SRTM Models as Tools to Build a Spatial Data Infrastructure for Colombia

Fernando Salazar - Universidad de los Andes, Bogotá

1. Historical Notes on Colombian Cartography
2. Colombia's Topographical Maps
3. Watershed delineation and Digital Terrain Models based on Topographical Maps
4. SRTM 3-arc second unfinished digital elevation data set applications:
   a) Georeferencing LANDSAT imagery
   b) Hydrological and Relief Models derived from SRTM
5. Building a Spatial Data Infrastructure for Colombia

Prehistory

Teįžuna, the Lost City of the Tayrona Culture

Sierra Nevada de Santa Marta

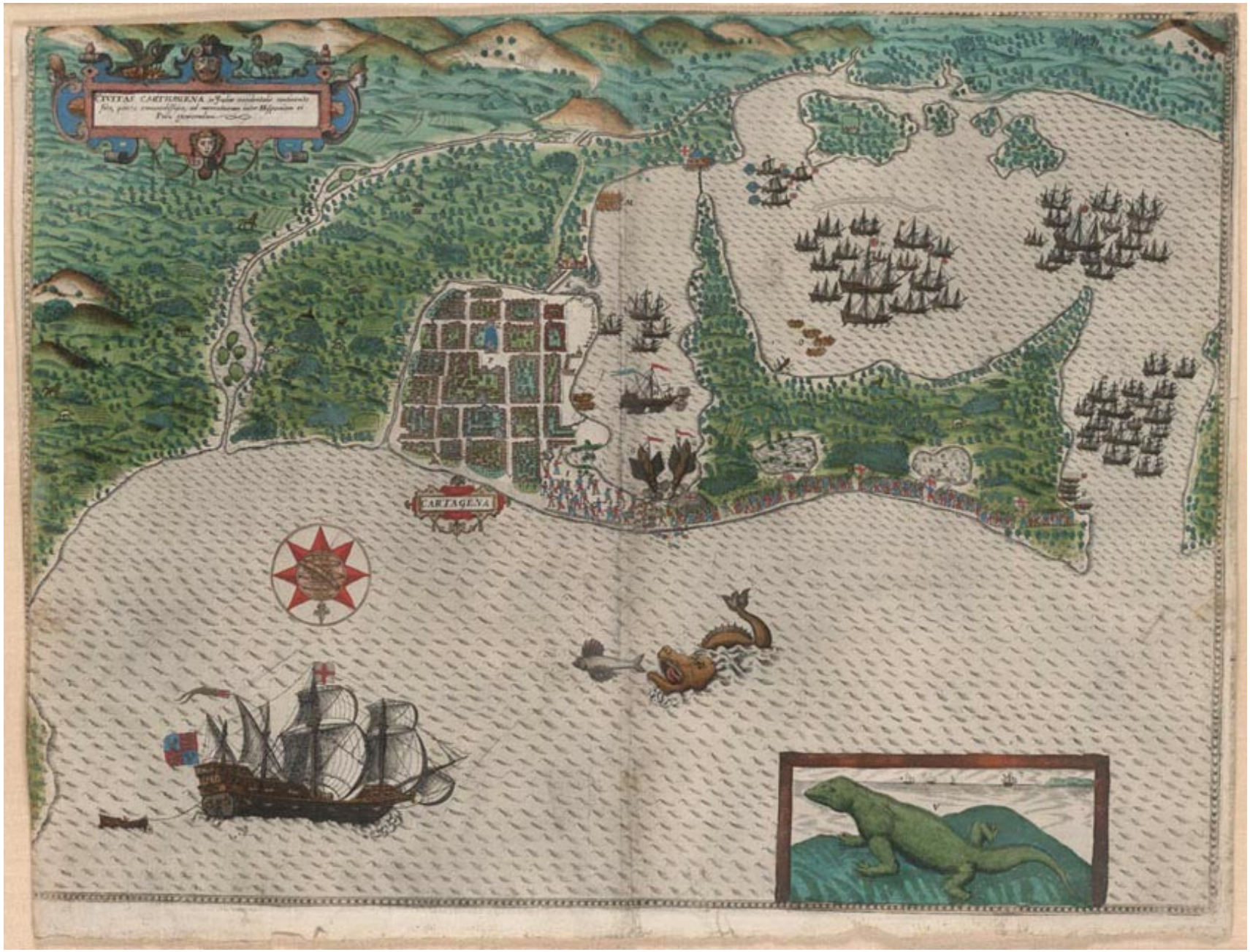
The Stone Map of Doanama

Sierra Nevada de Santa Marta

16th and 17th Centuries

Techialoyan land records, San Juan Tolcayuca, Mexico. Aztec, 17th century. Manuscript map on amate (fig tree bark) paper. Jay I. Kislak Collection. Library of Congress, http://www.loc.gov/exhibits/kislak/kislak-exhibit.html

16th and 17th Centuries



Baptista Boazio (fl. 1588-1606), Cartagena [Colombia], Hand-colored engraving, 1589. Library of Congress, http://www.loc.gov/exhibits/kislak/kislak-exhibit.html

History

Francisco José de Caldas (1768-1816)

Baron Alexander von Humboldt (1769-1859)

4° 35' 56.95" Northern Latitude

74° 4' 51.5" Western Longitude

International Ellipsoid 1924

Bogotá Observatory Datum

Villegas Editores

Observatorio Astronómico, Museo del Siglo XIX y Palacio Echeverri.

19th Century

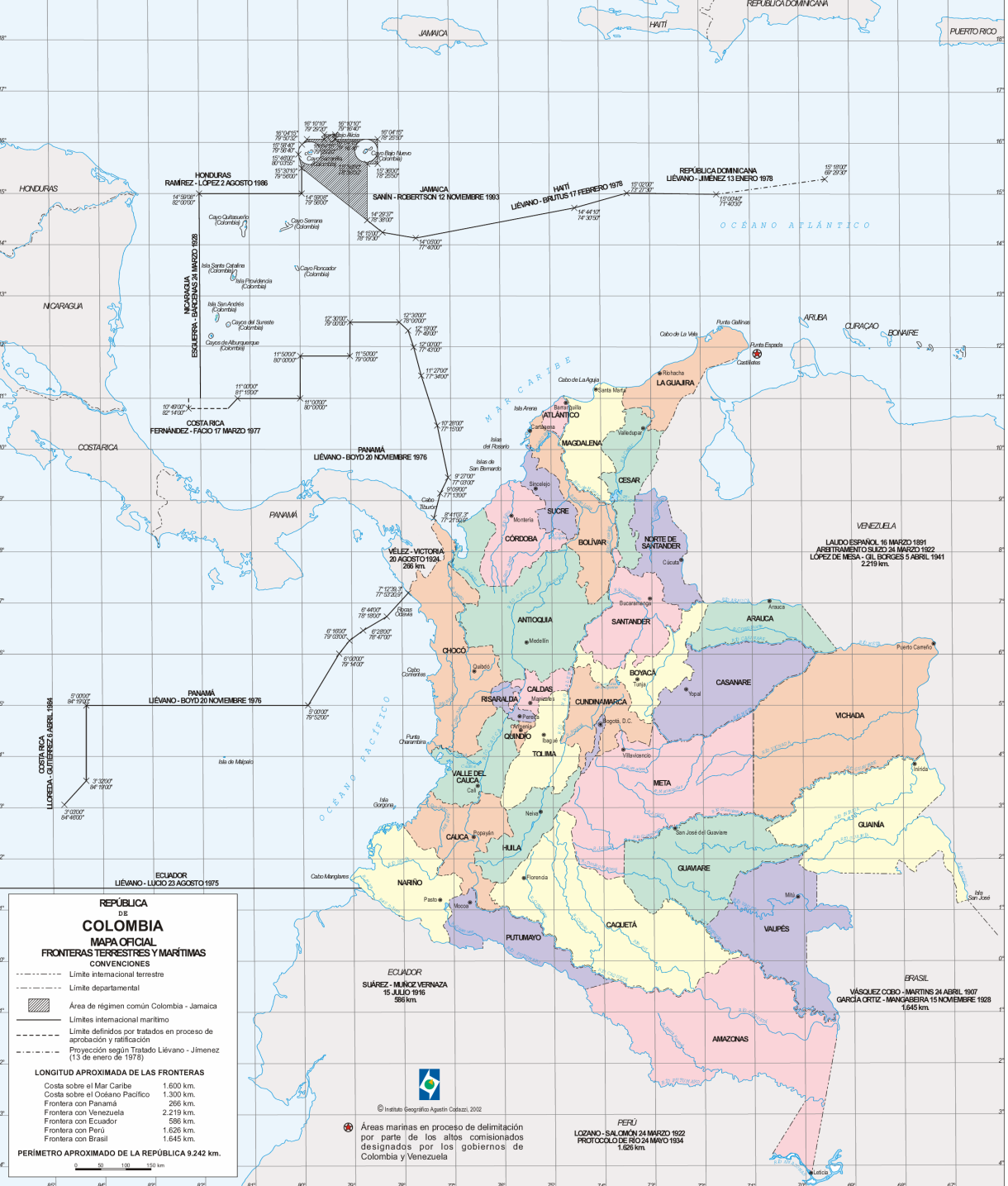
Drawings and notes on the Magdalena river by Alexander von Humboldt.

In 1849 the Chorographic Commission was created with the mission to compile the national map and describe the customs of the peoples of the regions visited.

Agustín Codazzi acted as chief of the commission.

In his 10th and last great expedition, without any support from the Government, heading towards the Sierra Nevada de Santa Marta to draw the map of the region, fell gravelly ill and died, in the small town of Espíritu Santo, today called Codazzi.

The Longitudes and Frontiers Office was founded in 1903, published maps at different scales and directed the international commissions on international boundaries.



INSTITUTO GEOGRÁFICO AGUSTÍN CODAZZI

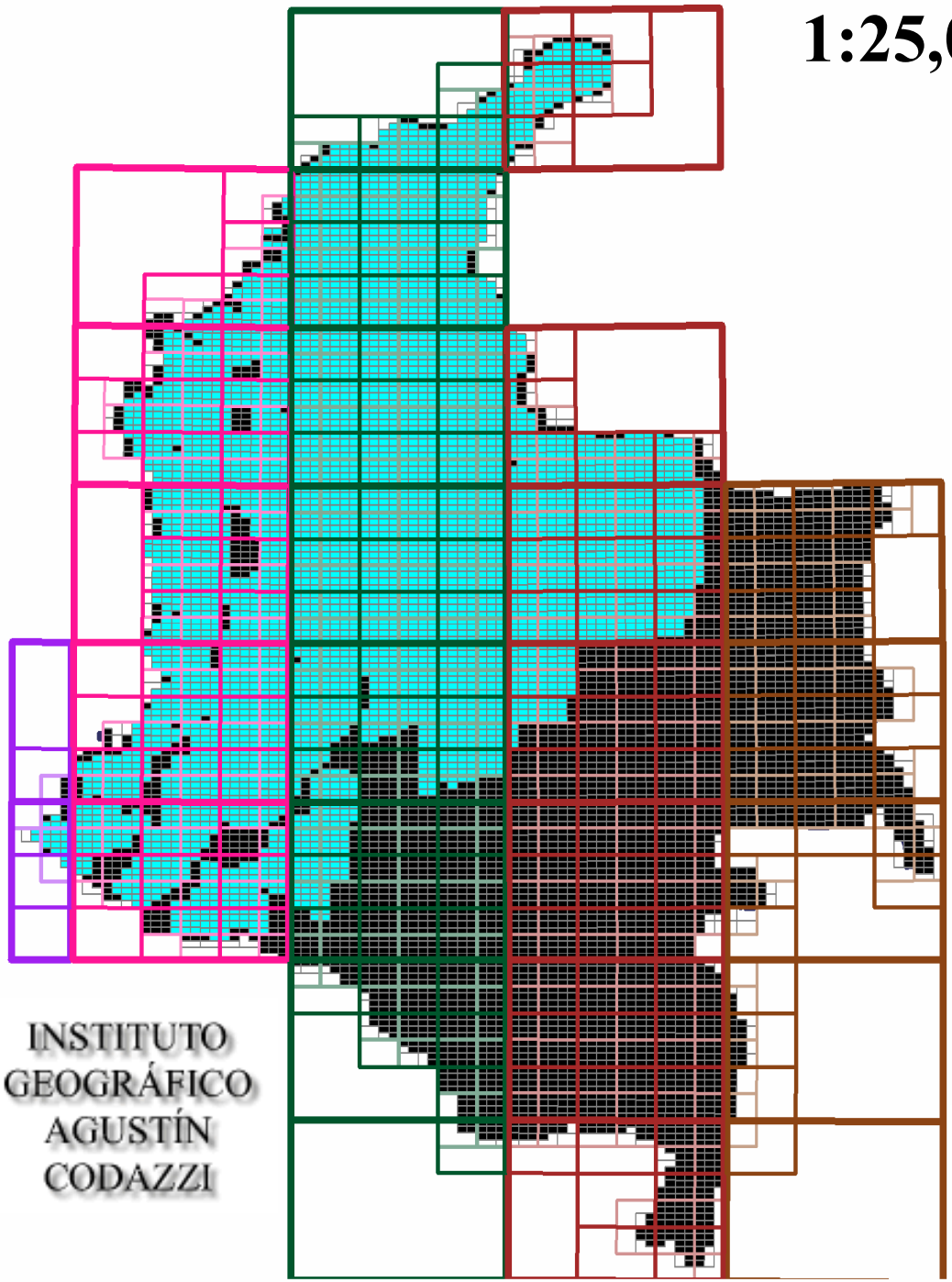
The Military Geographic Institute was created in 1935, then fused with the National Cadastral Section.

In 1959, it was restructured and named Instituto Geográfico "Agustín Codazzi" – IGAC.

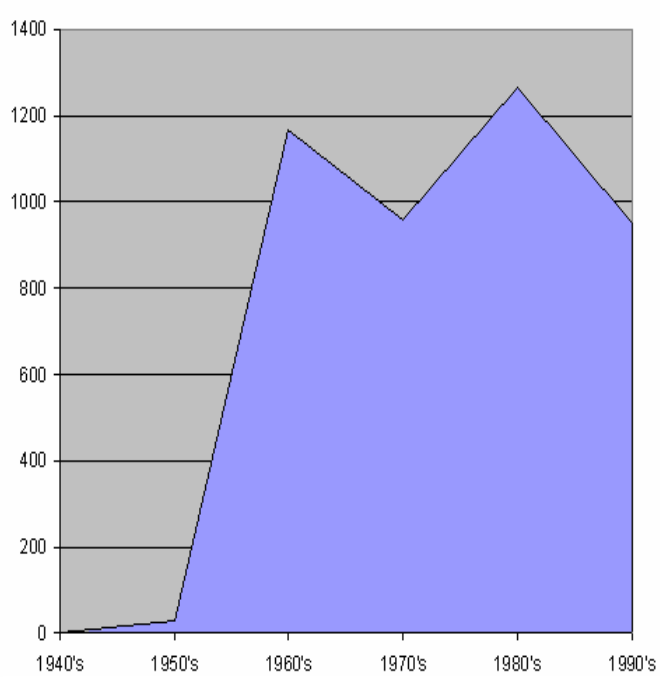
It is in charge of cadastral formation and the official cartography of Colombia.

www.igac.gov.co

1:25,000 Scale IGAC Coverage



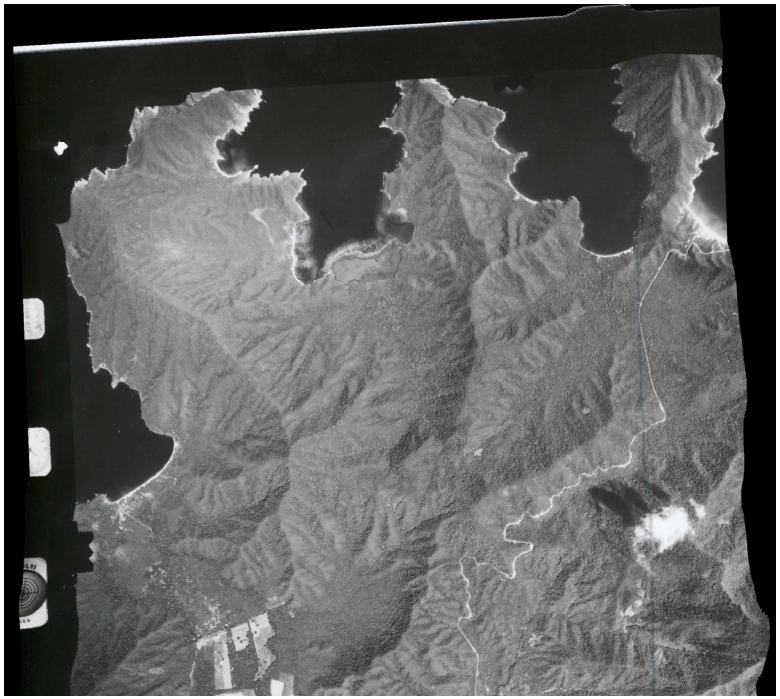
4,374 out of 8,146
(53.70%)

