LINKING FOREST MAPPING TO CARBON ASSESSMENT – THE MEXICAN EXAMPLE

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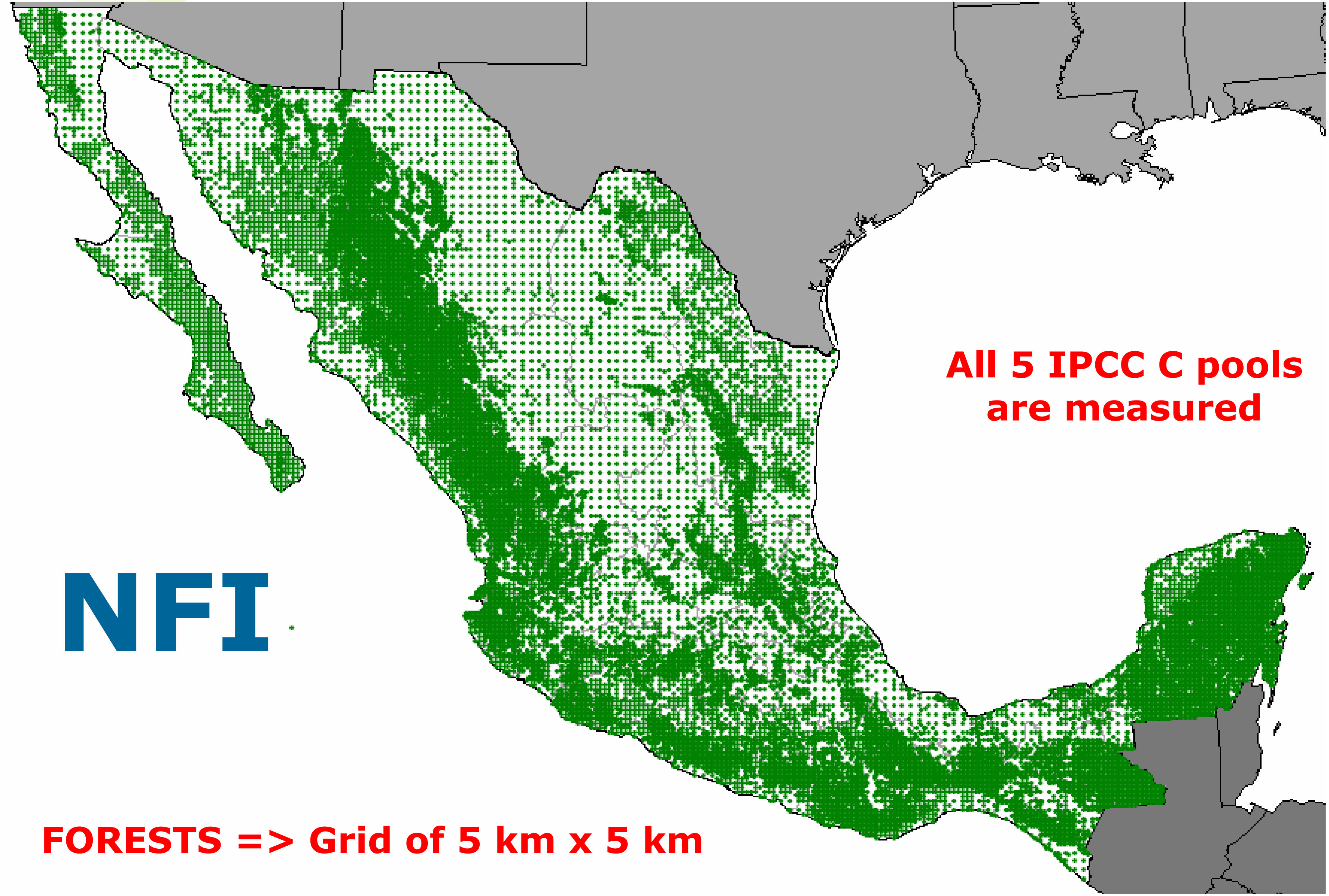
PRESENTATION OUTLINE

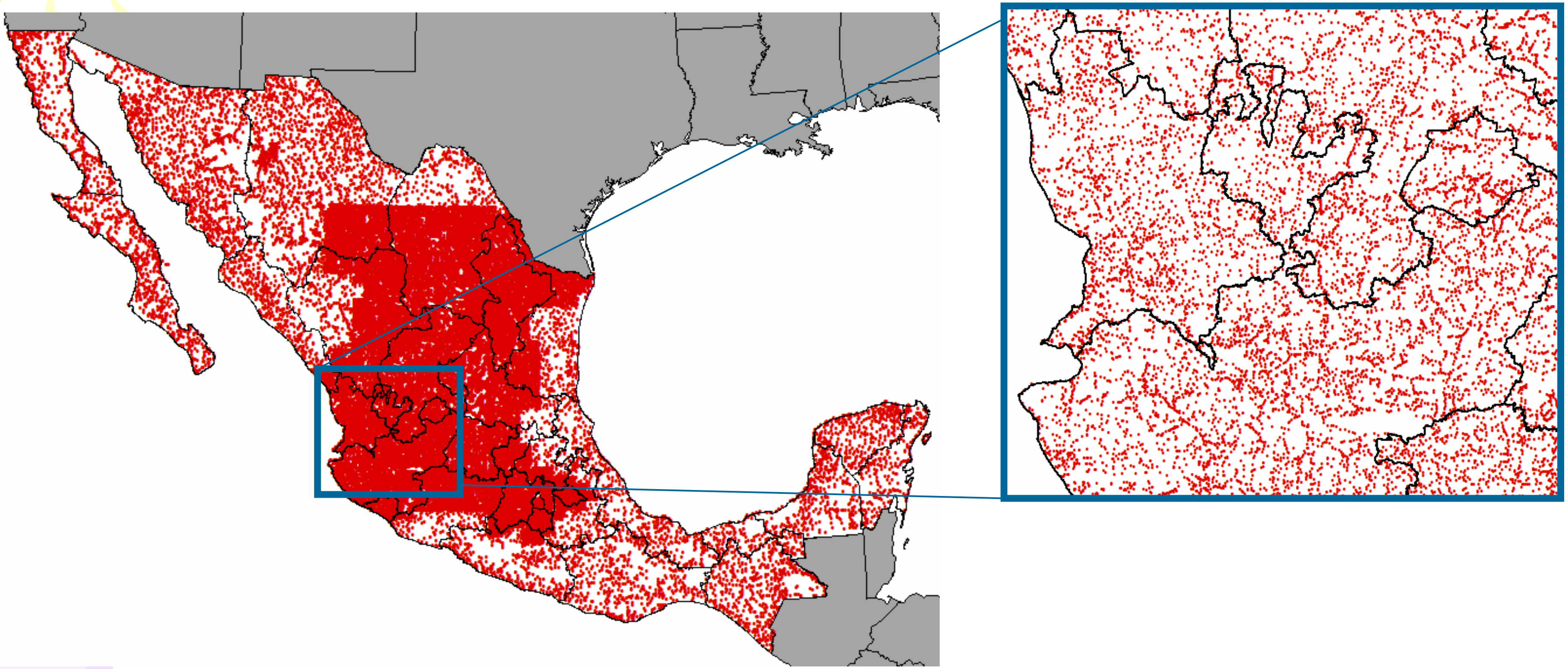
- National scale C emissions are realistic?
- Activity data scale dependence of emission factors
- LULUC mapping at Forest minimum area definition: where the forest is gone?
- Ground and satellite data fusion: make the best with what you have

Aprox 25,000 plots (4 sampling sites 400 m2) established, of which 23,000 measured

20% re-measured every year (2009 -)



SOIL PROFILES DISTRIBUTION (54, 868)

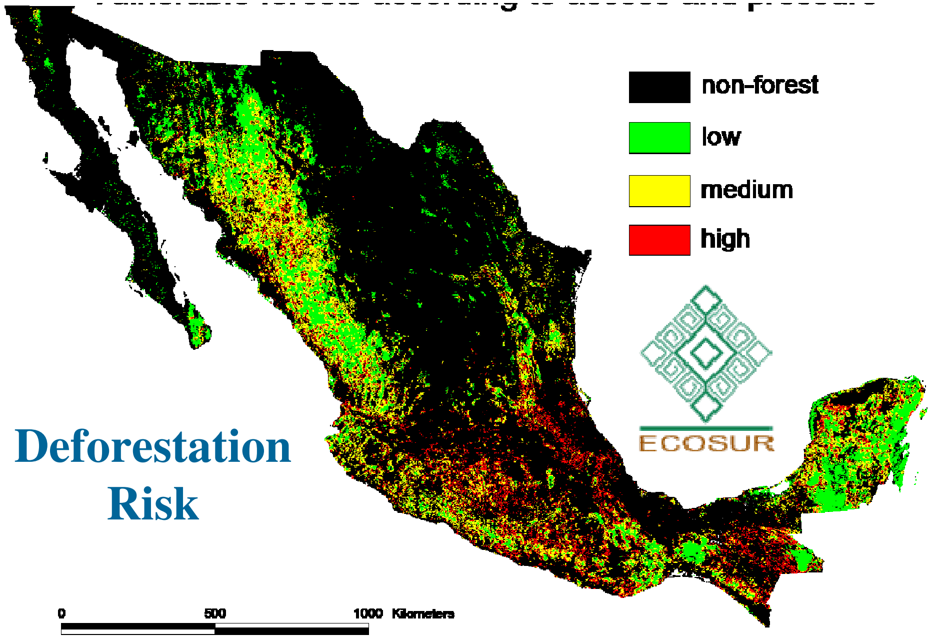


Ubicación geográfica de los perfiles de suelo. Cobertura nacional y detalle de acercamiento

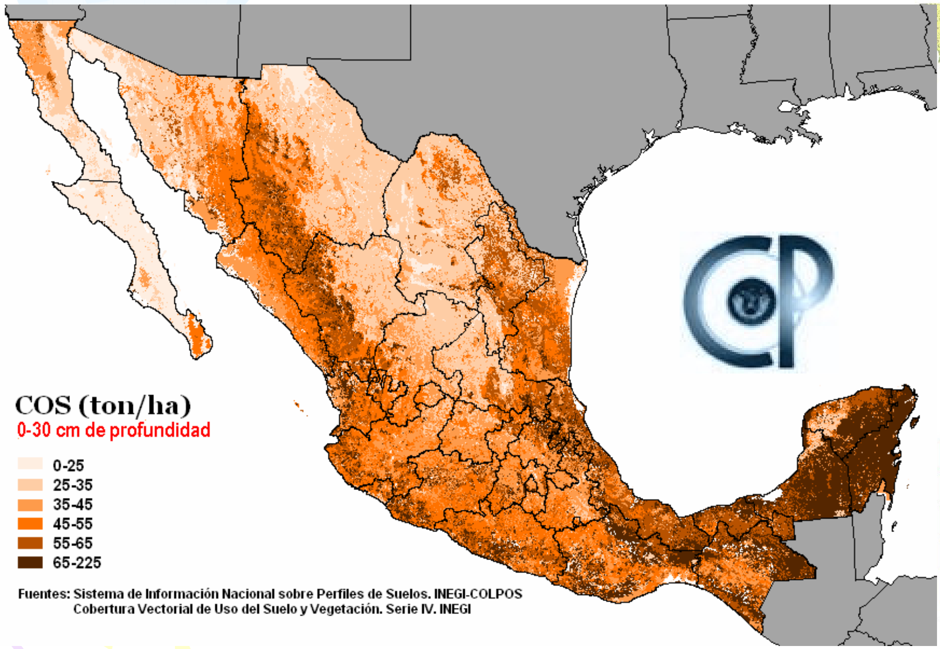
Land-Use maps (1993, 2002, 2007)

