



EMBRAER DEFESA & SEGURANÇA

Synthetic Aperture Radar and Image Processing

João Moreira

USP, January 23rd, 2017

► CONTENT

1. Why SAR?
2. SAR Principles;
3. Airborne Segment;
4. Ground Segment;
5. Products and Applications.

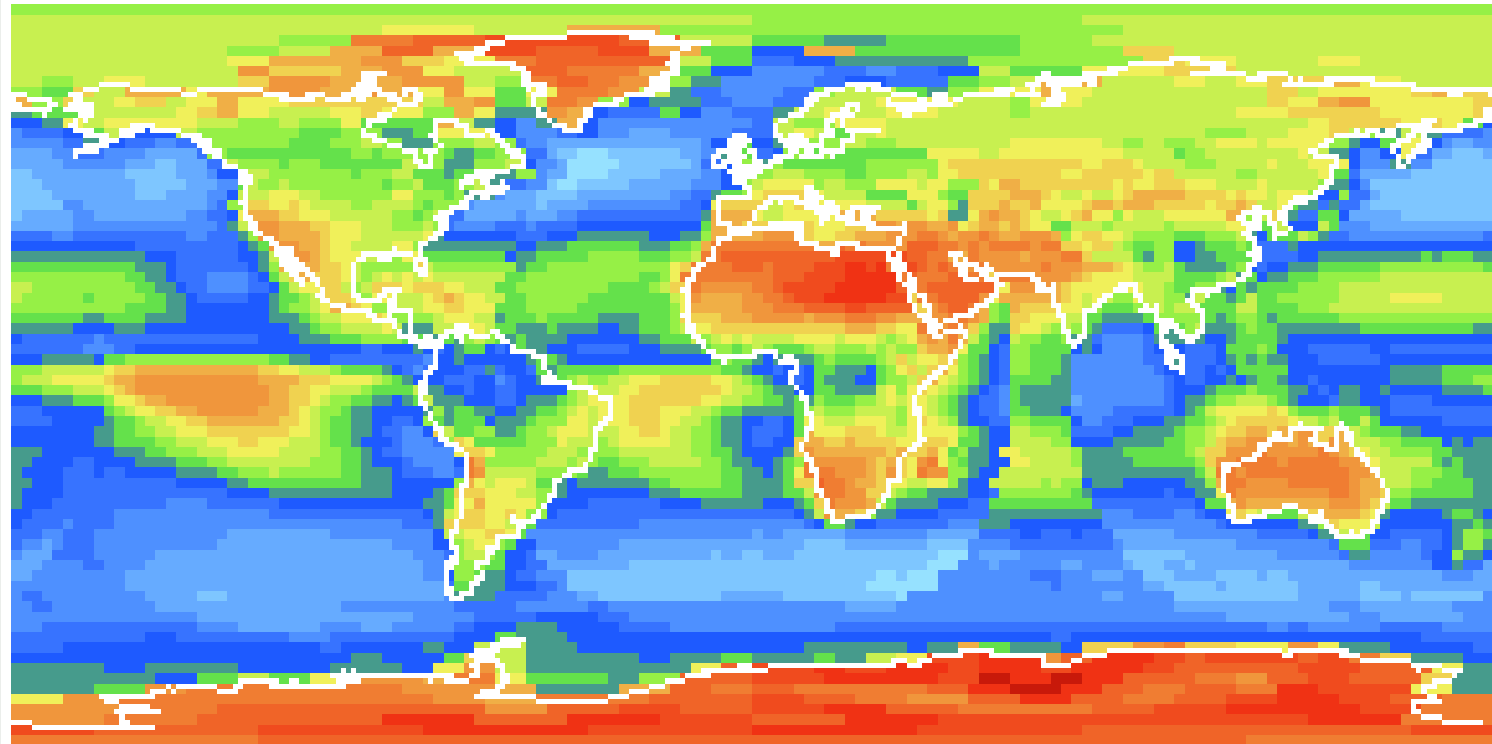




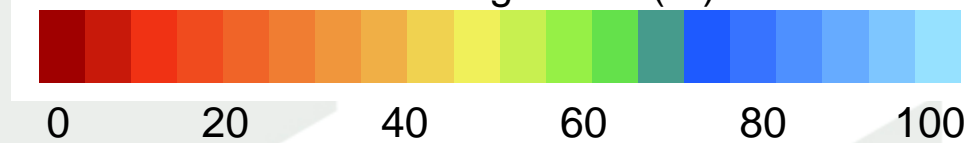
WHY SAR?

Why SAR ?

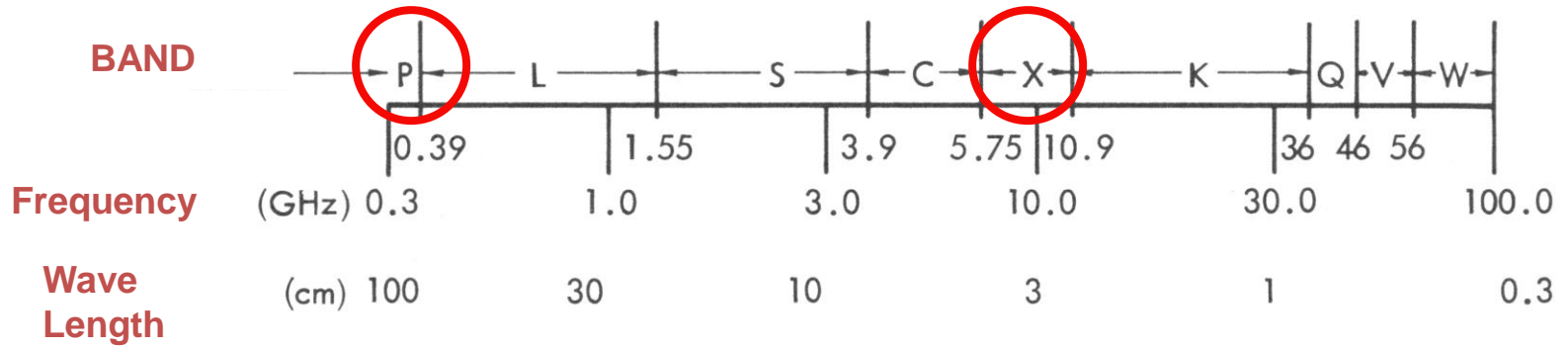
Mean Cloud Coverage Worldwide



Mean Cloud Coverage Rate (%)

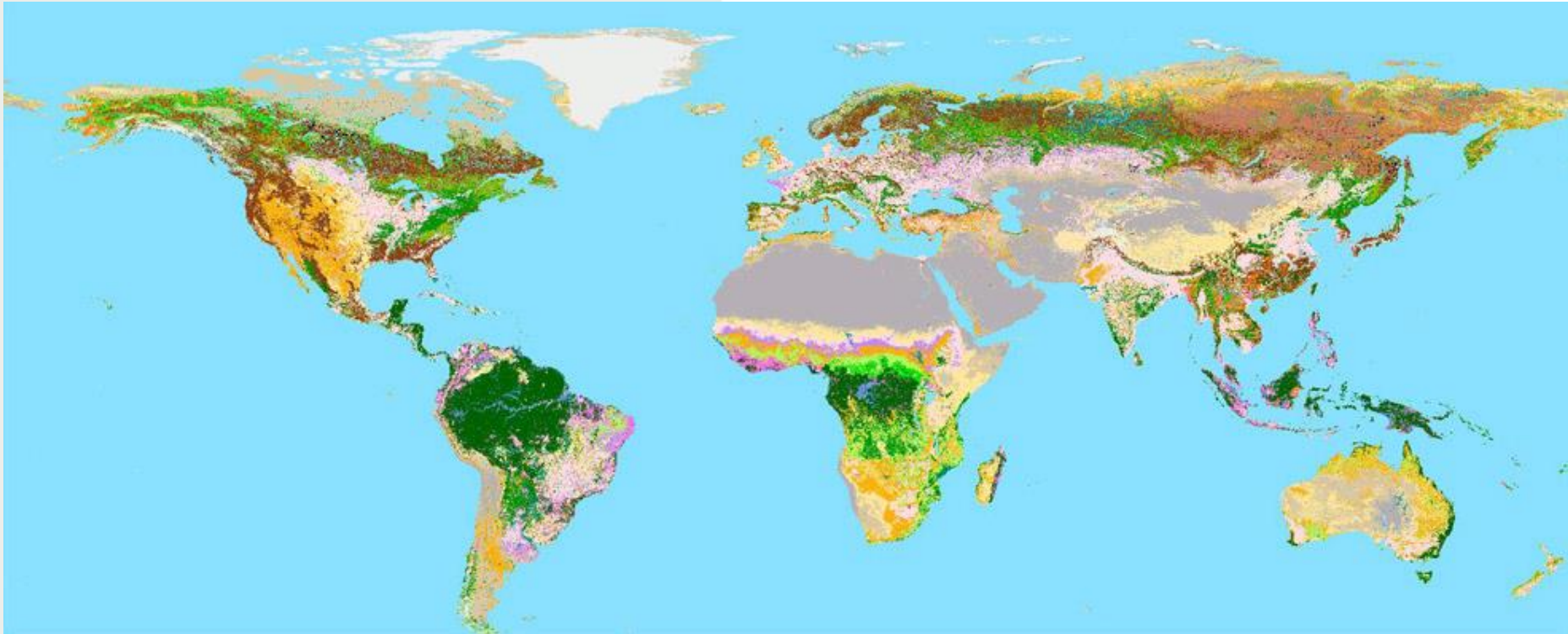


Radar Frequencies

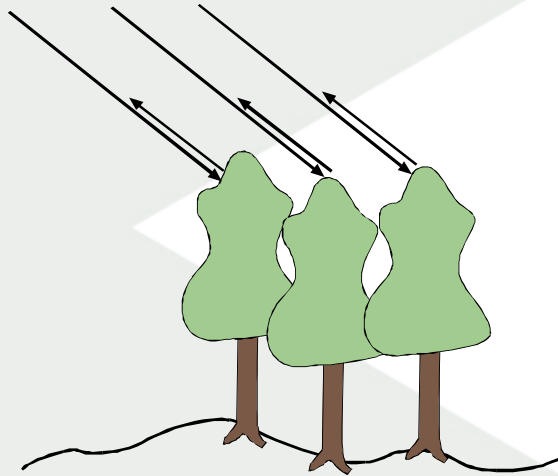


Why P-band ?