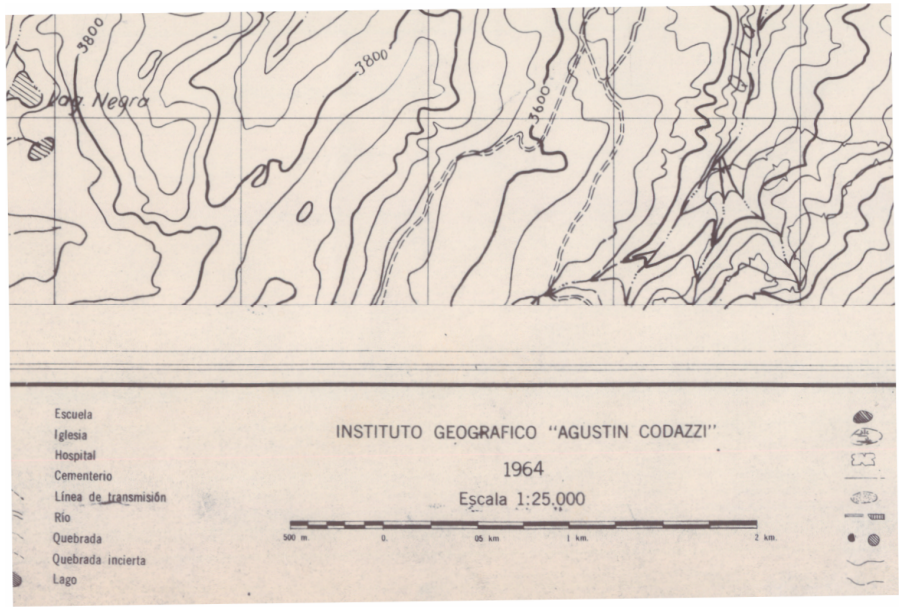


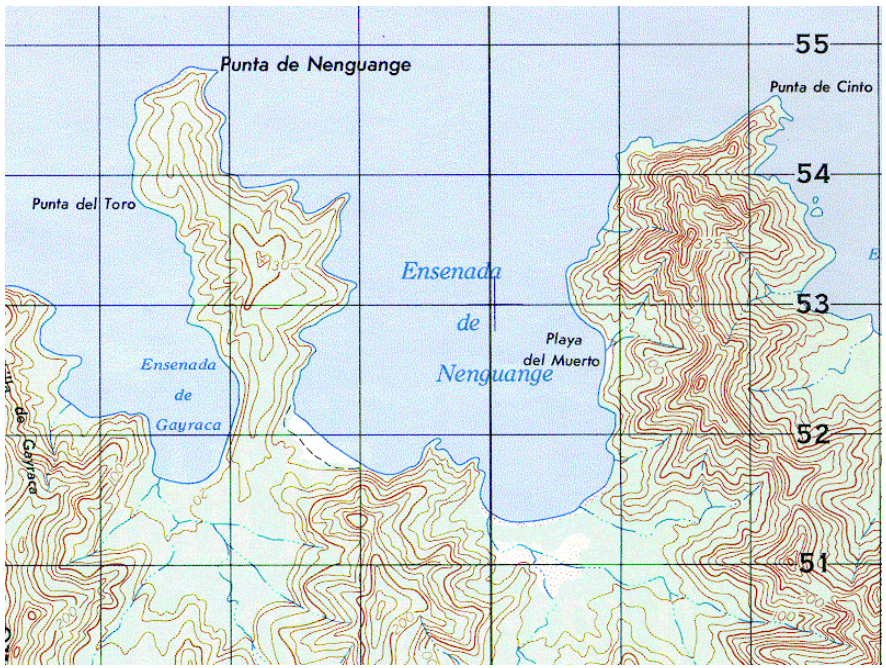
INSTITUTO GEOGRÁFICO AGUSTÍN CODAZZI

www.igac.gov.co

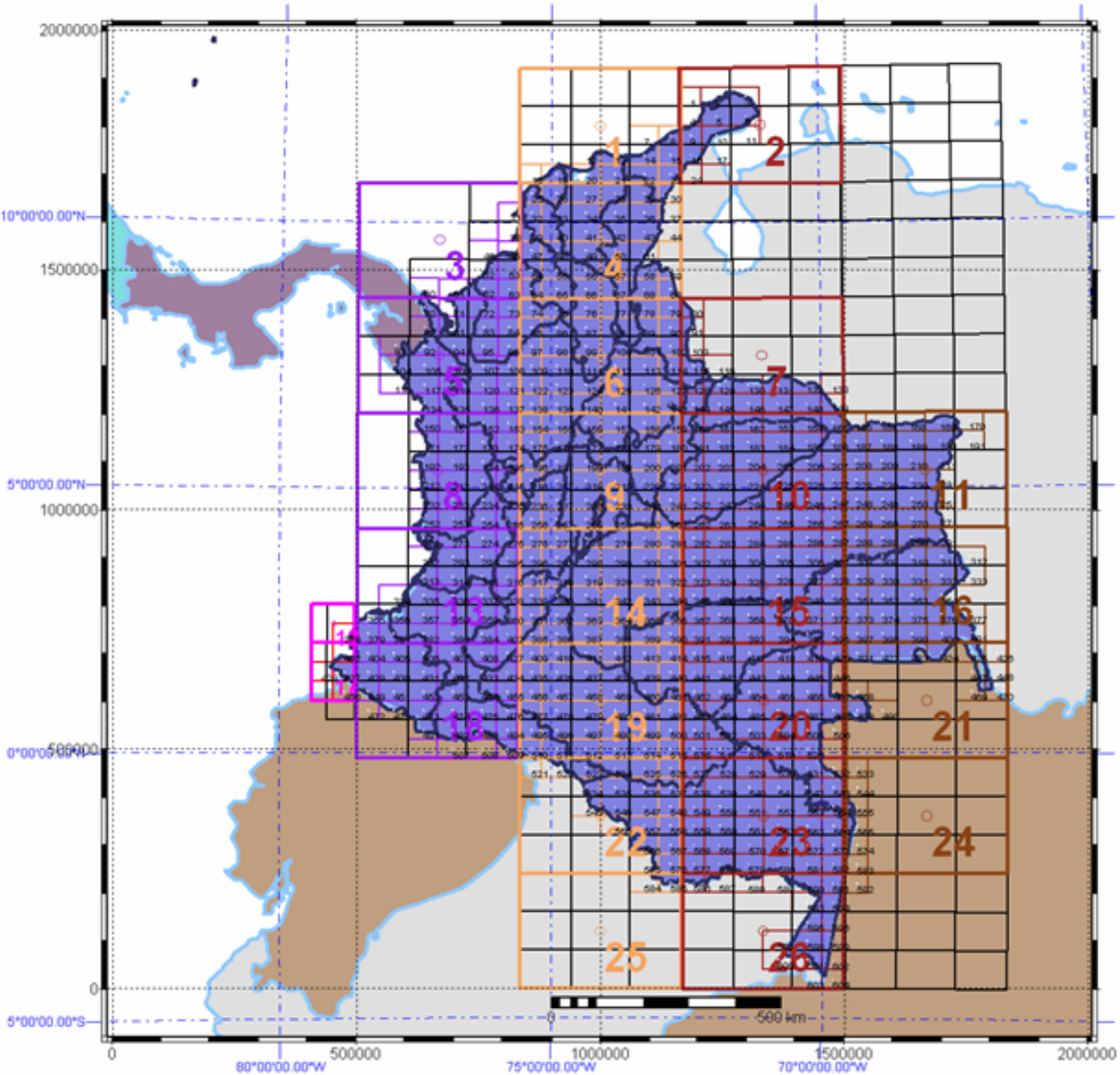
1:25,000 and 1:50,000 Topographical Maps







Cartographical Indices



INSTITUTO GEOGRÁFICO AGUSTÍN CODAZZI

Transverse Mercator or Conformal Gauss Projection

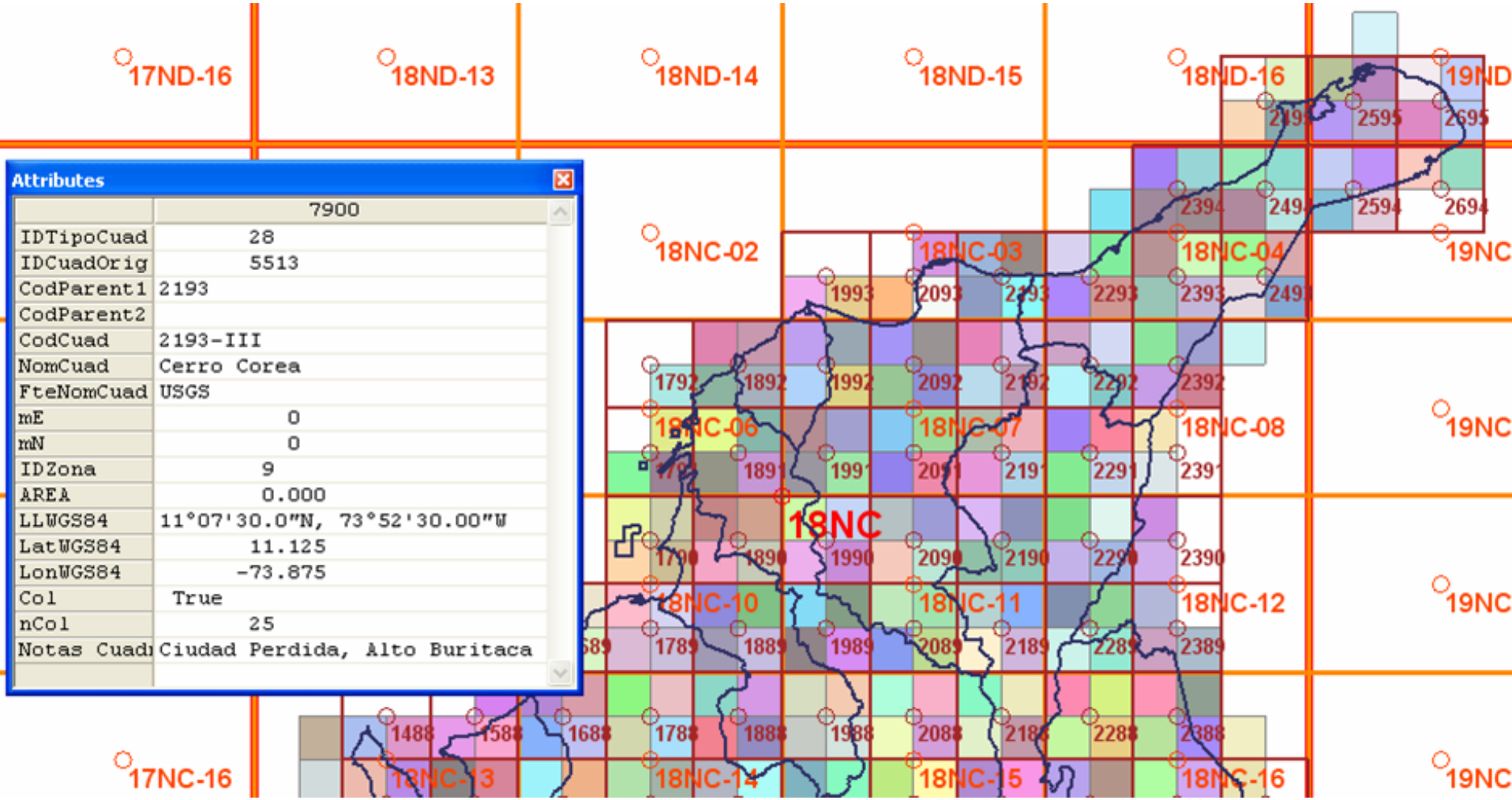
International Ellipsoid of 1909 or 1928

Bogotá Observatory Datum

5 Origins

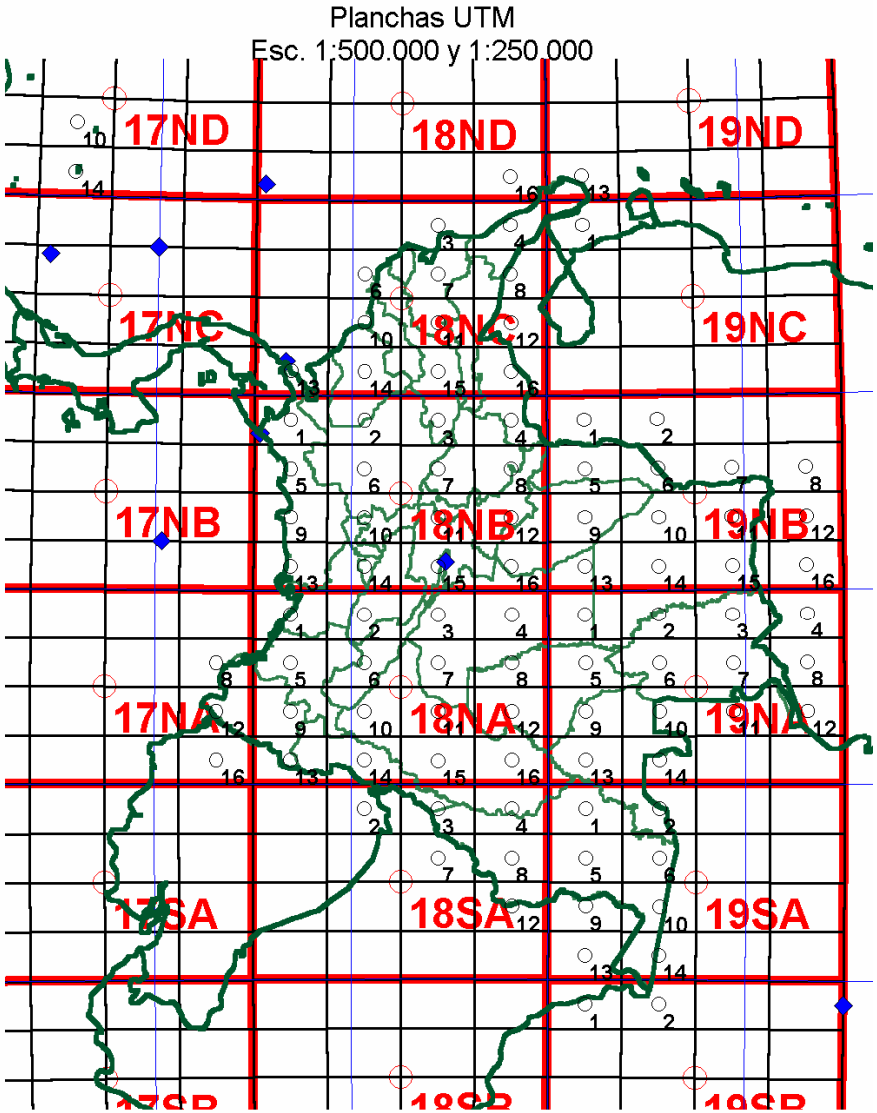
605 1:100,000 scale sheets

1:50k, 1:100k, 1:250k, 1:500k Scale USGS and NIMA Maps



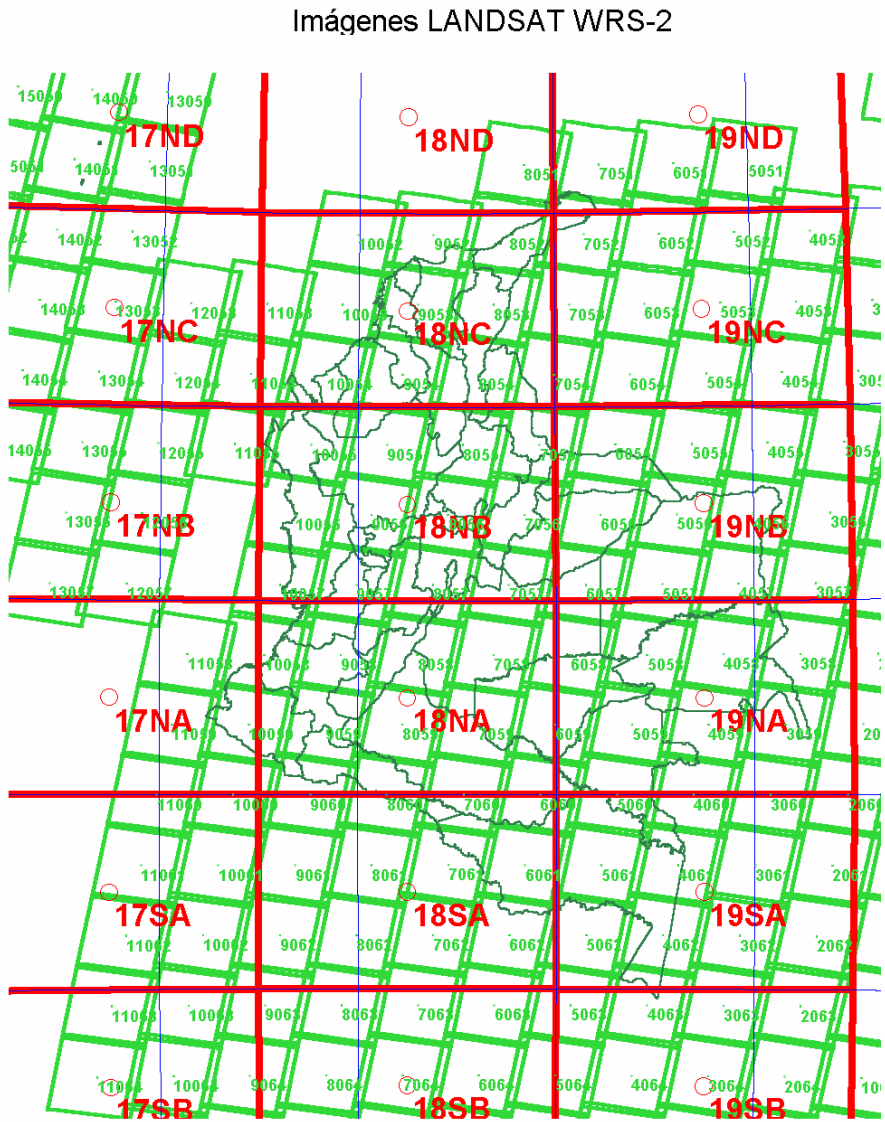
UTM Projections:

- Provisional South American Ellipsoid of 1956 – Colombia
- World Geodetic System 1984



Fuentes: Catálogo de Publicaciones y Servicios,
Mapas Departamentales; IGAC
Elaboró: Fernando Salazar Holguín
ILWIS 3.2 Academic
Marzo de 2004

0 500 km
1 : 15000000

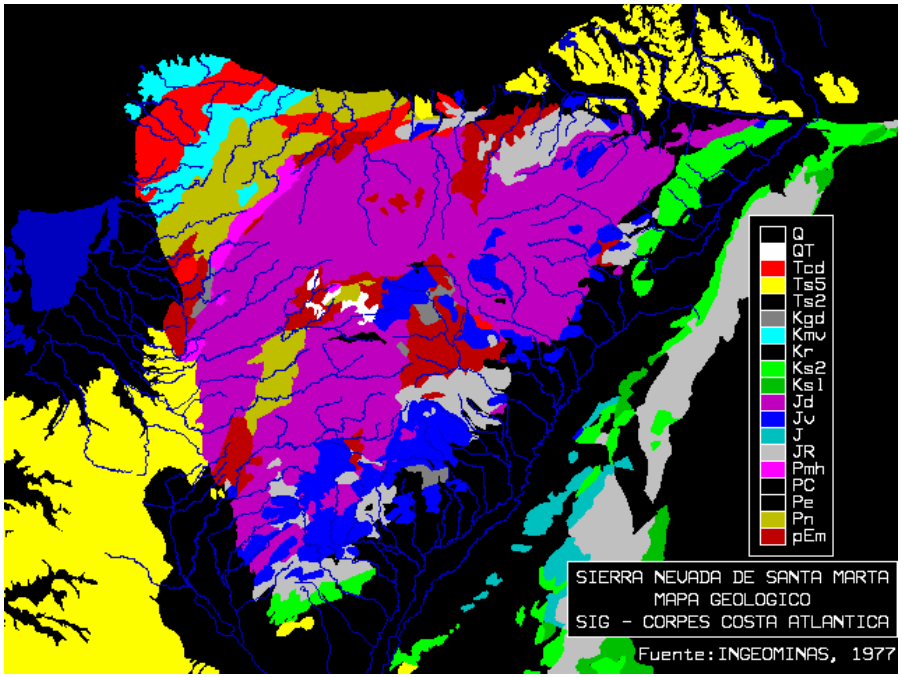


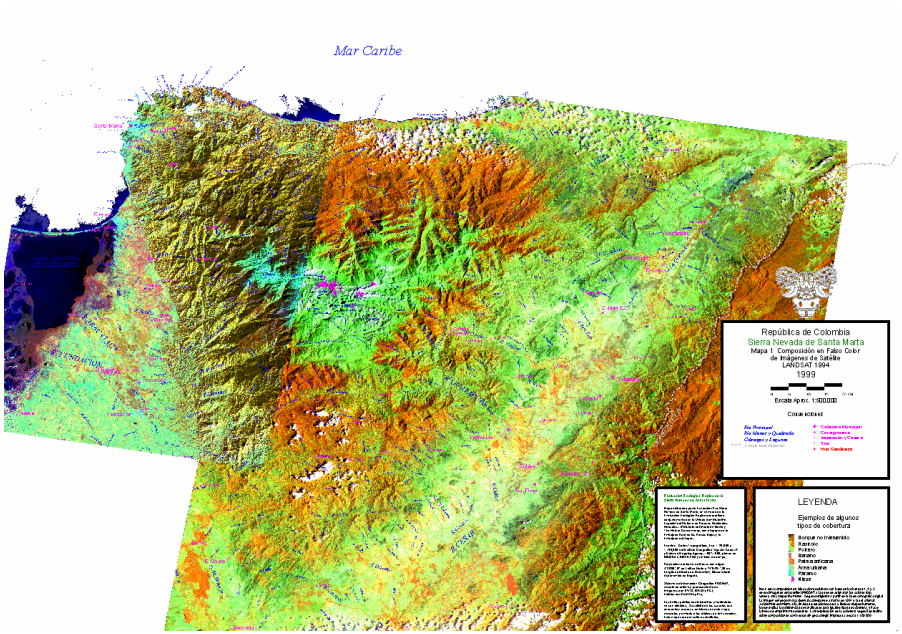
Fuentes: USGS National Satellite Land Remote
Sensing Data Archive, Mapas Departamentales; IGAC
Elaboró: Fernando Salazar Holguín
ILWIS 3.2 Academic
Marzo de 2004

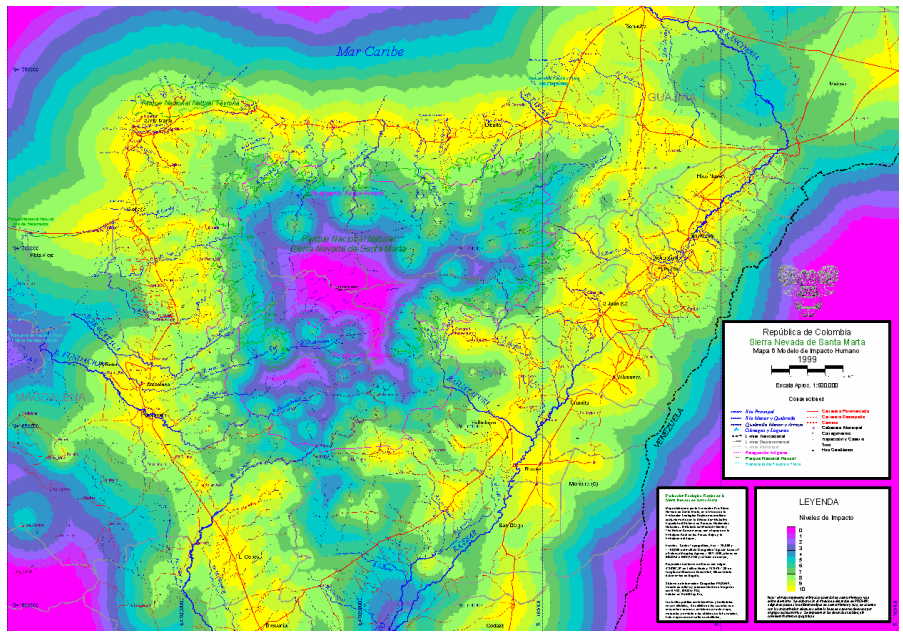
0 500 km
1 : 13000000

Salazar, F. Geographical Indices for Maps and Remote Sensing Images of Colombia. Instituto Geográfico Agustín Codazzi. [ILWIS 3.2 Academic – Microsoft Access Application]. ftp://sig.uniandes.edu.co

Sierra Nevada de Santa Marta - Rapid Ecological Assessment

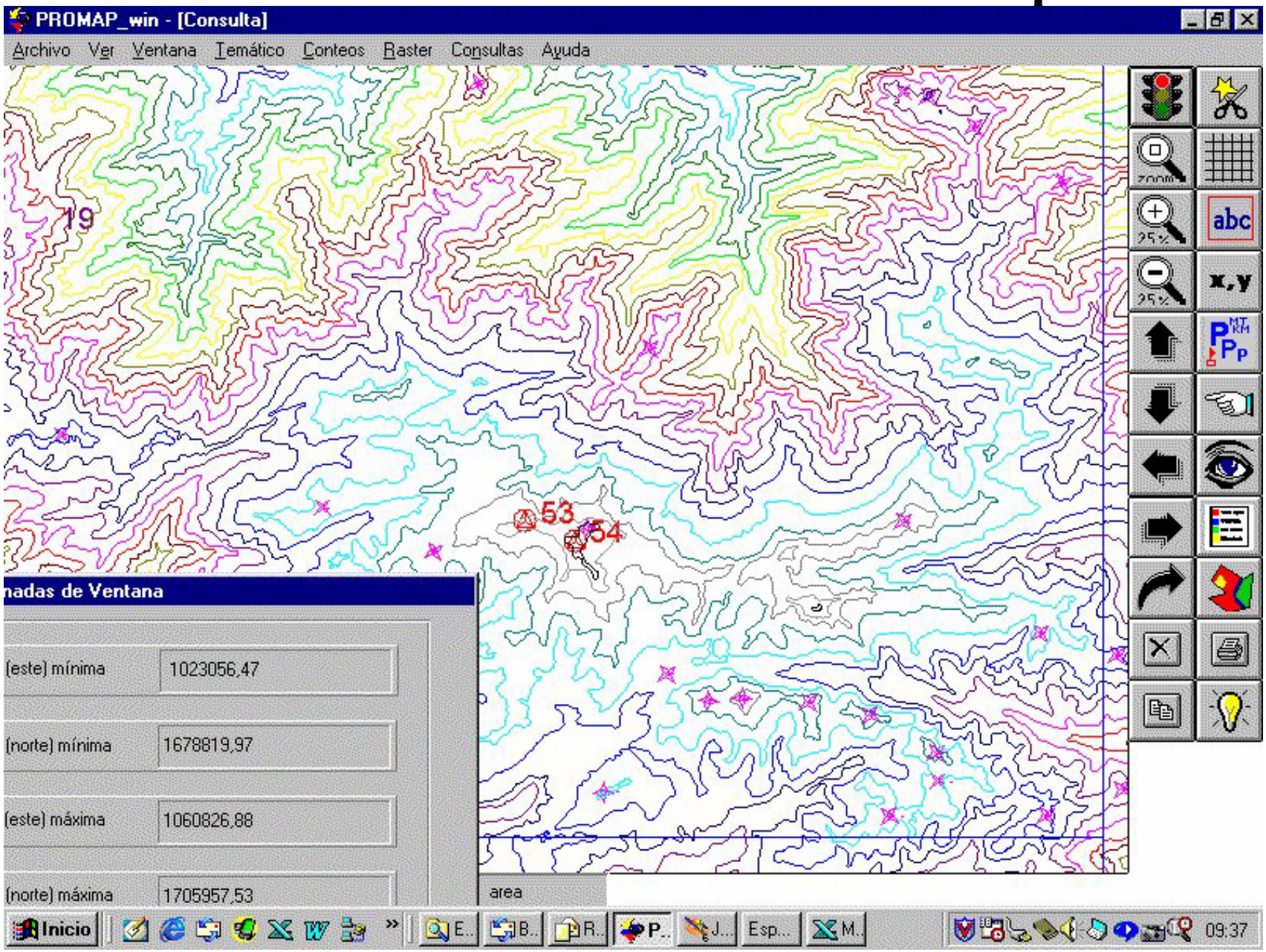






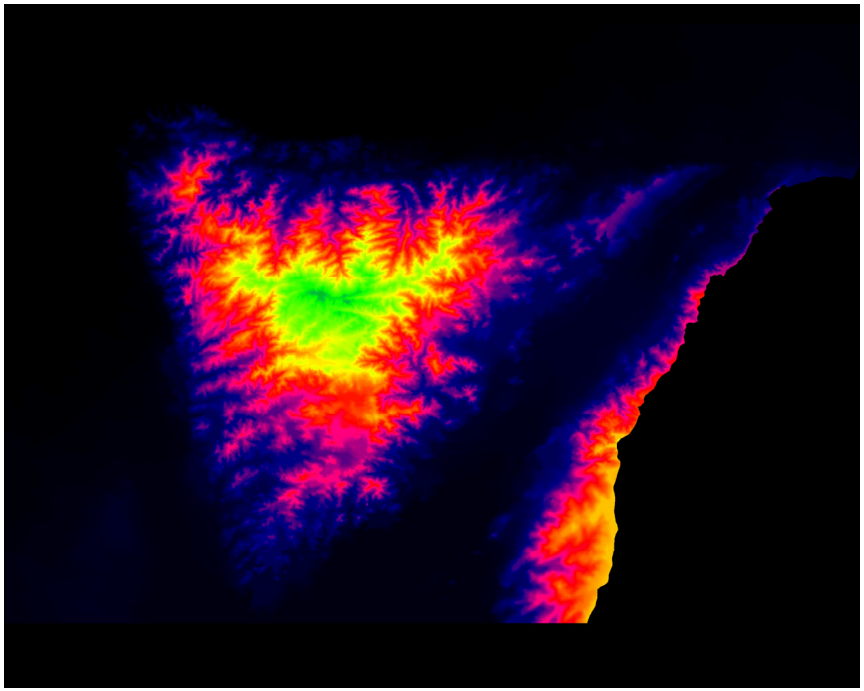
Fundación Pro-Sierra Nevada de Santa Marta, www.prosierra.org; The Nature Conservancy, www.nature.org; et al.

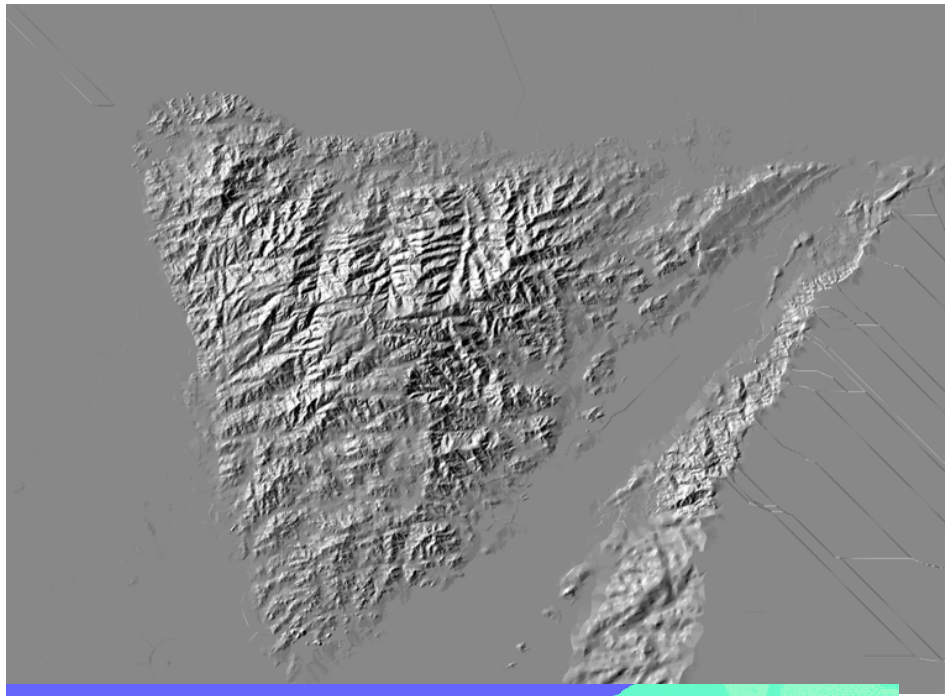
Sierra Nevada de Santa Marta - DTM Preparation

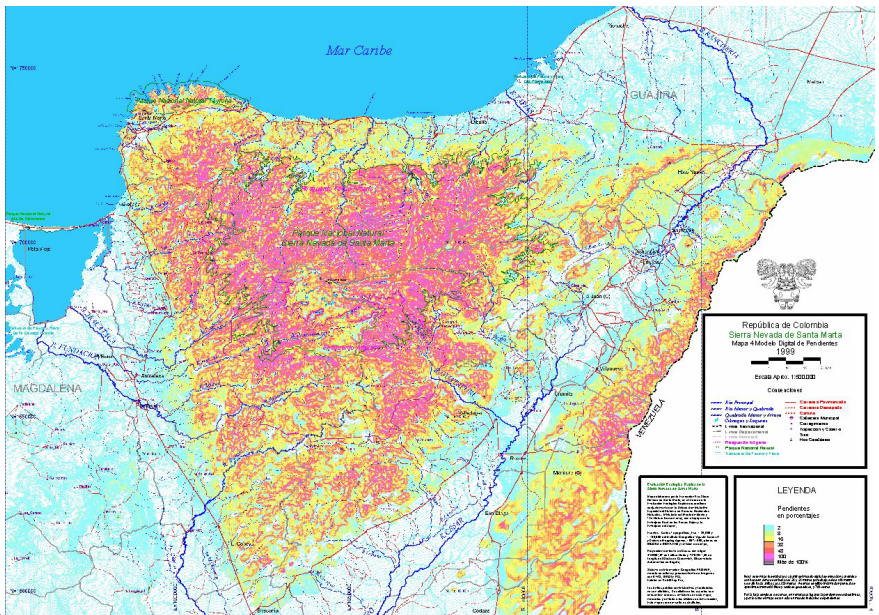


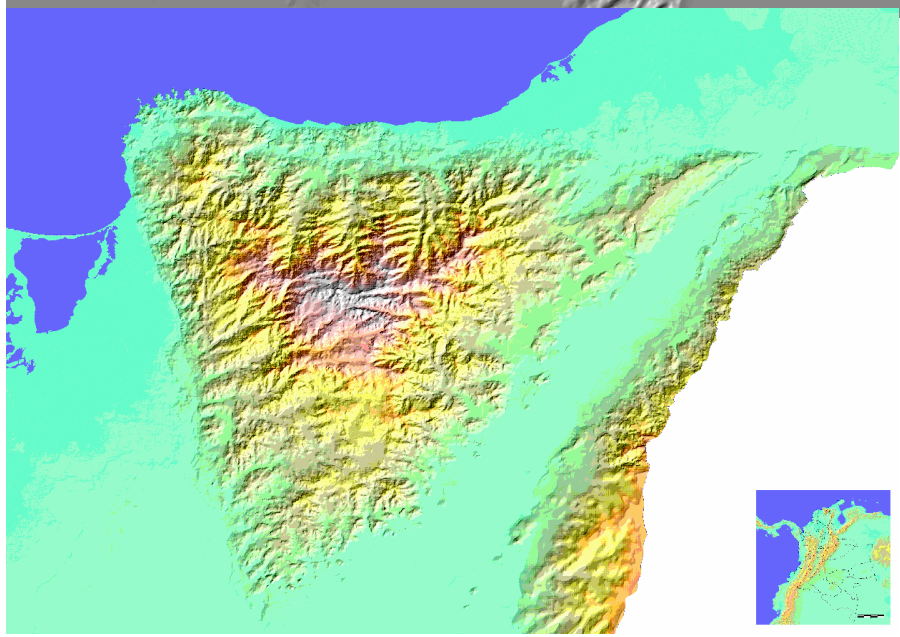
Fundación Pro-Sierra Nevada de Santa Marta, www.prosierra.org

