Definition of degradation

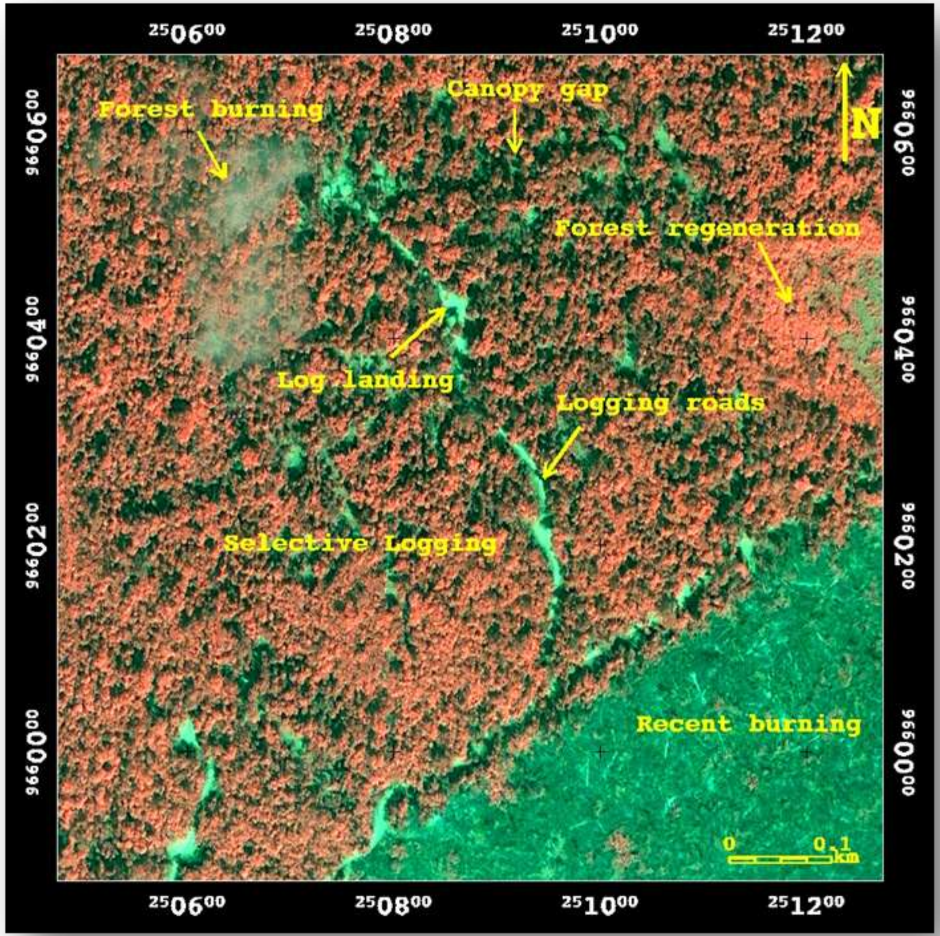
- General Definition:

  "…loss of carbon stock within forests that remain forests."

- Removal of carbon forest stocks should be persistent.
- There is no replacement of the original forest cover by other type of land cover type.
- Forest degradation can also generate negative social impacts.

Challenges to Define Forest Degradation

- Mapping boundary between forest degradation and forests is not clearly defined.
- Forest degradation creates a mixture of environments including undisturbed forests, small clearings and old degraded forests (i.e., forest regeneration).



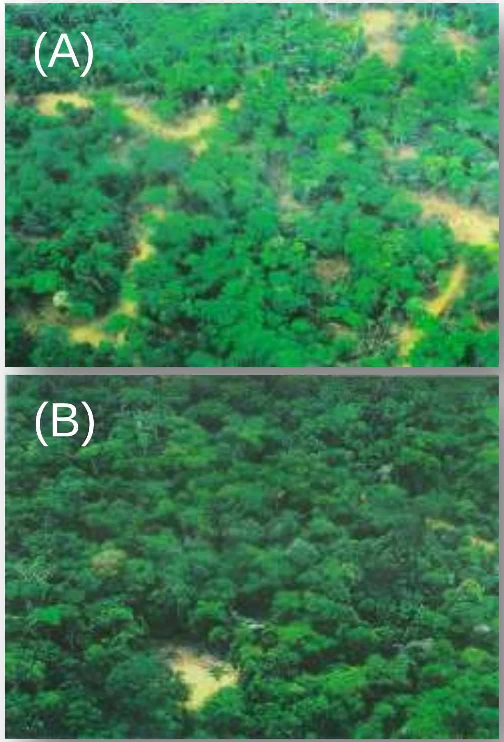
Types of Forest Degradation

- Forest degradation can be caused by one or a combination of anthropogenic threats and detectability by Earth Observation systems is not always possible.