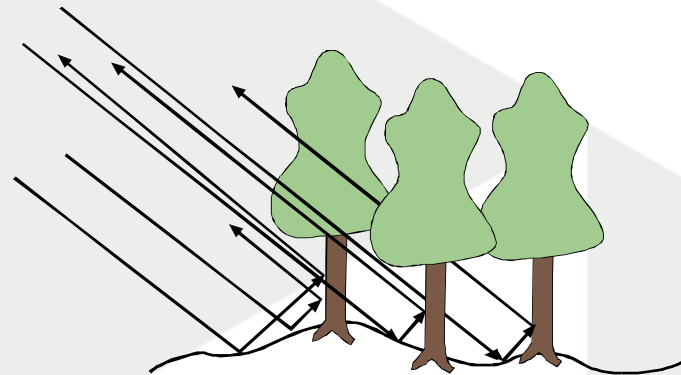
Vegetation Coverage Worldwide



PENETRATION OF X- AND P-BAND SIGNALS THROUGH VEGETATION



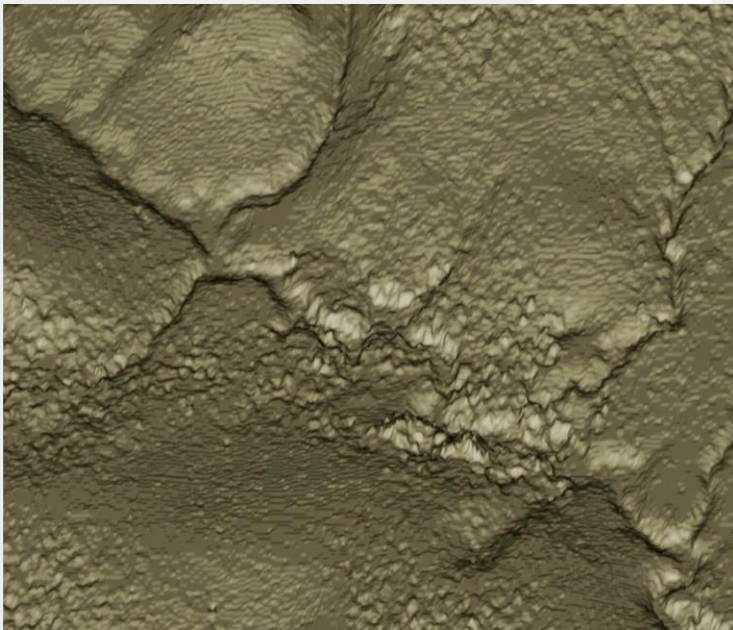
X-band



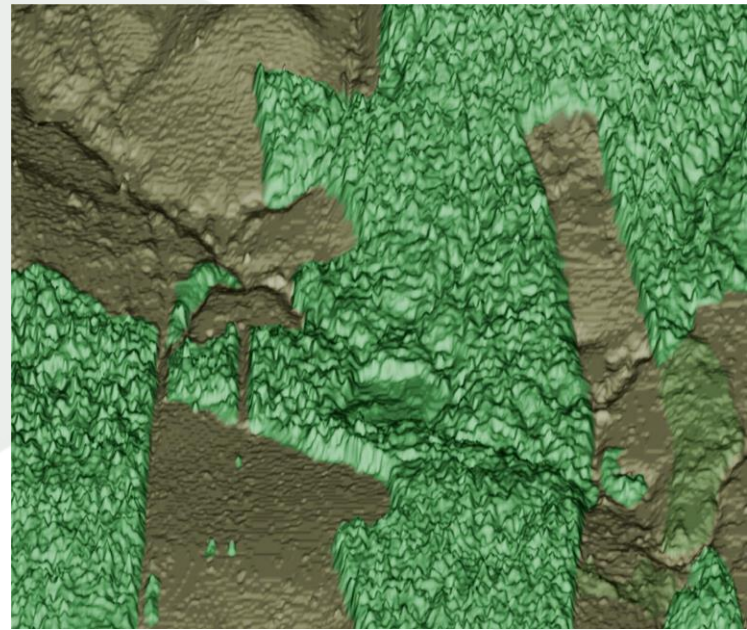
P-band

DTM and DSM

Terrain height model derived from P-band data



Surface height model derived from X-band data



Comparison: Radar X/P and Ikonos



Ortho Image of Ikonos - 02/2007, Paragominas Airport

Comparison: Radar X/P and Ikonos



Ortho Image in X band - 11/2006, Paragominas Airport

Comparison: Radar X/P and Ikonos

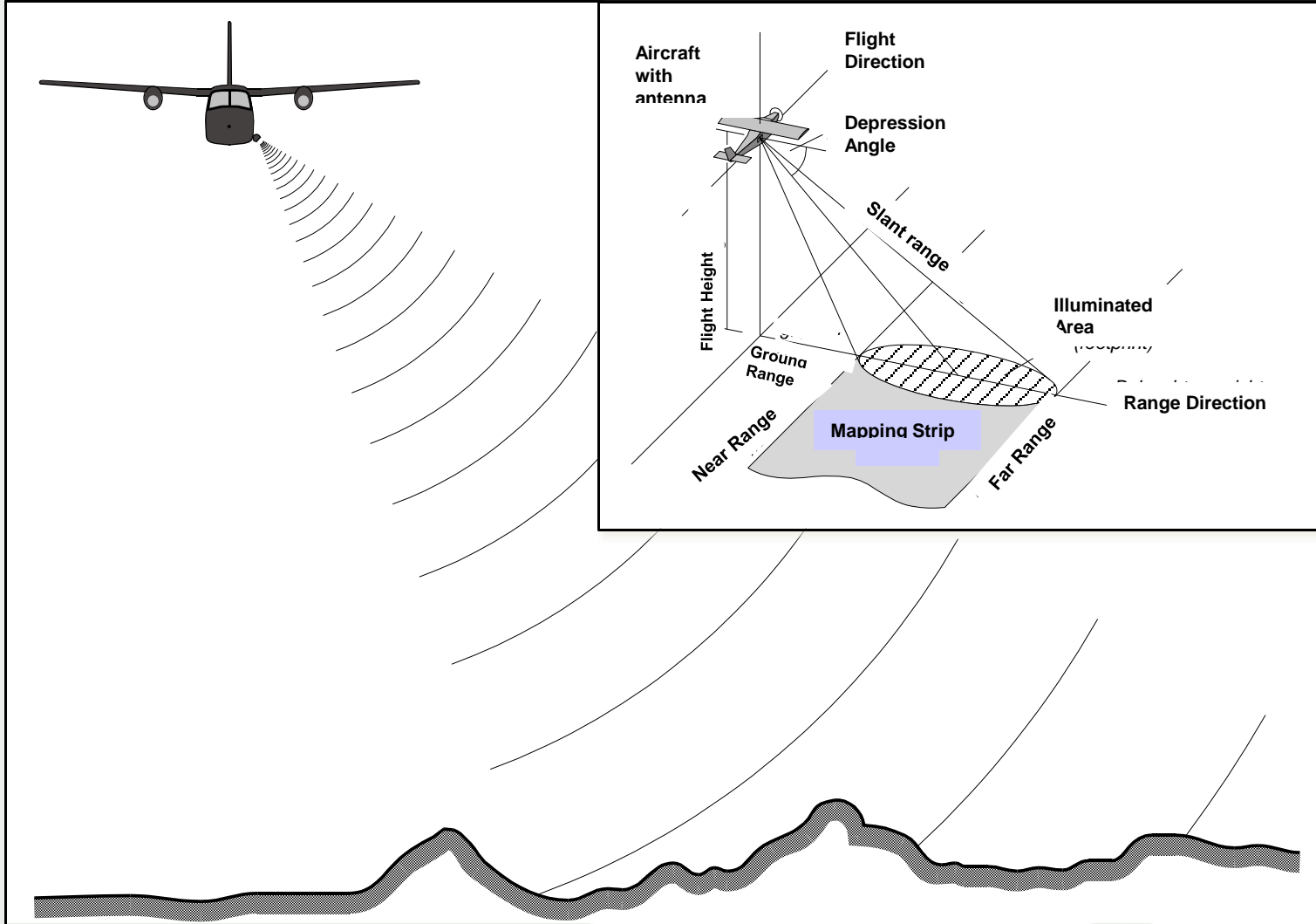


Ortho Image in P band - 11/2006, Paragominas Airport



SAR PRINCIPLES

Radar Illumination Geometry





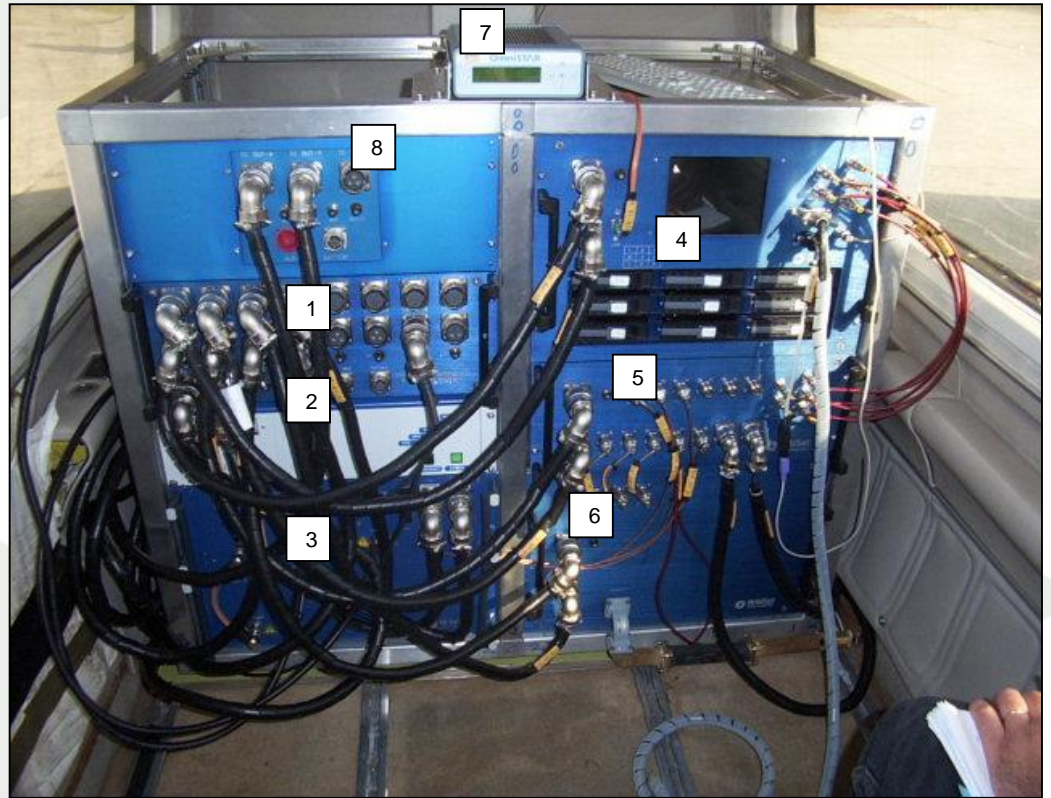
AIRBORNE SEGMENT

Data Acquisition: Flight Survey



OrbiSAR-1: inside airplane

- 1 – Energy Distribution
- 2 – Applanix POS AV
- 3 – P-Band transmission
- 4 – Control Computer
- 5 – RADAR receiver
- 6 – X-Band transmission
- 7 – Omnistar (Differential GPS)
- 8 – Mains supply



OrbiSAR-1

- **Flight Segment:**
X-Band antenna set



IMU mounted on the beam



OrbiSAR-1

- **OrbiSAR-1 Flight Segment : P-Band antenna**



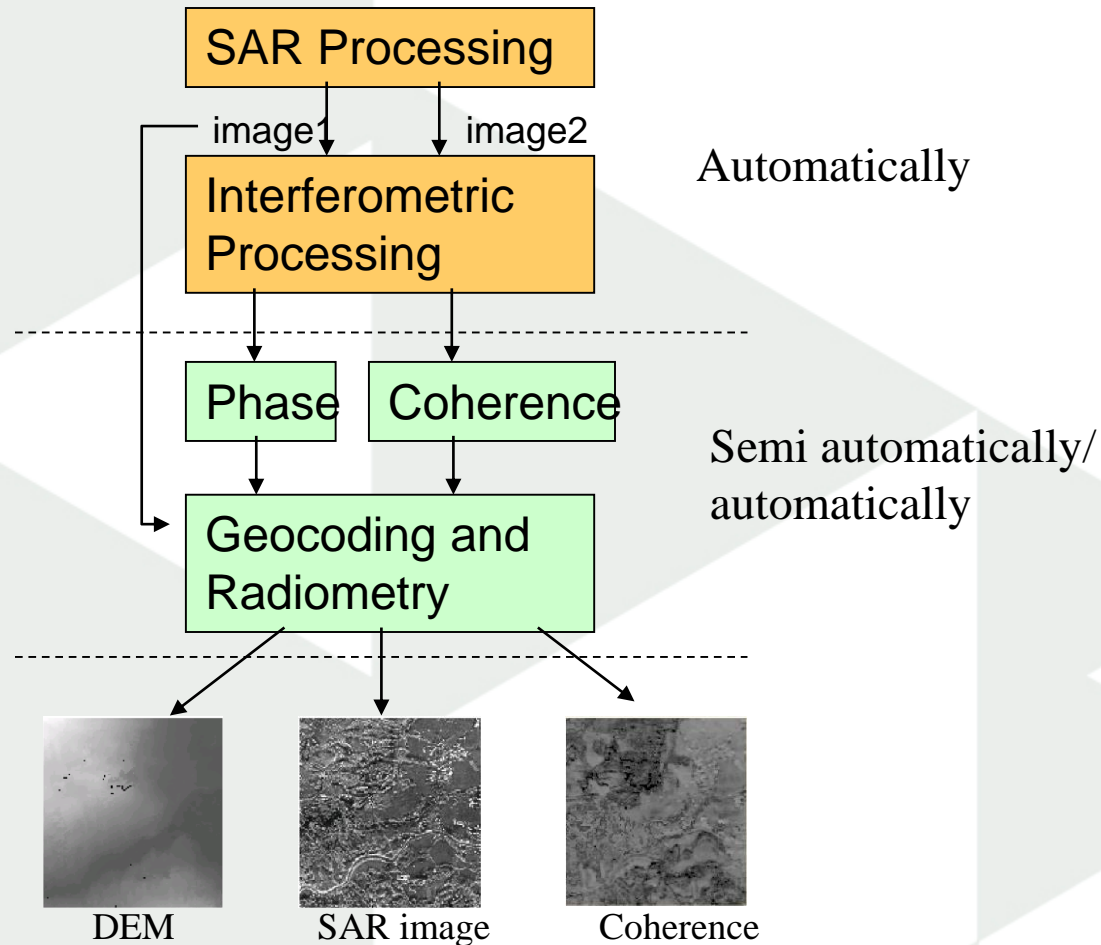
Survey Flight



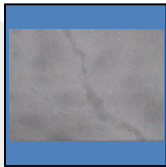
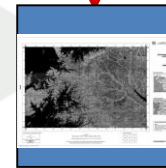
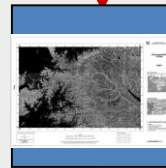
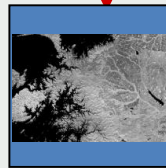
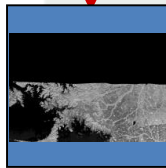
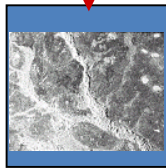
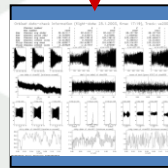
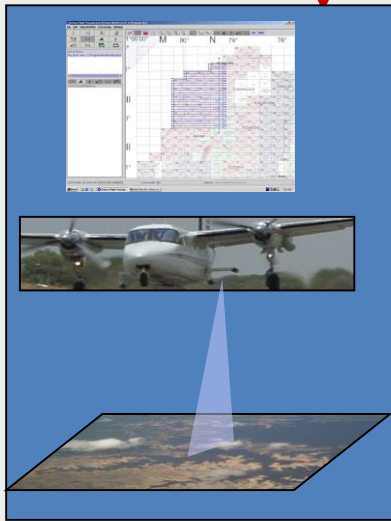
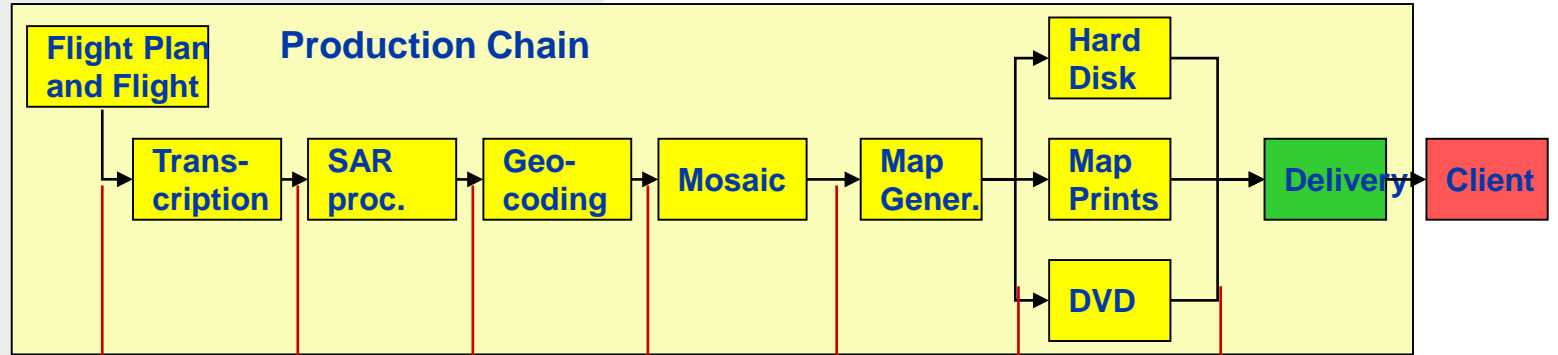