Sierra Nevada DTM



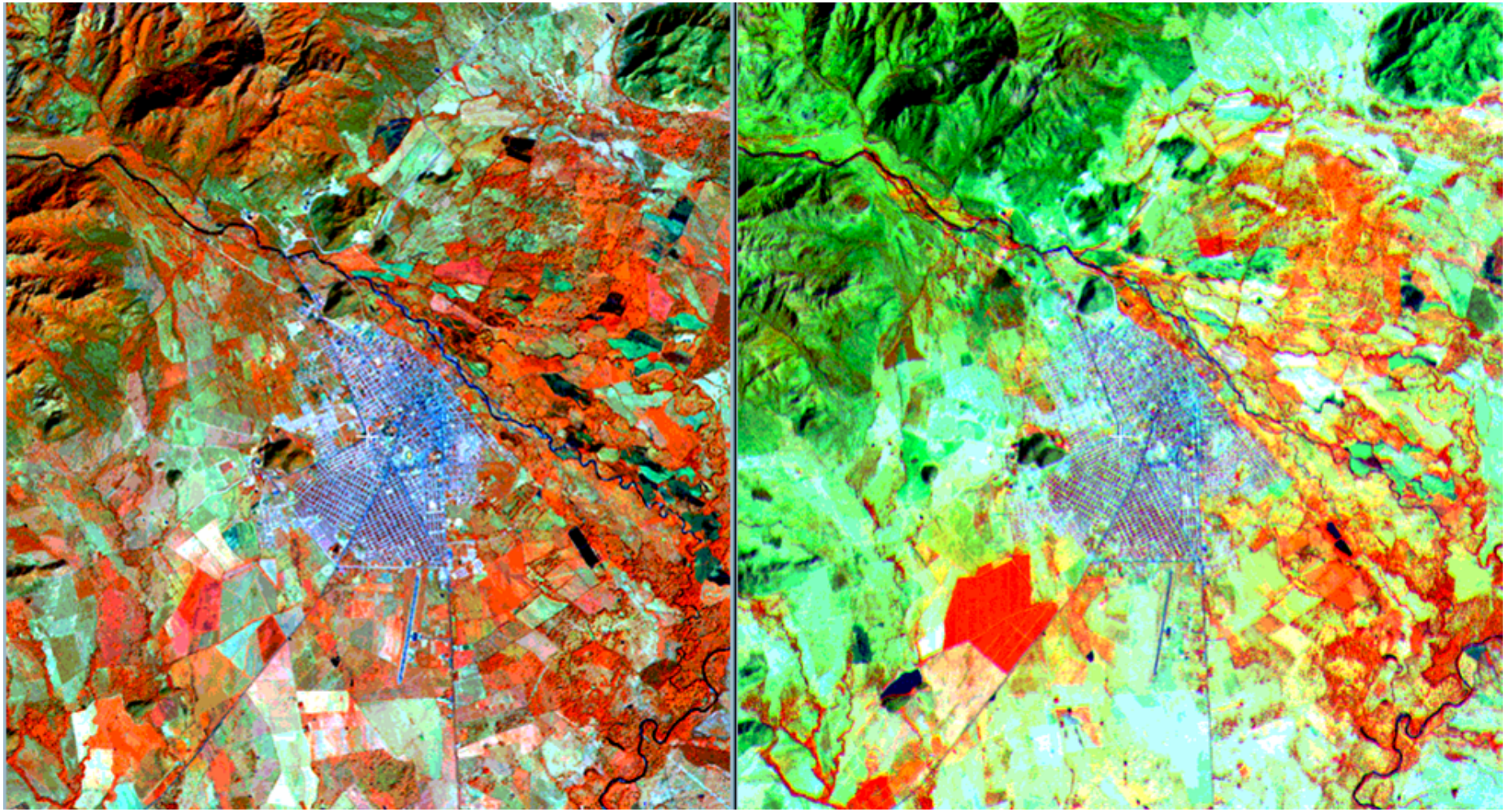






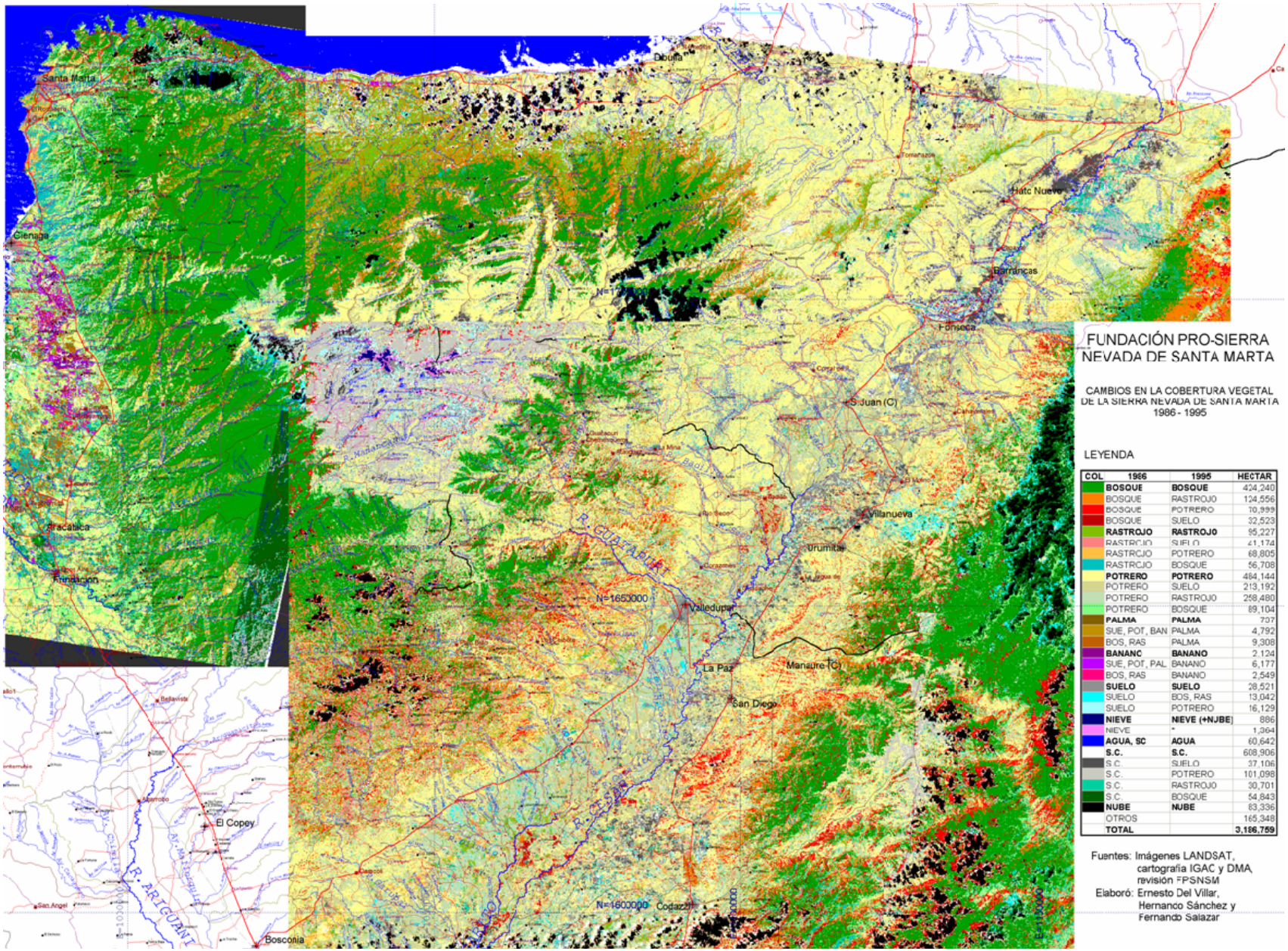
Fundación Pro-Sierra Nevada de Santa Marta, 1999. www.prosierra.org

Vegetation Cover and Land Use Changes



Orthrectification of LANDSAT Images from 1985-1995, based on DTM

Vegetation Cover and Land Use Changes

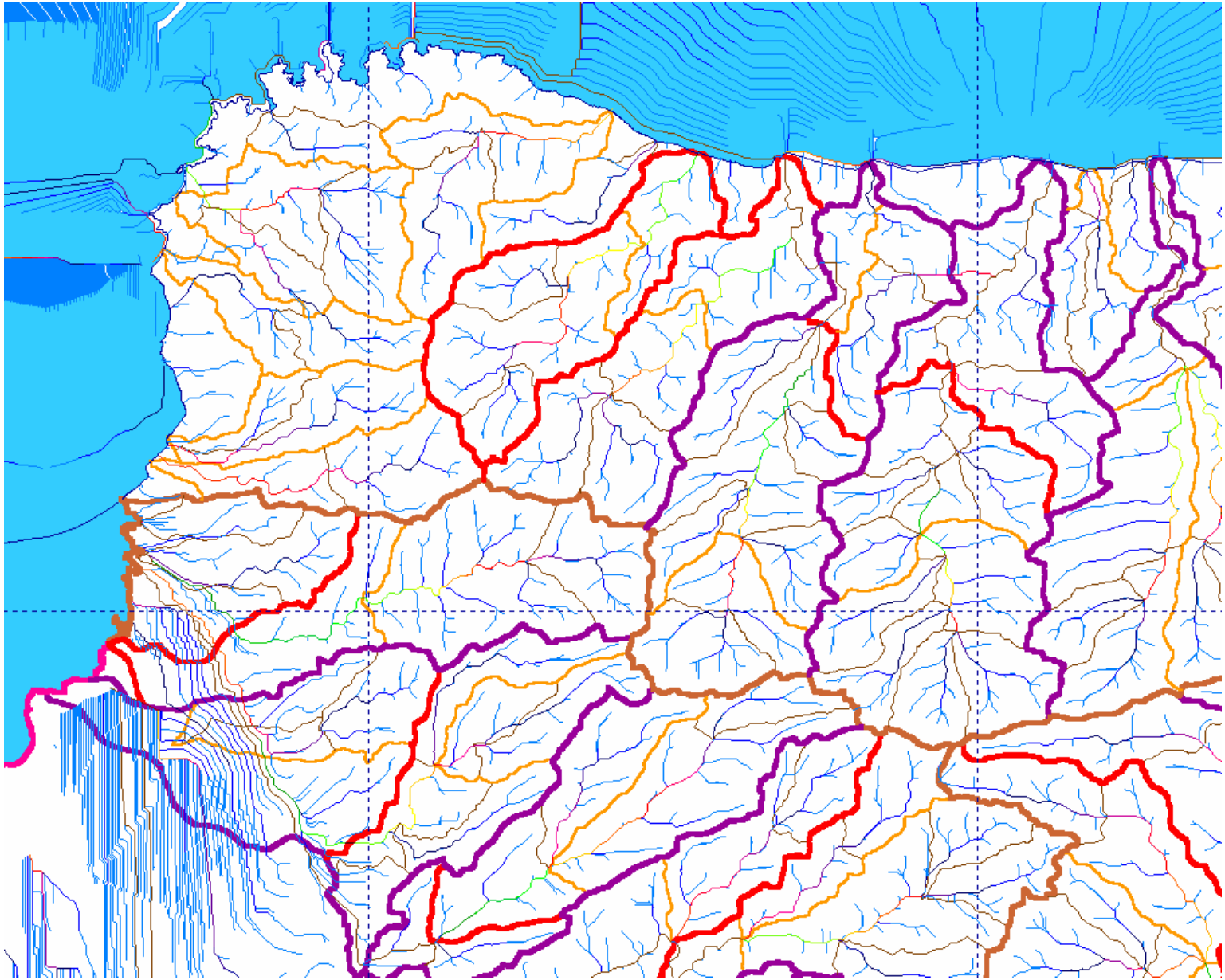


COL	1986	1995	HECTAR
	BOSQUE	BOSQUE	424,240
	BOSQUE	RASTROJO	124,556
	BOSQUE	POTRERO	70,999
	BOSQUE	SUELO	32,523
	RASTROJO	RASTROJO	95,227
	RASTROJO	SUELO	41,174
	RASTROJO	POTRERO	68,805
	RASTROJO	BOSQUE	56,708
	POTRERO	POTRERO	484,144
	POTRERO	SUELO	213,192
	POTRERO	RASTROJO	258,480
	POTRERO	BOSQUE	89,104
	PALMA	PALMA	797
	SUE, POT, BAN	PALMA	4,792
	BOS, RAS	PALMA	9,308
	BANANO	BANANO	2,124
	SUE, POT, PAL	BANANO	6,177
	BOS, RAS	BANANO	2,549
	SUELO	SUELO	28,521
	SUELO	BOS, RAS	13,042
	SUELO	POTRERO	16,129
	NIEVE	NIEVE (+NJBE)	886
	NIEVE	-	1,364
	AGUA, SC	AGUA	60,642
	S.C.	S.C.	608,906
	S.C.	SUELO	37,106
	S.C.	POTRERO	101,098
	S.C.	RASTROJO	30,701
	S.C.	BOSQUE	54,843
	NUBE	NUBE	83,336
	OTROS		165,348
	TOTAL		3,186,759

Fuentes: Imágenes LANDSAT, cartografía IGAC y DMA, revisión FPSNSM
Elaboró: Ernesto Del Villar, Hernando Sánchez y Fernando Salazar

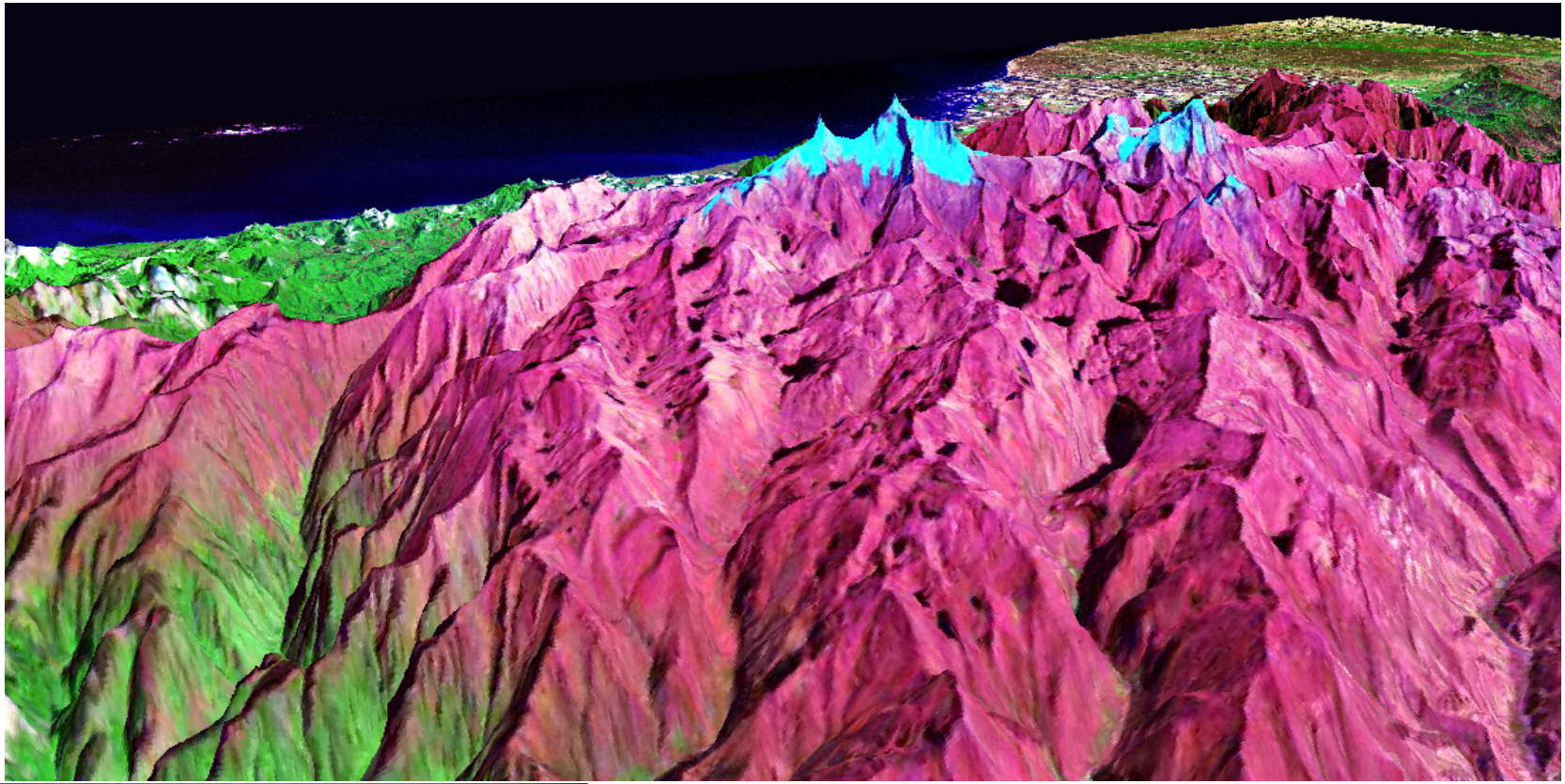
Sánchez, H.; Del Villar, E. and Salazar, F.; Fundación Pro-Sierra Nevada de Santa Marta, www.prosierra.org