Table 23.1 Detectability of different threats to tropical forests using available remote-sensing techniques. Marginally detectable threats are those that can be detected, at least partially, using high-resolution methods or specialized detection algorithms that are expensive, technically challenging to implement, and available only for limited or specific areas.

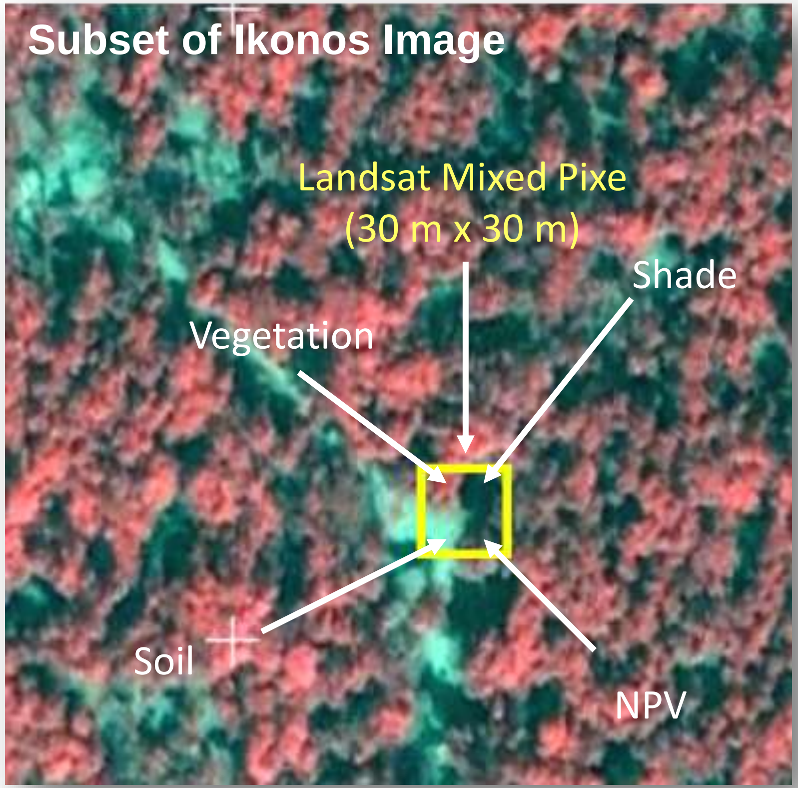
Readily detectable	Marginally detectable	Not detectable
Deforestation	Recent selective logging	Hunting or defaunation
Habitat fragmentation	Surface fires	Harvests of many nontimber forest products
Major forest fires	Effects of climate change on plant phenology	Effects of pathogens
Major highways	Small-scale gold mining	Compositional shifts in plant communities from climate change
	Wider roads (6–20 m width)	Nonrecent selective logging
	Some invasions of exotic plant species	Narrow roads (<6 m width)
		Most secondary effects

Source: Laurence and Peres, 2006.



(A) Predatory unplanned logging, and (B) Reduced Impact Logging (RIL) Paragominas, Pará, Brazil

Direct mapping of degradation using Spectral Mixture Modeling (SMA)

