Measuring Deforestation

A Statistical Approach

CARPE - TECHNICAL TOOLKIT WORKSHOP

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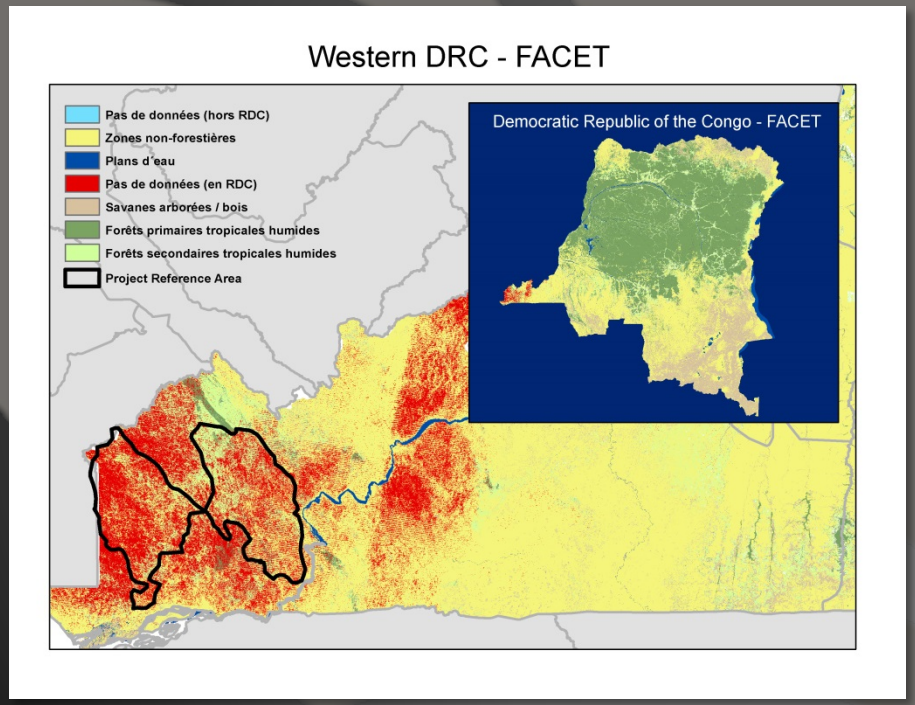
My Background

- Remote Sensing scientist
- Undergraduate degree in Aerospace Engineering from the University of Colorado at Boulder
  - On Mission Operations team for the Student Nitric Oxide Explorer (SNOE) as an undergad.
- Masters in Geography from UCSB (Santa Barbara)
  - Studied African agriculture (Kenya) and developed a temporal model to support the FEWS NET system based on MODIS NDVI metrics.
  - Interested in RS-based tools to support anthropogenic challenges

Why A Statistical Approach?

Challenges to traditional "wall-to-wall" approaches

- Cloudiness, image imperfections (SLC-off)
- Image availability, cost for large-extent problems

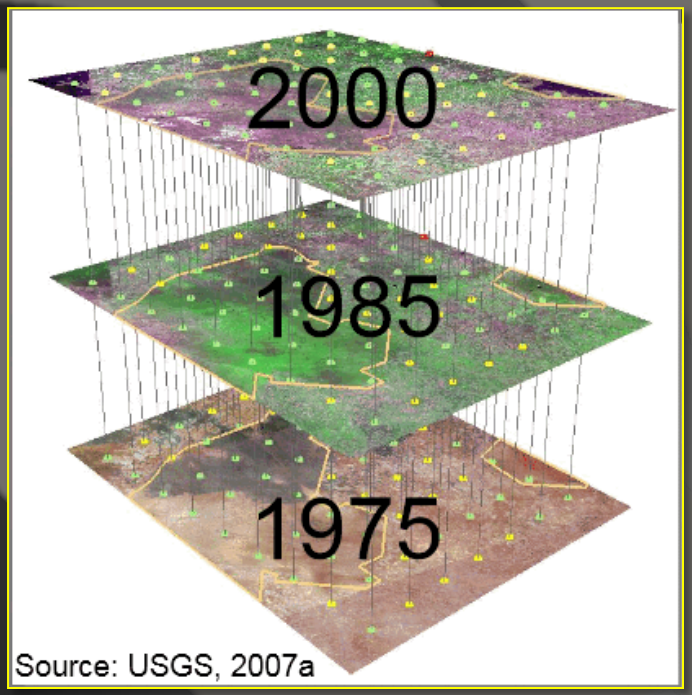


Example: The Mayombe Forest, one *cloudiest* areas in the DRC. Wall-to-wall mapping cannot track the deforestation trends here.

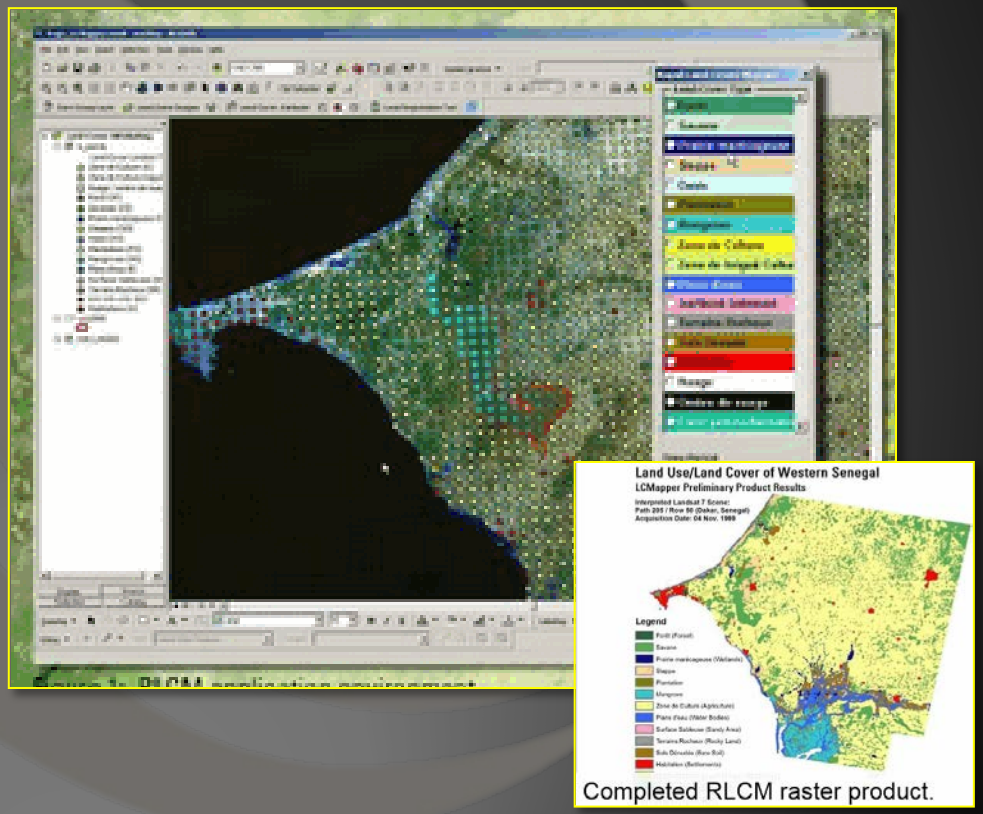
Solution Built on Crop Area Estimation Tools

Rapid Land Cover Mapper (RLCM) developed at USGS/EROS

- See: http://edcintl.cr.usgs.gov/ip/rlcm/index.php



Source: USGS, 2007a



Completed RLCM raster product.