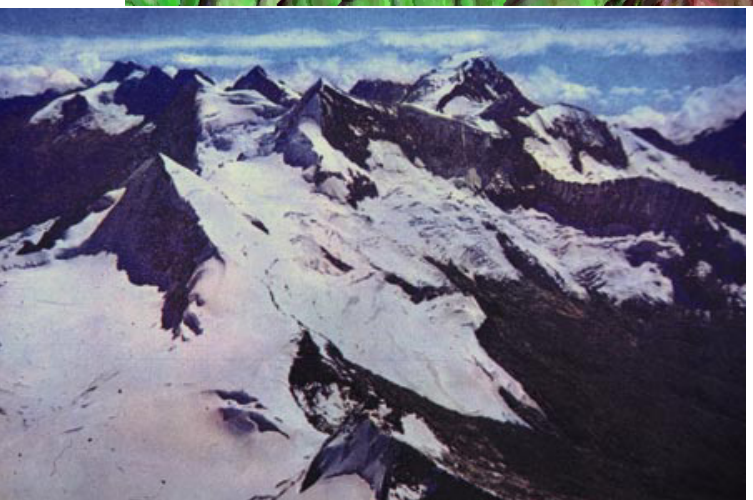
DTM Products



Watershed Divides drawn manually, Drainage Network derived from DTM; based on USGS and IGAC Topo Maps

LANDSAT CC 742 over DTM based on Topo Maps

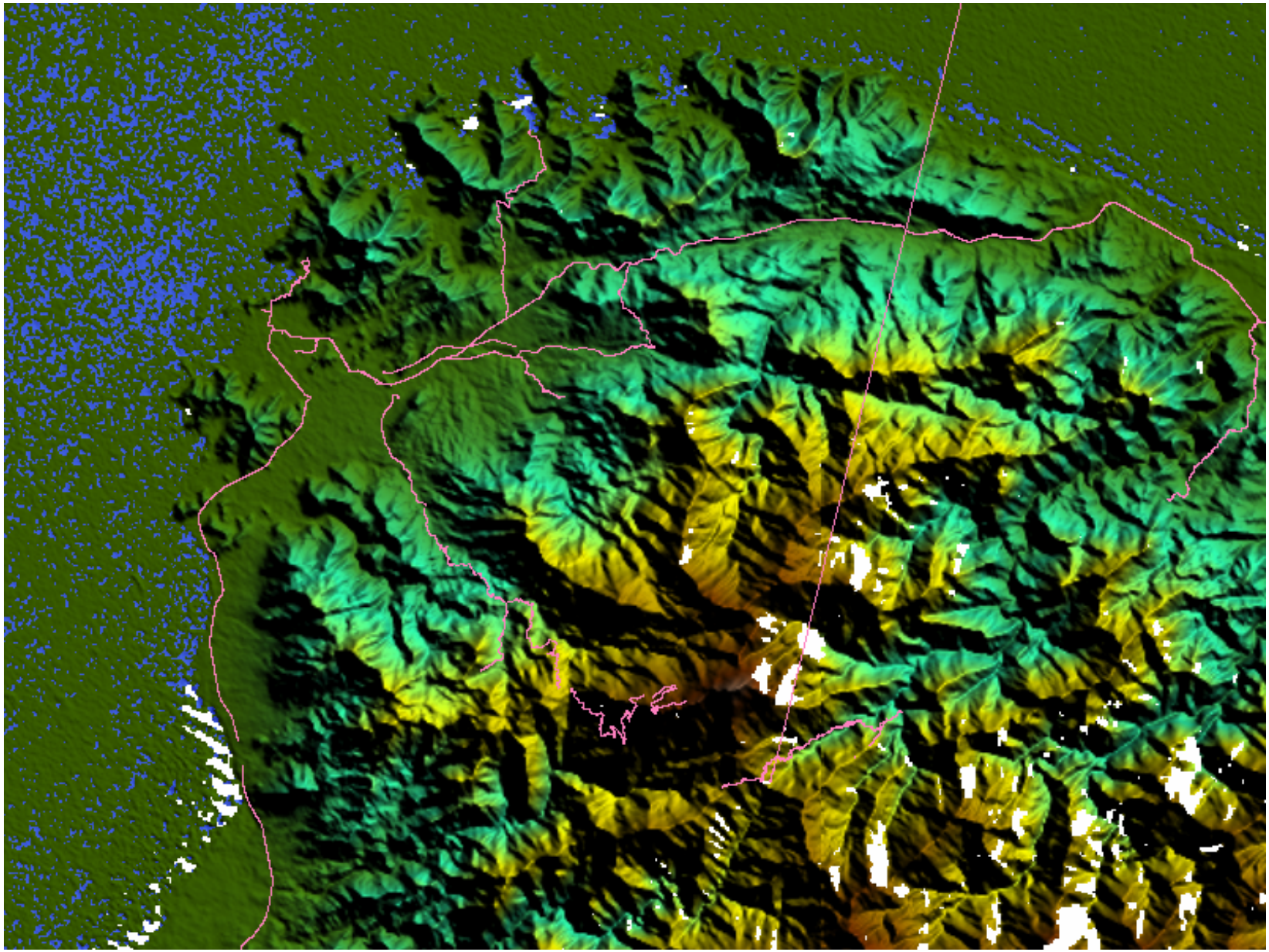




LANDSAT composition over 3D view based on 1:100,000 scale IGAC topographical maps

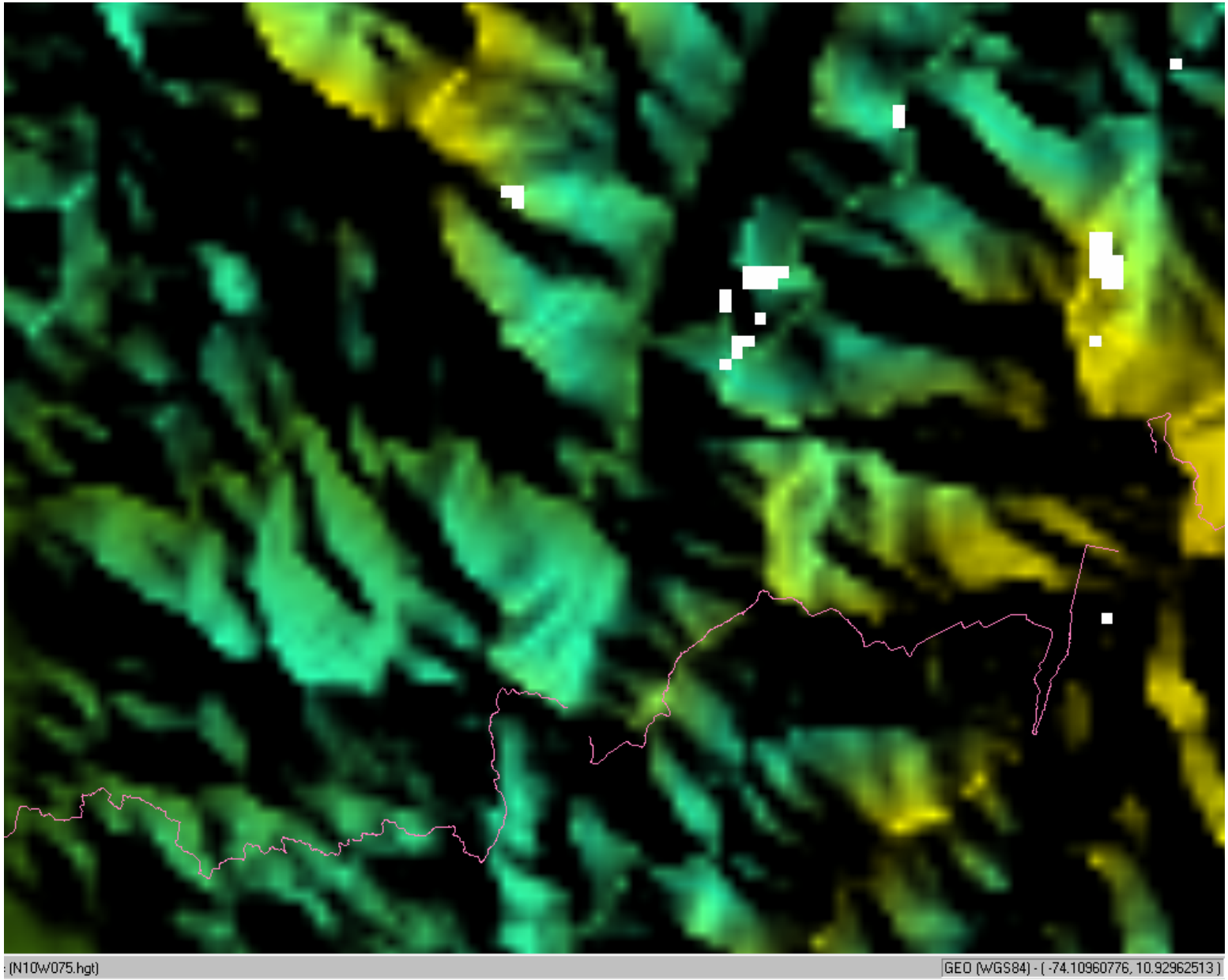
Oblique aerial photograph of the highest peaks of the Sierra Nevada de Santa Marta seen from the east. Photograph courtesy of Movifoto.
http://pubs.usgs.gov/prof/p1386i/colombia/marta.html

SRTM 3 arc-second unfinished



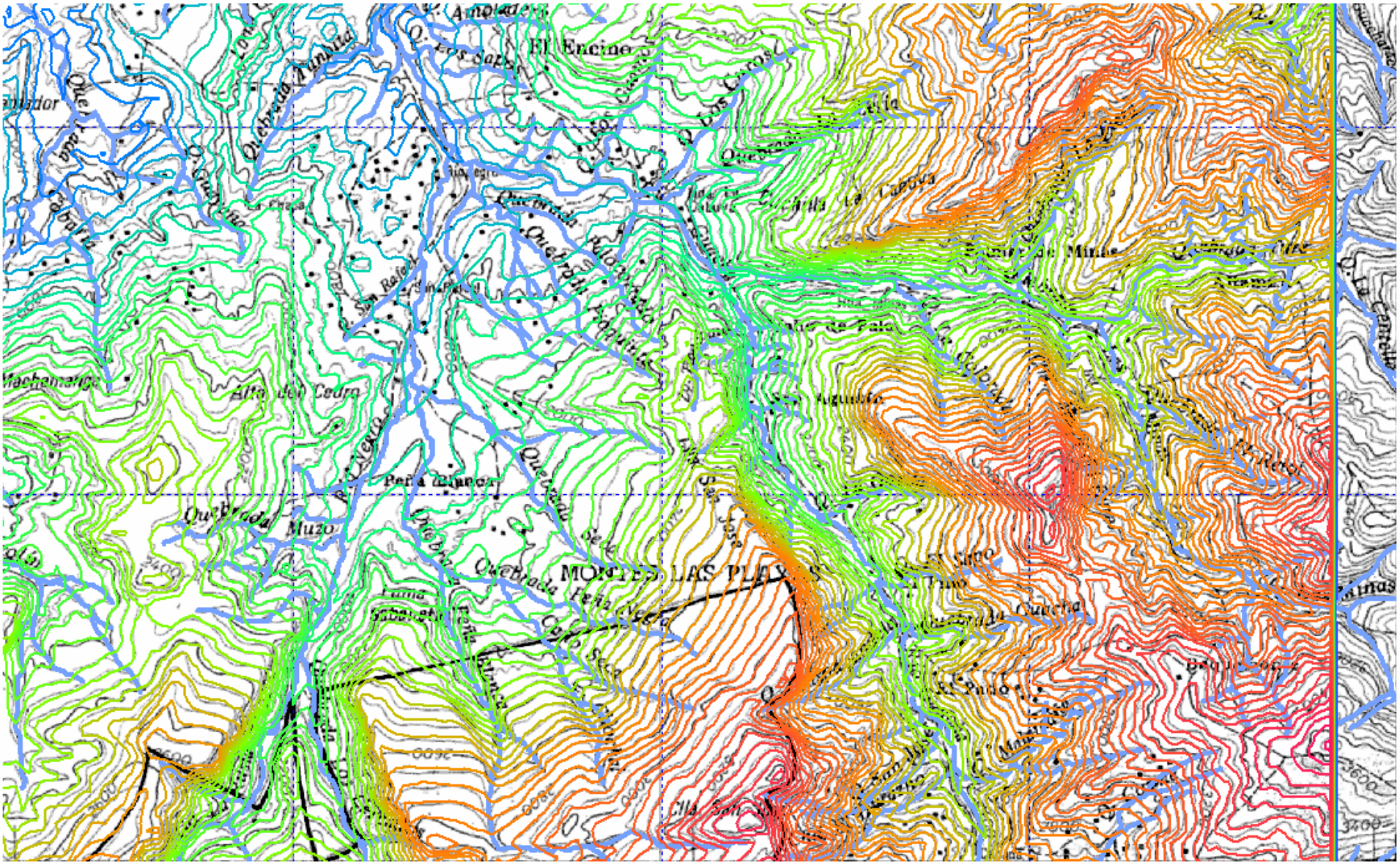
GPS tracks by F. Salazar

SRTM 3 arc-second unfinished

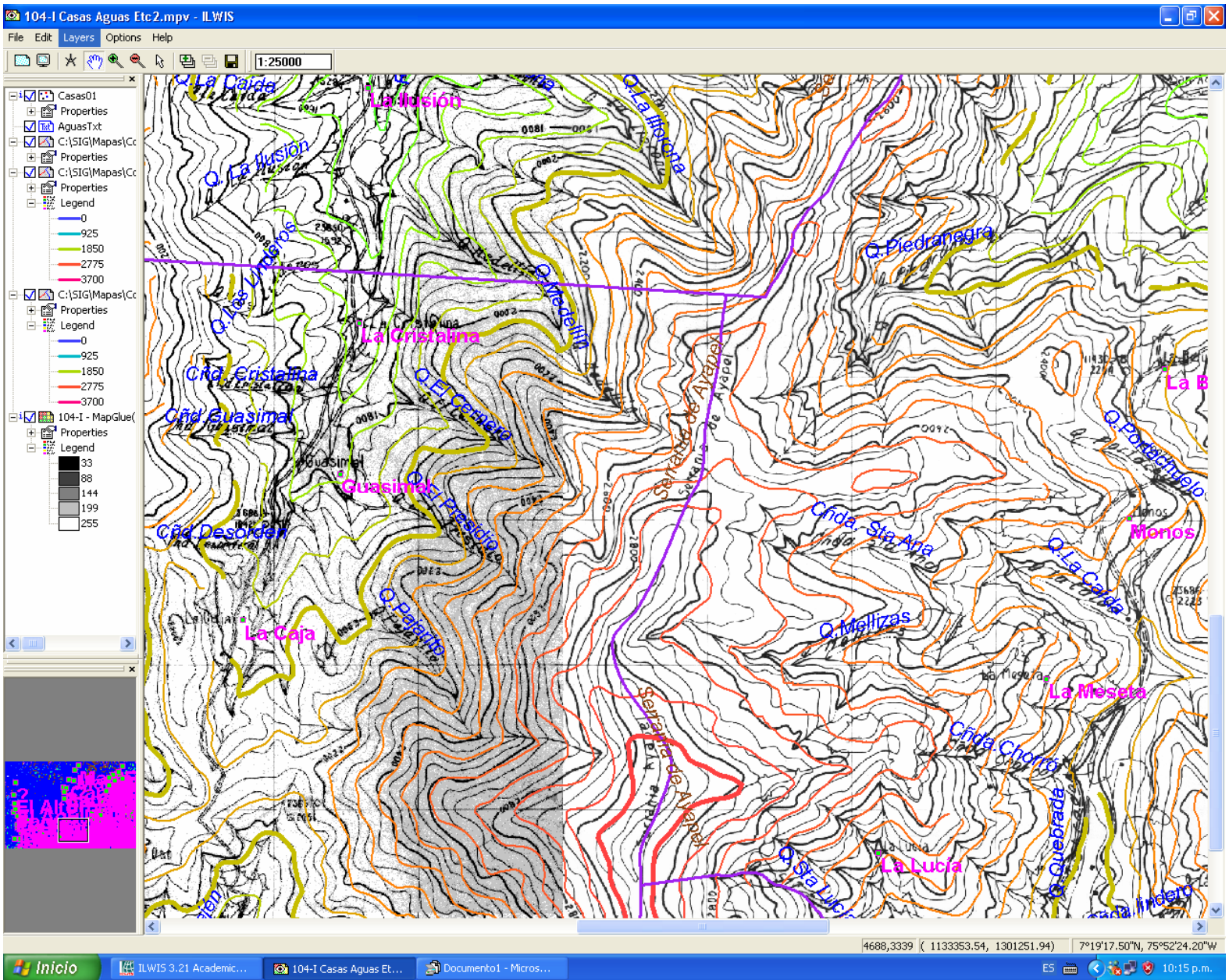


GPS tracks by F. Salazar

Contour lines every 50 meter derived from SRTM 3 arc-second unfinished over a scanned image of 1:100,000 scale IGAC Map from 1966.