NATIONAL SCALE 2007

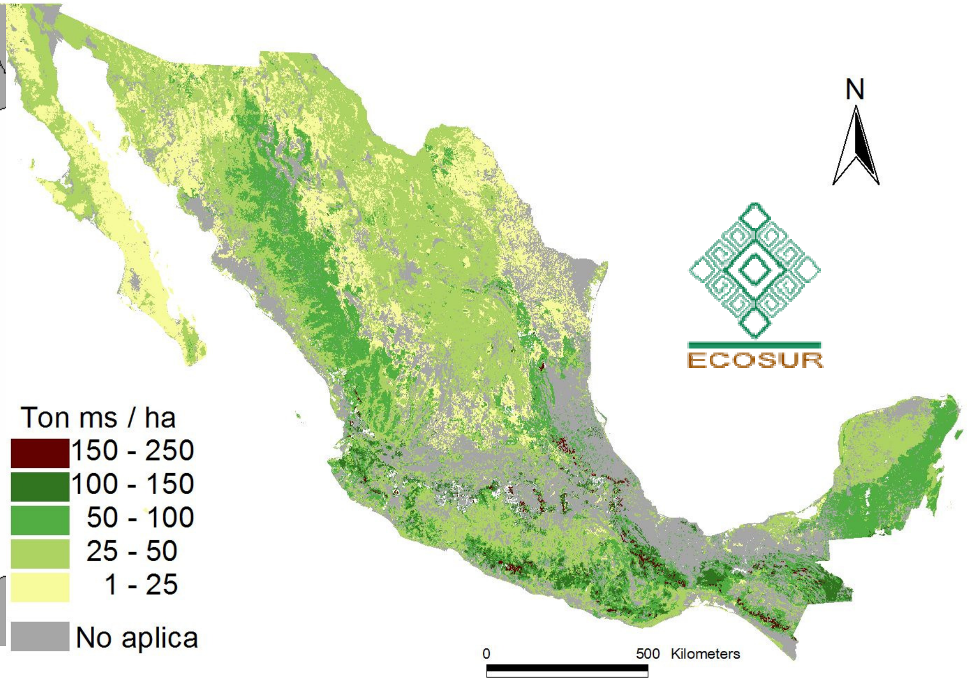
Deforestation Risk



Soil Organic Carbon



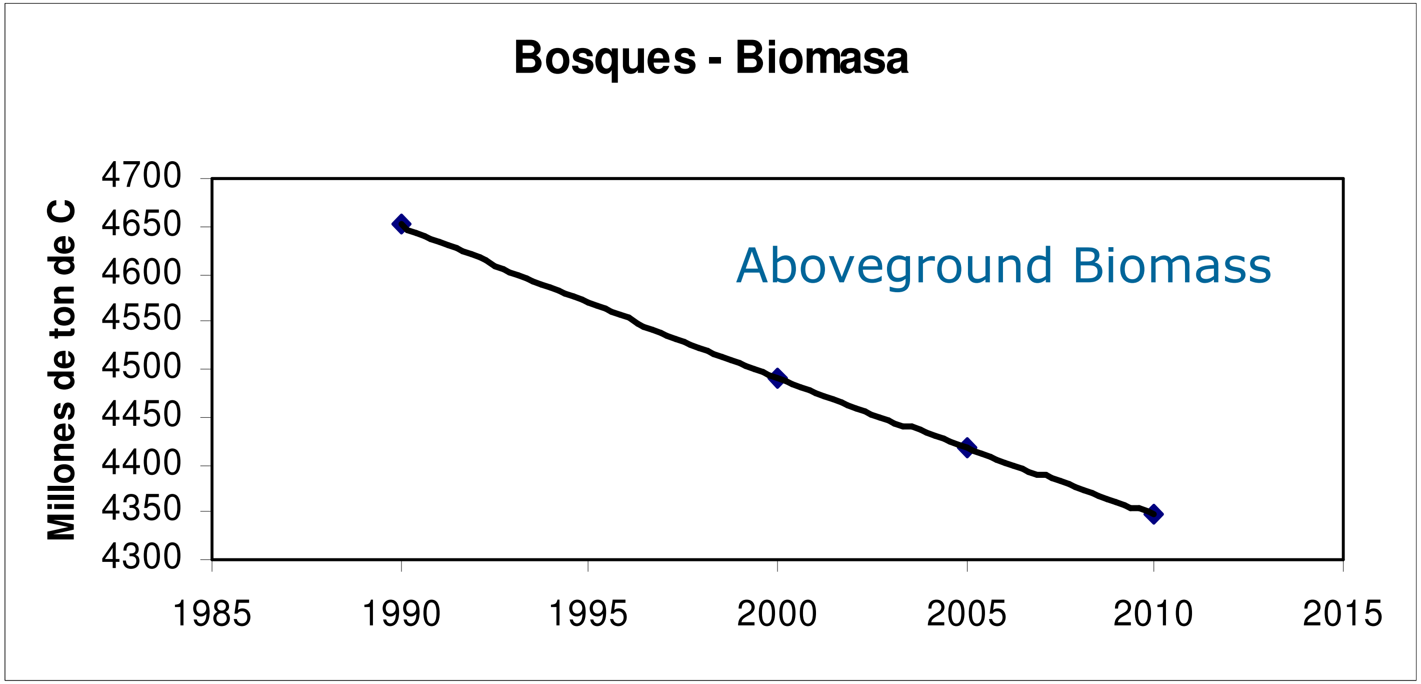
Aboveground Biomass

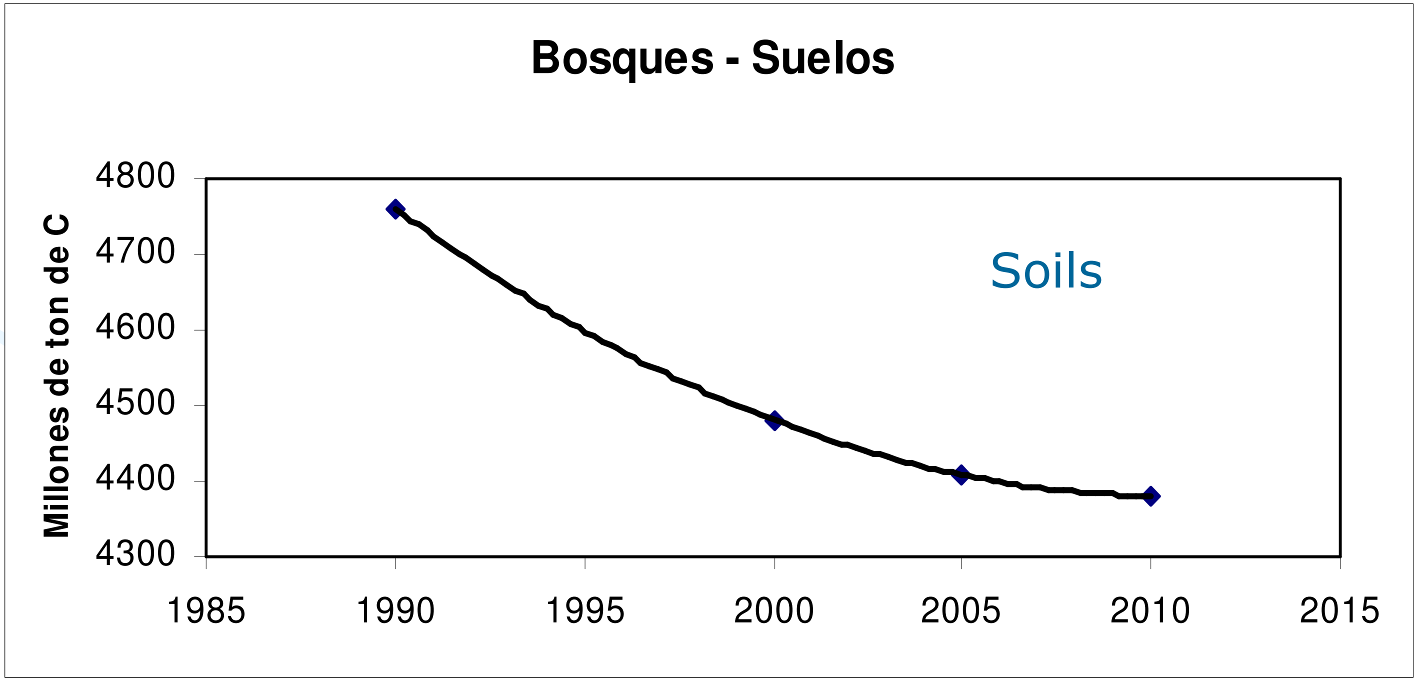


FORESTS

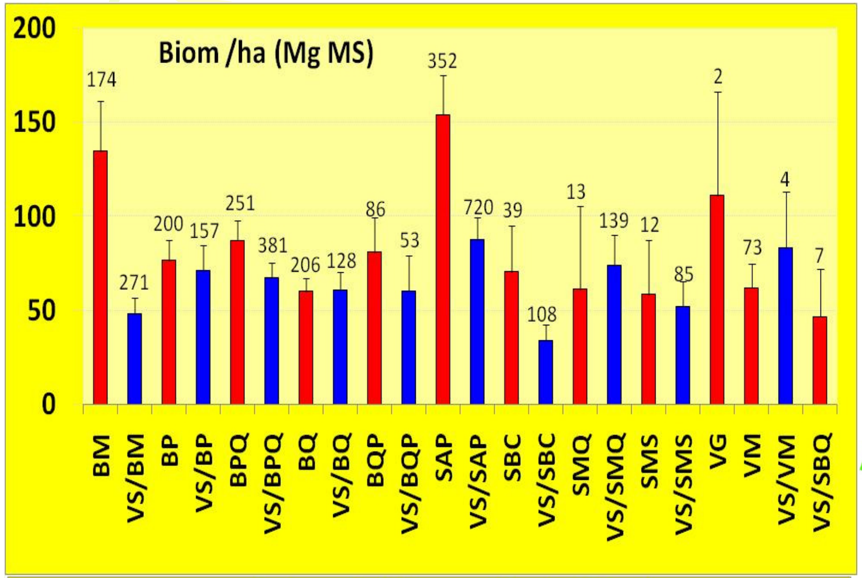
National Reference Scenarios

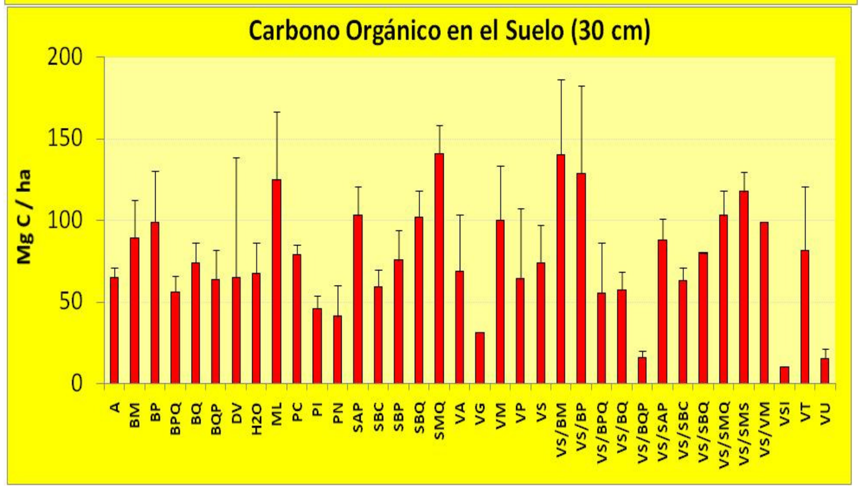
Approach “3” Tier 2