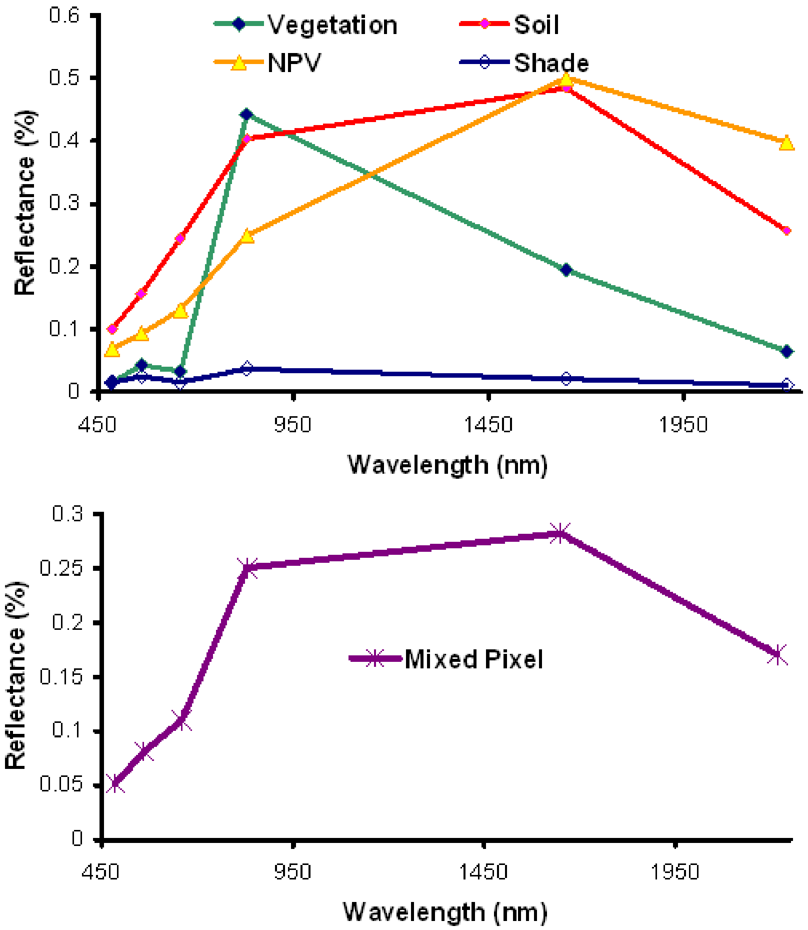


- The most common spectrally pure materials (i.e., endmembers) found in degraded forests are:
  - Green vegetation
  - Soil
  - Non-photosynthetic vegetation (NPV)
  - Shade
- Mixed pixels predominates in degraded forests

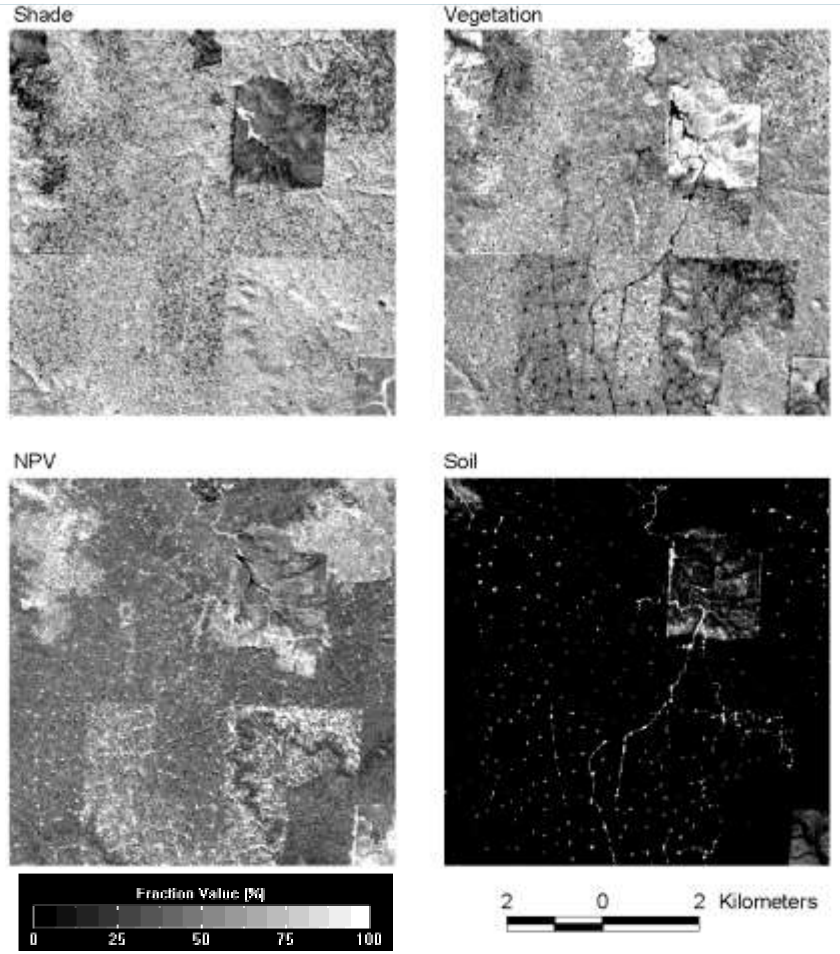
Landsat Mixed Pixel

- SMA has been proposed to overcome the mixed pixel problem found in degraded forests.
- Mixed pixels can be decomposed into fractions of endmembers.