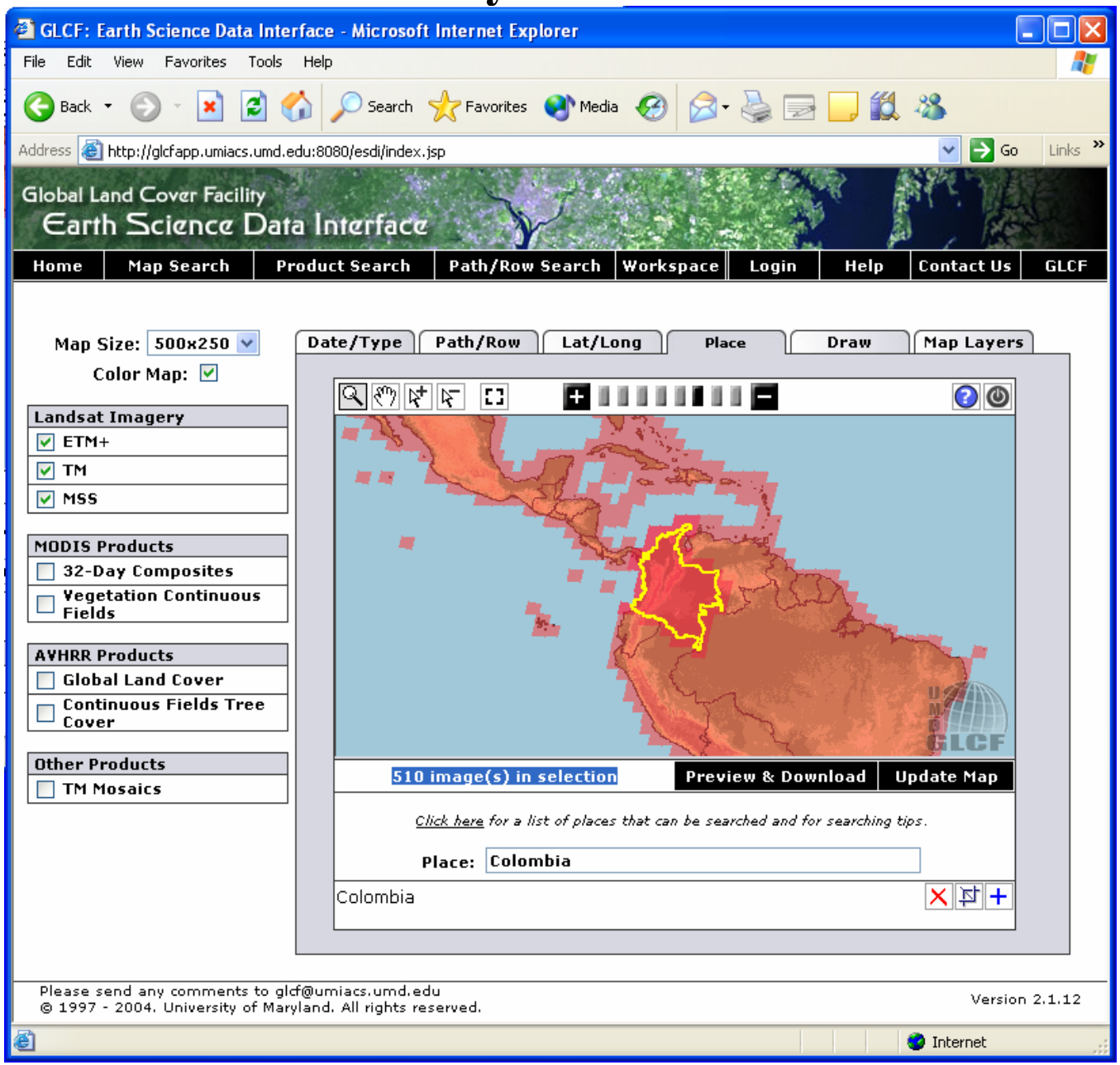
Contour lines every 100 meter derived from SRTM 3 arc-second unfinished over 1:25,000 scale IGAC Map from 1966. Cañaveral Indigenous Reserve, Paramillo.



San Salvador, Guachaca and Don Diego Watersheds

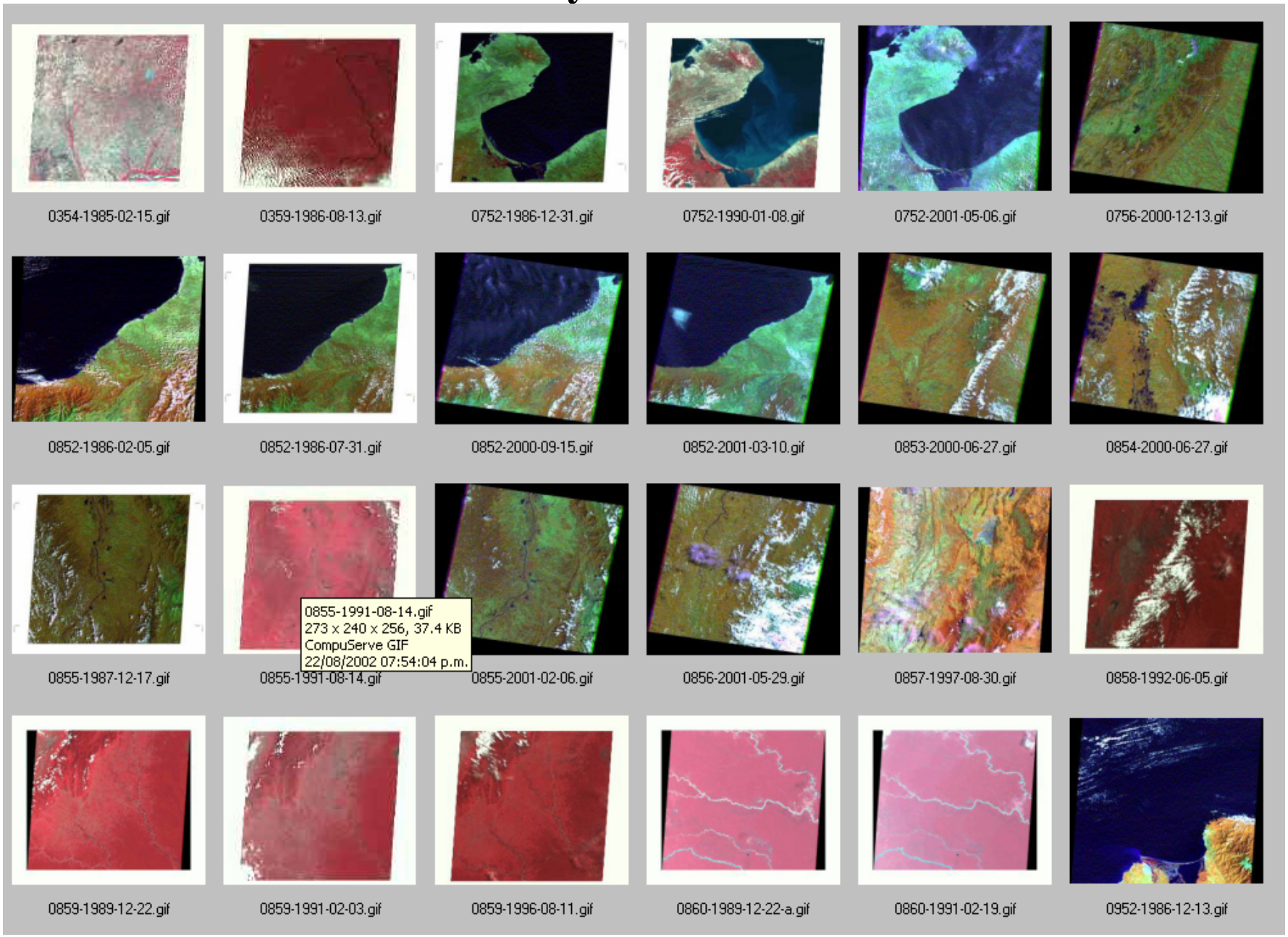
Sierra Nevada de Santa Marta

Global Land Cover Facility – Earth Science Data Interface



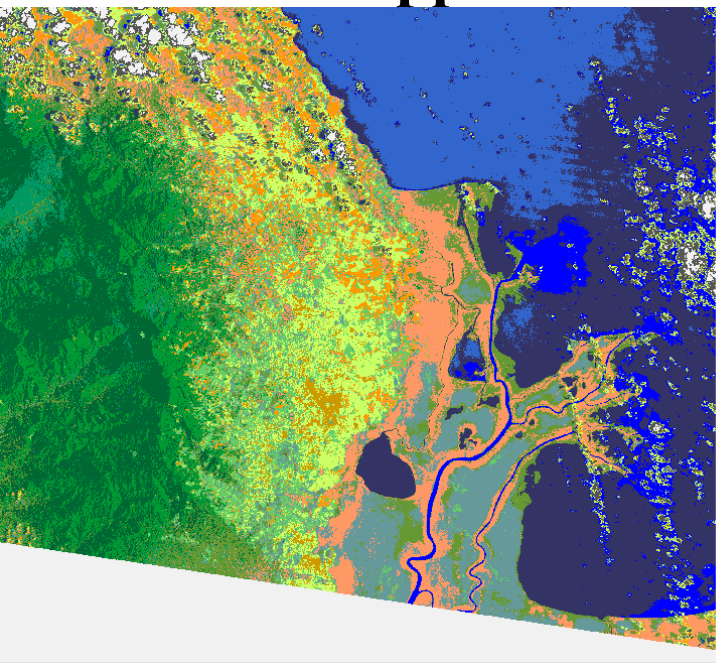
http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp

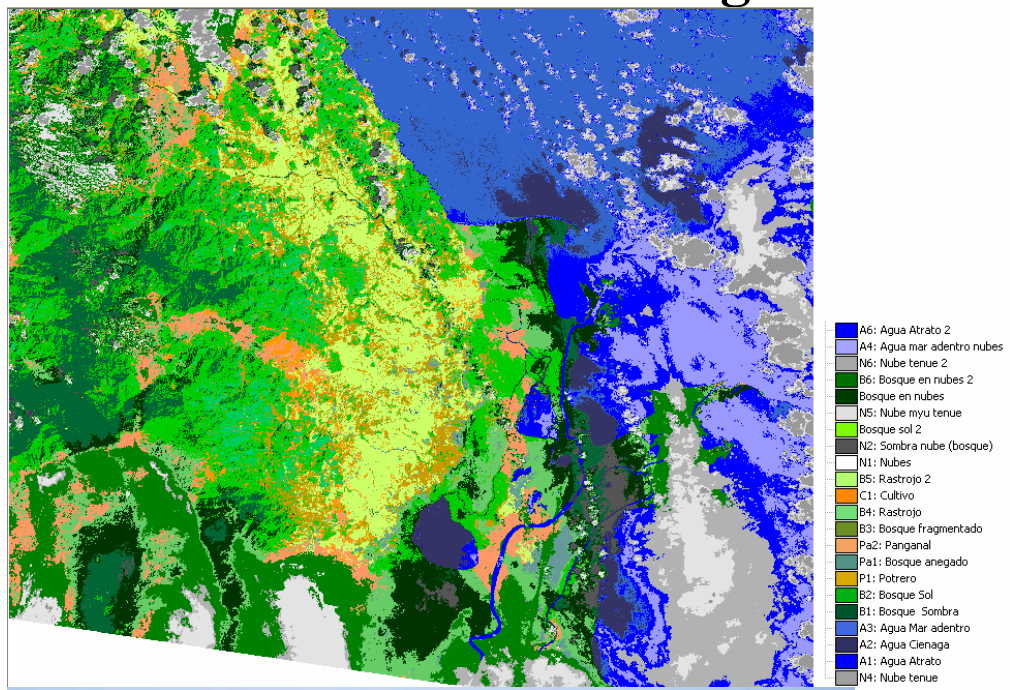
Global Land Cover Facility – Earth Science Data Interface

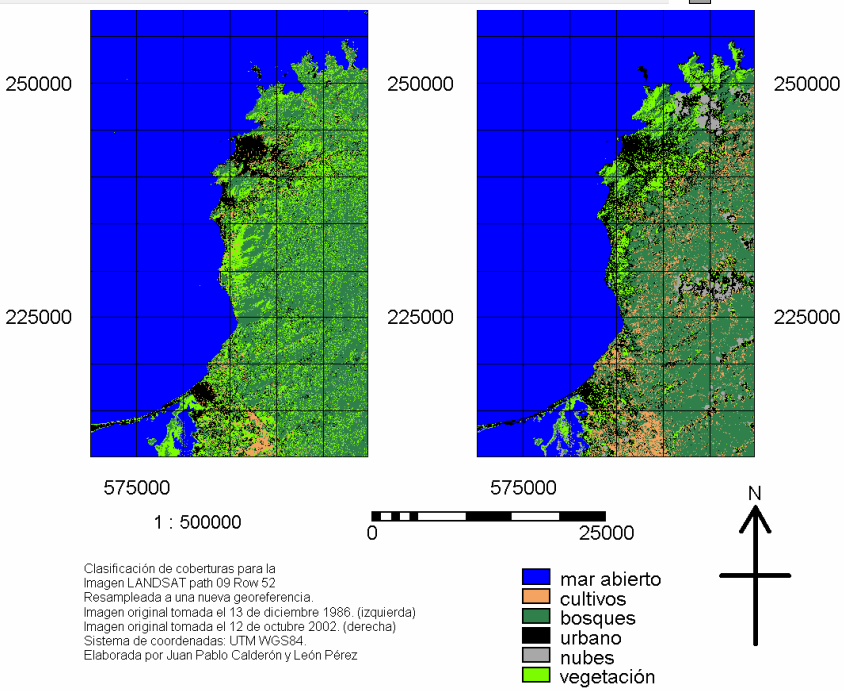


http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp

SRTM Applications in the Darien and Santa Marta regions

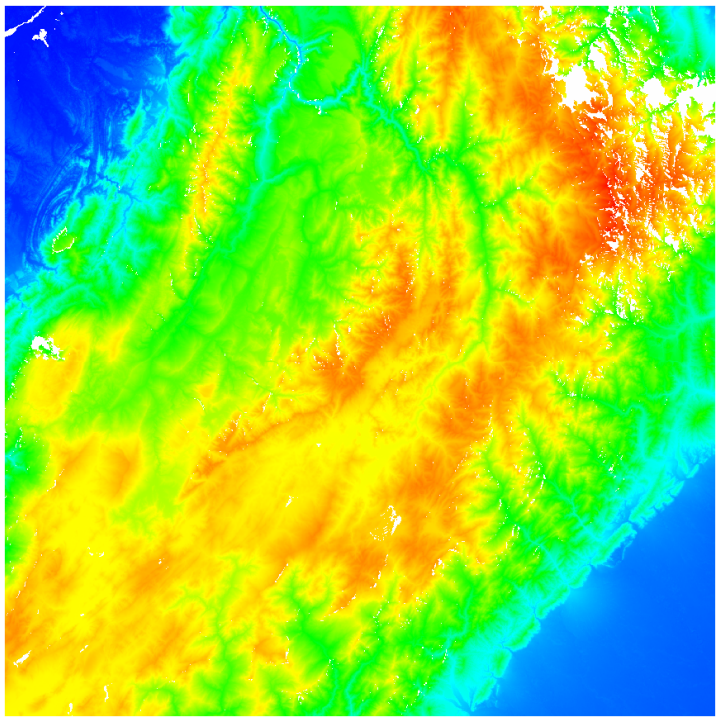




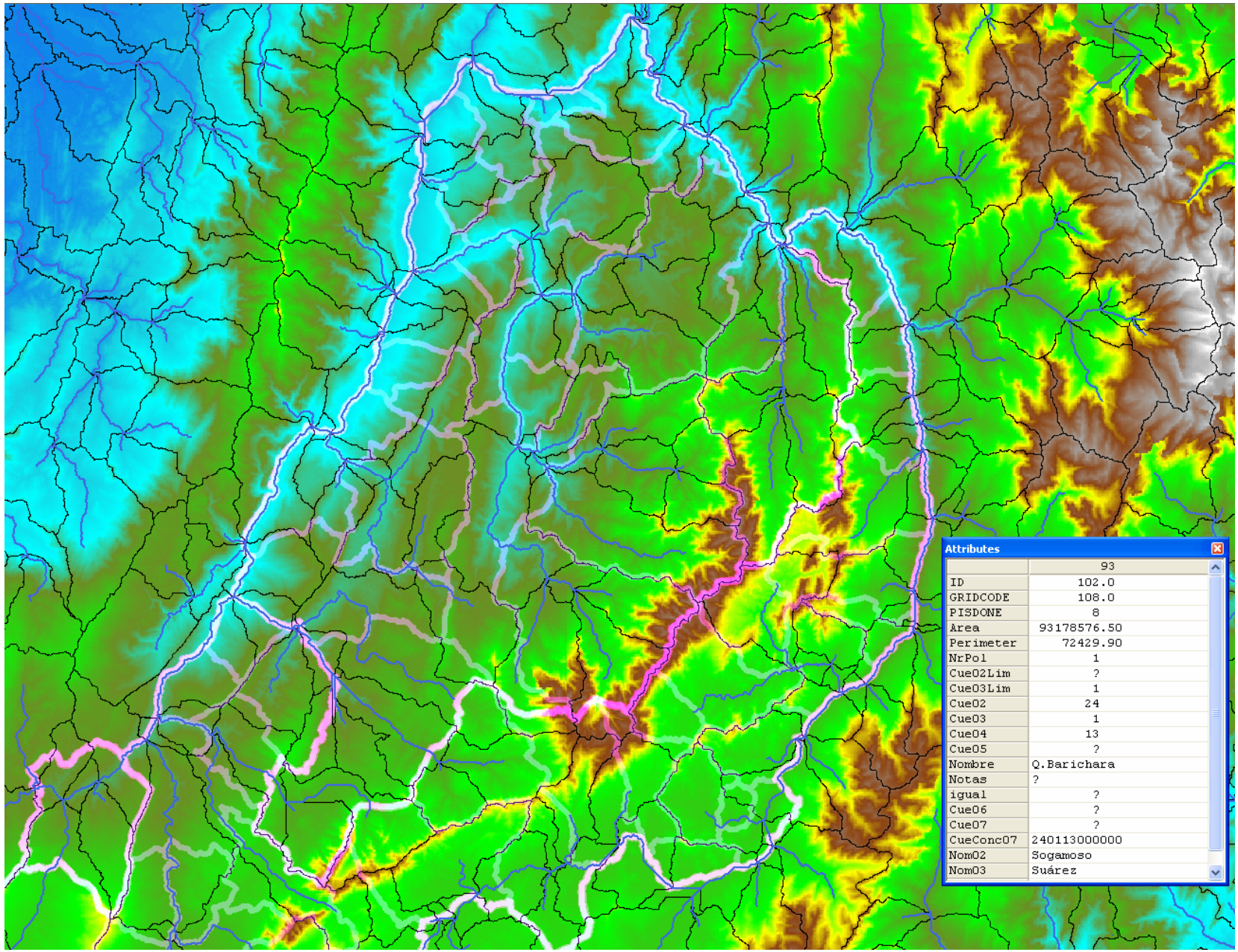


Clasificación de coberturas para la
Imagen LANDSAT path 09 Row 52
Resampleada a una nueva georeferencia.
Imagen original tomada el 13 de diciembre 1986. (izquierda)
Imagen original tomada el 12 de octubre 2002. (derecha)
Sistema de coordenadas: UTM WGS84.
Elaborada por Juan Pablo Calderón y León Pérez