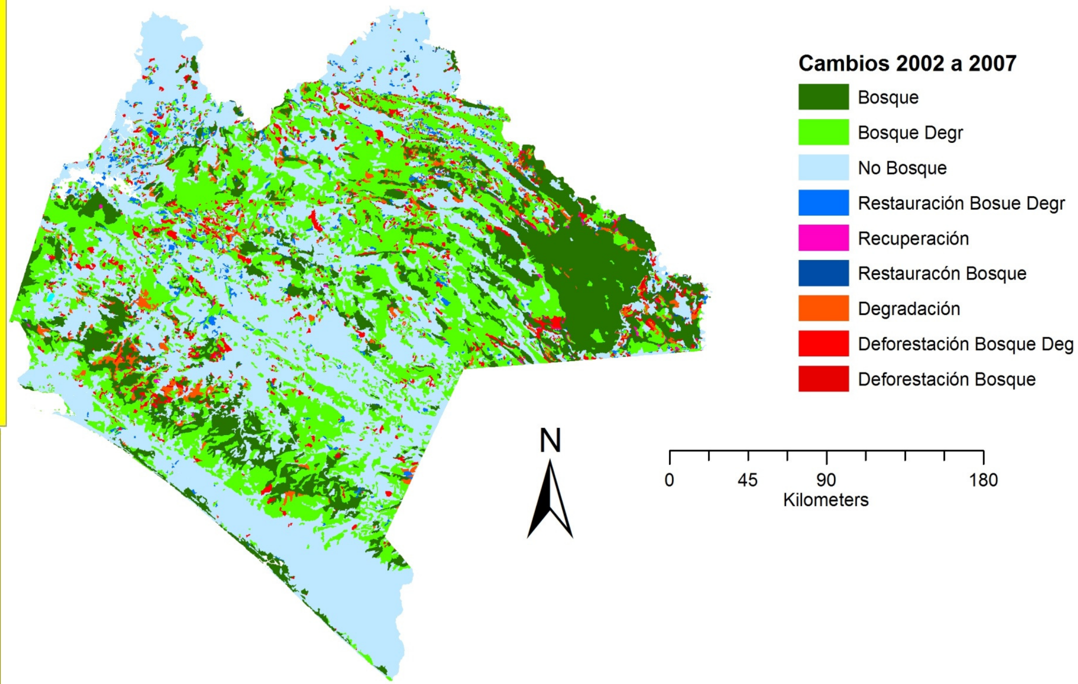


SCALE DEPENDENT C EMISSIONS: ACTIVITY DATA





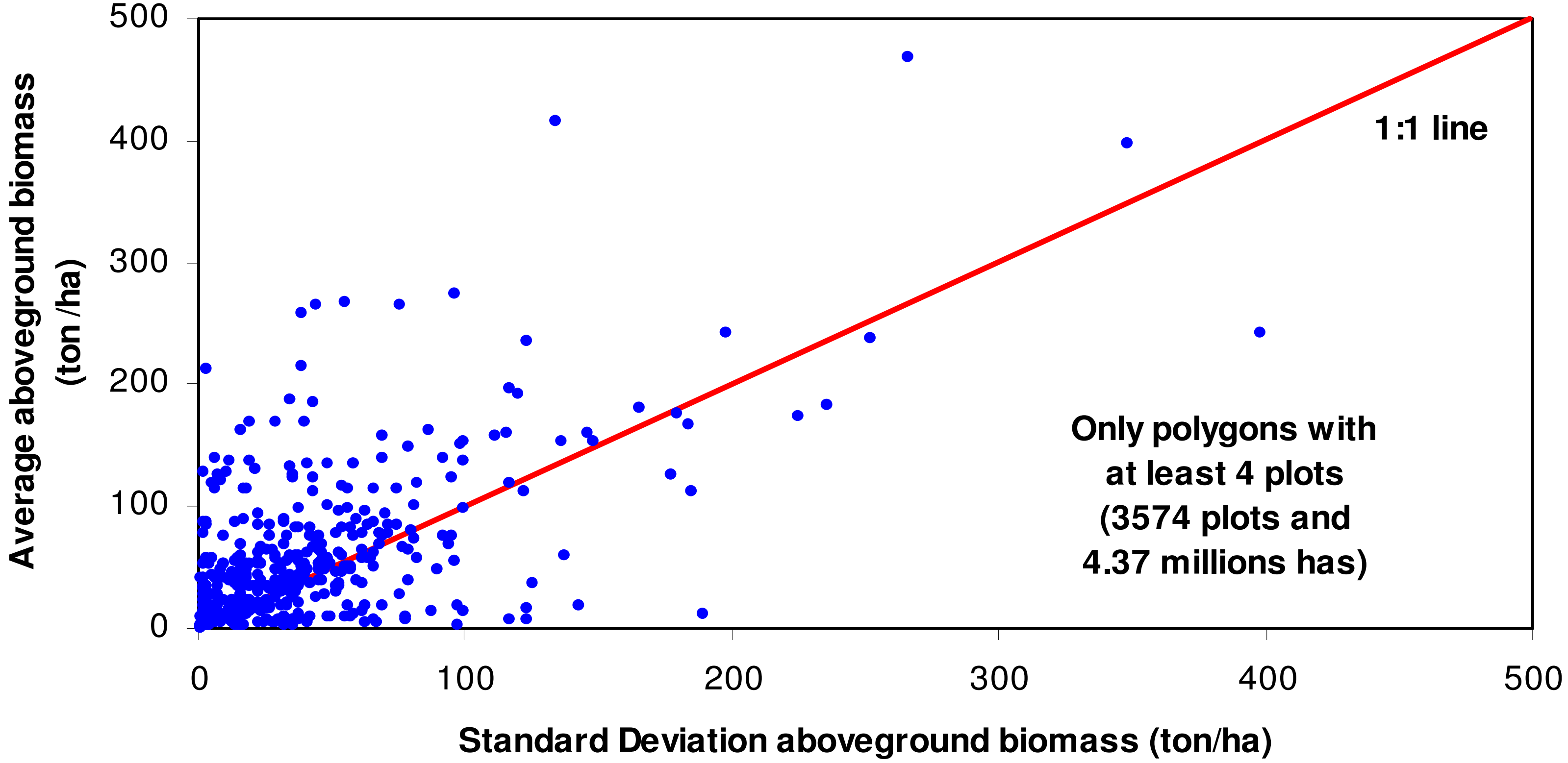
Chiapas State



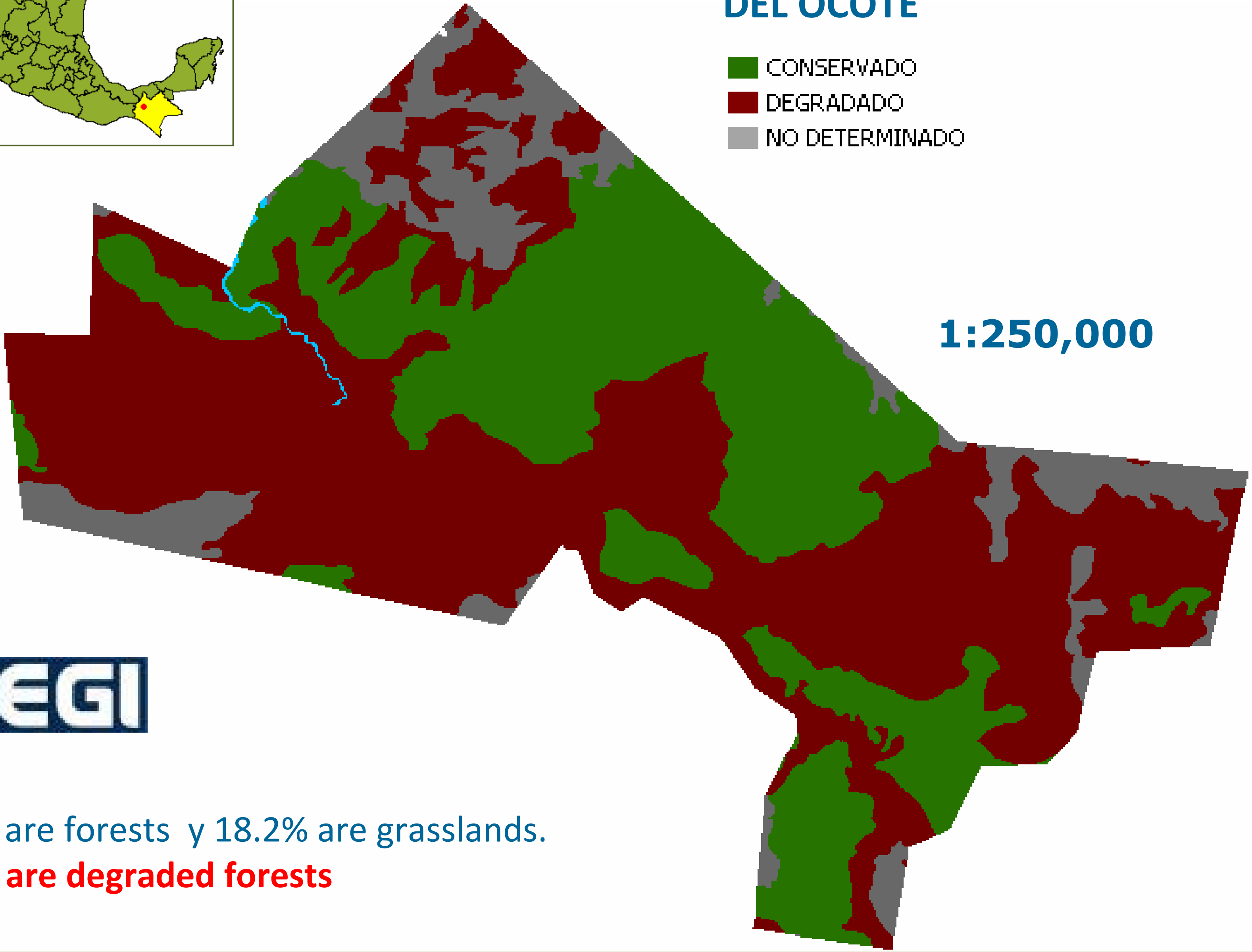
LUC maps => 1:250,000 scale

UNCERTAINTY IN LU HOMOGENOUS POLYGONS 1:250,000

Forests in Chiapas: Average=94.3; Standard deviation=124.2
(Each point is a LU polygon associated to 1:250,000 map)