Choosing a Reference Area

Depends heavily on Project Type – VM0009 allows for multiple project types

1. Unplanned Deforestation
   - Reference Area should be physically close to project
   - Similar geographically (i.e. land cover strata, water density, road density, same deforestation drivers and agents
2. Planned Deforestation
   - Reference Area ideally will be owned by same agent of deforestation
   - Less dependent on physical proximity, more on similarity of concession characteristics
   - Similar distance to major market(s), similar forest type (species), etc.

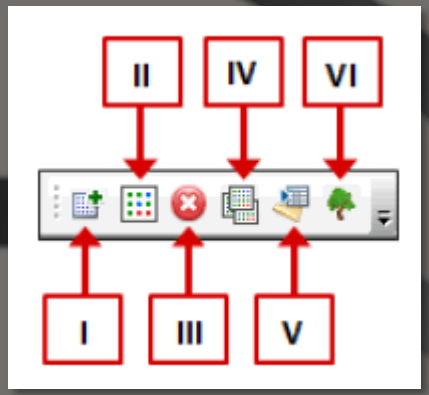
The Biomass Emission Model (BEM)

One answer to the challenges of measuring land cover change in the form of deforestation

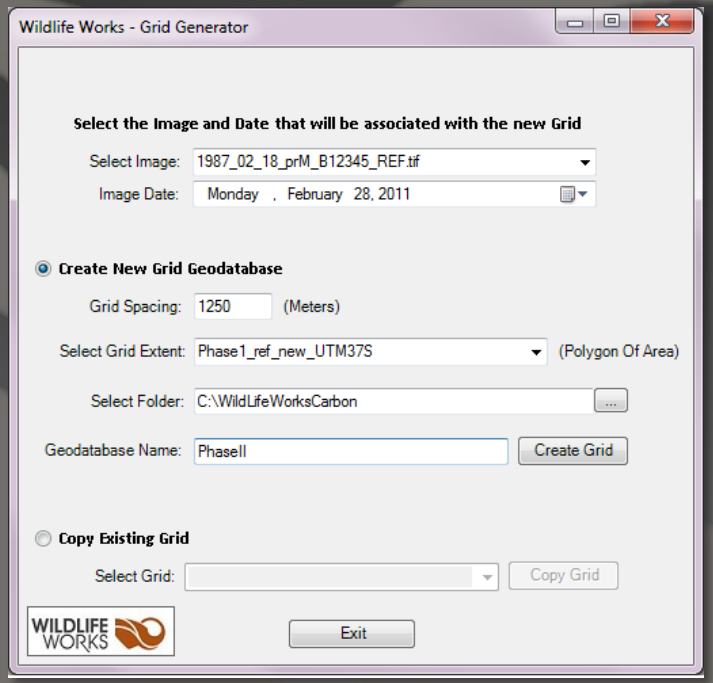
- Developed at Wildlife Works by Jeremy Freund and Kyle Holland (EcoPartners).
- An alternative approach to *temporal* modeling (land cover change)
- Gaining support and most importantly *understanding*. Interested in discussion / criticism (constructive)
- Not “the answer” or the only approach that can work