GROUND SEGMENT

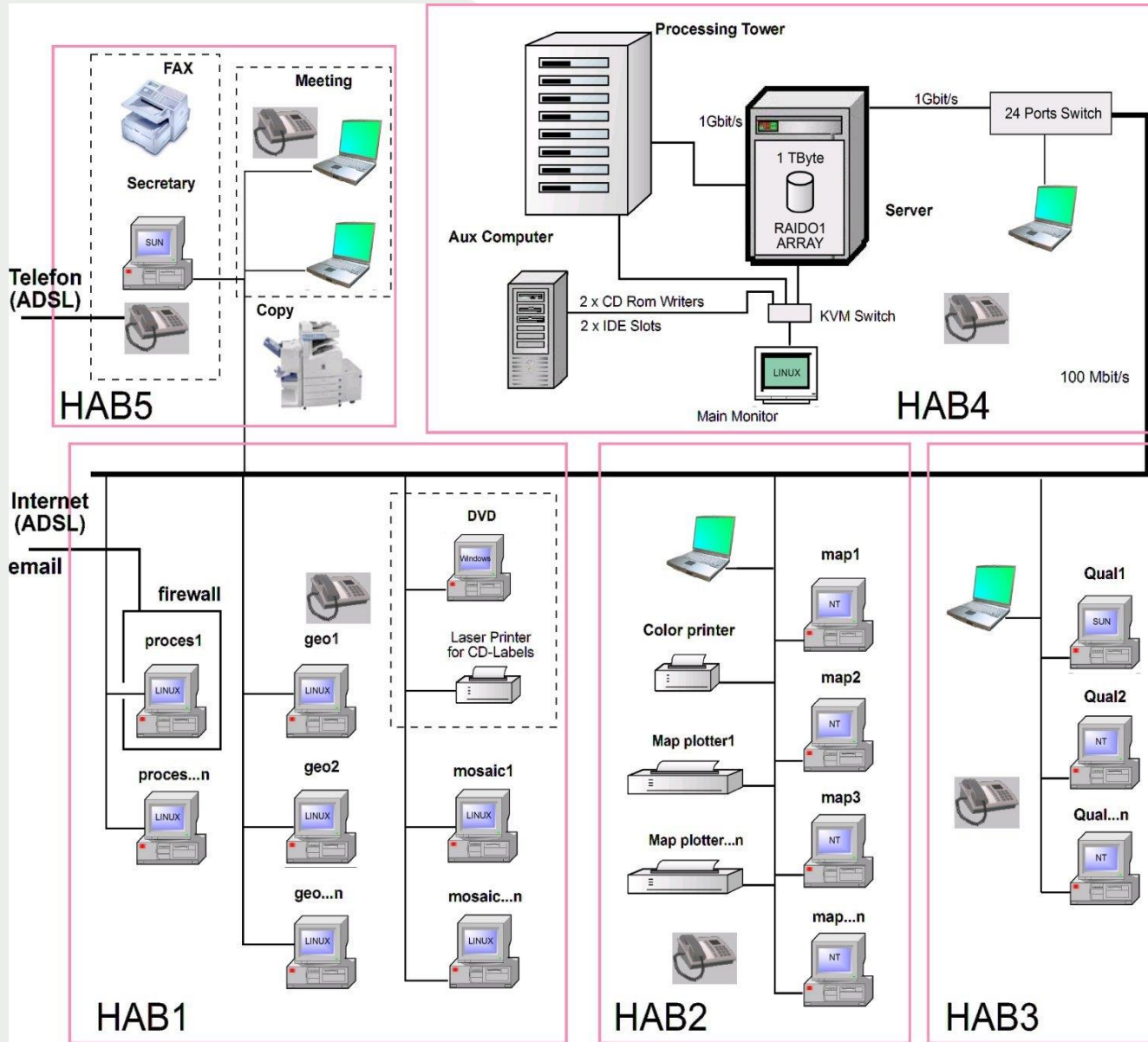
Data Acquisition: from Processing up to Contour Lines



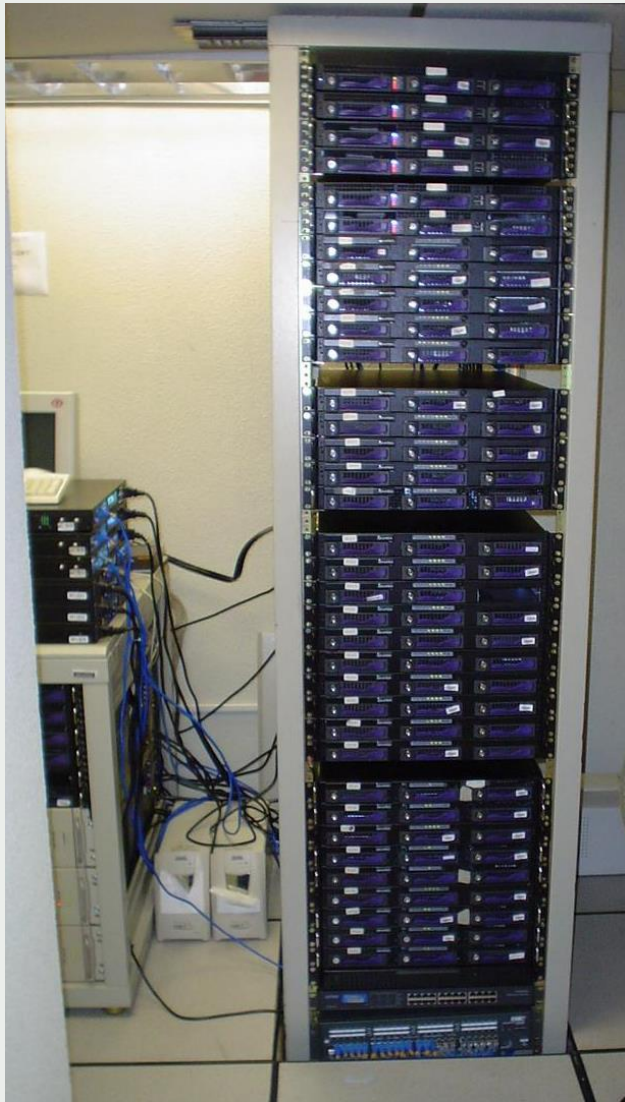
Production chain



Processing Block Diagram



Data Processing



Cartography



Data Acquisition: Ground Support for Flight Survey



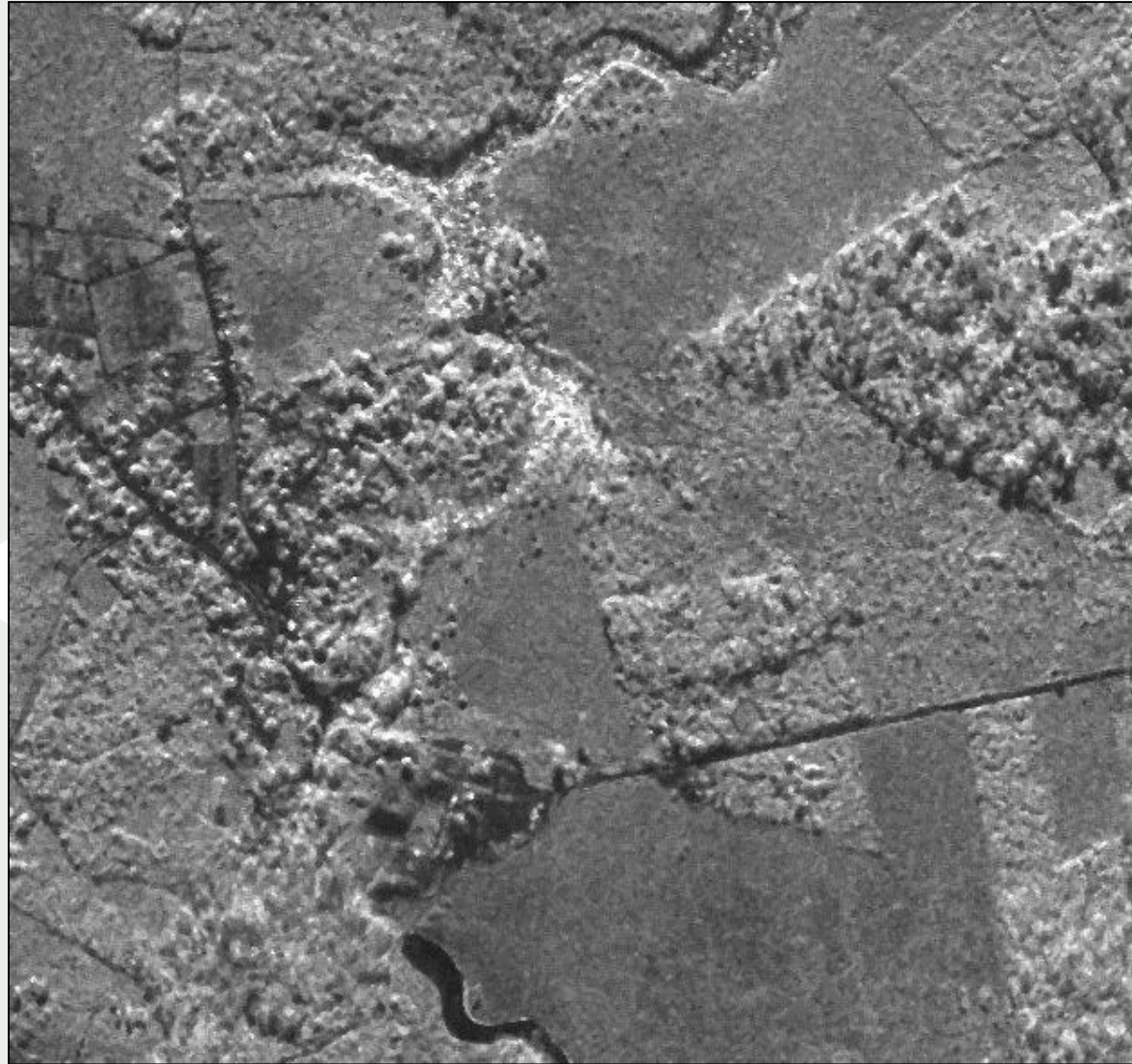
Data Acquisition: Ground Support for Flight Survey





PRODUCTS AND APPLICATION

X-band ORI



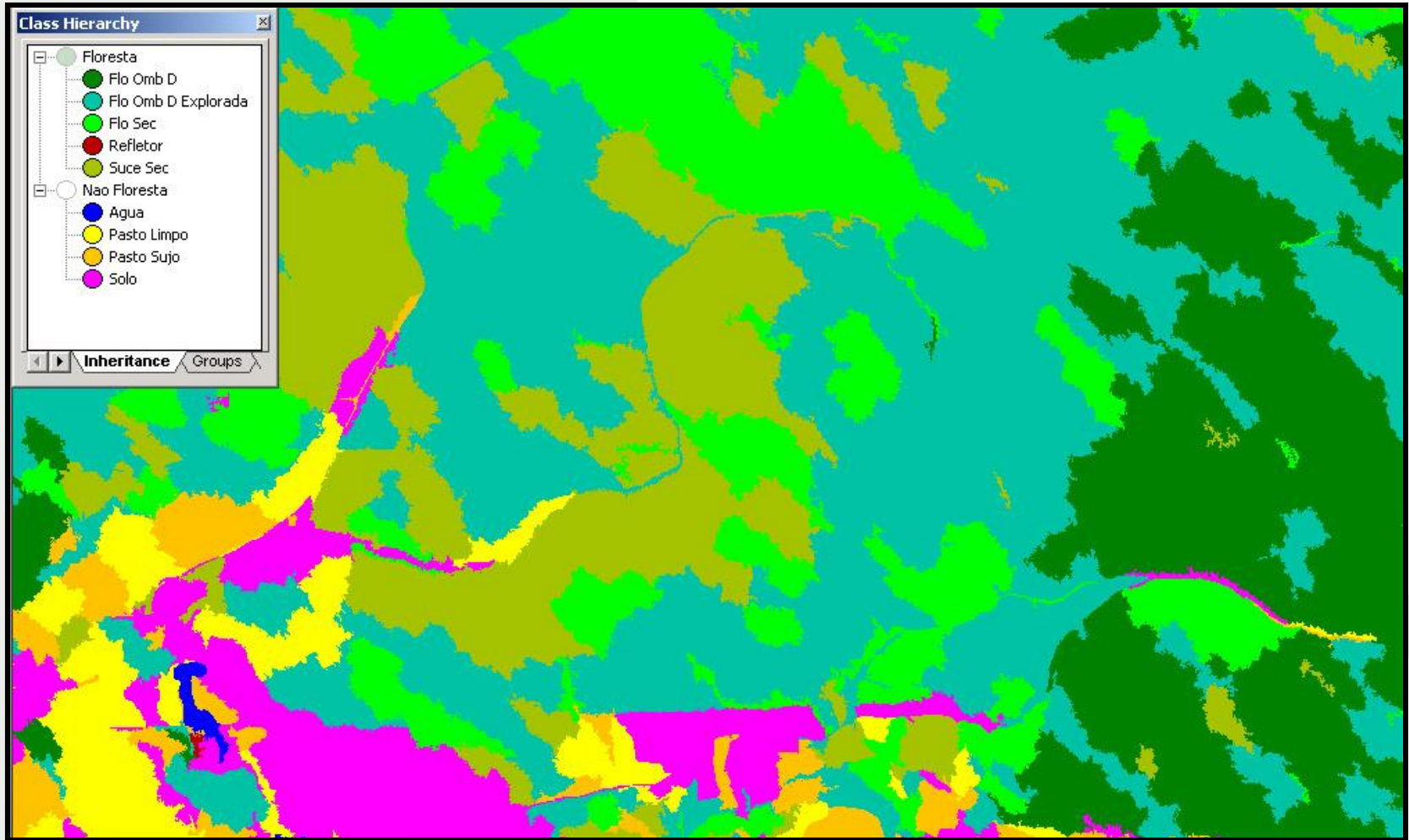
Band: X
Resolution: 2.5 m
Scale: 1:25.000