RESERVA DE LA BIOSFERA DEL OCOTE

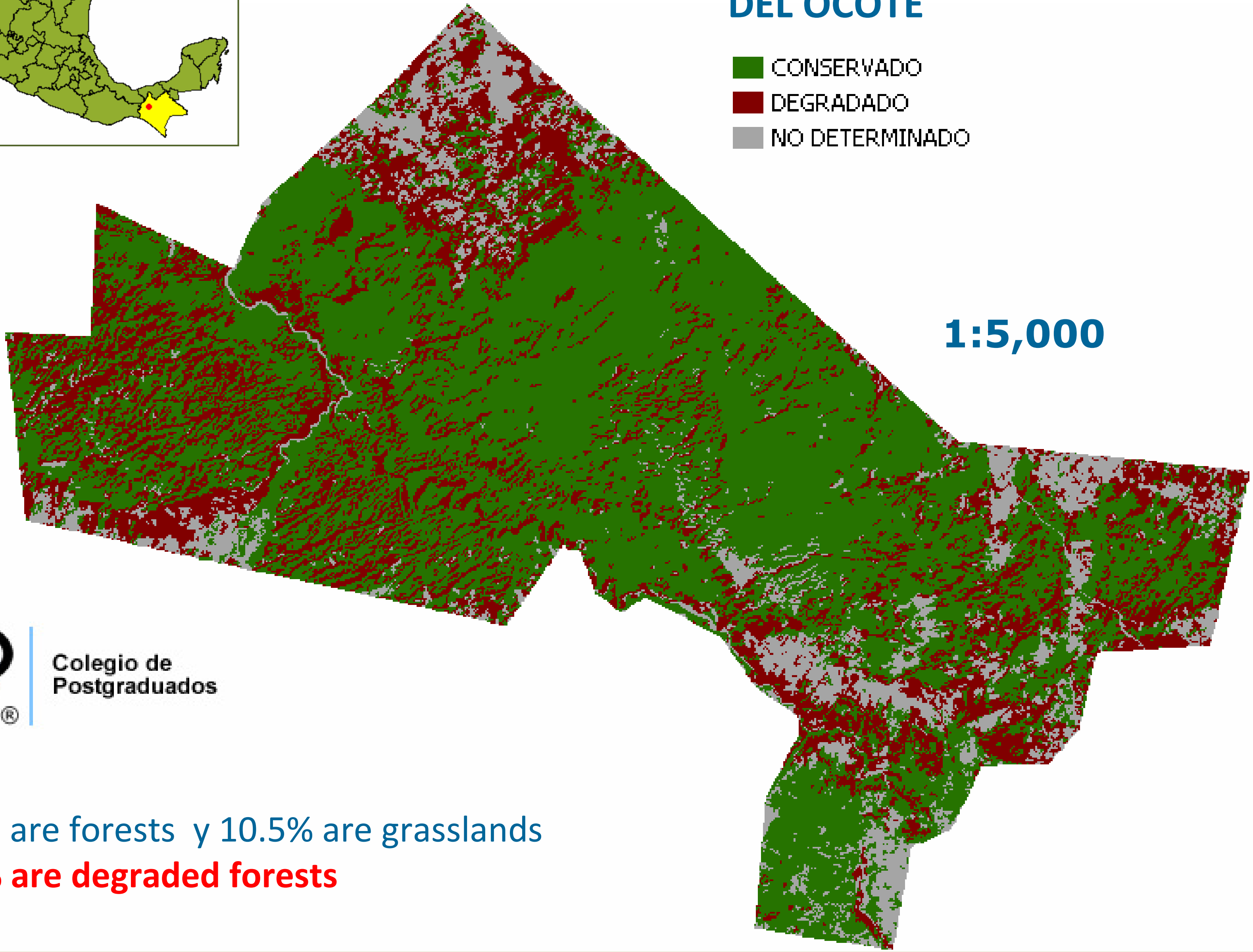


INEGI

81.3% are forests y 18.2% are grasslands.