Biomass Emission Model GIS Tool

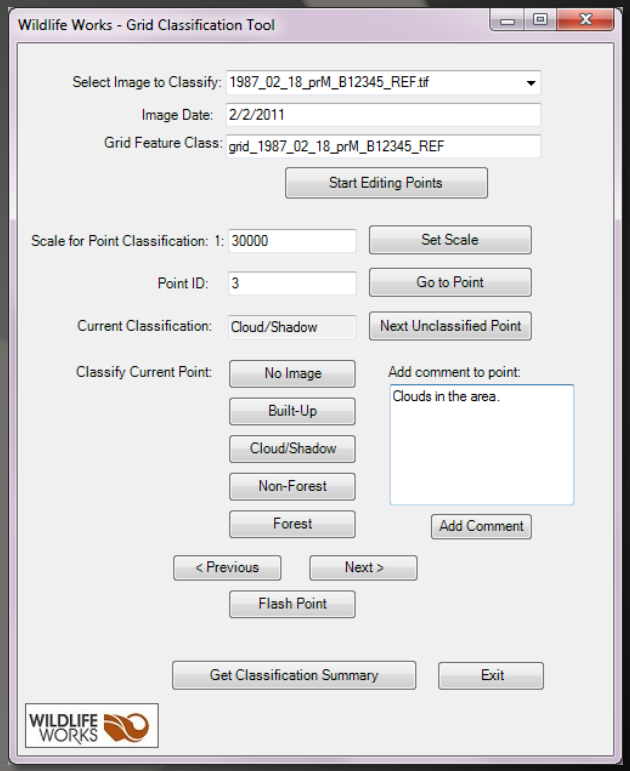
WWC GIS Toolbar



1. Grid Generator

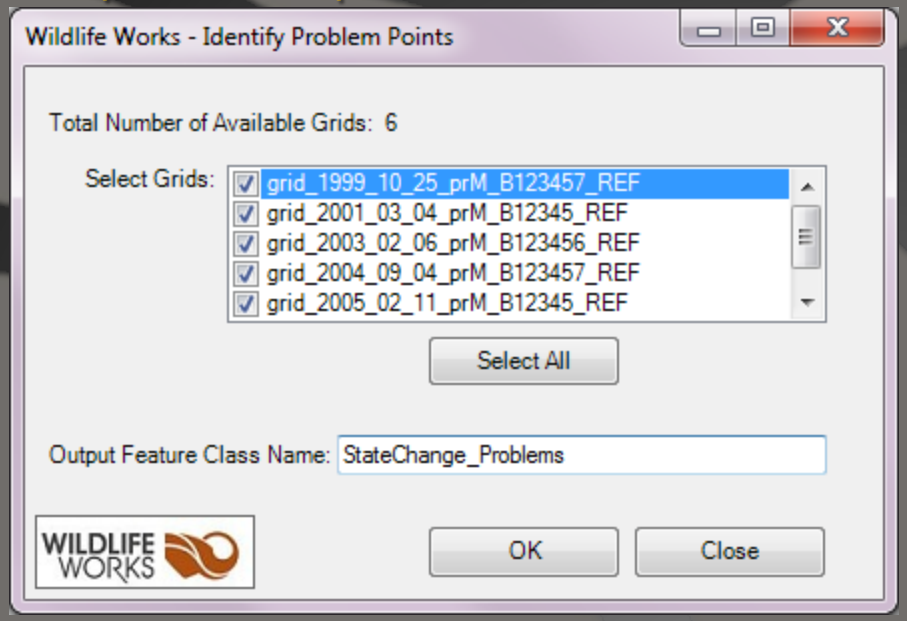


2. Classifier

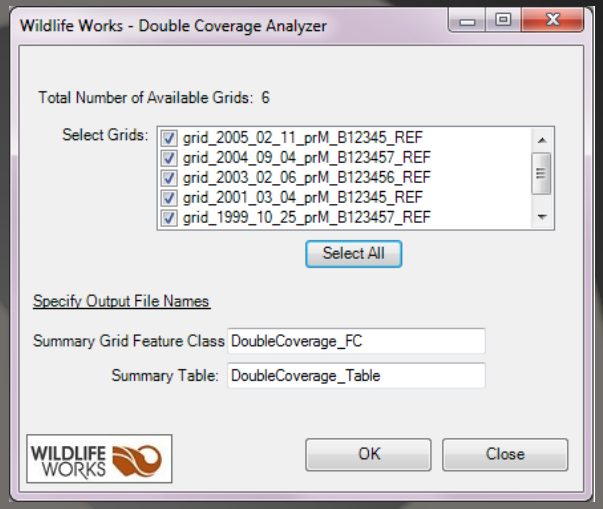


Biomass Emission Model GIS Tool

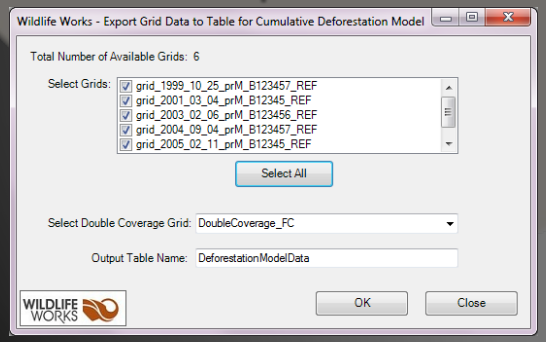
3. “problem point” identifier



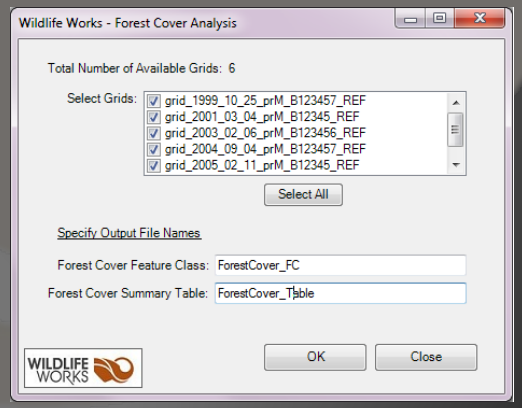
4. Double-coverage Analyzer



5. Grid Export

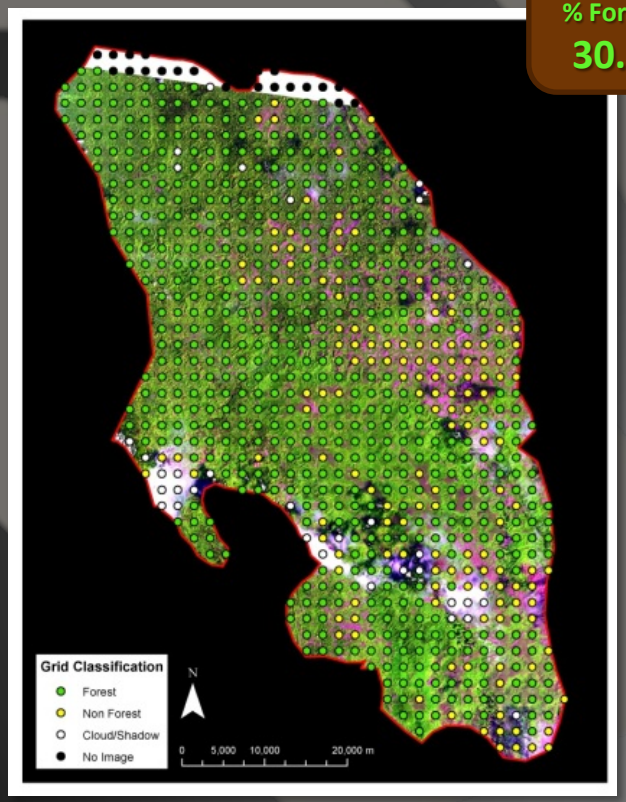


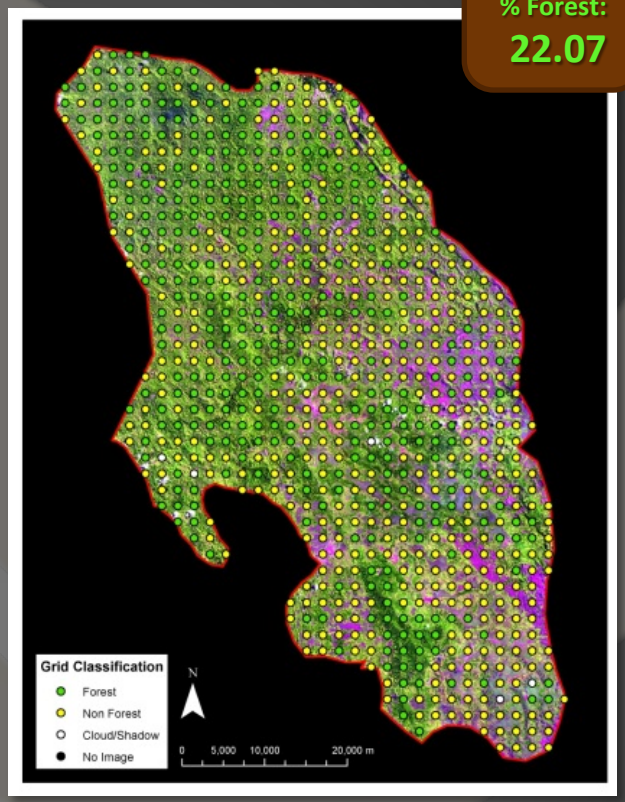
6. Forest Cover Analyzer



A BEM Example: Mayombe Forest

- Multiple image dates analyzed (no limit on number of images)
- Any georeferenced imagery allowed (aerial photos, high res, etc.)