SRTM Applications in the Eastern Cordillera

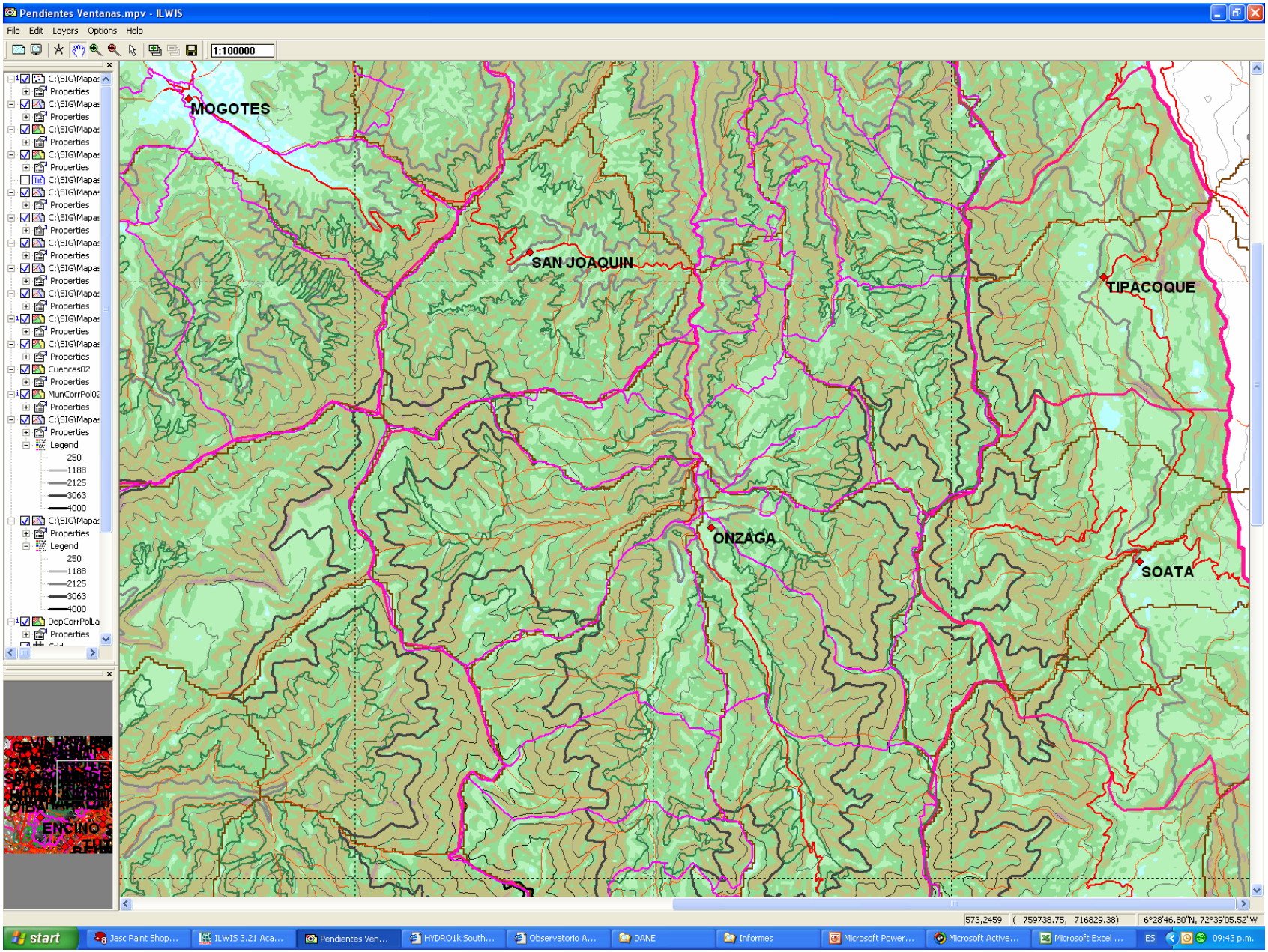


Watersheds and Rivers derived from SRTM 3 arc-second over Political Boundaries

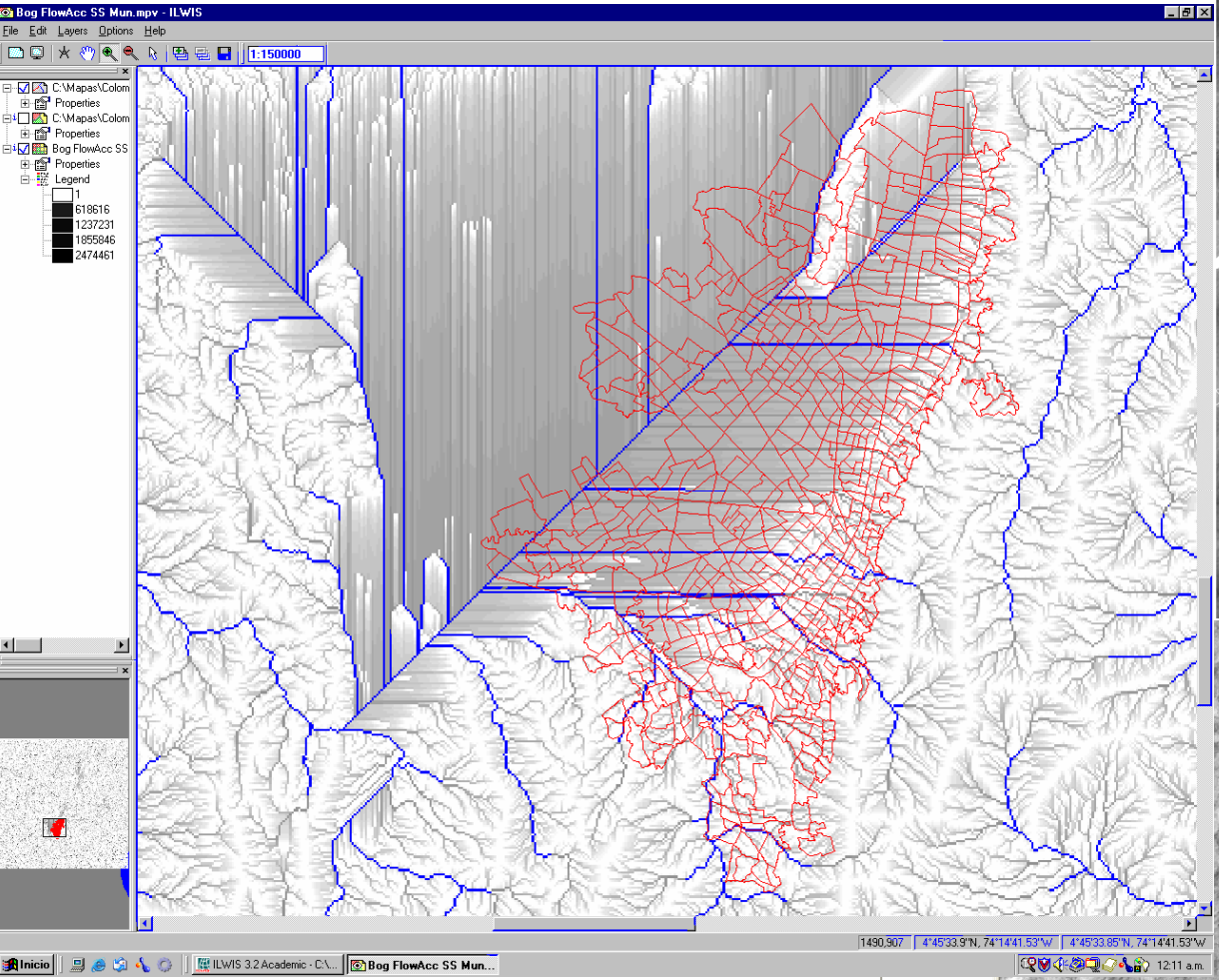


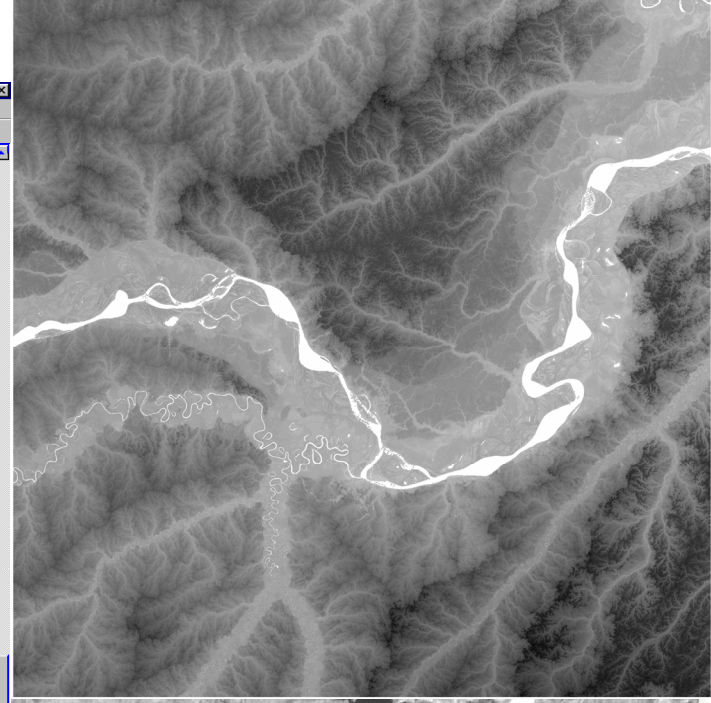
Salazar, F., Fundación Natura.

Slope Classes derived from SRTM 90 m and resampled to 30 m



Flat terrain, water bodies; Filling Voids and Sinks





SRTM 3” Hydrological Model over Bogotá’s sectors (www.dane.gov.co)

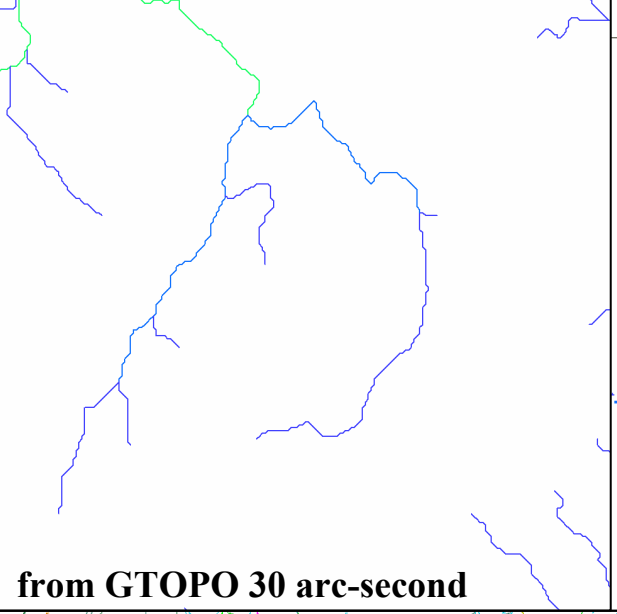
SRTM 3” of Leticia, Amazonas, SE Colombia

LANDSAT ETM+, Urrá Dam, Córdoba, NW Colombia

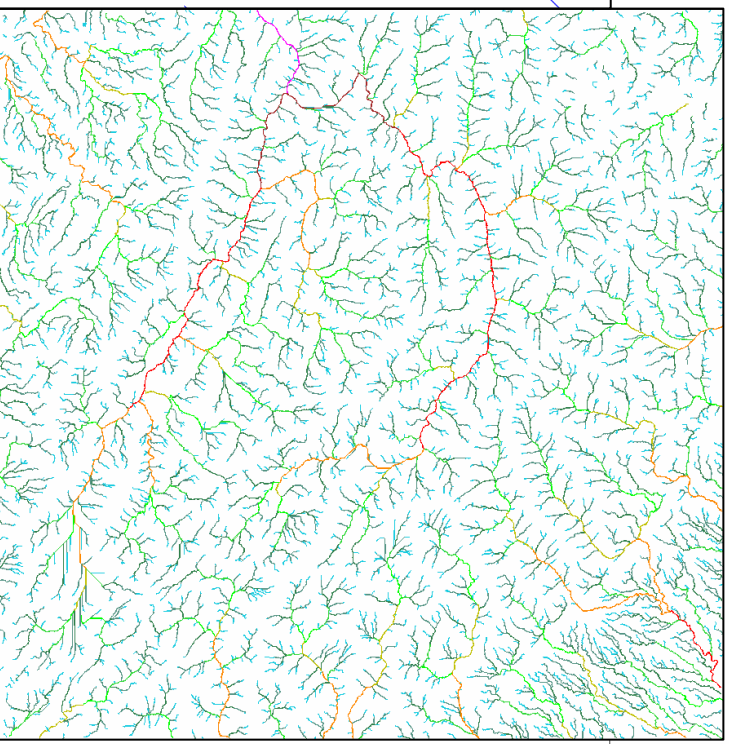
HYDRO1k *Streams data set for South America*

Land Processes Distributed Active Archive Center

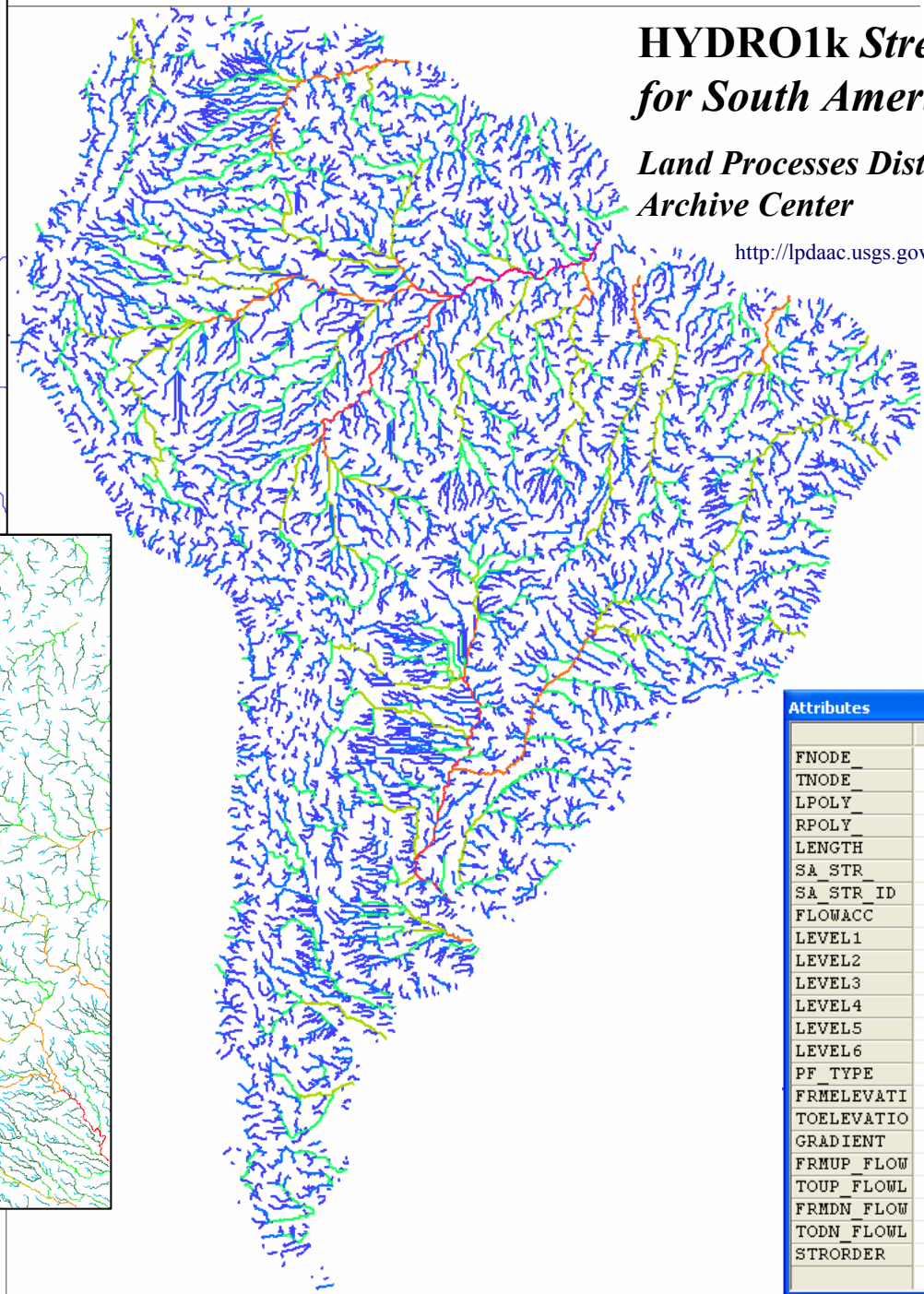
http://lpdaac.usgs.gov/gtopo30/hydro/sa_streams.asp