66.1% are degraded forests

RESERVA DE LA BIOSFERA DEL OCOTE



1:5,000

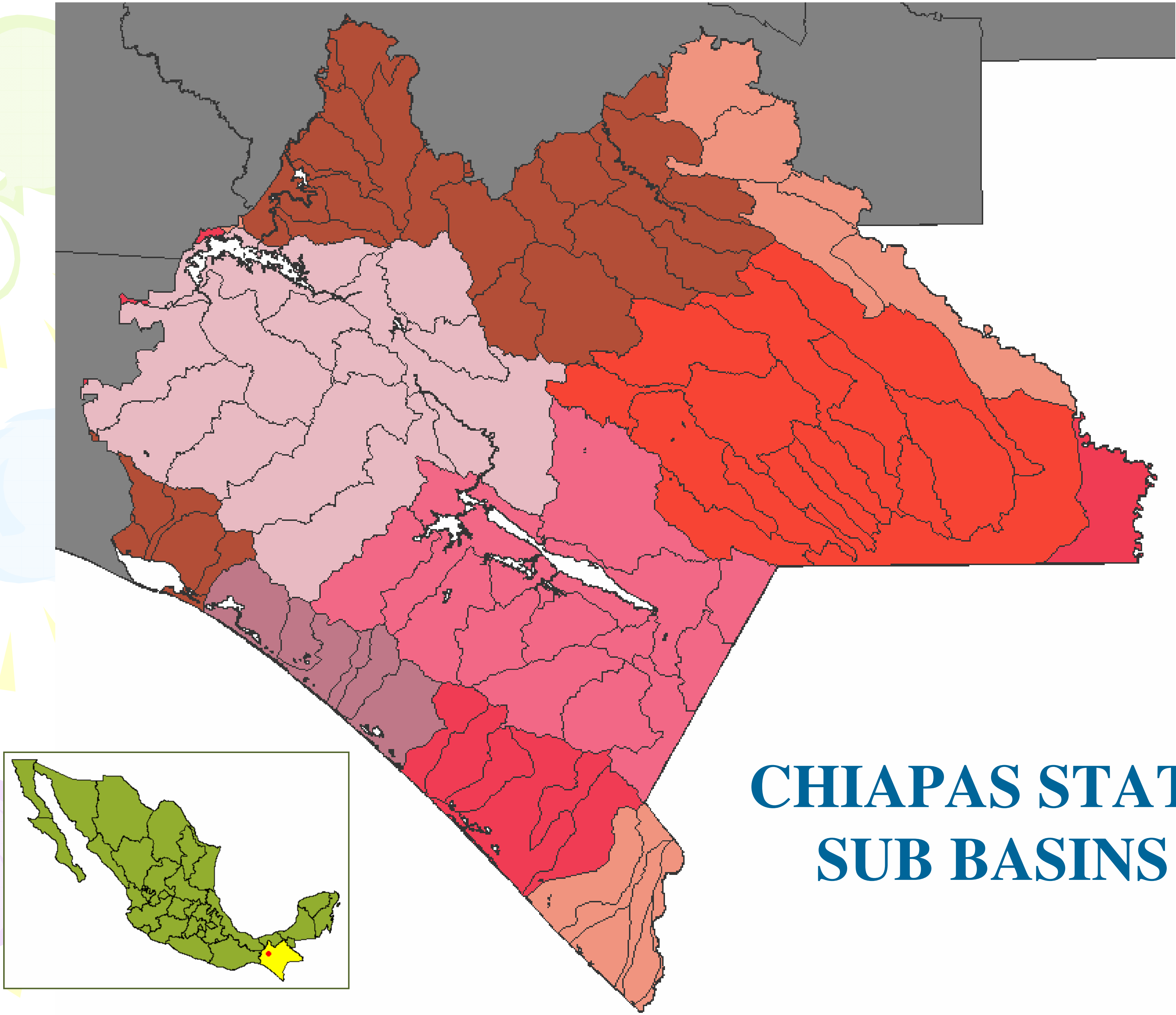
Colegio de Postgraduados

88.2% are forests y 10.5% are grasslands

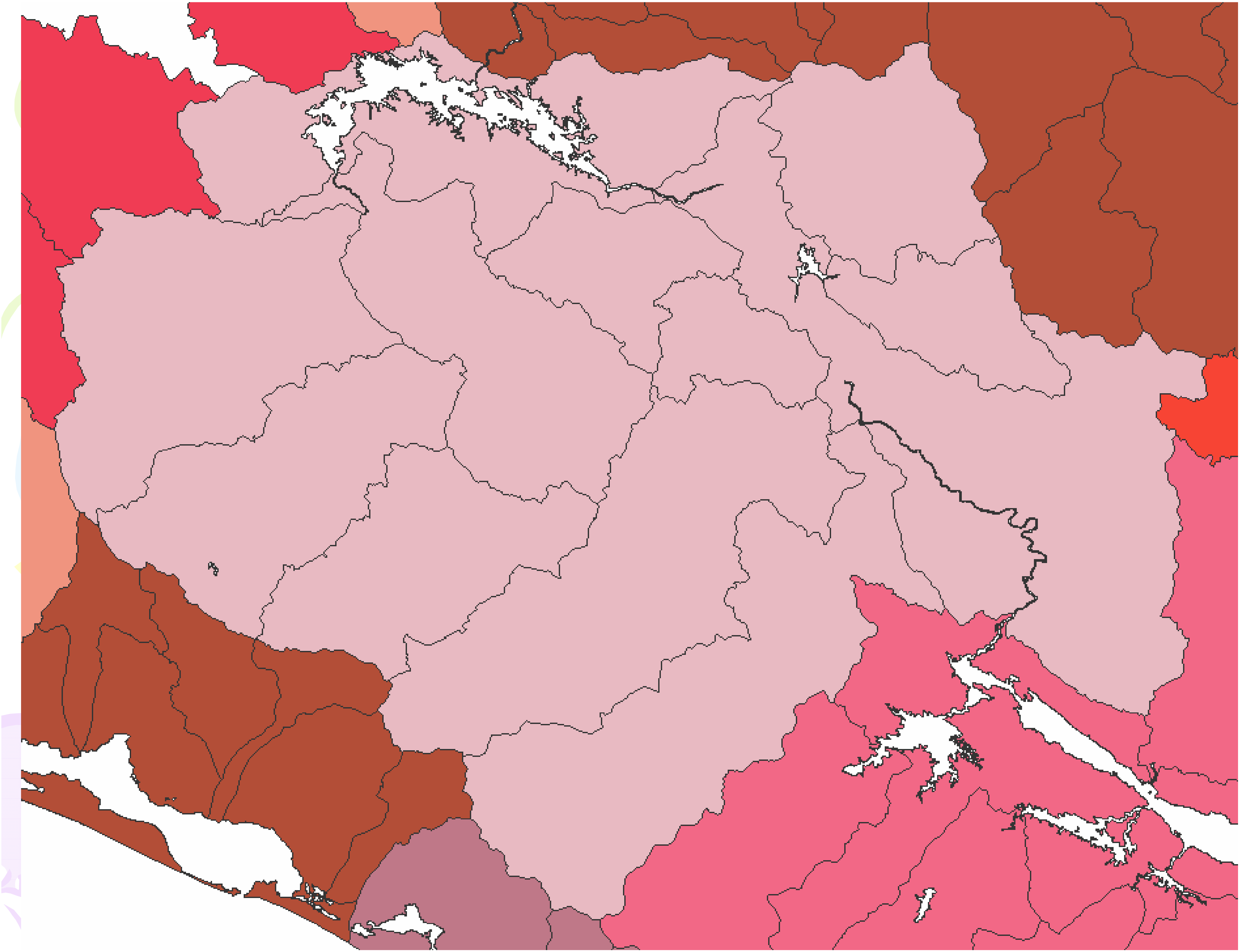
30.2% are degraded forests

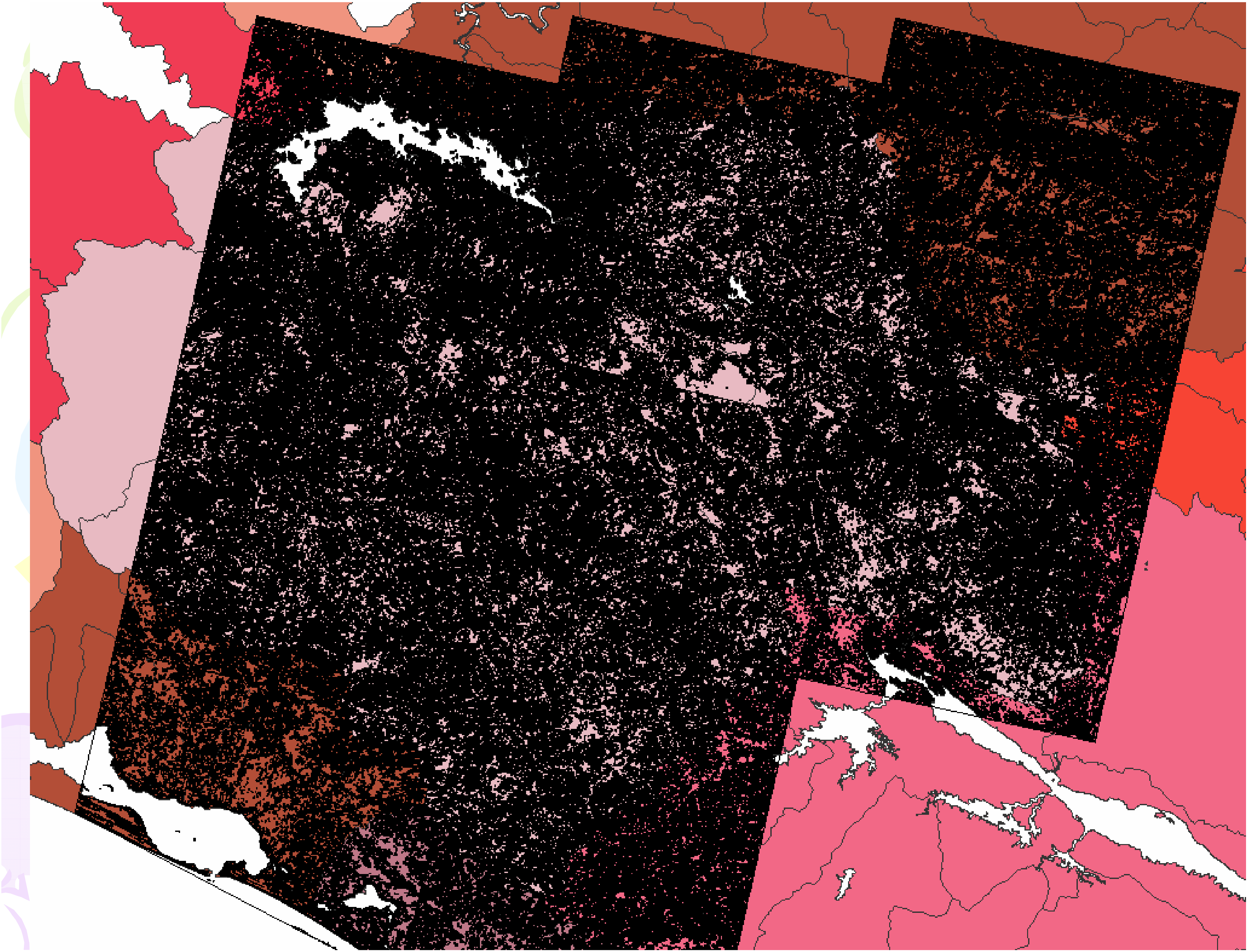
LULUC GIS 1:5,000 (minimum mapping unit: 1 ha)

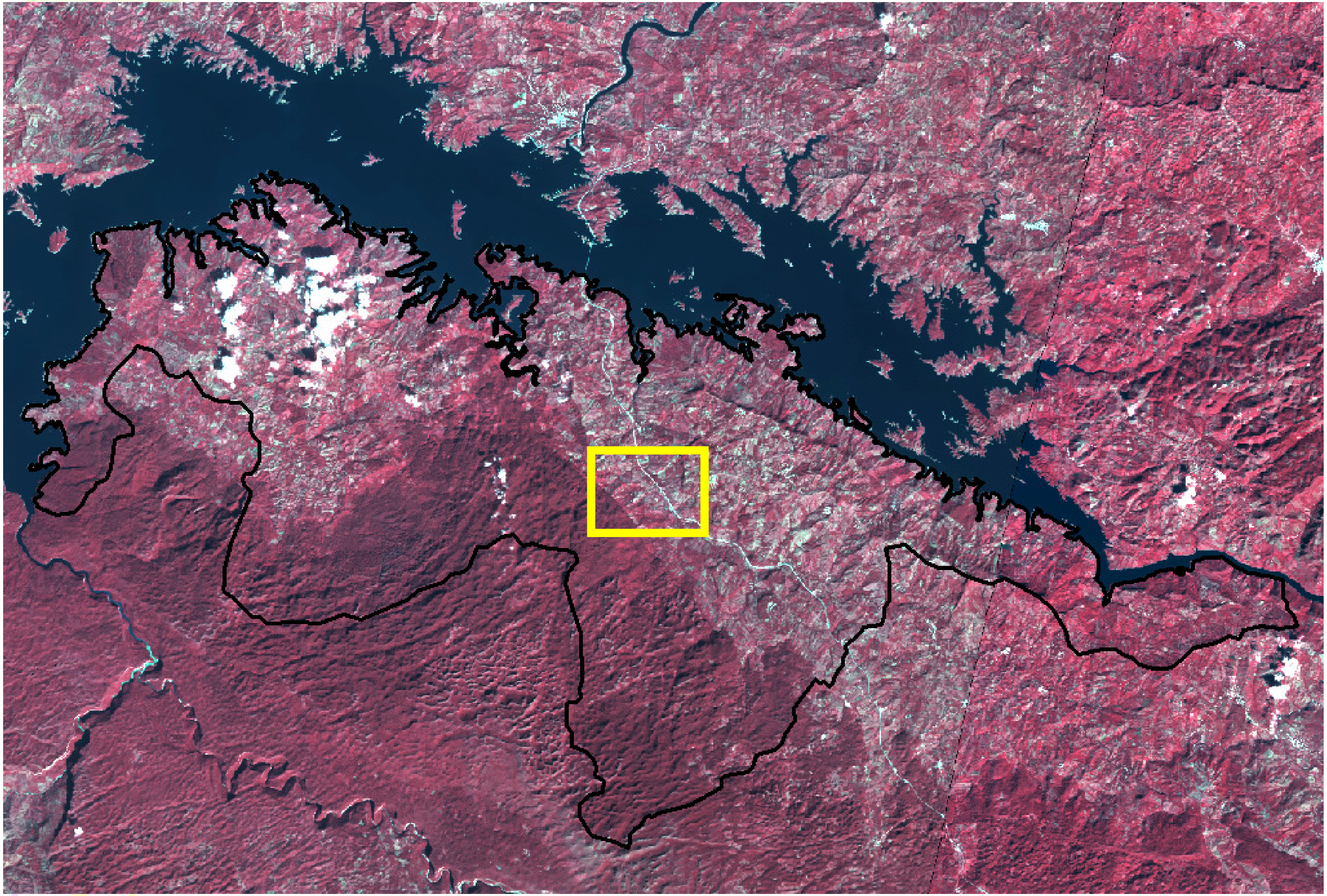
- Forest/Non Forest
- Forest: open/dense/deciduous; primary/secondary
- Year 2003-2010 (SPOT 5 imagery), wall-to-wall coverage (to be finished in 2011) – as a benchmarking
- Manual interpretation using multiple sources
- SPOT images (2.5 m color fusion)