P-band ORI

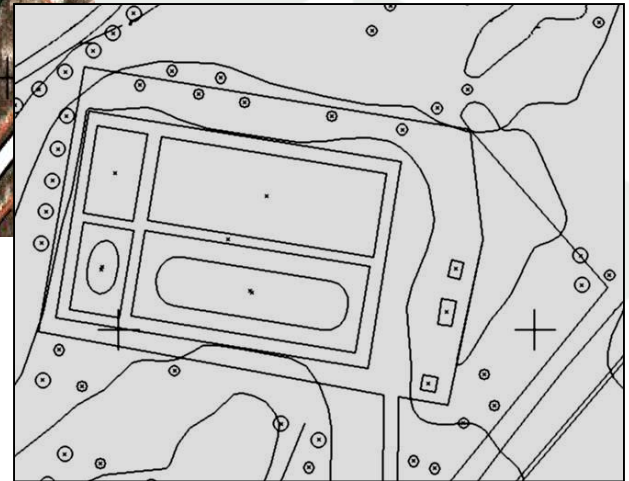
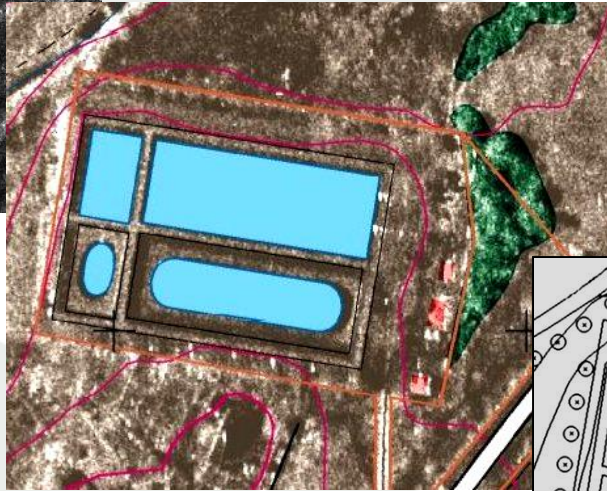
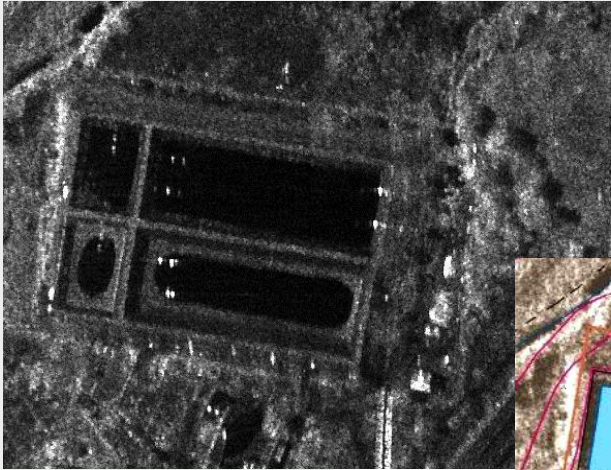


Band: P
Resolution: 2.5 m
Scale: 1:25.000

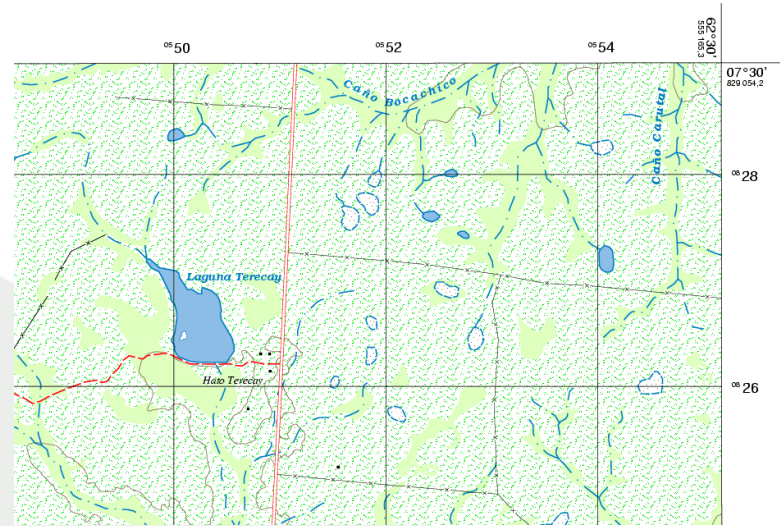
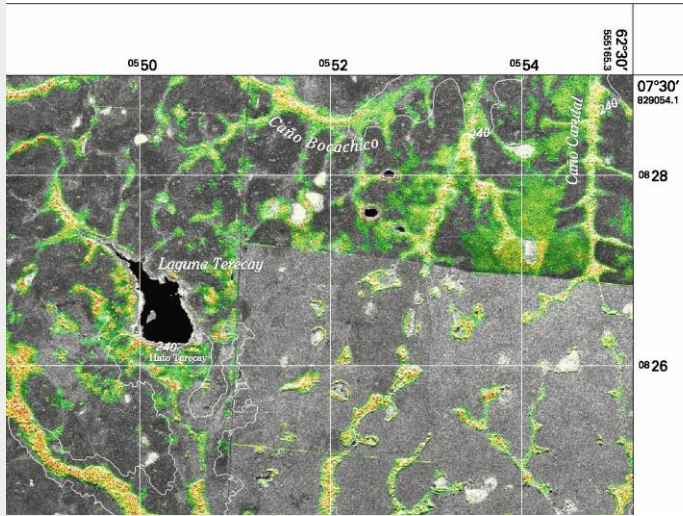
Classification using X and P-pol ORIs and DSM-DTM



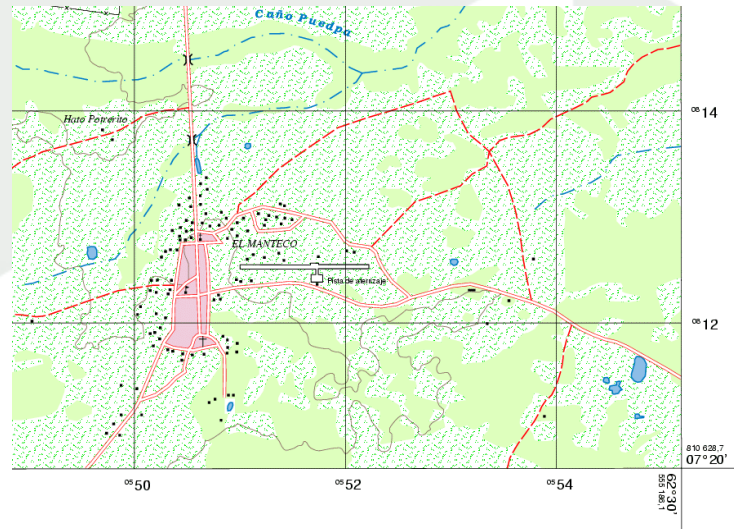
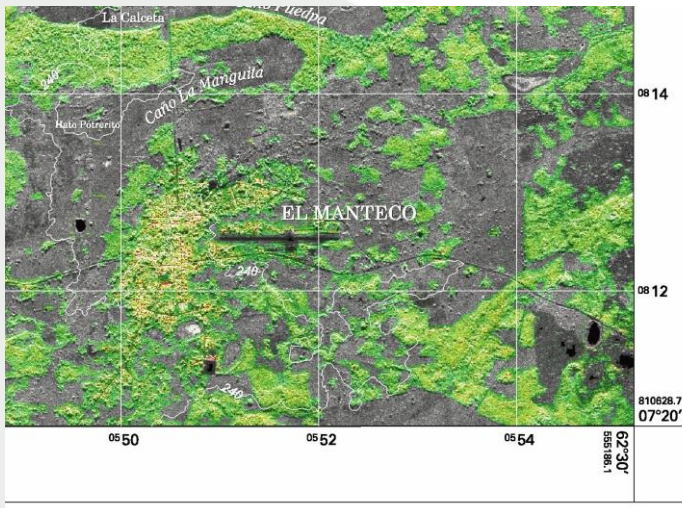
Vectorization



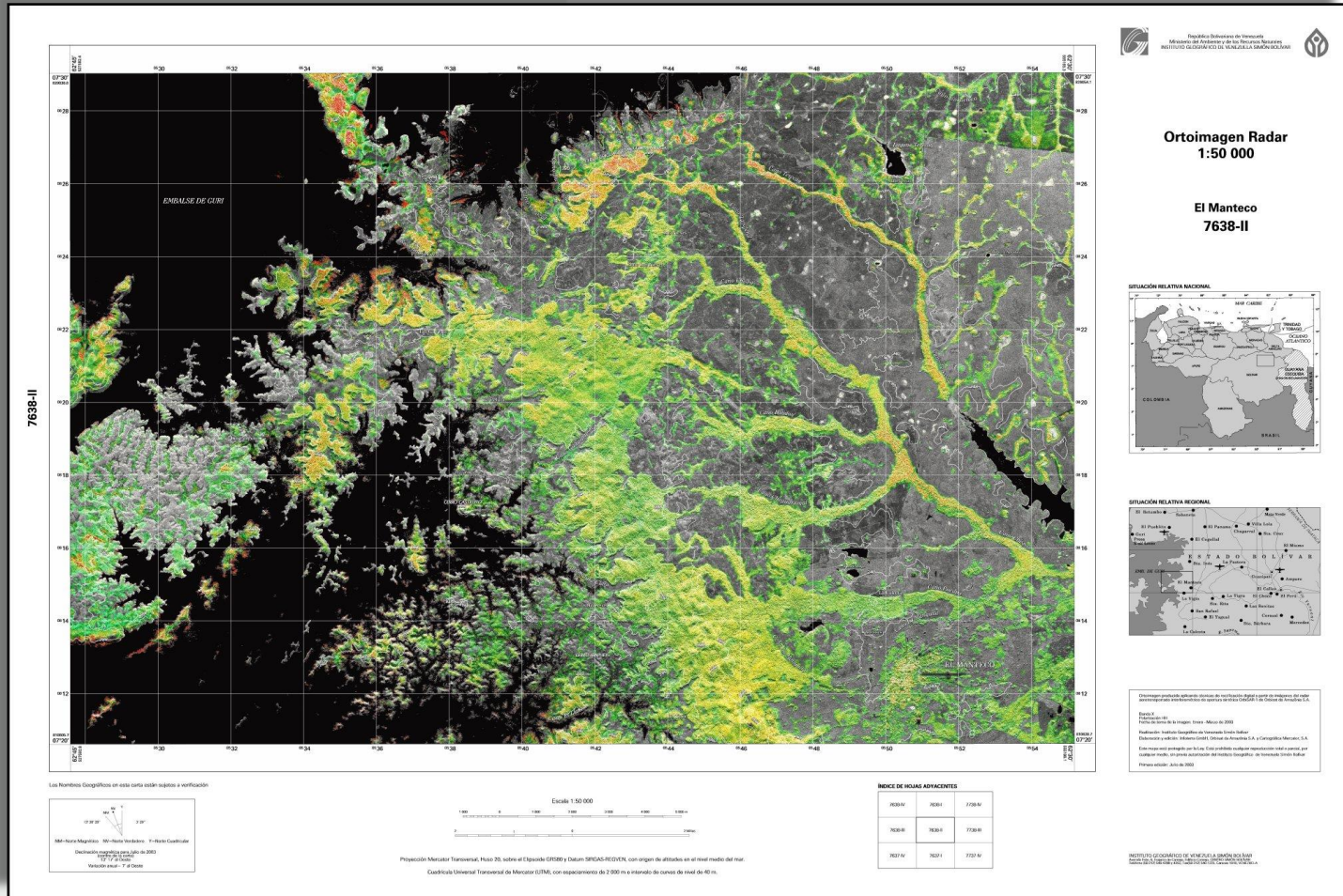
First detailed example of topographic map production