from GTOPO 30 arc-second



Sogamoso Drainage System derived from SRTM 3 arc-second unfinished



Attributes

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TNODE_	6927.0
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RPOLY_	0.0
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SA_STR_ID	21889.0
FLOWACC	21889.0
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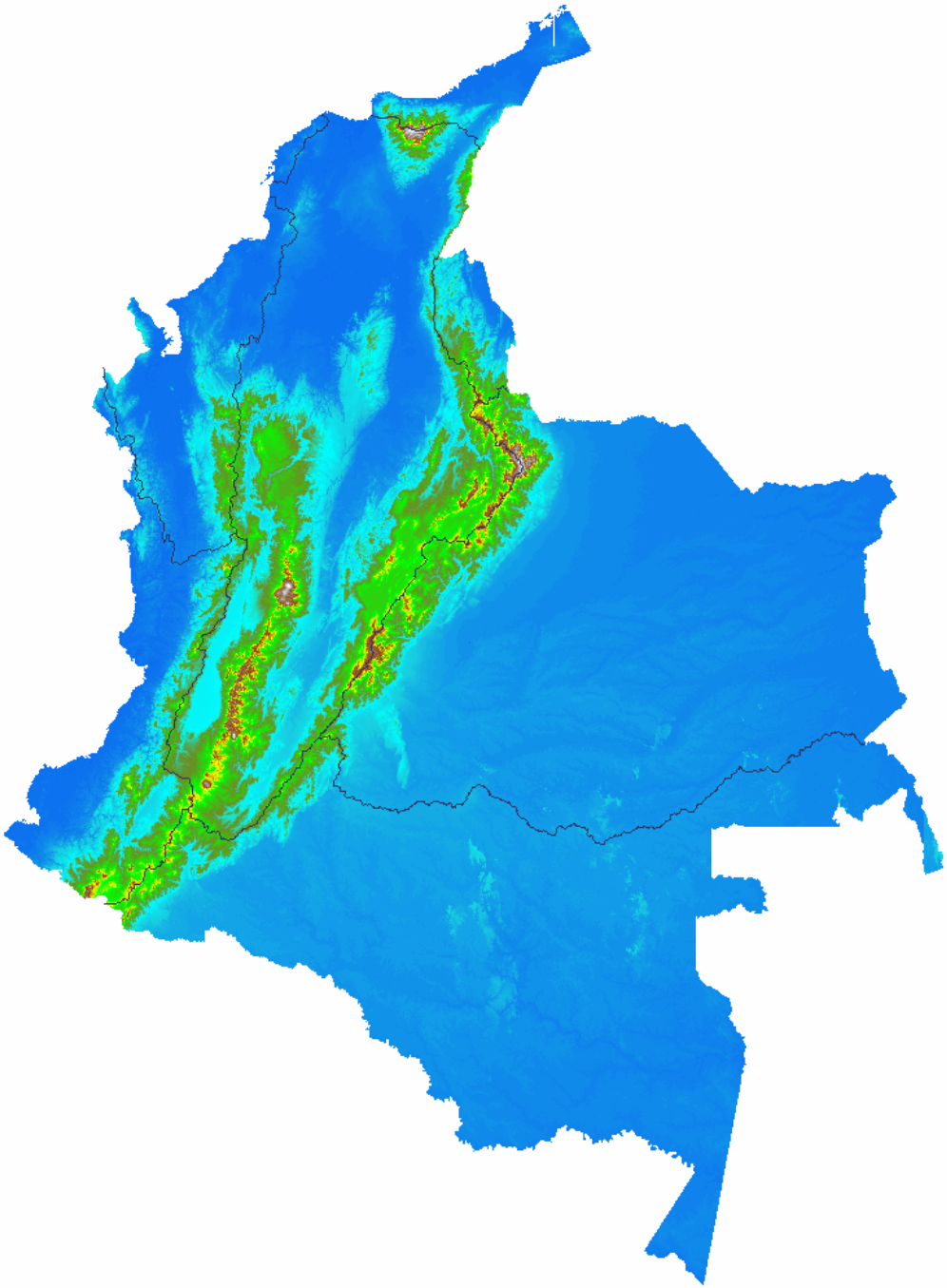
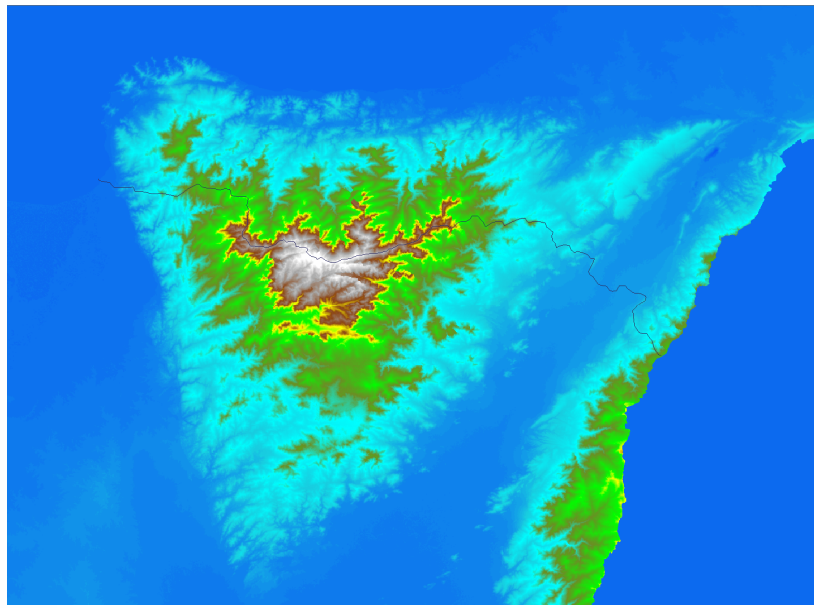
LEVEL2	18.0
LEVEL3	188.0
LEVEL4	1881.0
LEVEL5	18810.0
LEVEL6	188100.0
PF_TYPE	3
FRMELEVATI	524
TOELEVATIO	22
GRADIENT	0.0038659155
FRMUP_FLOW	282664
TOUP_FLOWL	869392
FRMDN_FLOW	726007
TODN_FLOWL	596156
STRORDER	3

SRTM 3” Mosaic

66 WRS-2 Tiles downloaded from University of Maryland’s GLCF-ESDI

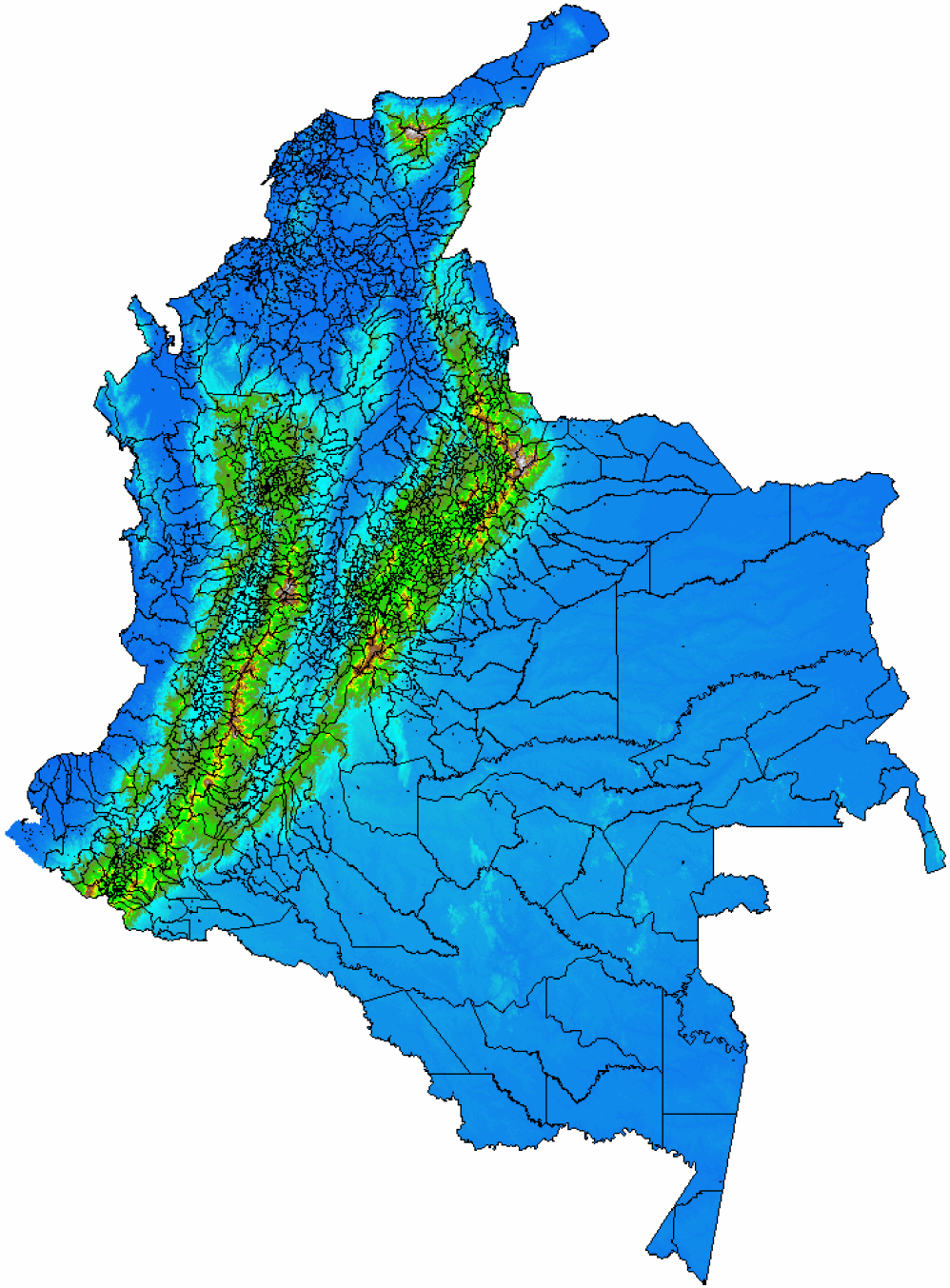
- **Voids filled with majority filter (ILWIS 3.2 Academic)**
- **Resampled to 180 m., and glued UTM 18N**





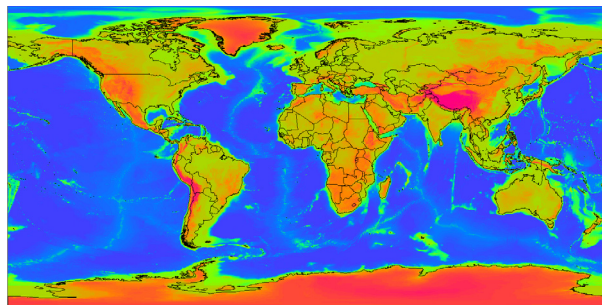
Salazar, F. and Pedraza C., 2005. Universidad de los Andes

Colombia's Regional Spatial Data Infrastructure



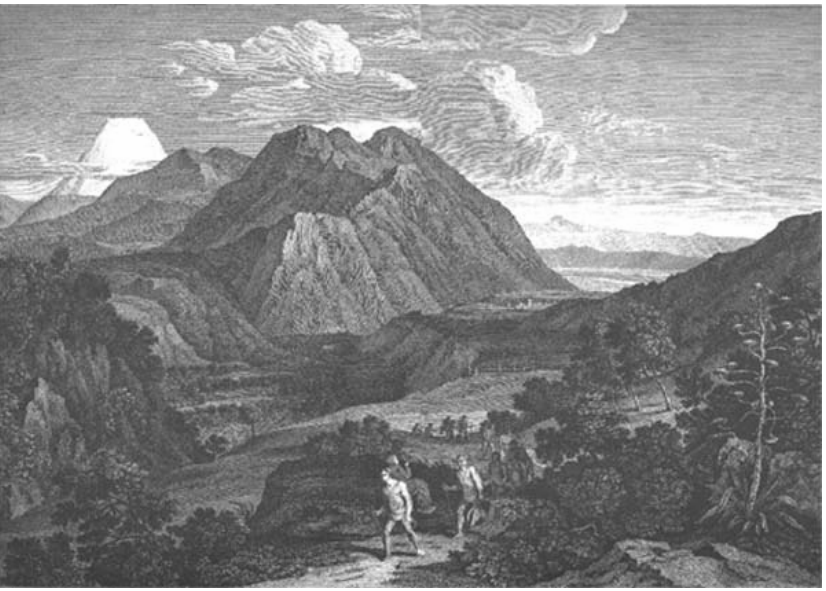
Design and build a GIS web portal that will provide the basic Spatial Data Infrastructure for research, environmental and development applications at regional, semi-detailed and detailed scales, containing progressively:

- a geographical index, or sensitive map, to cartography and remote sensing images of Colombia
- SRTM derived models: Watershed and Hydrological vector maps (shape files) and raster databases; Slope, Aspect, Hill Shading maps, etc.
- links and mirrors to related web sites offering geographical information

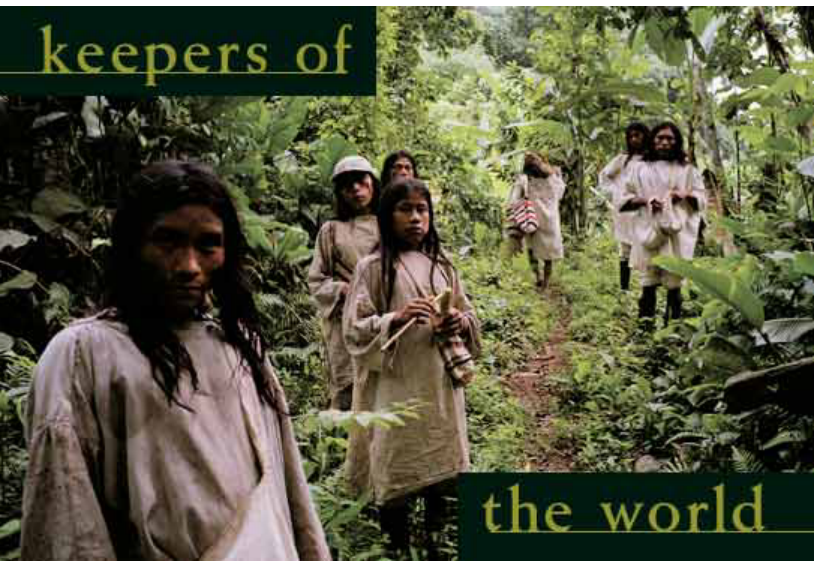


National Geophysical Data Center, TerrainBase Global DTM

Acknowledgements



Anonymous Italian engraving after Humboldt's drawing.
http://www.banrep.gov.co/blaavirtual/humboldt/vistas/quindio.htm



Stephen Ferry.
http://magma.nationalgeographic.com/ngm/0410/feature3/index.html

Campesinos and indigenous peoples of different regions of Colombia

SRTM Workshop Organizing Committee

Universidad de los Andes, Bogotá, www.uniandes.edu.co

Fundación Pro-Sierra Nevada de Santa Marta, www.prosierra.org

Fundación Natura, www.natura.org.co

Instituto Geográfico Agustín Codazzi - IGAC, www.igac.gov.co

Presidency of the Republic, www.presidencia.gov.co

The Nature Conservancy, www.nature.org

University of Maryland's Global Land Cover Facility;

PROSIS Ltda., www.procalculoprosis.com

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Salazar, Fernando et al. 1999. **Evaluación Ecológica Rápida - Definición de áreas críticas para la conservación en la Sierra Nevada de Santa Marta.** Fundación Pro-Sierra Nevada de Santa Marta, Ministerio del Medio Ambiente - Unidad Administrativa Especial del Sistema de Parques Nacionales Naturales, The Nature Conservancy - USAID, Embajada del Japón. Dirección científica y elaboración digital de los mapas. ISBN: 958-95613-6-5. Ultracolor. Bogotá,. www.prosierra.org

United States Geological Survey (USGS). 2004. **The National Map - Seamless Data Distribution System Viewer**. http://seamless.usgs.gov/index.htm

University of Maryland, Global Land Cover Facility; 2005. **Earth Science Data Interface.** Version 2.1.17. http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp

Programs Used

ILWIS 3.2 Academic, http://www.itc.nl/ilwis/default.asp; ArcView, http://www.esri.com/software/arcgis/arcview/index.html;

Global Mapper, http://www.globalmapper.com/; Microsoft Office Professional; PROMAP.