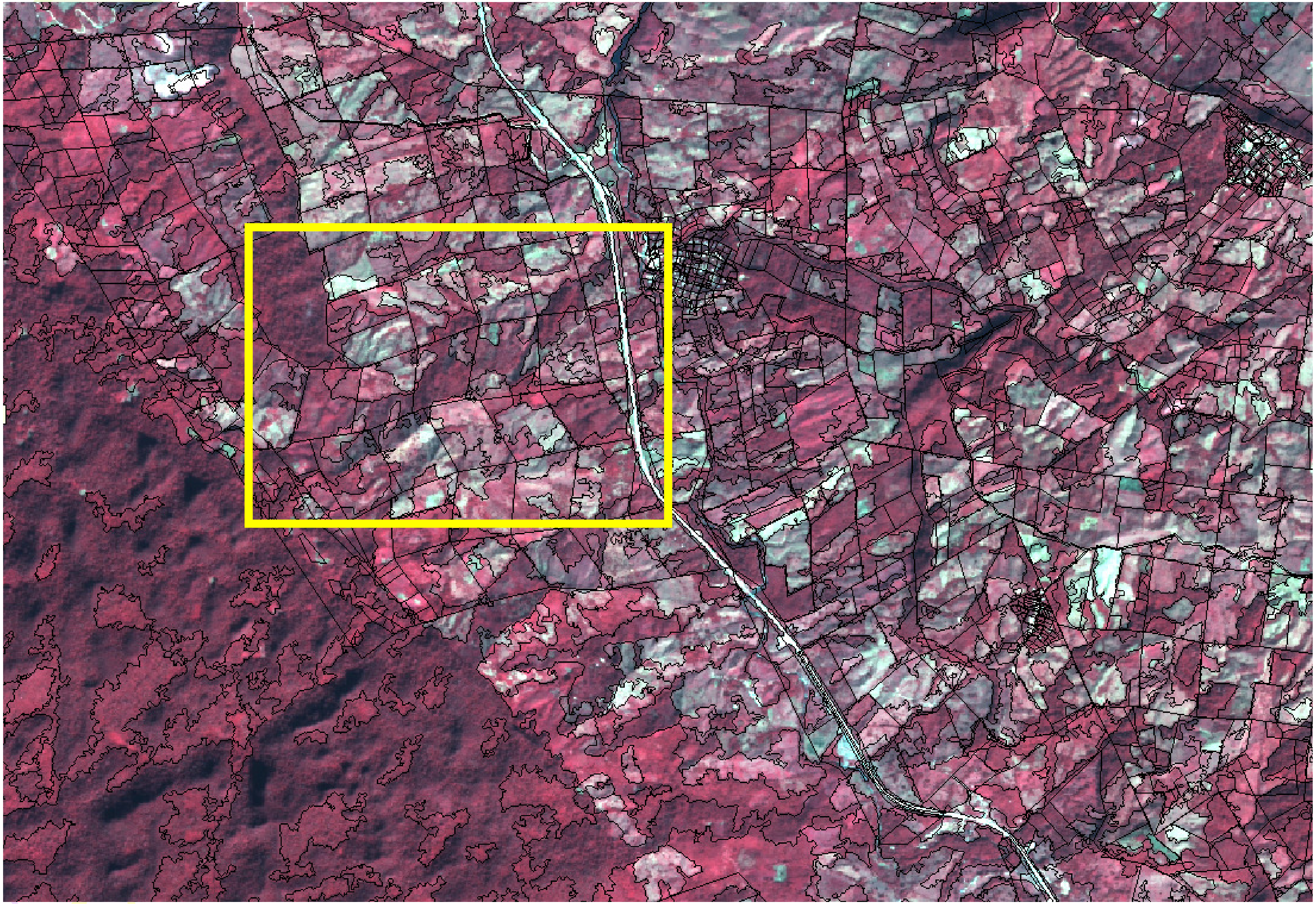


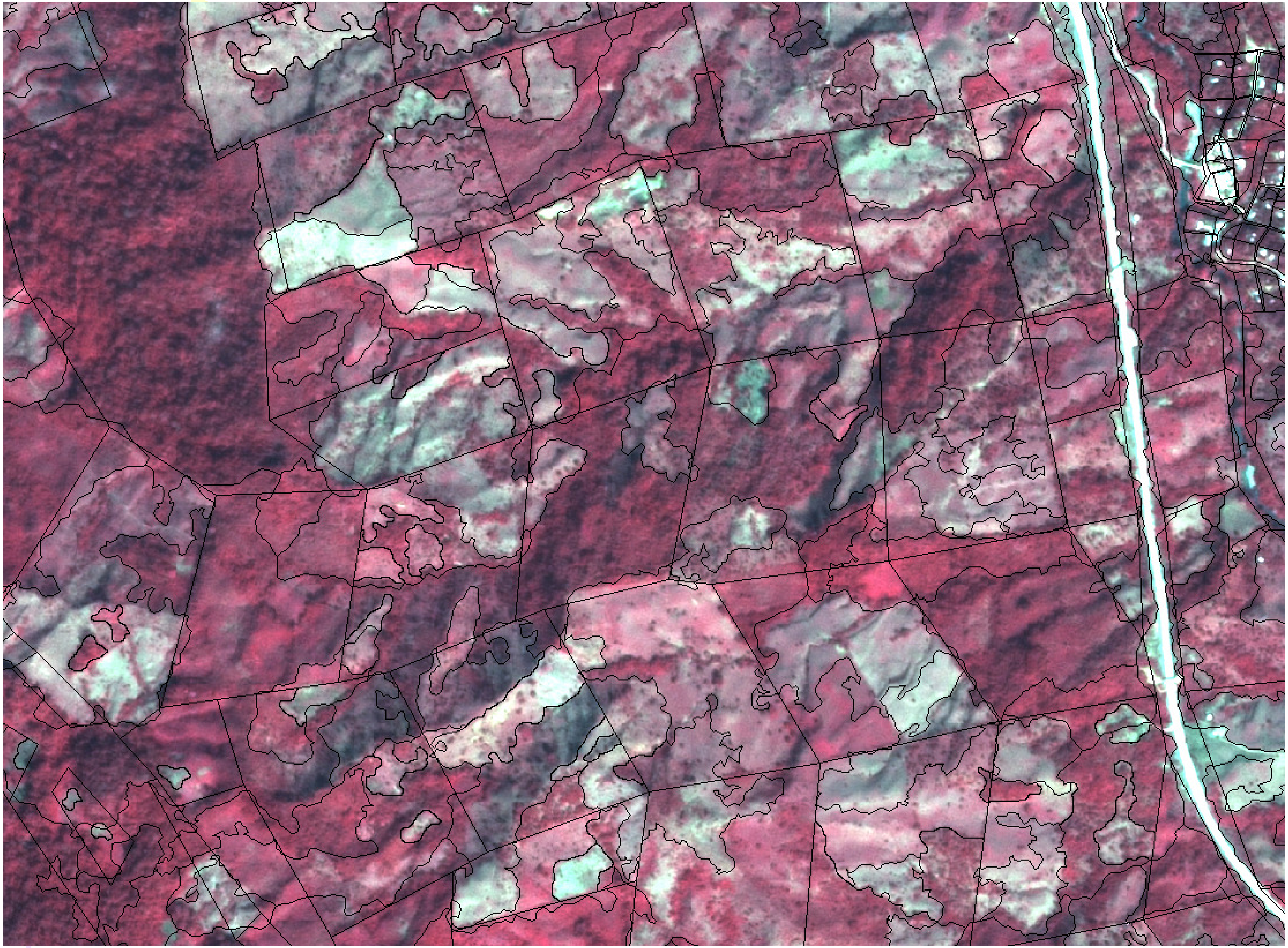
CHIAPAS STATE SUB BASINS





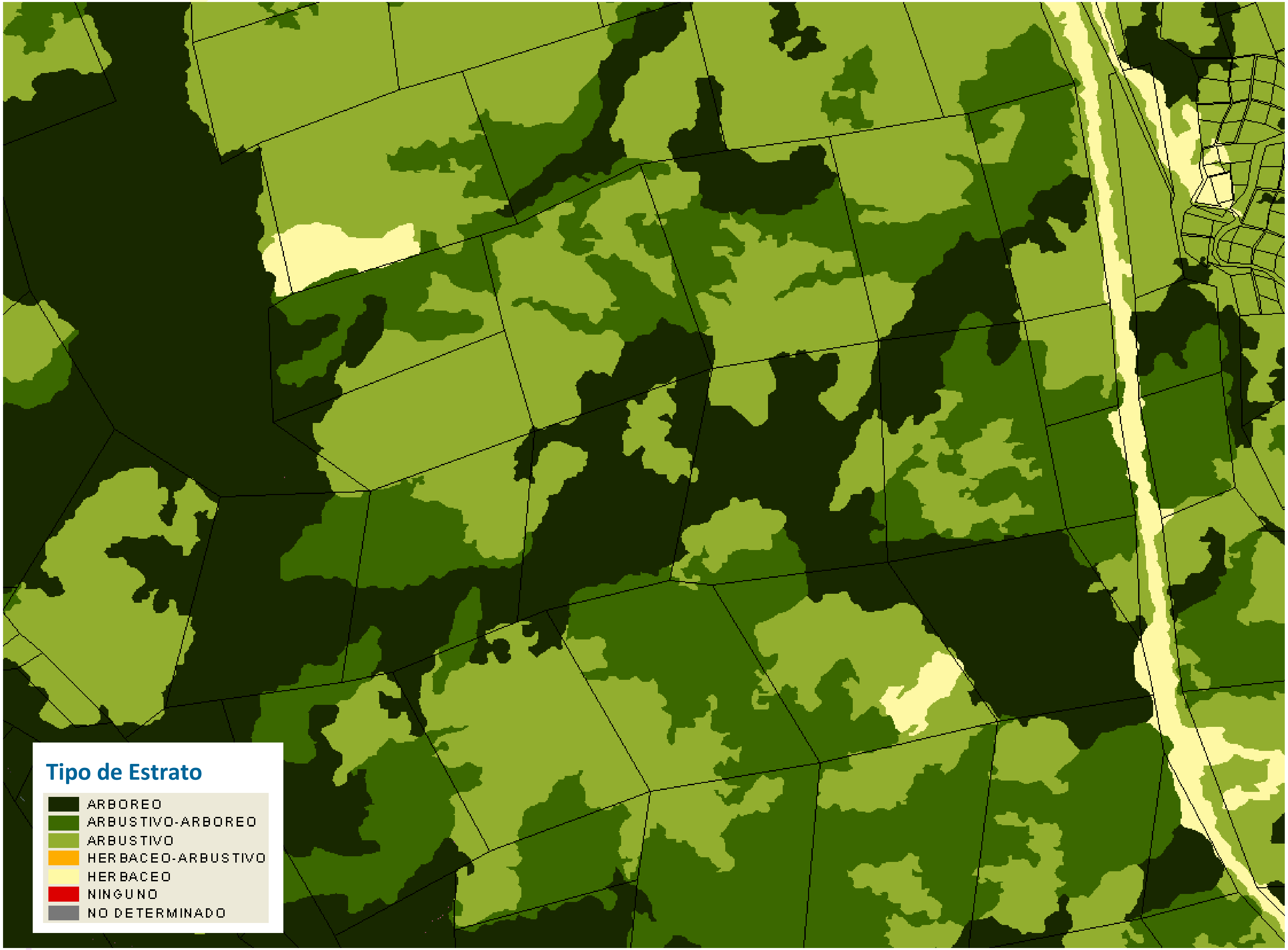


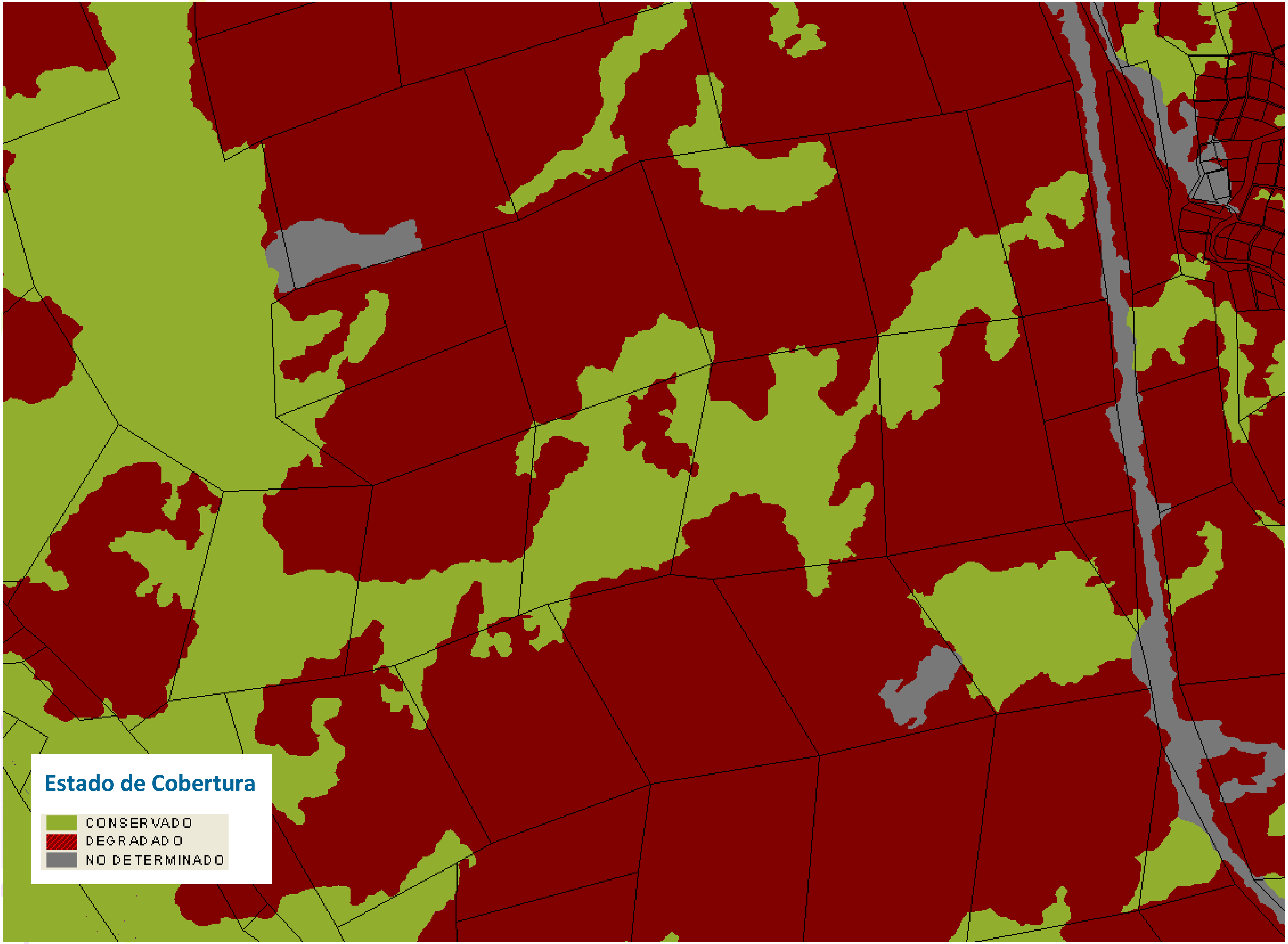




Clase de Cobertura
BOSQUE
PASTIZAL
AGRICULTURA
SUELO
OTRO
CUERPO DE AGUA

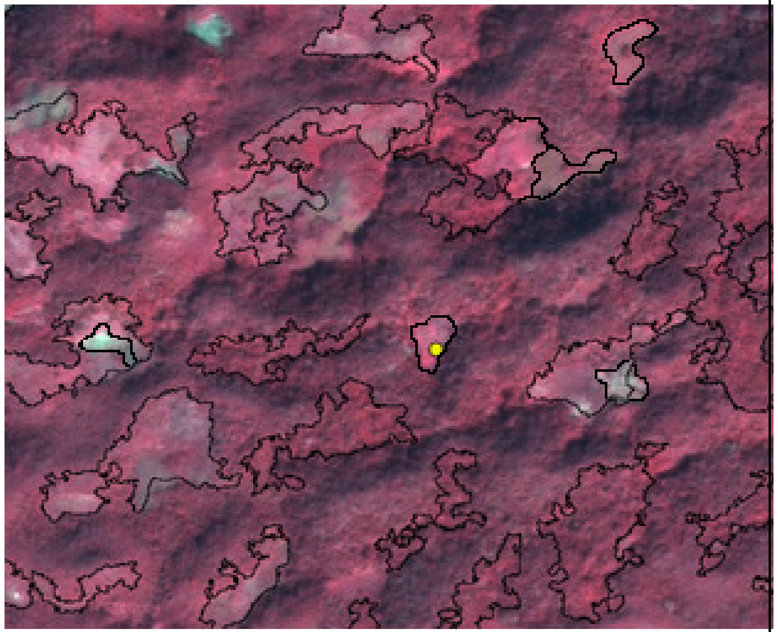

Densidad de Cobertura
CERRADO
ABIERTO
MUY ABIERTO
SIN COBERTURA
NO DETERMINADO


Tipo de Estrato
ARBOREO
ARBUSTIVO-ARBOREO
ARBUSTIVO
HERBACEO-ARBUSTIVO
HERBACEO
NINGUNO
NO DETERMINADO


Estado de Cobertura
CONSERVADO
DEGRADADO
NO DETERMINADO

B5. Bosque arbustivo-arbóreo cerrado degradado.

SPOT IMAGERY



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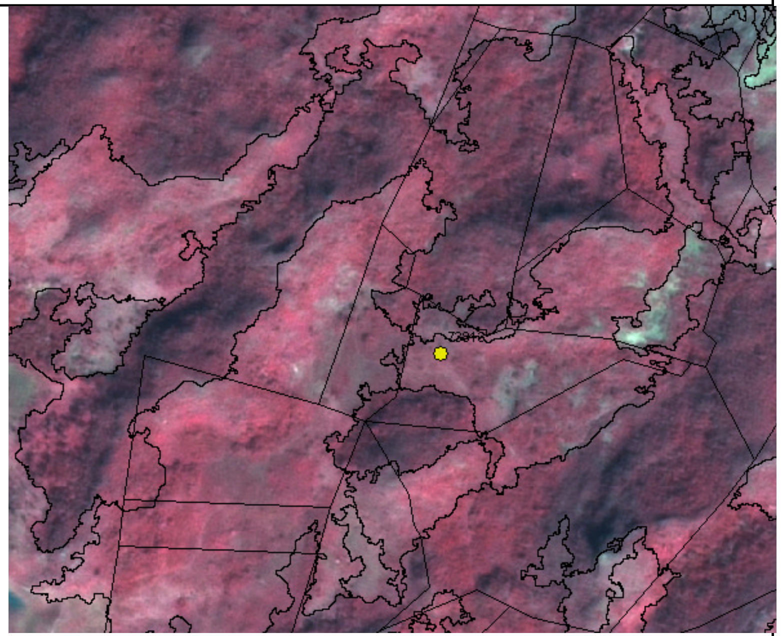

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SATELLITE AND GROUND DATA FUSION