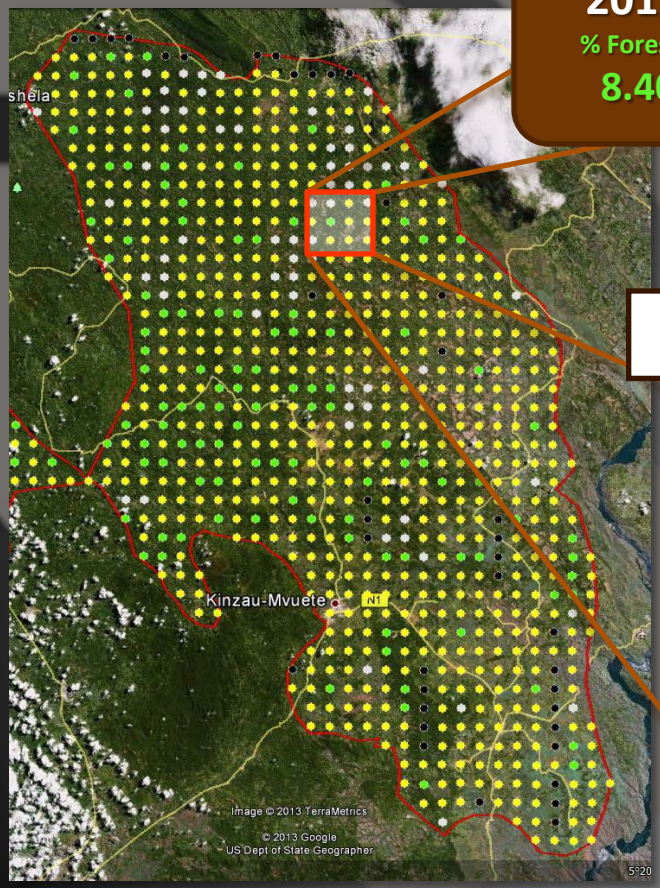


Measuring Historical Deforestation

Final year validation with high-resolution imagery

High Resolution: 2011 imagery

Final year observation:



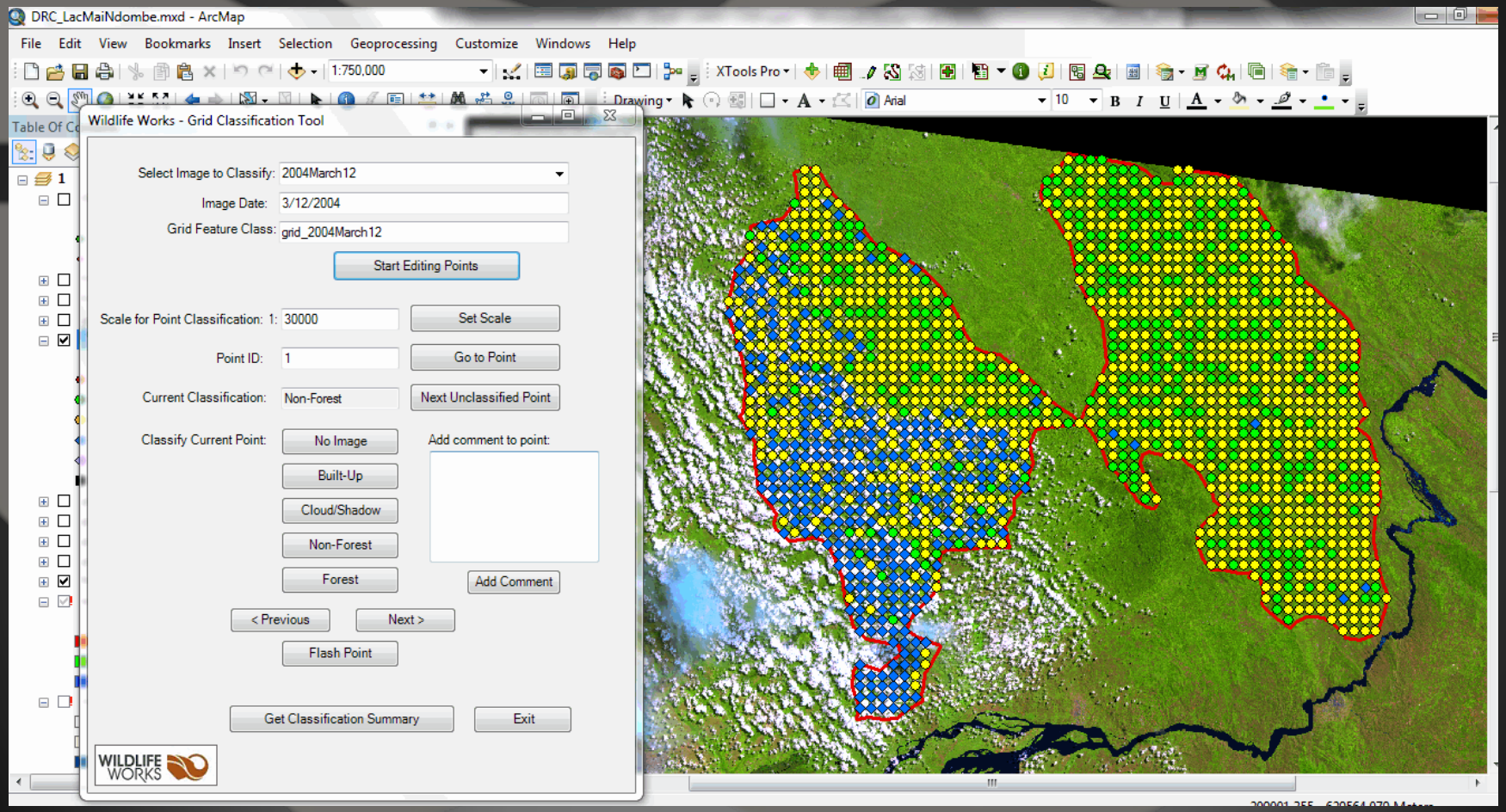
2011

% Forest:

8.40

GIS Example

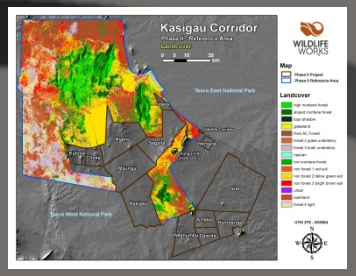
Mayombe Forest - DRC



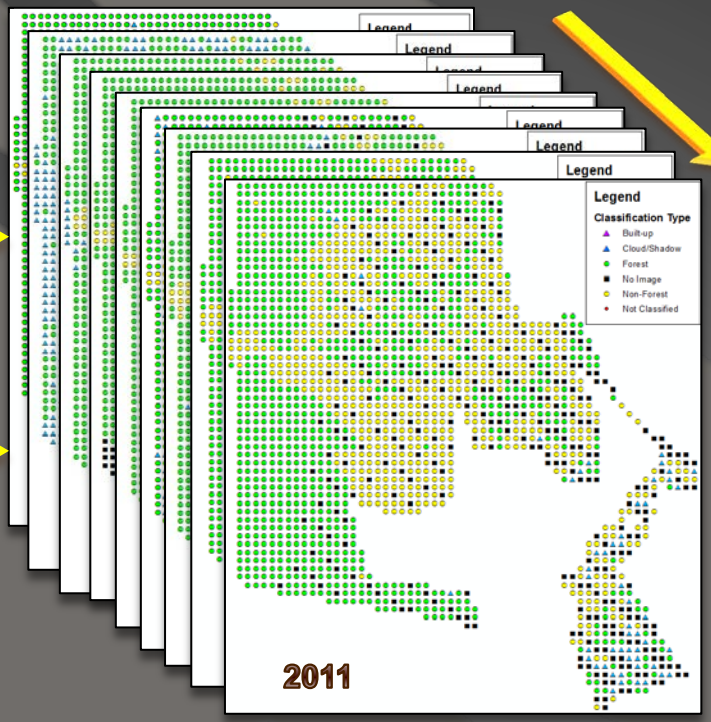
BEM Modeling Process

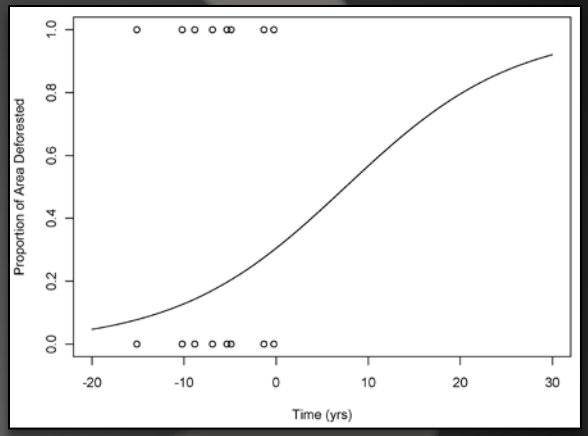
GIS classification tools used to feed logistic model