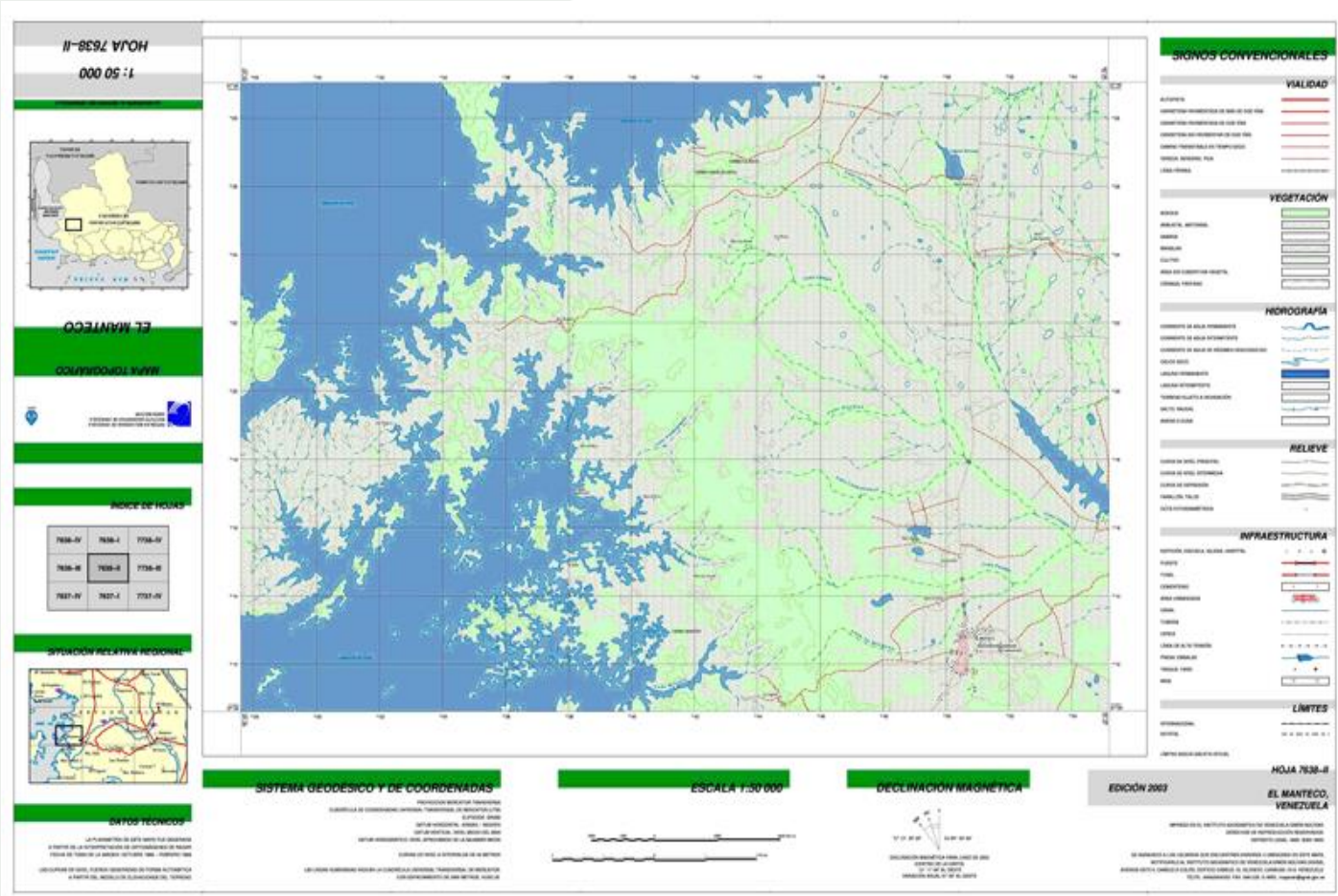
Second detailed example of topographic map production



