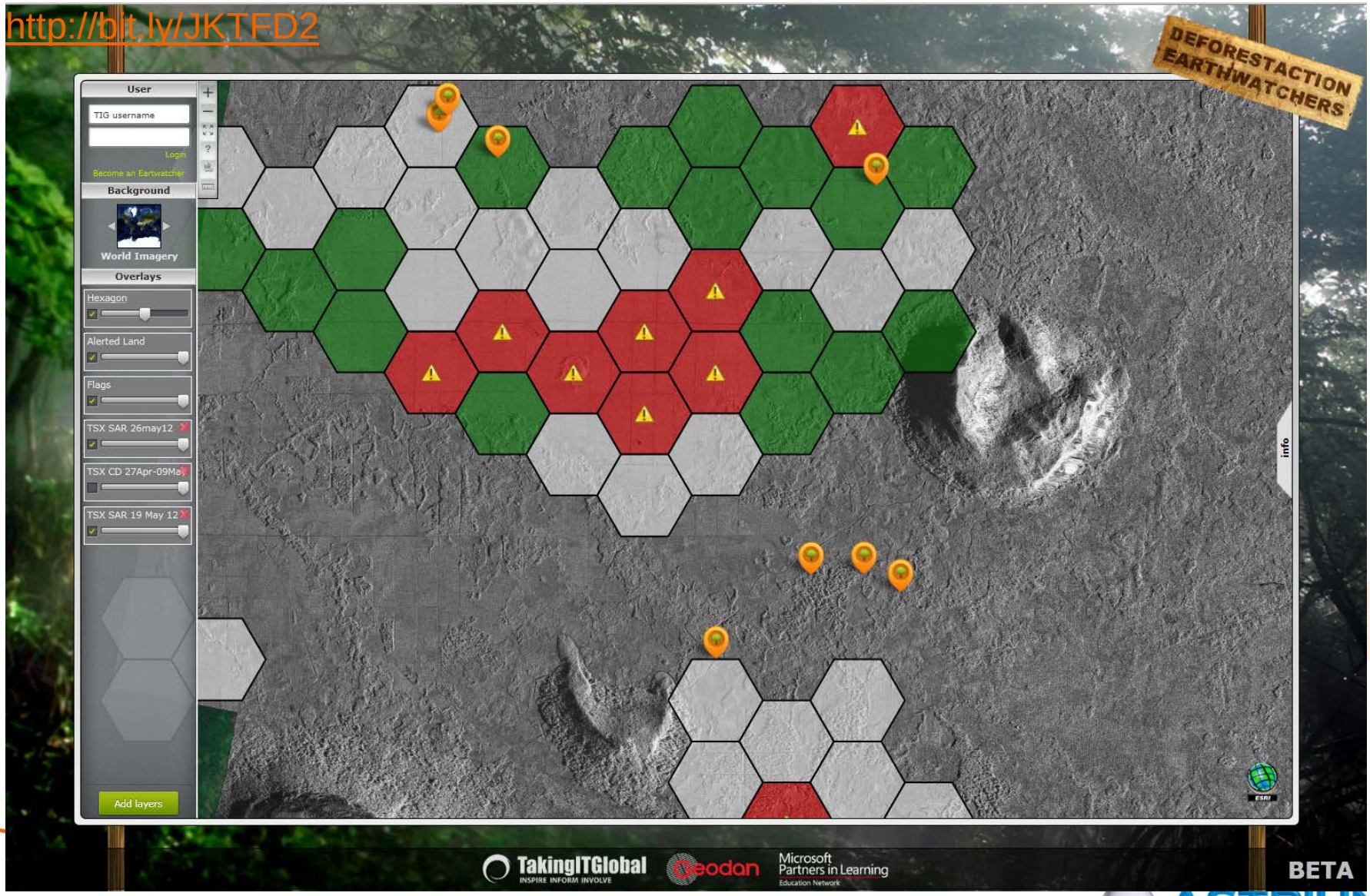
RGB color composite and indica
polygons for backscatter incr
(blue) and decreased (red)

TerraSAR-X Support to GMES masters 2011 GEODAN

- Scope
  - Support EarthWatchers & Eco- warriors with timely information of forest changes in Kalimantan
- Data in Use
  - Near real-time SAR imagery
  - several updates each month
  - base optical map for comprehension
- Achievements
  - Timely support of web-based crowd -sourced rainforest monitoring by TerraSAR-X imagery & automatic change detection layers
  - >10 acquisitions delivered
  - 4 Change Detection products; Examples of detected automatically changes in EarthWatchers Wiki
    - http://shout.tiged.org/dfahq/writing/?id=34571
      http://dfa.tigweb.org/about/?section=current

Alert areas in Panjang, Kalimantan detected with TerraSAR-X

http://bit.ly/JKTFD2



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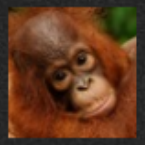

EcoWarriors Rise

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The TerraSAR-x satellite is sensitive enough to

The **TerraSAR**-x satellite is sensitive enough to detect when even a single large tree is removed from the forest...