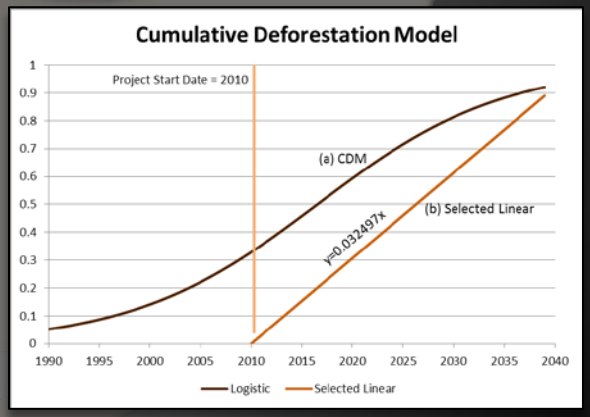
Reference Area



WW GIS Software Tools



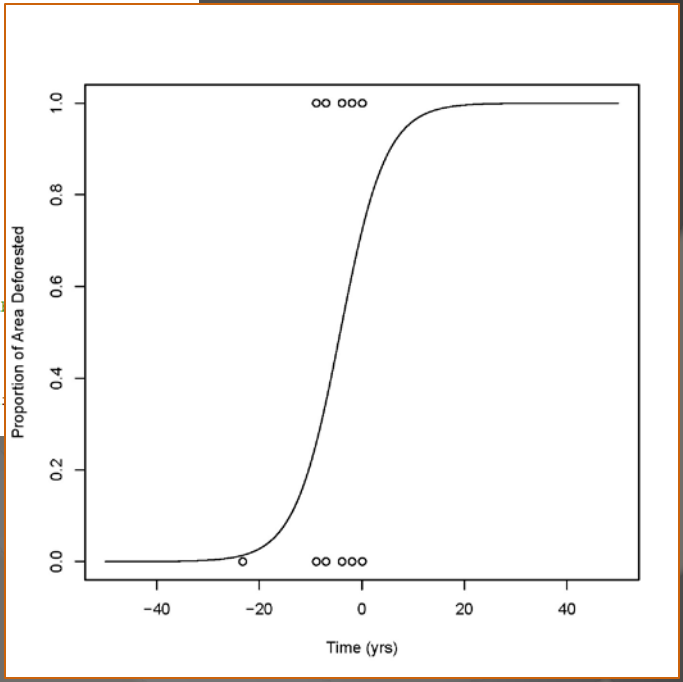




Logistic Model

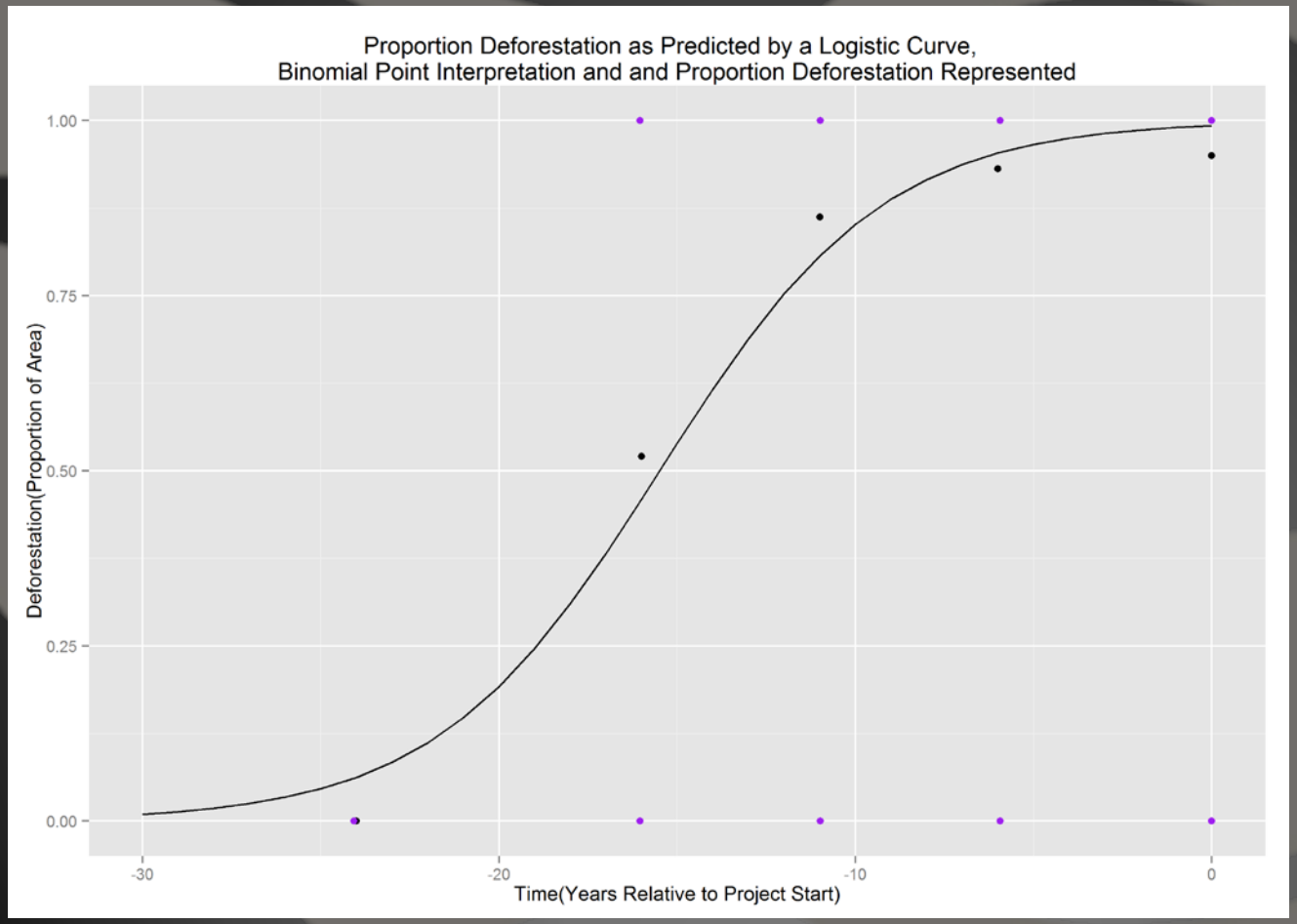
Simply coded using Statistics package (like R)

```
#read Lac Mai Ndombe CSV
stuff=read.csv("C:\\Users\\Jeremy\\Dropbox\\WWC - ecoPartners\\Active Projects\\DRC -

head(stuff)
attach(stuff)
Time<-strptime(Observation_Date, "%m/%d/%Y")
Time2<-as.Date(Time)
Time2
#set  project start date to 0
Zero<-as.Date("2011/3/11")
#T.Time<-as.numeric(Sys.Date()-Time2)
temp.time<-as.numeric(Zero-Time2)
T.Time<-temp.time*-1
T.Time
stuff2<-cbind(stuff,T.Time)

#Summarize input data
summary(stuff)

#Assimilate dependent (deforestation) and independent (Time) varia
formula=State~T.Time

#Fit the CDM and Summarize
model.glm=glm(formula,data=stuff2,weights=Weight,family=binomial(li
summary(model.glm)
```



Logistic Model Results

Mayombe Forest - DRC



Logistic Deforestation: Literature Sources

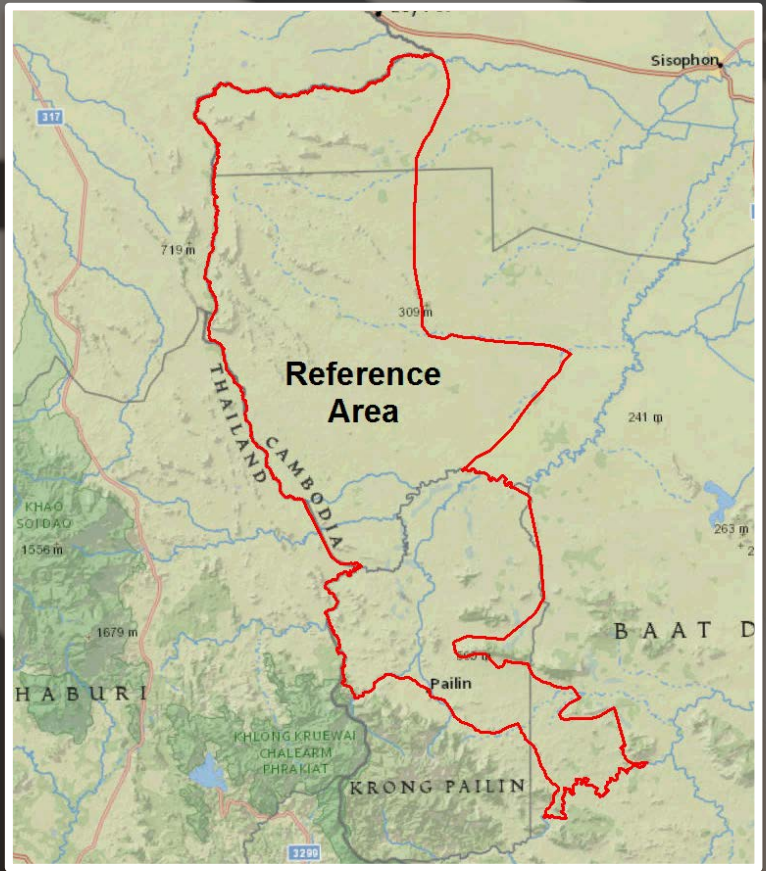
- Arellano-Neri & Frohn, 2001
- Kaimowitz, Mendez, Puntodewo, & Vanclay, 2002
- Linkie, Smith, & Leader-Williams, 2004
- Ludeke, Maggio, & Reid, 1990
- Mahapatra & Kant, 2005