ORTHO-IMAGE WITH CONTOUR LINES



Corresponding Topographic Map in scale 1:50,000

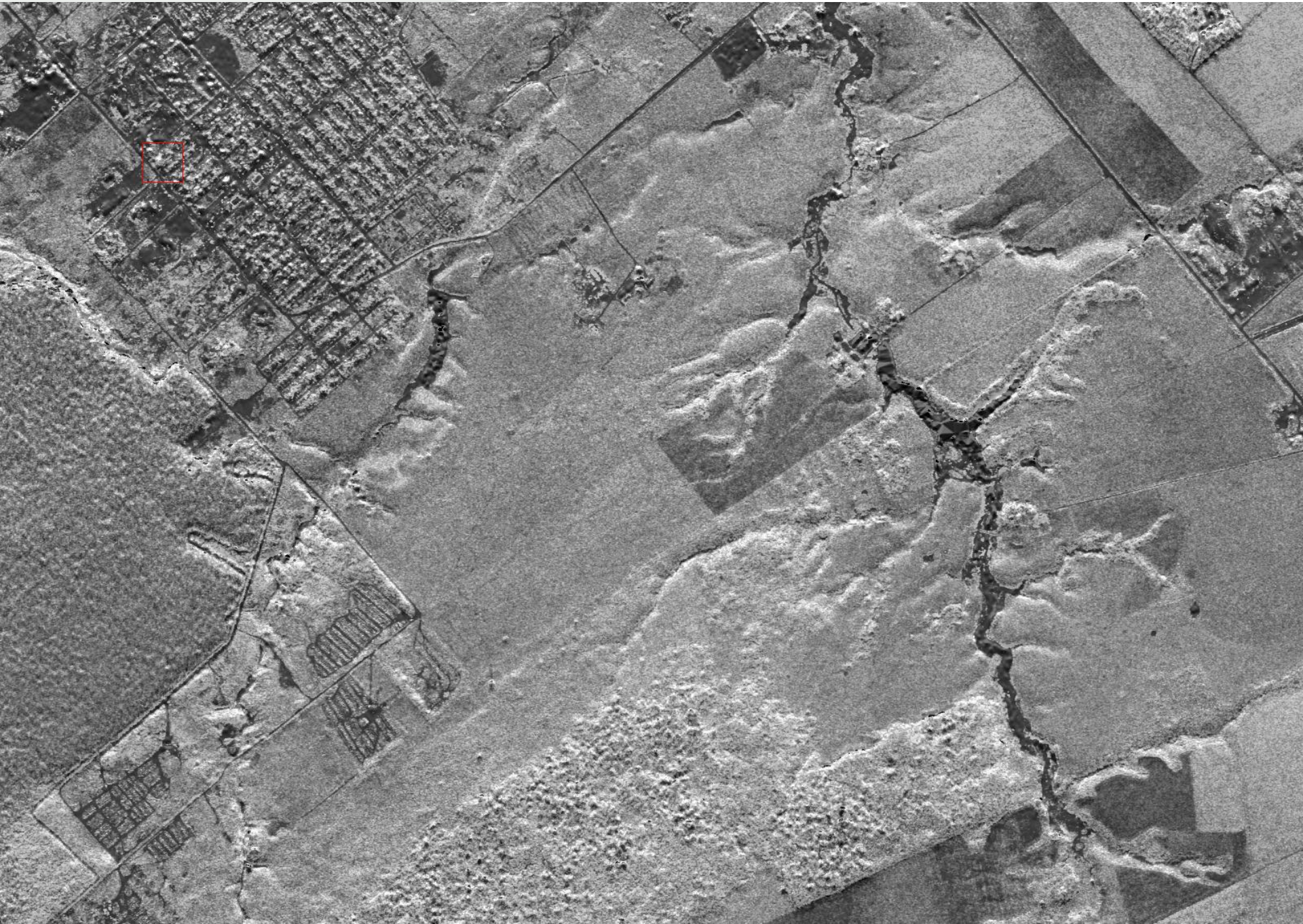




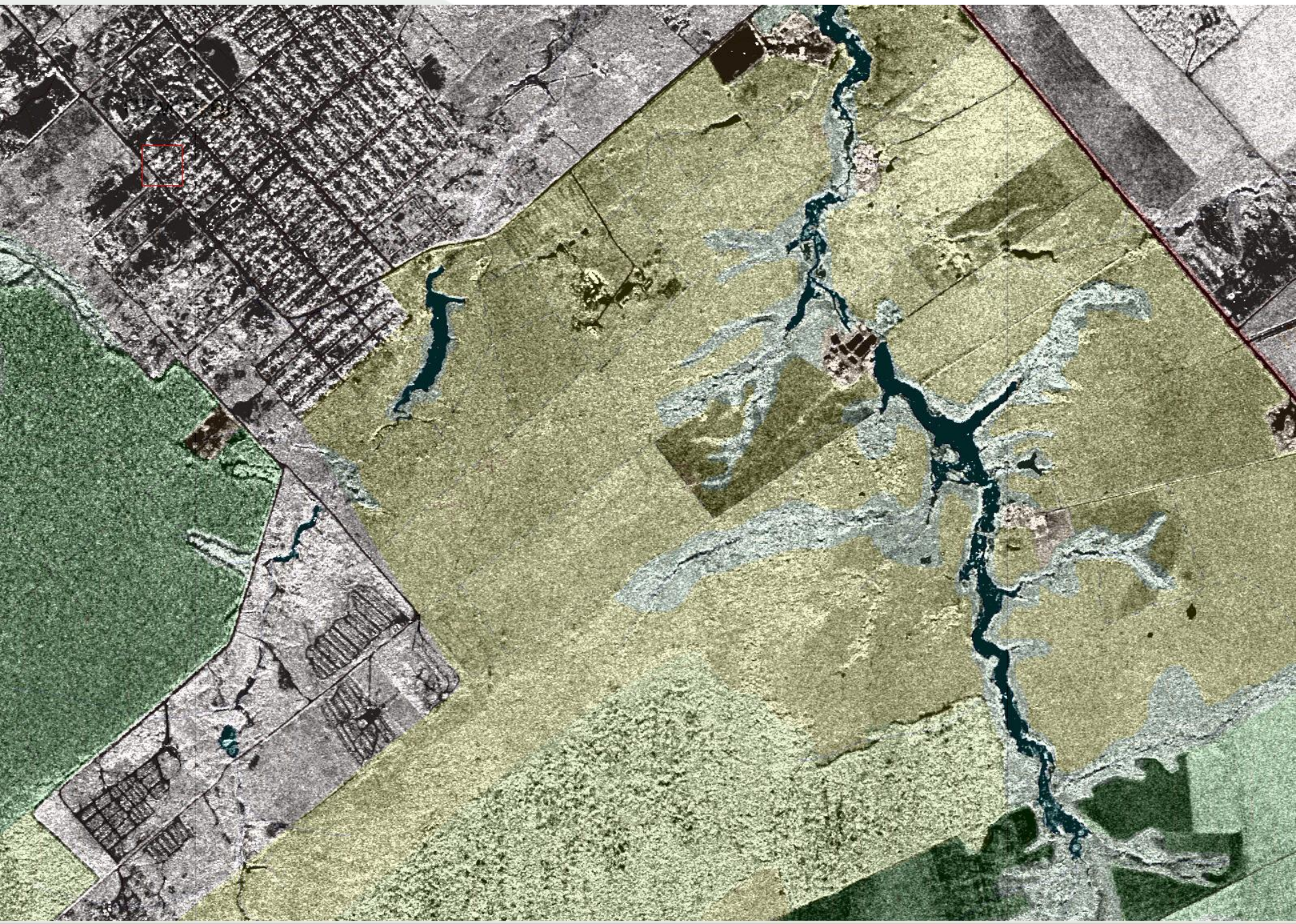
MAP GENERATION

Selected Area

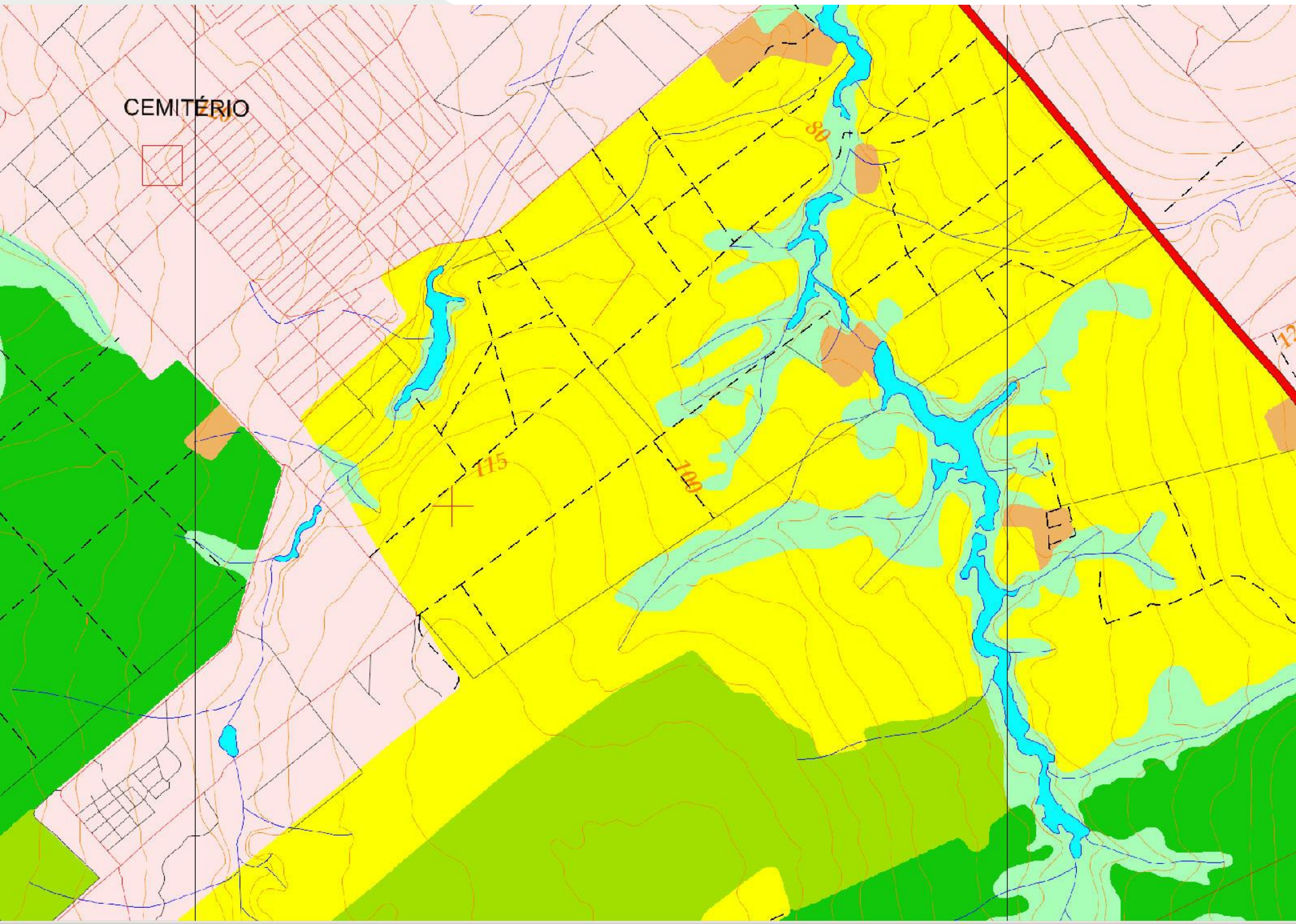
Selected Area



TRANSITION: Image X: 85% - Topographic Map 1/25.000: 15%



Topographic Map - Scale 1/25.000

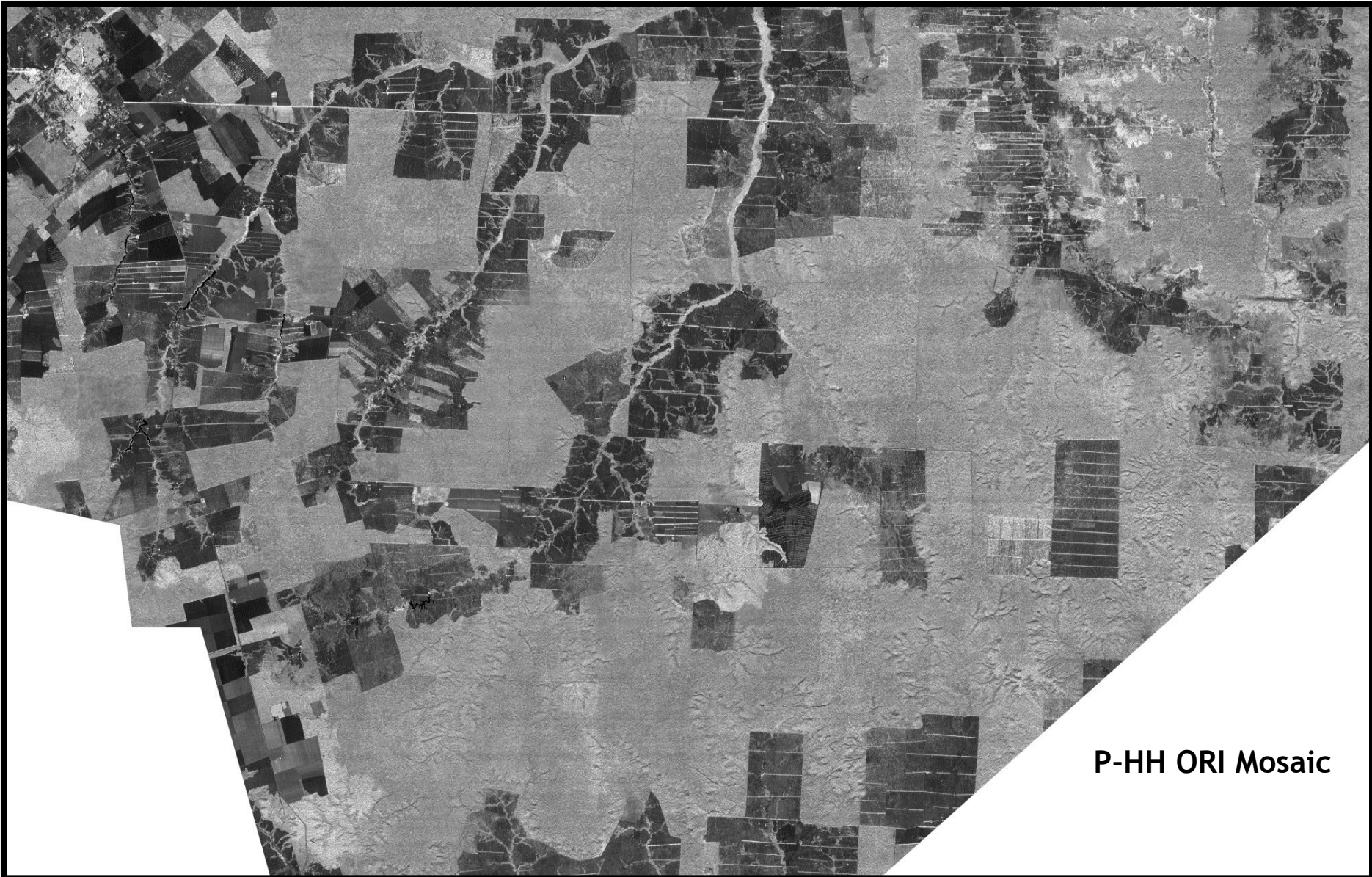


Miltônia-Paragominas



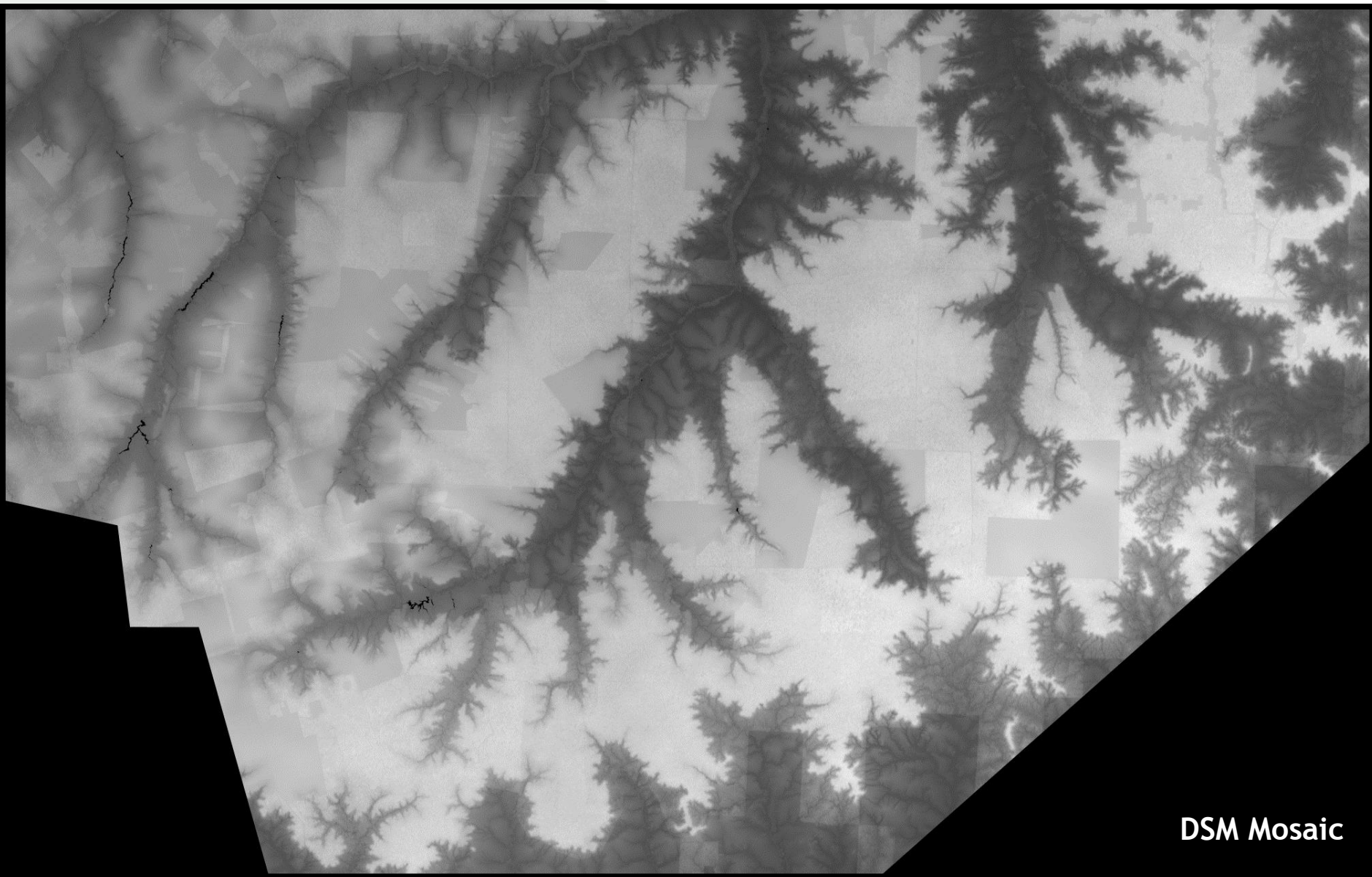
X ORI Mosaic