GENERAL APPROACH

- Use a scale invariant approach to process ground and satellite data
- Stratify ground and satellite data for LU classes
- Characterize structure funcion (spatial variability) for ground and satellite data.
- Use the Bayesian indicator multiscale geostatistics theory to characterize uncertainty associated to all information classes
- Optimal estimation of full probability distribution merging all information sources
- Up-scaling: Monte Carlo simulations

GENERAL SOLUTION FOR MULTISCALE DATA FUSION

Using the scaling relation: $$V_\lambda = \lambda^\gamma$$

$$\lambda = L / l; L = Area\_Size; l = Pixel / Plot\_Size$$

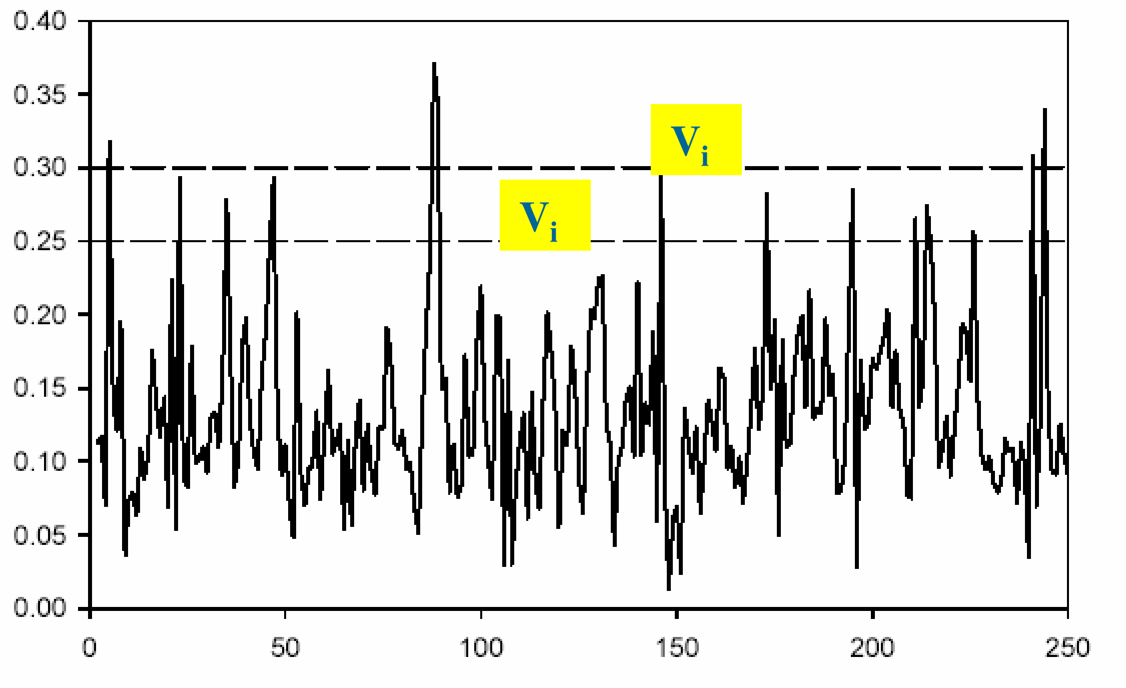
Determine the singularity level: $$\gamma = \frac{\log(V_\lambda)}{\log(\lambda)}$$