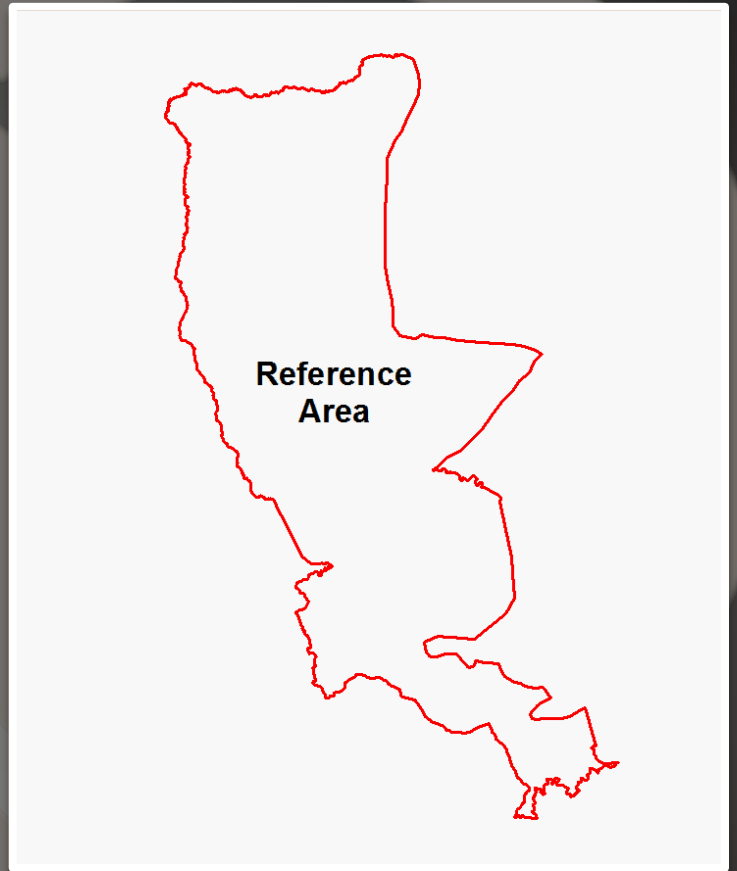
Wildlife Works' BEM Resources

- Published in VCS Methodology: VM0009
- Utilized for successful VCS REDD Project validation/verification:
  - The Kasigau Corridor REDD+ Project (Phase I and II) - Kenya
  - The Lac Mai Ndombe REDD+ Project – DRC
  - Anthrotect's Choco-Darien Project – Colombia
  - The Kariba REDD Project - Zimbabwe

Measuring Historical Deforestation

Animation: Samlaut, Cambodia feasibility study





Thank You!

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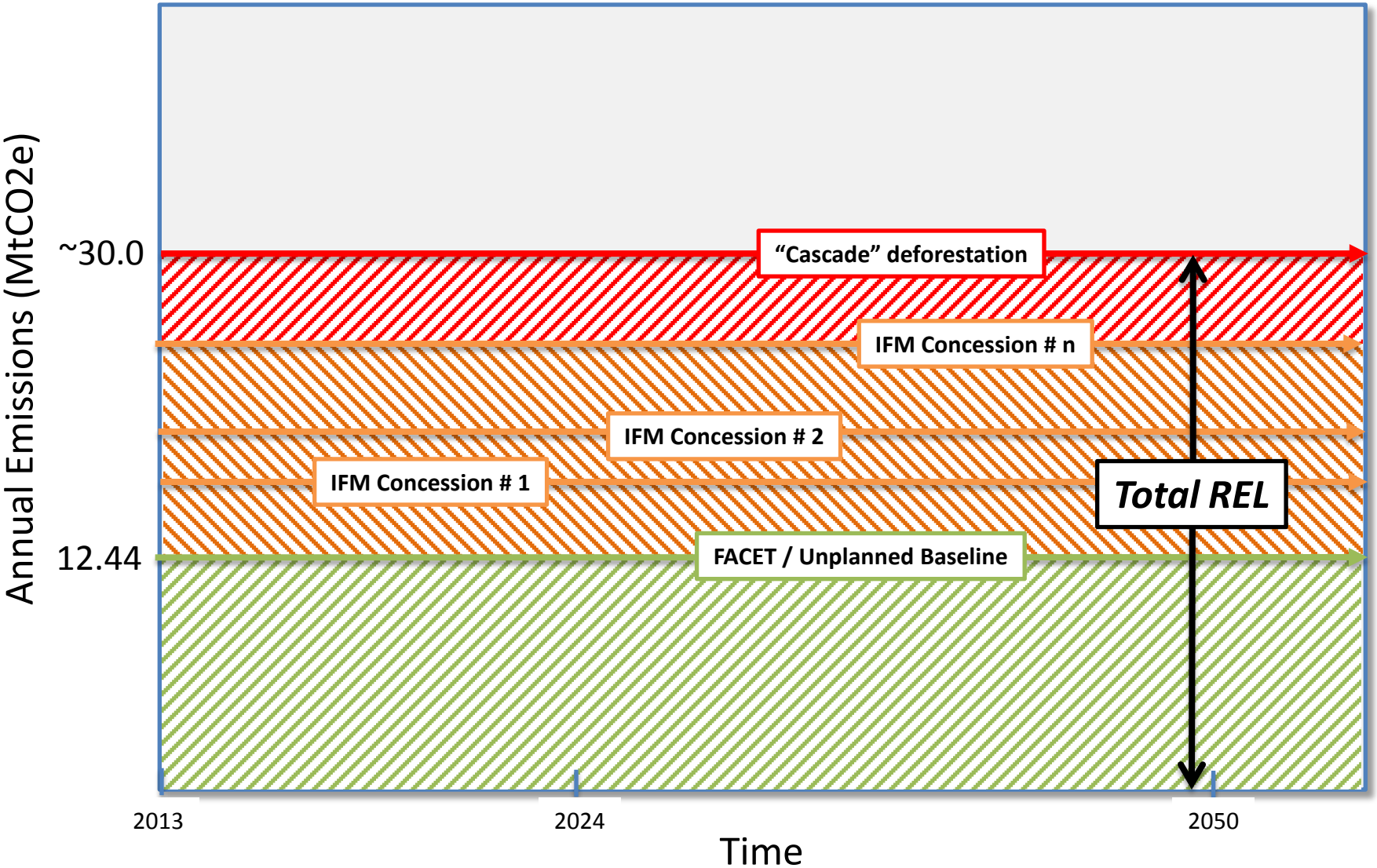
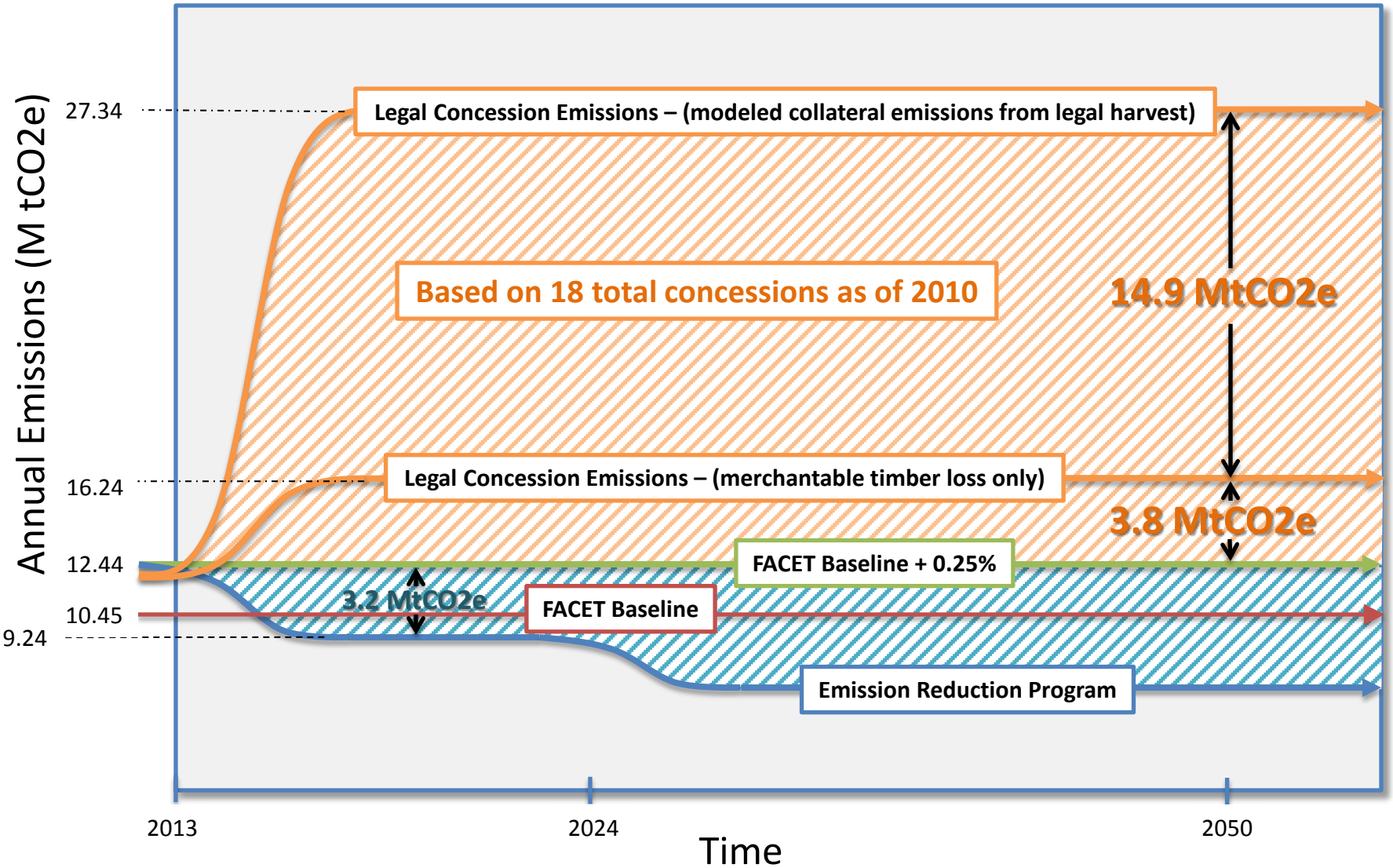
Reference Level (REL)