Projeto Miltônia-Paragominas



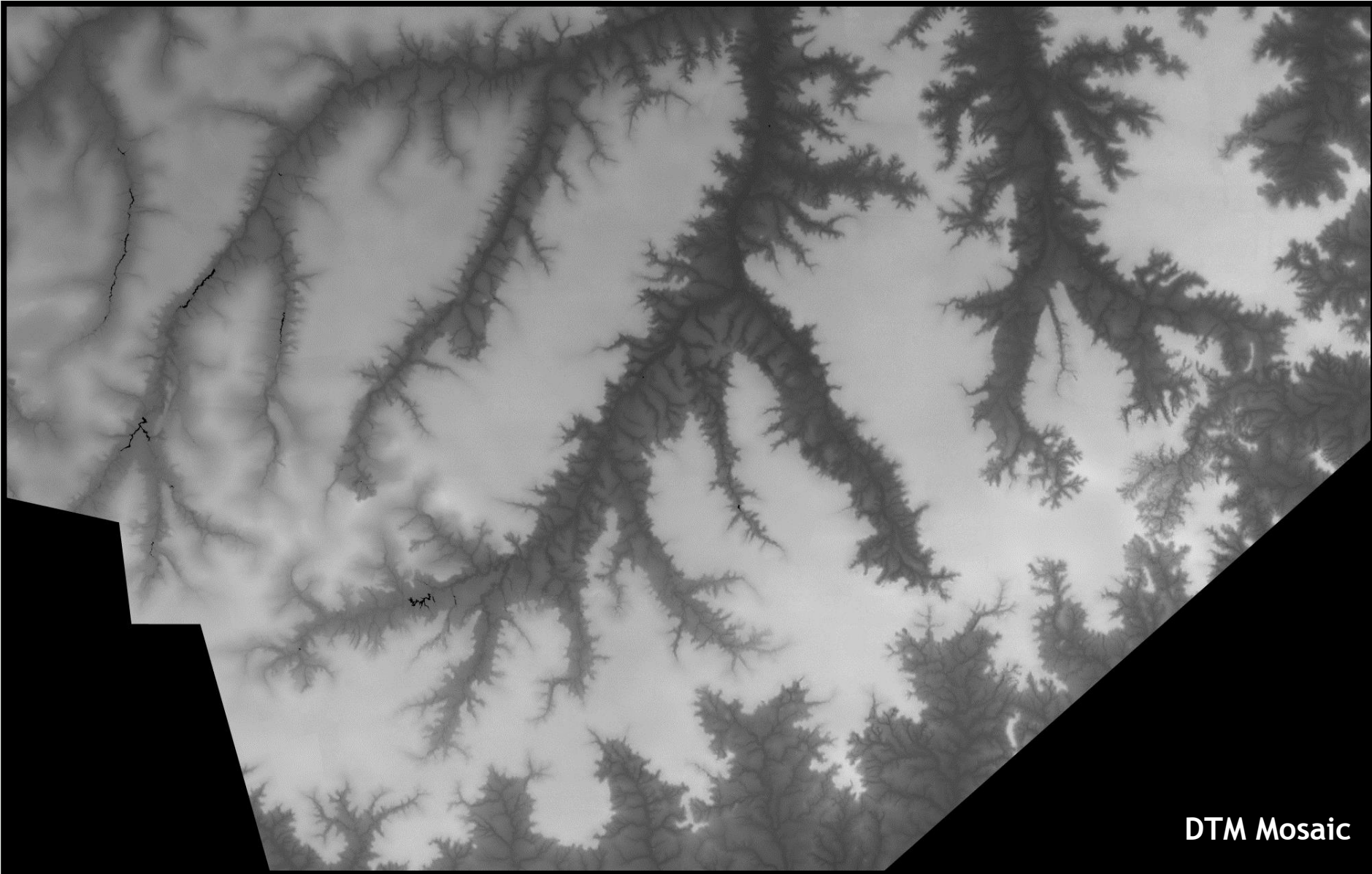
P-HH ORI Mosaic

Projeto Miltônia-Paragominas



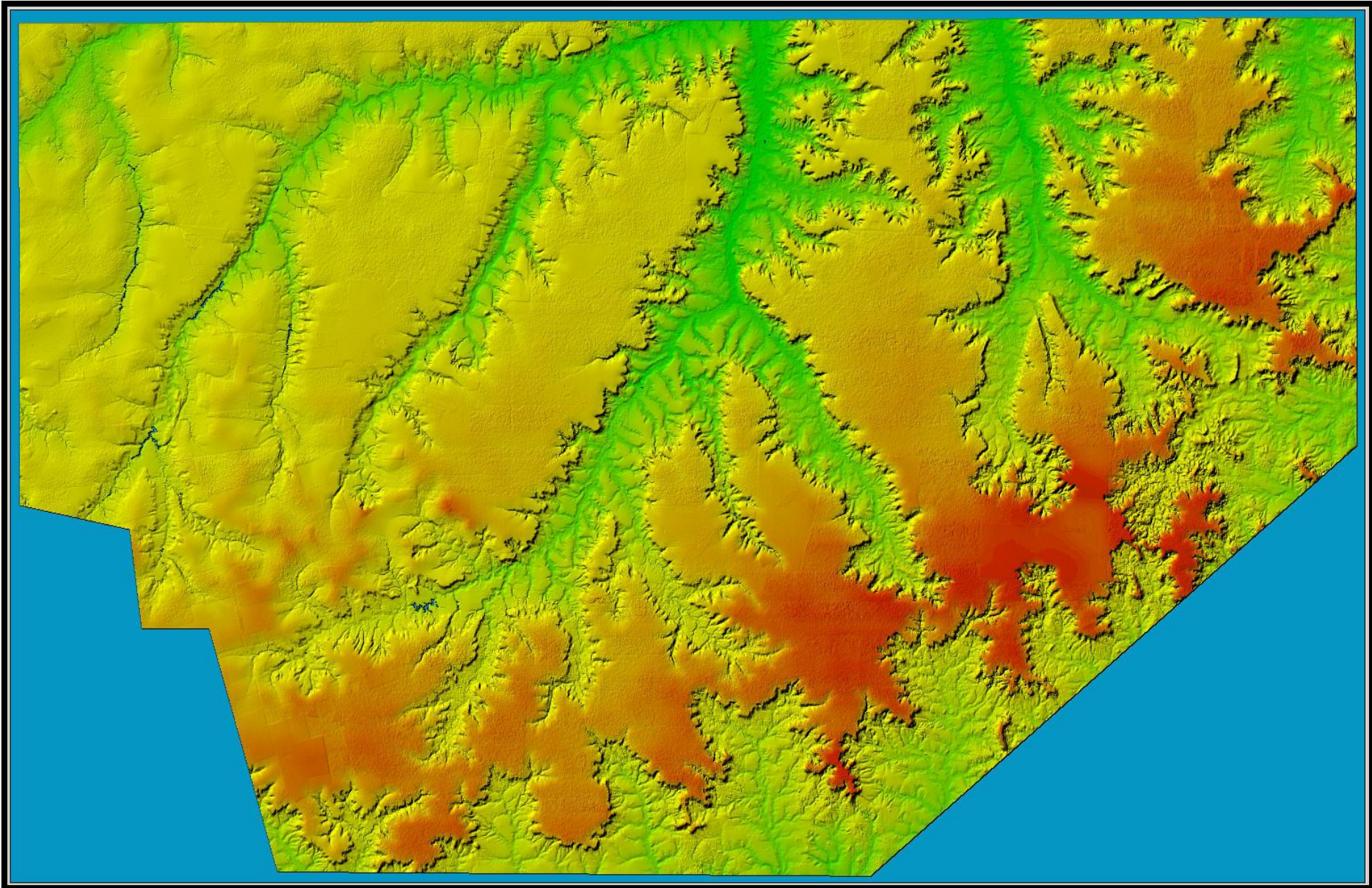
DSM Mosaic

Projeto Miltônia-Paragominas

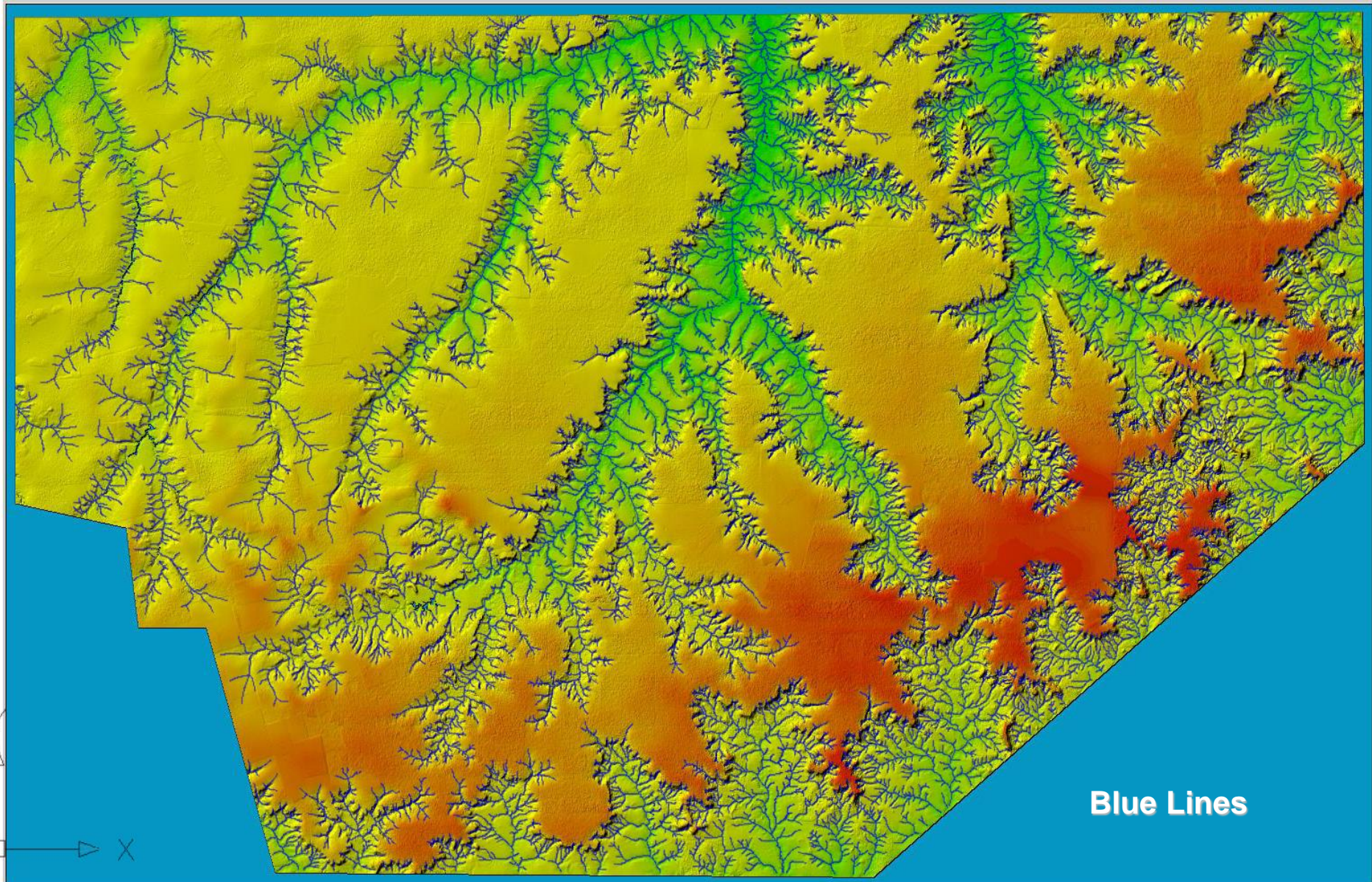


DTM Mosaic

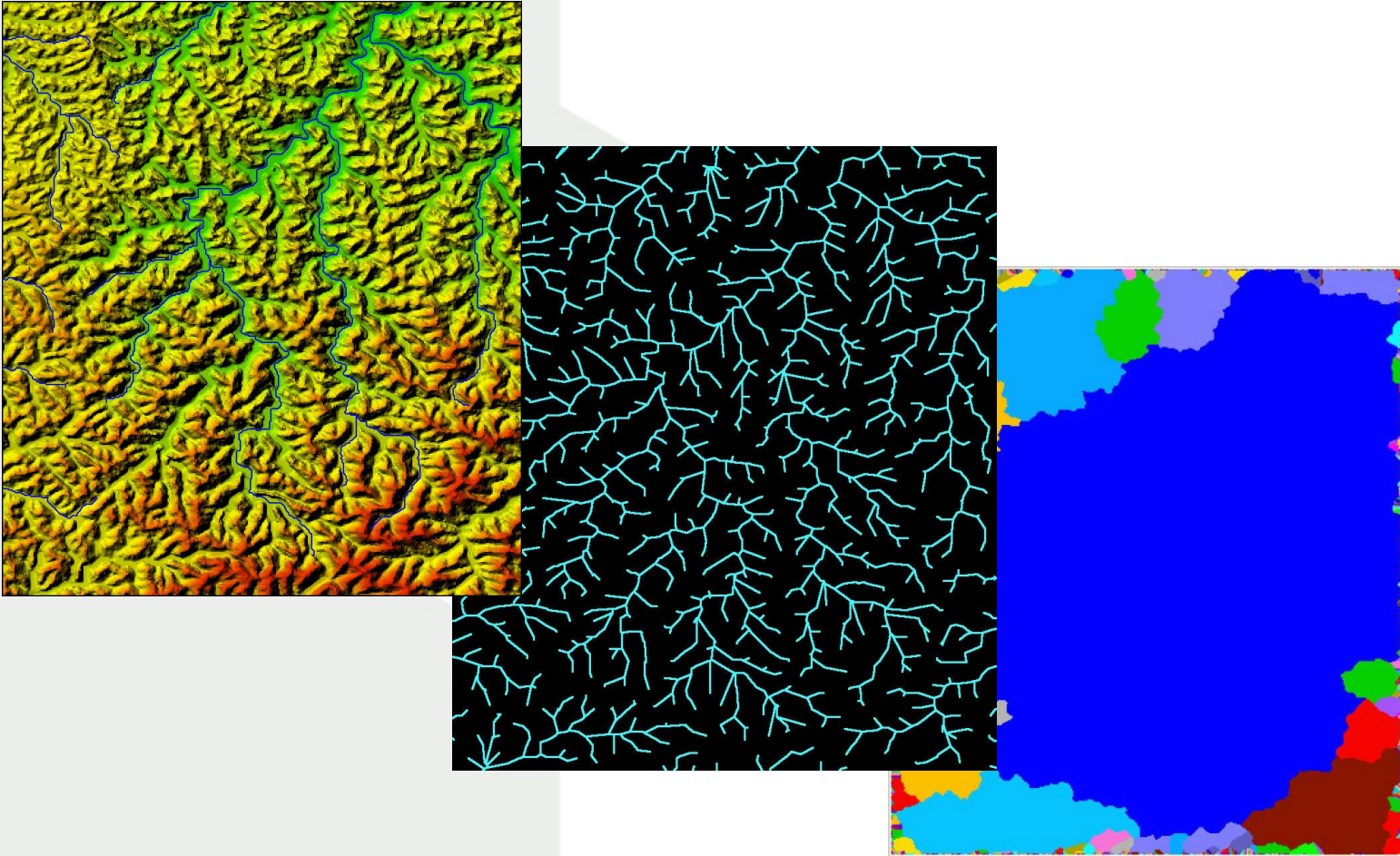
Miltônia-Paragominas: DTM Mosaic



Miltônia-Paragominas: DTM with drainage network

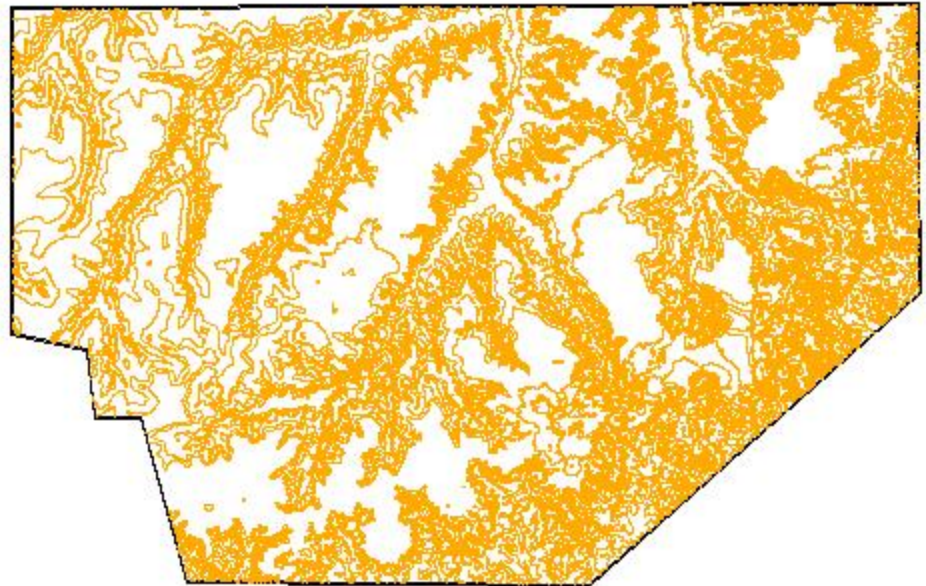
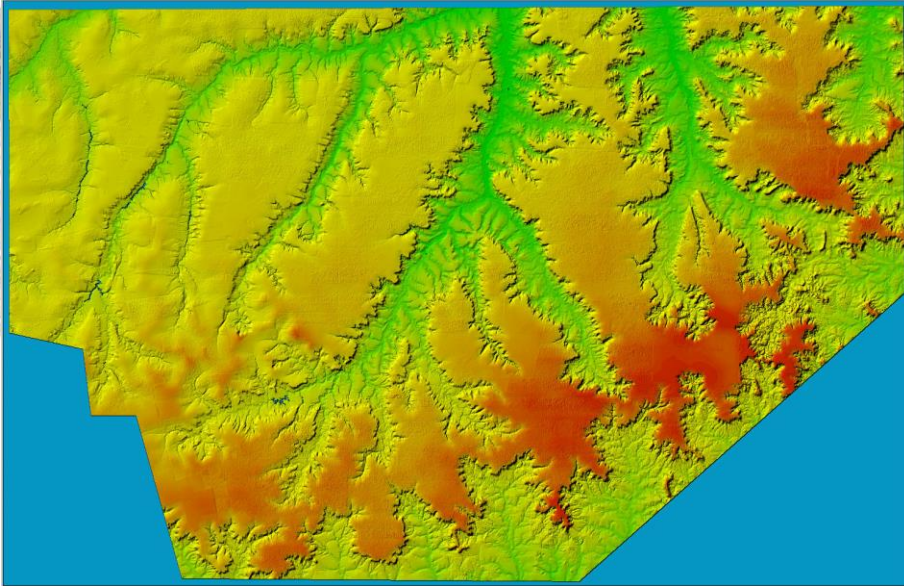