Image Endmembers



Interpreting Endmember Fractions



- Shade:
  - Topography and forest canopy roughness , and large clearings
- Green Vegetation:
  - Canopy gaps, forest regeneration and clearings
- Soil:
  - Logging infrastructure (roads and log landings)
- NPV:
  - Canopy damage and burning scars

Souza Jr. et al. 2003, RSE

Combining Fraction Information to Enhance Forest Degradation Detection

NDFI – Normalized Differencing Fraction Index

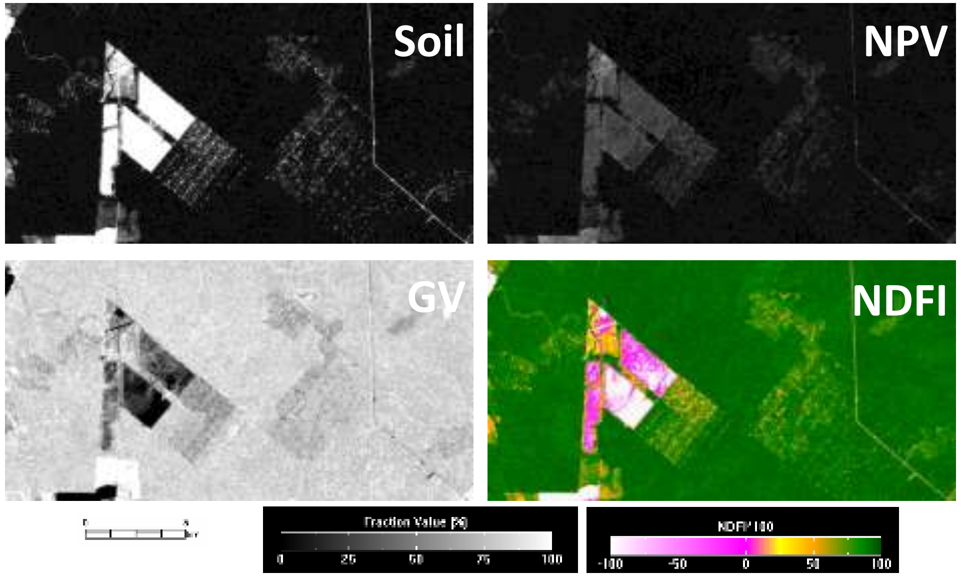
$$NDFI = \frac{GV_{Shade} - (NPV + Soil)}{GV_{Shade} + NPV + Soil}$$