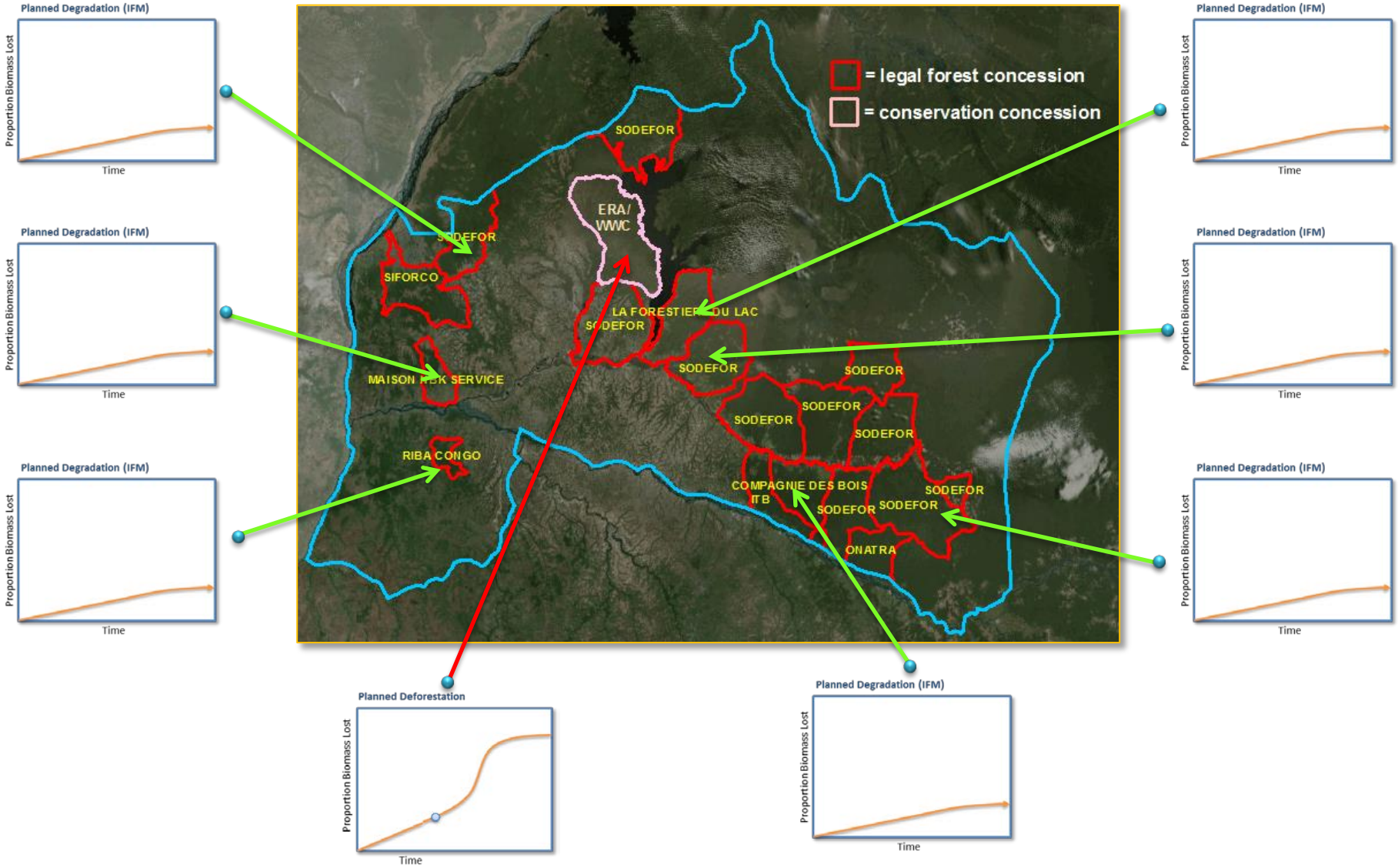


Legal Concession Emissions vs. FACET-based ERs

= Legal logging concession emissions

= Projected emission reductions under WWF / FACET-based reference scenario



Future Mai Ndombe Province Land-use Based REL

Separate reference levels for each concession