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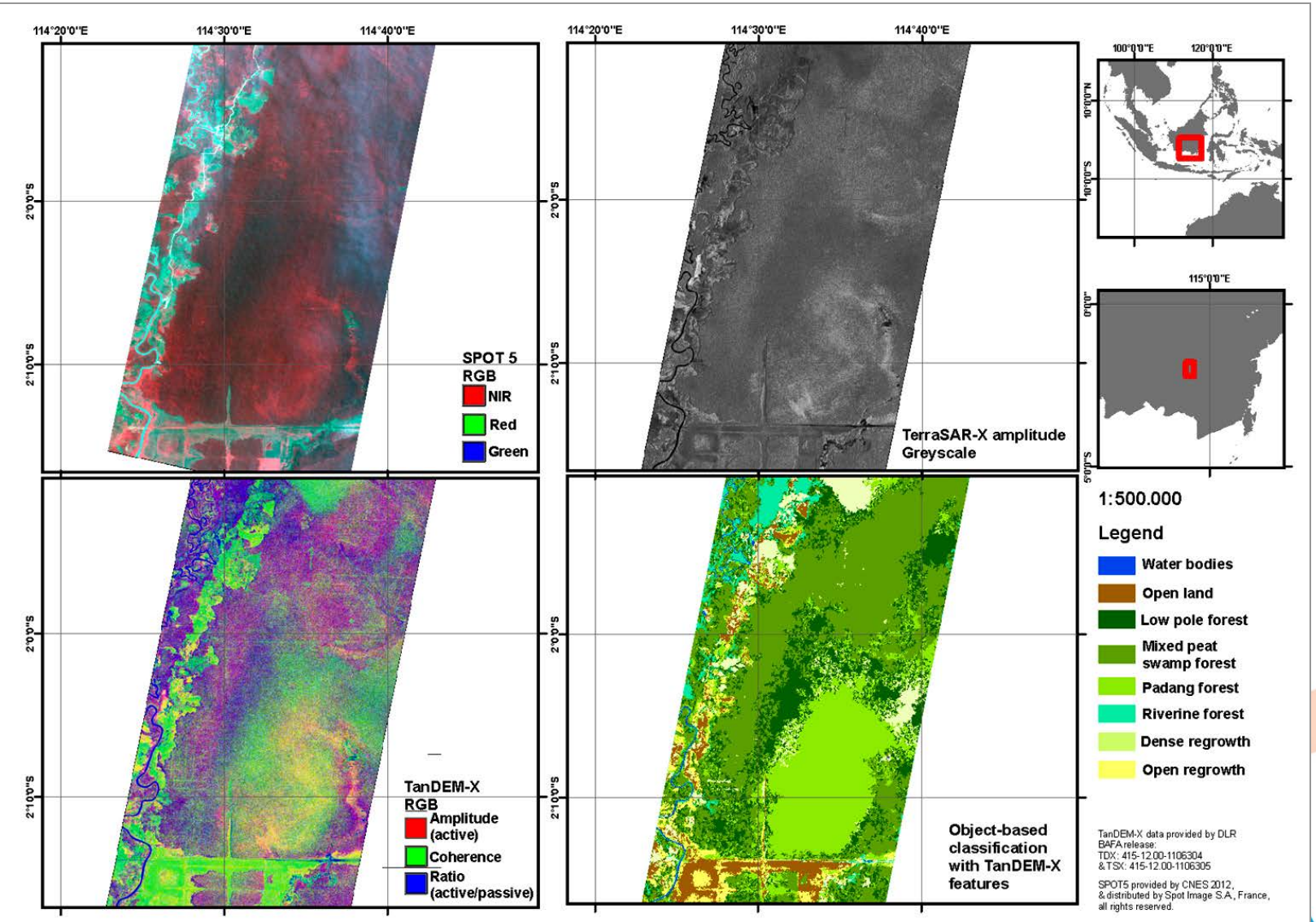
Outlook

TanDEM-X a potential source for reference mapping ?



M. Schlund, F. von Poncet, S. Kuntz & C.Schmullius (2012): "Importance of bistatic SAR features from TanDEM-X for forest mapping and monitoring". Selected for Special issue of Remote Sensing of Environment (RSE) for Forestsat conference papers.

Classification accuracy (bistatic features)
Kappa= 0.84

Thank you for your attention

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