$$GV_{Shade} = \frac{GV}{100 - Shade}$$

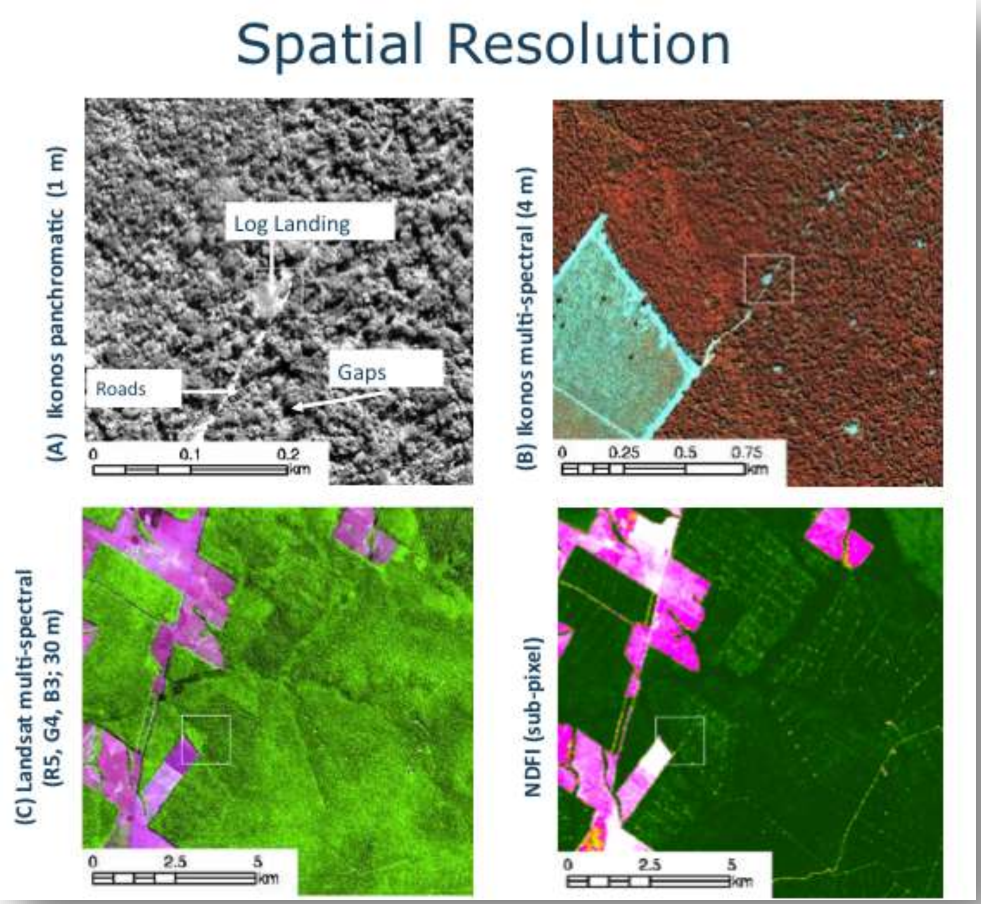
$$-1 \leq NDFI \leq 1$$

Souza Jr. (2005), RES

Paragominas,Pará State - 223/62



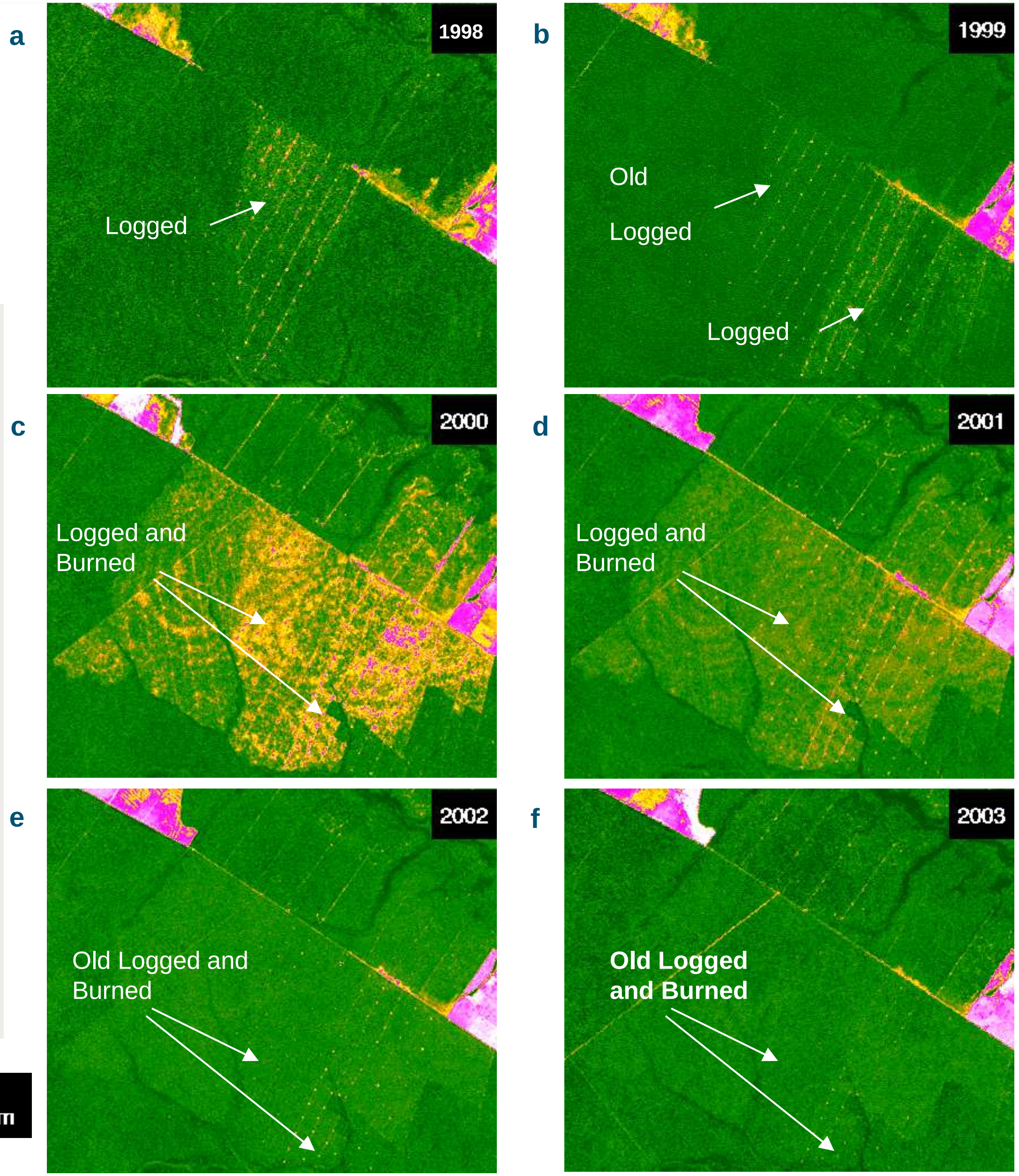
Remote sensing methods



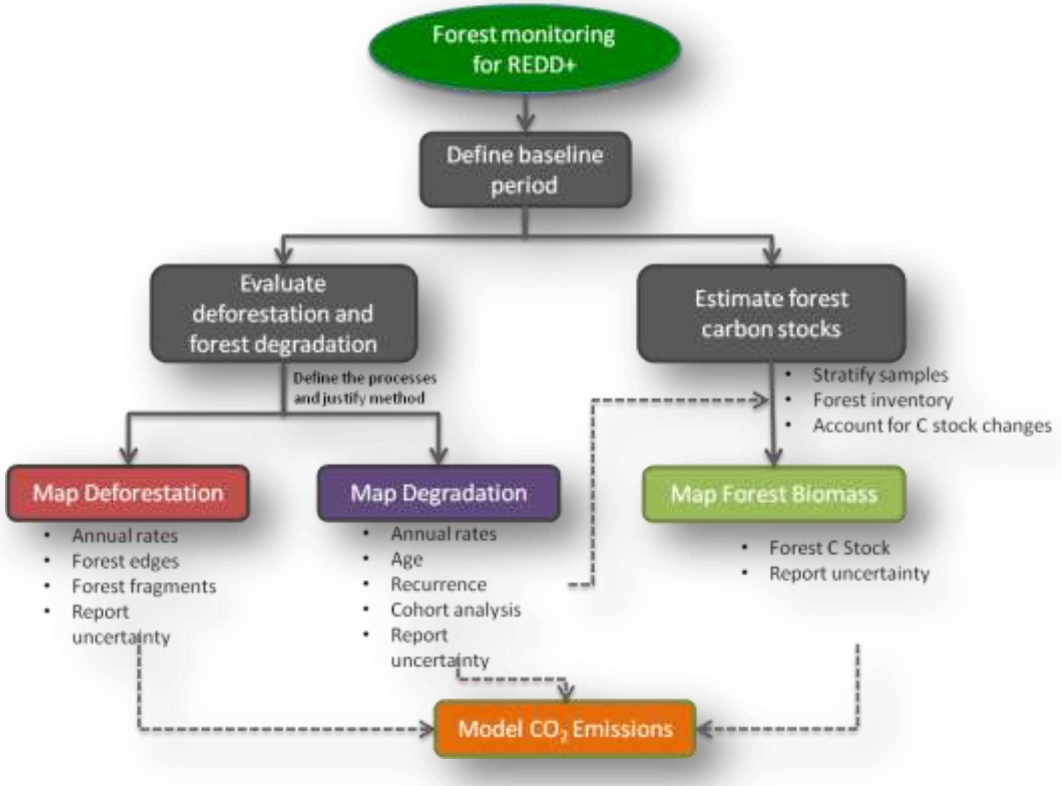
- Very high spatial resolution imagery facilitate visual detection of forest degradation but makes it more challenge to map.
- Medium spectral resolution imagery with higher number of spectral bands, such as Landsat, can be more useful to map and monitor forest degradation.

Dynamic of Forest Degradation

- Forest degradation signal changes fast.
- There is a synergism of forest degradation processes that can reduces more C stocks of degraded forests.
- Recurrent forest degradation is expected and creates even more loss of C stocks.
- Annual monitoring is required to keep track of forest degradation process.



Combining field and remote sensing



Combining field and remote sensing observations and statistical and spatial modeling is required to map and estimate forest carbon changes associated with forest degradation.

Source: Souza, 2012.