Drainage, Water Bodies , Bassins and Micro Bassins



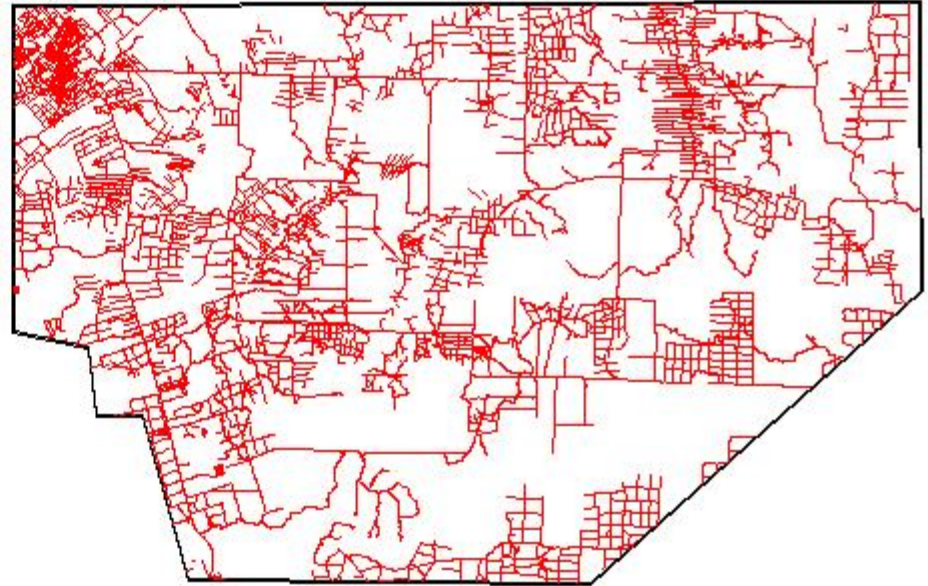
Miltônia-Paragominas

Contour Lines



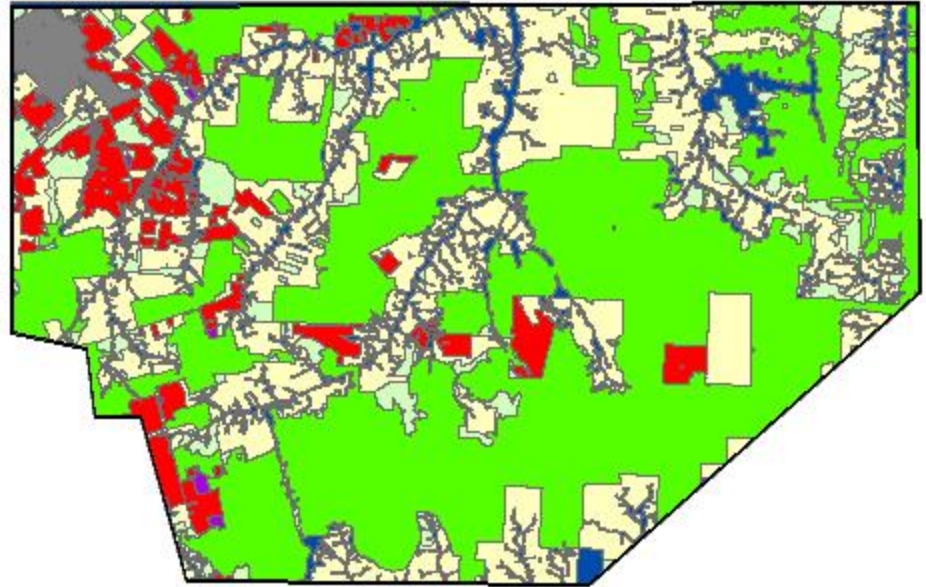
Miltônia-Paragominas

Road Network

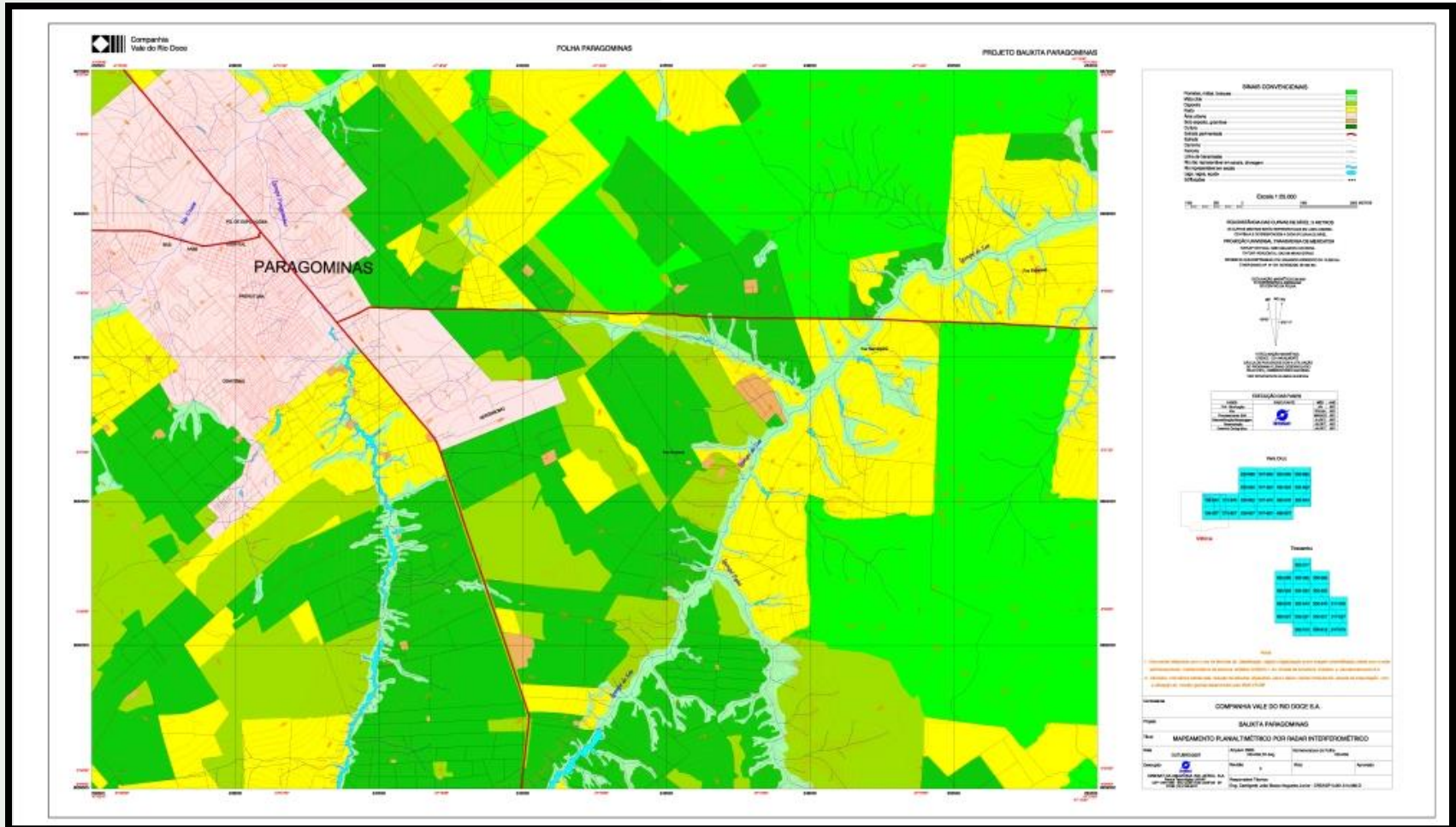


Miltônia-Paragominas

Image Classification



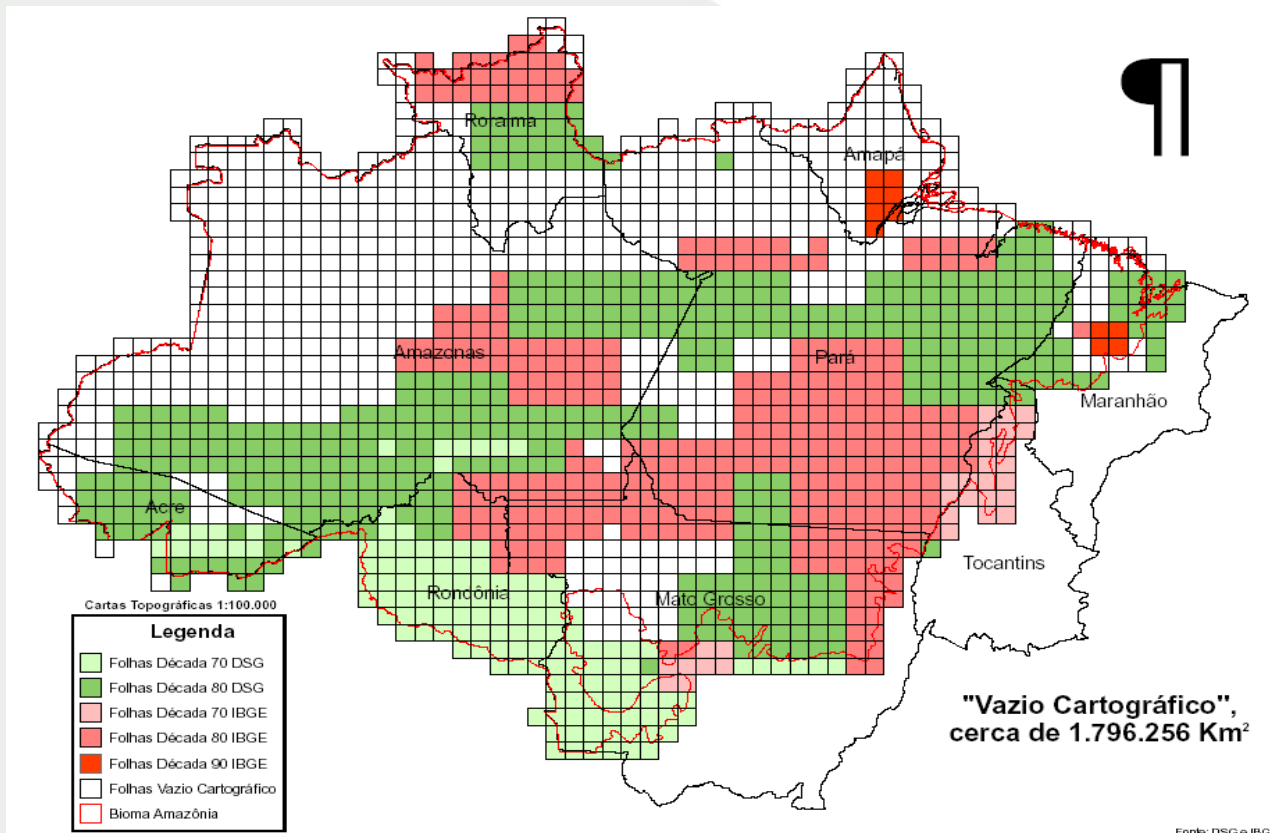
Final Line Map



CARTOGRAPHY OF THE AMAZON

● White Boxes: no maps available in 1:100.000 scale

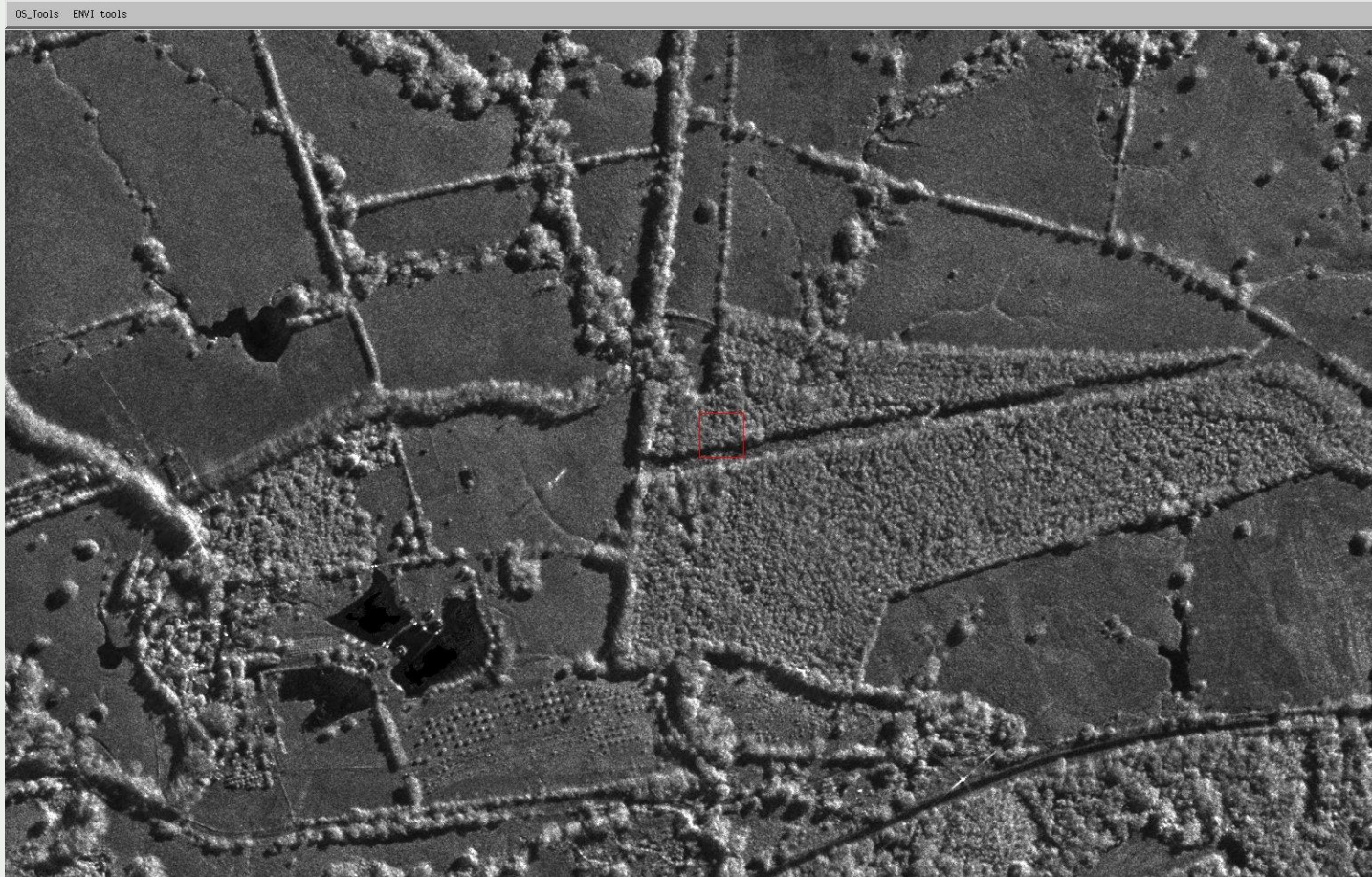
→ 1.796.256 km² or 2.464 map sheets in scale 1:50.000



CARTOGRAPHY OF THE AMAZON - AM



X BAND SAR IMAGE - PANAMA



Panama
1:10.000



EMBRAER DEFESA & SEGURANÇA

Thank You