Apply the Bayesian indicator geostatistical theory to singularities (scale invariant) => multiscaling

INDICATOR GEOSTATISTICS => NON LINEARITY Y NON GAUSSIANITY

INDICATORS => CODING OF
PROBABILITY CUMULATED FUNCTION

$$I_V = \begin{cases} 1, \text{ if } V(x) \leq v_i \\ 0, \text{sif } V(x) > v_i \end{cases}$$

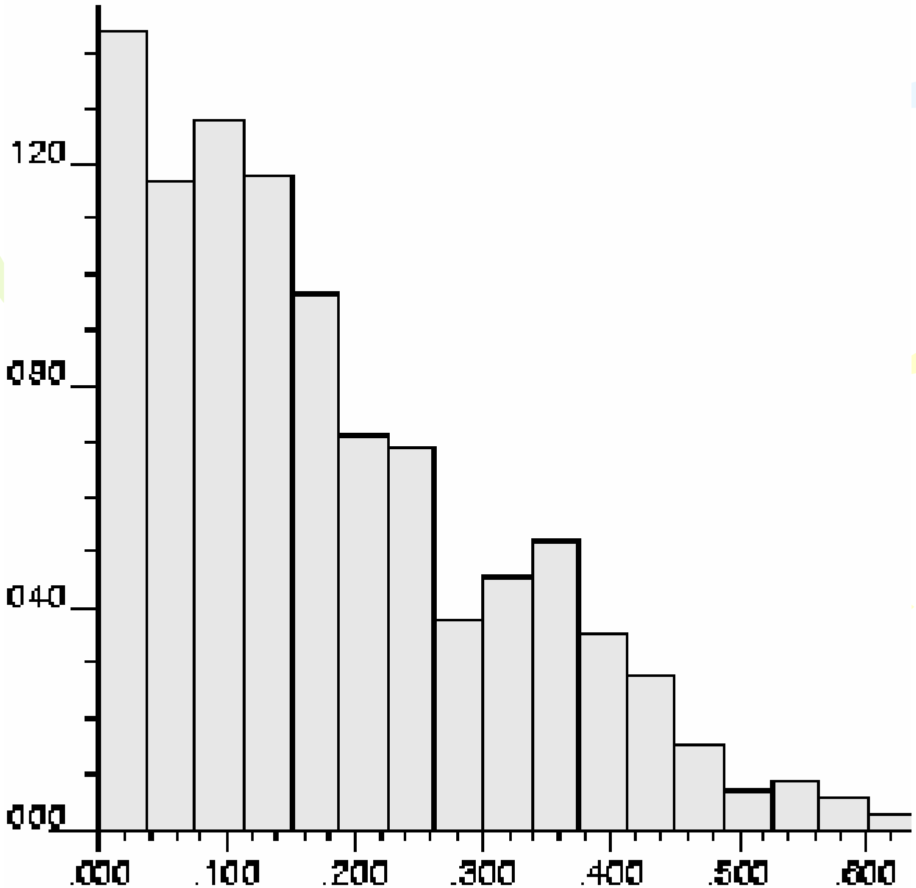


Criteria =>

+ Conservative estimates
+ Local dependence

RESULTS OF ESTIMATIONS USING INDICATOR GEOSTATISTICS (full characterization of uncertainty)

In each point or pixel of the national mesh will be a probability distribution of C =>



INDIRECT INFORMATION

- Cualitative classes: open / dense; primary / secondary; strata dominance => different C densities (ranges spatially conditioned)
- Rapid appraisal: diameter and canopy cover classes, stratum dominance, intact/degraded - Basal Area (Bitterlich)=> Range estimations (plots): lesser then, greater than, range
- Context: bi or multivariate analysis (altitude, slope, soil class, precipitation class, etc.) => probability distributions (average and CI)

REQUIREMENTS: CO-REGISTRED (same plot) INFORMATION FOR CALIBRATION

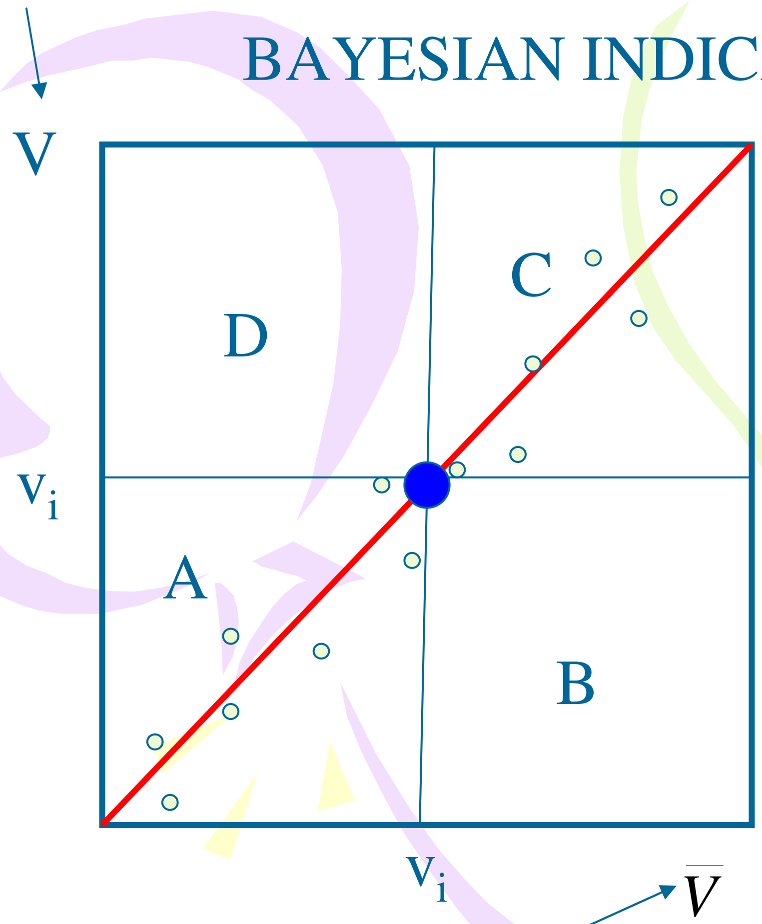
INFORMATION TYPOLOGY (Indicators codification)

- Hard data (standard protocol measurements => Expensive, few)
- Soft data (indirect and rapid measurements => Cheap, many)
  - Unique value (type A)
  - Range or interval of values (Type B)
  - Probability distributions (Type C)
  - Classes (Tipo X => sets-scale)
- Merging uncertainty: optimal estimates honoring information types

BI or MULTIVARIATE INDIRECT INFORMATION – SATELLITE, LU, CONTEXT, ETC. (COREGISTERED)

carbon

BAYESIAN INDICATOR GEOSTATISTICS



Indirect variable (satellite or other)

$$I_V = \begin{cases} 1, \text{ if } V(x) \leq v_i \\ 0, \text{ if } V(x) > v_i \end{cases}$$

$$P\{\overline{V}(x) \leq v_i \mid V(x) \leq v_i\} = p_1$$

$$P\{\overline{V}(x) \leq v_i \mid V(x) > v_i\} = p_2$$

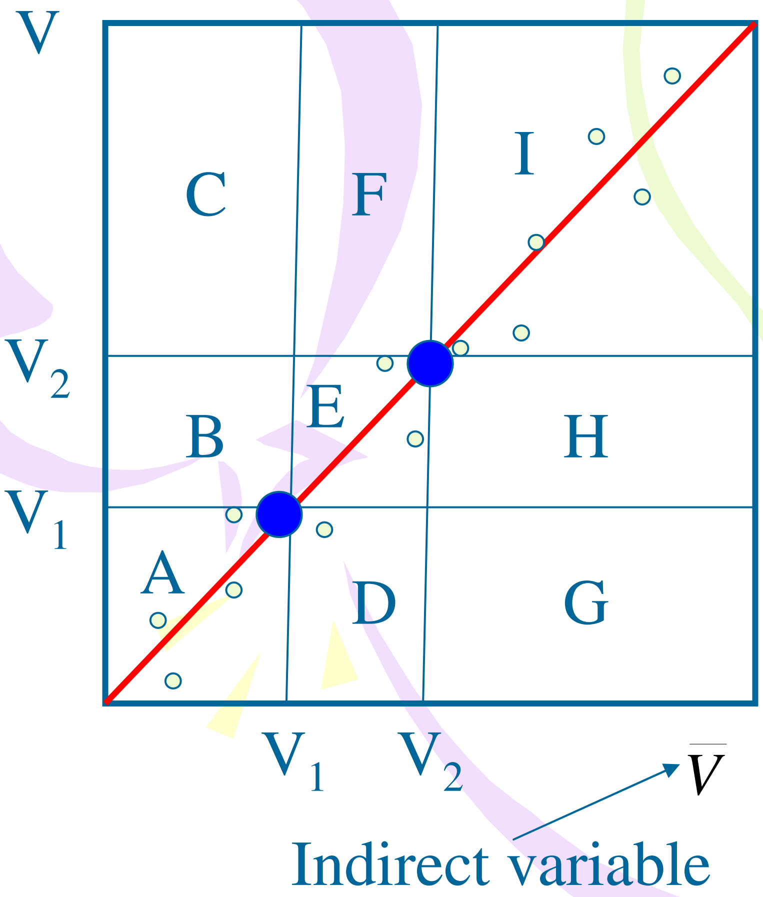
Information quality =>

$$p_1 = \frac{A}{A+D}$$

$$p_2 = \frac{B}{B+C}$$

With p_1 y p_2 => Indicator covariance function

INDIRECT INFORMATION (CLASSES => Sets-Scale)



$$p_1 = \frac{E}{D+E+F}$$

$$p_2 = \frac{B+H}{A+B+C+G+H+I}$$

Applications:

+ Forest classes (dense/open)
+ Others: primary/secondary

GENERAL APPROACH FOR MRV SYSTEM

- A general framework for information (and knowledge) fusion or integration
- Any kind of information (including cualitative estimations) is useful for reduction of uncertainty
- Any progressive and scalable approach and tier to MRV can be used. Results in the uncertainty of estimations.
- A non stop strategy for operational MRV systems (go with that you have!)
- As a default, a satellite C density (tier 1) can be implemented with minimum costs. This can be used for national accounting, subnational areas (projects) can be implemented trough community monitoring. Enough flexibility for every country capacity.

CONAFOR
COMISIÓN NACIONAL FORESTAL

PMC
Programa Mexicano del Carbono

ECOSUR

Thanks

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